National Aeronautics and Space Administration
President's FY 2012 Budget Request Detail — Full Cost View

Budget Authority, $ in million	Actual FY2010	CR FY 2011	Auth Act FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Science	4,497.6	4,469.0	5,005.6	5,016.8	5,016.8	5,016.8	5,016.8	5,016.8
Earth Science	1,439.3		1,801.8	1,797.4	1,821.7	1,818.5	1,858.2	1,915.4
Planetary Science	1,364.4		1,485.7	1,540.7	1,429.3	1,394.7	1,344.2	1,256.8
Astrophysics	647.3		1,076.3	682.7	758.1	775.5	779.8	810.9
James Webb Space Telescope	438.7			373.7	375.0	375.0	375.0	375.0
Heliophysics	608.0		641.9	622.3	632.7	653.0	659.7	658.7
Aeronautics	497.0	501.0	579.6	569.4	569.4	569.4	569.4	569.4
Space Technology	275.2	327.2	512.0	1,024.2	1,024.2	1,024.2	1,024.2	1,024.2
Exploration	3,625.8	3,594.3	3,706.0	3,948.7	3,948.7	3,948.7	3,948.7	3,948.7
Human Exploration Capabilities	3,287.5		2,751.0	2,810.2	2,810.2	2,810.2	2,810.2	2,810.2
Commercial Spaceflight	39.1		612.0	850.0	850.0	850.0	850.0	850.0
Exploration Research and Development	299.2		343.0	288.5	288.5	288.5	288.5	288.5
Space Operations	6,141.8	6,146.8	5,508.5	4,346.9	4,346.9	4,346.9	4,346.9	4,346.9
Space Shuttle	3,101.4		1,609.7	664.9	79.7	0.8	0.8	0.9
International Space Station	2,312.7		2,779.8	2,841.5	2,960.4	3,005.4	3,098.0	3,174.8
Space and Flight Support (SFS)	727.7		1,119.0	840.6	1,306.8	1,340.7	1,248.1	1,171.2
Education	180.1	182.5	145.8	138.4	138.4	138.4	138.4	138.4
Cross-Agency Support	3,017.6	3,018.8	3,111.4	3,192.0	3,192.0	3,192.0	3,192.0	3,192.0
Center Management and Operations	2,161.2			2,402.9	2,402.9	2,402.9	2,402.9	2,402.9
Agency Management and Operations	766.2			789.1	789.1	789.1	789.1	789.1
Institutional Investments	27.2			0.0	0.0	0.0	0.0	0.0
Congressionally Directed Items	63.0			0.0	0.0	0.0	0.0	0.0
Construction and Environmental Compliance and Restoration	452.8	448.3	394.3	450.4	450.4	450.4	450.4	450.4
Construction of Facilities	389.4			397.9	384.0	359.5	362.9	360.0
Environmental Compliance and Restoration	63.4			52.5	66.4	90.9	87.5	90.4
Inspector General	36.4	36.4	37.0	37.5	37.5	37.5	37.5	37.5
NASA FY 2011	18,724.3	18,724.3	19,000.0	18,724.3	18,724.3	18,724.3	18,724.3	18,724.3

National Aeronautics and Space Administration
President's FY 2012 Budget Request Detail — Separate Labor Allocations

Budget Authority, $ in million	Actual FY2010	CR FY 2011	Auth Act FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Science	**4,497.6**	**4,469.0**	**5,005.6**	**5,016.8**	**5,016.8**	**5,016.8**	**5,016.8**	**5,016.8**
Earth Science	1,439.3		1,801.8	1,653.0	1,679.2	1,665.3	1,691.4	1,727.3
Planetary Science	1,364.4		1,485.7	1,488.9	1,365.7	1,326.4	1,271.0	1,188.9
Astrophysics	647.3		1,076.3	637.7	708.3	721.0	713.5	741.9
James Webb Space Telescope	438.7			354.6	359.3	365.3	371.6	371.6
Heliophysics	608.0		641.9	577.9	591.0	612.4	627.2	628.6
SMD Civil Service Labor and Expenses				304.7	313.2	326.5	342.2	358.6
Aeronautics	**497.0**	**501.0**	**579.6**	**569.4**	**569.4**	**569.4**	**569.4**	**569.4**
Space Technology	**275.2**	**327.2**	**512.0**	**1,024.2**	**1,024.2**	**1,024.2**	**1,024.2**	**1,024.2**
Exploration	**3,625.8**	**3,594.3**	**3,706.0**	**3,948.7**	**3,948.7**	**3,948.7**	**3,948.7**	**3,948.7**
Human Exploration Capabilities	3,287.5		2,751.0	2,605.8	2,591.2	2,581.4	2,570.4	2,560.2
Commercial Spaceflight	39.1		612.0	792.8	795.0	792.5	789.9	785.5
Exploration Research and Development	299.2		343.0	211.4	214.3	211.2	207.5	203.7
ESMD Civil Service Labor and Expenses				338.7	348.2	363.6	381.1	399.4
Space Operations	**6,141.8**	**6,146.8**	**5,508.5**	**4,346.9**	**4,346.9**	**4,346.9**	**4,346.9**	**4,346.9**
Space Shuttle	3,101.4		1,609.7	636.8	65.8	0.0	0.0	0.0
International Space Station	2,312.7		2,779.8	2,667.0	2,775.8	2,818.0	2,847.3	2,883.8
Space and Flight Support (SFS)	727.7		1,119.0	699.8	1,156.8	1,168.7	1,122.2	1,067.5
SOMD Civil Service Labor and Expenses				343.4	348.5	360.2	377.5	395.6
Education	**180.1**	**182.5**	**145.8**	**138.4**	**138.4**	**138.4**	**138.4**	**138.4**
Cross-Agency Support	**3,017.6**	**3,018.8**	**3,111.4**	**3,192.0**	**3,192.0**	**3,192.0**	**3,192.0**	**3,192.0**
Center Management and Operations	2,161.2			2,402.9	2,402.9	2,402.9	2,402.9	2,402.9
Agency Management and Operations	766.2			789.1	789.1	789.1	789.1	789.1
Institutional Investments	27.2			0.0	0.0	0.0	0.0	0.0
Congressionally Directed Items	63.0			0.0	0.0	0.0	0.0	0.0
Construction and Environmental Compliance and Restoration	**452.8**	**448.3**	**394.3**	**450.4**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	389.4			397.9	384.0	359.5	362.9	360.0
Environmental Compliance and Restoration	63.4			52.5	66.4	90.9	87.5	90.4
Inspector General	**36.4**	**36.4**	**37.0**	**37.5**	**37.5**	**37.5**	**37.5**	**37.5**
NASA FY 2011	**18,724.3**	**18,724.3**	**19,000.0**	**18,724.3**	**18,724.3**	**18,724.3**	**18,724.3**	**18,724.3**

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
President's FY 2012 Budget Request Detail — Full Cost

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Science	**$4,497.6**	**$4,469.0**	**$5,016.8**	**$5,016.8**	**$5,016.8**	**$5,016.8**	**$5,016.8**
Earth Science	**$1,439.3**		**$1,797.4**	**$1,821.7**	**$1,818.5**	**$1,858.2**	**$1,915.4**
Earth Science Research	$375.8		$450.4	$464.0	$475.3	$487.4	$499.0
Earth Science Research and Analysis	$275.7		$338.2	$349.3	$357.3	$367.4	$377.4
Computing and Management	$100.1		$112.2	$114.6	$118.0	$120.1	$121.6
Earth Systematic Missions	$705.2		$900.0	$914.6	$844.5	$855.7	$920.3
Global Precipitation Measurement (GPM)	$155.0		$98.4	$83.6	$47.5	$30.6	$21.5
Glory Mission	$31.8		$5.8	$4.3	$6.4	$5.9	$6.0
Landsat Data Continuity Mission (LDCM)	$106.0		$159.3	$67.9	$2.2	$2.2	$2.3
NPOESS Preparatory Project (NPP)	$82.1		$16.1	$7.3	$7.2	$6.9	$6.4
Ice, Cloud, and land Elevation Satellite (ICESat-II)	$38.9		$113.4	$170.8	$138.7	$90.1	$32.6
Soil Moisture Active and Passive (SMAP)	$70.0		$137.3	$172.8	$31.5	$29.7	$14.5
Other Missions and Data Analysis	$221.5		$369.6	$408.0	$611.0	$690.3	$837.1
Earth System Science Pathfinder	$128.4		$190.9	$184.0	$232.8	$241.7	$216.8
Aquarius	$22.3		$5.4	$5.1	$5.2	$5.1	$5.2
OCO-2	$62.0		$91.0	$41.0	$13.0	$4.0	$0.0
Venture Class Missions	$6.3		$62.1	$104.8	$180.6	$197.5	$175.7
Other Missions and Data Analysis	$37.9		$32.4	$33.1	$34.0	$35.1	$35.9
Earth Science Multi-Mission Operations	$149.0		$168.5	$167.5	$168.1	$172.1	$176.4
Earth Science Multi-Mission Operations	$149.0		$168.5	$167.5	$168.1	$172.1	$176.4
Earth Science Technology	$45.6		$51.2	$53.6	$58.4	$60.5	$61.7
Earth Science Technology	$45.6		$51.2	$53.6	$58.4	$60.5	$61.7
Applied Sciences	$35.3		$36.4	$38.0	$39.4	$40.7	$41.1
Pathways	$35.3		$36.4	$38.0	$39.4	$40.7	$41.1
Planetary Science	**$1,364.4**		**$1,540.7**	**$1,429.3**	**$1,394.7**	**$1,344.2**	**$1,256.8**
Planetary Science Research	$161.6		$192.1	$205.1	$218.2	$218.5	$221.3
Planetary Science Research and Analysis	$131.5		$140.9	$142.4	$147.5	$150.7	$158.2
Other Missions and Data Analysis	$21.3		$25.3	$27.2	$33.6	$30.1	$25.2
Education and Directorate Management	$3.0		$5.4	$15.0	$16.6	$17.0	$16.8
Near Earth Object Observations	$5.8		$20.4	$20.5	$20.6	$20.7	$21.1
Lunar Quest Program	$94.5		$129.6	$97.7	$54.8	$34.3	$26.2
Lunar Science	$31.4		$54.4	$50.3	$51.4	$30.7	$22.4
Lunar Atmosphere and Dust Environment Explorer	$48.2		$71.8	$44.2	$0.0	$0.0	$0.0
International Lunar Network	$14.9		$3.4	$3.3	$3.4	$3.6	$3.8
Discovery	$184.5		$179.1	$207.2	$260.4	$284.7	$258.3
Gravity Recovery and Interior Laboratory (GRAIL)	$124.1		$40.8	$4.7	$0.0	$0.0	$0.0
Other Missions and Data Analysis	$60.4		$138.3	$202.5	$260.4	$284.7	$258.3
New Frontiers	$279.6		$181.8	$273.2	$257.2	$305.9	$315.7
Juno	$257.1		$31.4	$17.8	$18.1	$16.8	$29.9
Other Missions and Data Analysis	$22.4		$150.4	$255.4	$239.1	$289.0	$285.8
Mars Exploration	$438.2		$602.2	$441.4	$414.0	$311.9	$247.2
2009 Mars Science Lab	$258.4		$138.0	$42.0	$38.5	$0.0	$0.0
MAVEN	$48.1		$245.7	$146.4	$37.6	$17.3	$5.3

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Planetary Science (continued)							
Other Missions and Data Analysis	$131.7		$218.6	$253.0	$337.9	$294.6	$241.9
Outer Planets	$100.6		$122.1	$88.7	$91.8	$91.6	$89.9
Outer Planets	$100.6		$122.1	$88.7	$91.8	$91.6	$89.9
Technology	$105.5		$133.9	$115.9	$98.4	$97.2	$98.3
Technology	$105.5		$133.9	$115.9	$98.4	$97.2	$98.3
Astrophysics	**$647.3**		**$682.7**	**$758.1**	**$775.5**	**$779.8**	**$810.9**
Astrophysics Research	$149.1		$168.7	$208.0	$220.3	$238.3	$248.4
Astrophysics Research and Analysis	$59.6		$67.6	$86.4	$87.8	$89.3	$92.7
Balloon Project	$28.2		$32.1	$35.7	$36.6	$37.3	$38.7
Other Missions and Data Analysis	$61.3		$69.1	$86.0	$95.9	$111.7	$117.0
Cosmic Origins	$225.3		$239.7	$244.5	$233.3	$216.1	$206.3
Hubble Space Telescope (HST)	$100.8		$98.3	$98.0	$98.0	$94.0	$90.0
Stratospheric Observatory for Infrared Astronomy (SOFIA)	$73.6		$84.2	$85.5	$88.0	$88.0	$86.0
Other Missions And Data Analysis	$50.9		$57.2	$61.0	$47.3	$34.1	$30.3
Physics of the Cosmos	$116.0		$106.0	$118.4	$122.0	$115.7	$121.8
Other Missions and Data Analysis	$116.0		$106.0	$118.4	$122.0	$115.7	$121.8
Exoplanet Exploration	$43.4		$50.0	$67.0	$63.8	$62.1	$69.8
Other Missions and Data Analysis	$43.4		$50.0	$67.0	$63.8	$62.1	$69.8
Astrophysics Explorer	$113.5		$118.3	$120.2	$136.1	$147.5	$164.5
Nuclear Spectroscopic Telescope Array (NuStar)	$56.2		$11.9	$4.2	$1.2	$0.0	$0.0
Gravity and Extreme Magnetism	$3.1		$74.1	$44.5	$23.1	$2.0	$0.0
Other Missions and Data Analysis	$54.2		$32.4	$71.5	$111.8	$145.5	$164.5
James Webb Space Telescope	**$438.7**		**$373.7**	**$375.0**	**$375.0**	**$375.0**	**$375.0**
James Webb Space Telescope	$438.7		$373.7	$375.0	$375.0	$375.0	$375.0
James Webb Space Telescope	$438.7		$373.7	$375.0	$375.0	$375.0	$375.0
Heliophysics	**$608.0**		**$622.3**	**$632.7**	**$653.0**	**$659.7**	**$658.7**
Heliophysics Research	$171.8		$159.2	$162.9	$165.7	$167.0	$169.5
Heliophysics Research and Analysis	$30.4		$31.1	$32.9	$33.8	$34.6	$35.0
Sounding Rockets	$48.7		$49.7	$51.0	$52.0	$52.7	$53.5
Research Range	$18.9		$20.3	$20.7	$21.2	$21.5	$21.8
Other Missions and Data Analysis	$73.8		$58.0	$58.3	$58.7	$58.3	$59.2
Living with a Star	$221.9		$211.0	$208.7	$207.5	$342.7	$360.0
Radiation Belt Storm Probes (RBSP)	$121.0		$92.2	$30.2	$22.0	$9.1	$0.0
Solar Probe Plus	$40.0		$52.7	$104.0	$104.1	$147.8	$233.7
Other Missions and Data Analysis	$60.9		$66.2	$74.5	$81.5	$185.8	$126.3
Solar Terrestrial Probes	$148.0		$182.2	$186.5	$185.8	$55.1	$40.7
Magnetospheric Multiscale (MMS)	$130.1		$164.3	$168.3	$166.0	$34.5	$20.4
Other Missions and Data Analysis	$17.9		$18.0	$18.1	$19.7	$20.6	$20.3
Heliophysics Explorer Program	$65.1		$69.8	$74.7	$94.0	$94.8	$88.4
IRIS	$41.1		$39.1	$12.1	$7.3	$1.2	$0.0
Other Missions and Data Analysis	$24.0		$30.7	$62.6	$86.7	$93.6	$88.4
New Millennium	$1.2		$0.0	$0.0	$0.0	$0.0	$0.0
New Millennium	$1.2		$0.0	$0.0	$0.0	$0.0	$0.0

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
President's FY 2012 Budget Request Detail — Full Cost

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Aeronautics	**$497.0**	**$501.0**	**$569.4**	**$569.4**	**$569.4**	**$569.4**	**$569.4**
Aeronautics	**$497.0**		**$569.4**	**$569.4**	**$569.4**	**$569.4**	**$569.4**
Aviation Safety	$74.0		$79.6	$79.8	$80.0	$80.3	$80.6
Aviation Safety	$74.0		$79.6	$79.8	$80.0	$80.3	$80.6
Airspace Systems	$79.0		$92.7	$92.3	$91.7	$90.9	$90.1
Airspace Systems	$79.0		$92.7	$92.3	$91.7	$90.9	$90.1
Fundamental Aeronautics	$199.0		$186.3	$187.3	$189.0	$190.9	$193.0
Fundamental Aeronautics	$199.0		$186.3	$187.3	$189.0	$190.9	$193.0
Aeronautics Test	$65.6		$79.4	$79.4	$79.5	$79.6	$79.7
Aeronautics Test	$65.6		$79.4	$79.4	$79.5	$79.6	$79.7
Integrated Systems Research	$56.9		$104.2	$103.7	$102.7	$101.7	$100.6
Environmentally Responsible Aviation	$56.9		$73.6	$72.6	$71.3	$70.2	$68.0
UAS Integration in the NAS	$0.0		$30.6	$31.0	$31.4	$31.5	$32.6
Aeronautics Strategy and Management	$22.6		$27.2	$26.9	$26.5	$26.0	$25.4
Aeronautics Strategy and Management	$22.6		$27.2	$26.9	$26.5	$26.0	$25.4
Space Technology	**$275.2**	**$327.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**
Space Technology	**$275.2**		**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**
SBIR and STTR	$96.0		$184.1	$184.1	$184.1	$184.1	$184.1
SBIR and STTR	$96.0		$184.1	$184.1	$184.1	$184.1	$184.1
Partnerships Dev & Strategic Integration	$20.3		$33.0	$33.0	$33.0	$33.0	$33.0
Partnership Development and Strategic Integration	$20.3		$33.0	$33.0	$33.0	$33.0	$33.0
Crosscutting Space Tech Development	$7.5		$497.1	$497.1	$497.1	$497.1	$497.1
Crosscutting Space Tech Development	$7.5		$497.1	$497.1	$497.1	$497.1	$497.1
Exploration Technology Development	$151.4		$310.0	$310.0	$310.0	$310.0	$310.0
Exploration Technology Development	$151.4		$310.0	$310.0	$310.0	$310.0	$310.0
Exploration	**$3,625.8**	**$3,594.3**	**$3,948.7**	**$3,948.7**	**$3,948.7**	**$3,948.7**	**$3,948.7**
Human Exploration Capabilities	**$3,287.5**		**$2,810.2**	**$2,810.2**	**$2,810.2**	**$2,810.2**	**$2,810.2**
Multi Purpose Crew Vehicle (MPCV)			$1,010.2				
Multi Purpose Crew Vehicle (MPCV)			$1,010.2				
Space Launch Systems (SLS)			$1,800.0				
Space Launch System (SLS)			$1,800.0				
Commercial Spaceflight	**$39.1**		**$850.0**	**$850.0**	**$850.0**	**$850.0**	**$850.0**
Commercial Cargo	$39.1		$0.0	$0.0	$0.0	$0.0	$0.0
Commercial Orbital Transportation Services	$39.1		$0.0	$0.0	$0.0	$0.0	$0.0
Commercial Crew	$0.0		$850.0	$850.0	$850.0	$850.0	$850.0
Commercial Crew	$0.0		$850.0	$850.0	$850.0	$850.0	$850.0
Exploration Research and Development	**$299.2**		**$288.5**	**$288.5**	**$288.5**	**$288.5**	**$288.5**
Human Research Program	$146.3		$164.1	$164.1	$164.1	$164.1	$164.1
Human Research Program	$146.3		$164.1	$164.1	$164.1	$164.1	$164.1
Advanced Explorations Systems	$152.9		$124.4	$124.4	$124.4	$124.4	$124.4
Advanced Explorations Systems	$152.9		$124.4	$124.4	$124.4	$124.4	$124.4

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Space Operations	**$6,141.8**	**$6,146.8**	**$4,346.9**	**$4,346.9**	**$4,346.9**	**$4,346.9**	**$4,346.9**
Space Shuttle	**$3,101.4**		**$664.9**	**$79.7**	**$0.8**	**$0.8**	**$0.9**
Space Shuttle Program	$3,101.4		$664.9	$79.7	$0.8	$0.8	$0.9
SPOC Pension Liability	$0.0		$547.9	$0.0	$0.0	$0.0	$0.0
Program Integration	$627.2		$38.8	$28.3	$0.0	$0.0	$0.0
Flight and Ground Operations	$1,115.4		$40.6	$23.1	$0.0	$0.0	$0.0
Flight Hardware	$1,358.8		$37.6	$28.3	$0.8	$0.8	$0.9
International Space Station	**$2,312.7**		**$2,841.5**	**$2,960.4**	**$3,005.4**	**$3,098.0**	**$3,174.8**
International Space Station Program	$2,312.7		$2,841.5	$2,960.4	$3,005.4	$3,098.0	$3,174.8
ISS Systems Operations and Maintenance	$1,555.2		$1,434.6	$1,576.1	$1,538.1	$1,665.3	$1,782.8
ISS Research	$129.5		$221.1	$210.7	$213.2	$221.1	$223.5
ISS Crew and Cargo Transportation	$628.0		$1,185.7	$1,173.6	$1,254.1	$1,211.6	$1,168.5
Space and Flight Support (SFS)	**$727.7**		**$840.6**	**$1,306.8**	**$1,340.7**	**$1,248.1**	**$1,171.2**
21st Century Space Launch Complex	$0.0		$168.0	$175.3	$168.1	$54.8	$42.9
21st Century Space Launch Complex	$0.0		$168.0	$175.3	$168.1	$54.8	$42.9
Space Communications and Navigation	$482.3		$436.0	$477.5	$484.5	$483.6	$481.9
Space Communications Networks	$363.3		$364.5	$398.2	$417.9	$425.2	$423.2
Space Communications Support	$93.5		$66.3	$65.7	$66.6	$58.4	$58.7
TDRS Replenishment	$25.4		$5.1	$13.7	$0.0	$0.0	$0.0
Human Space Flight Operations	$104.0		$111.4	$112.5	$112.6	$115.8	$116.4
Human Space Flight Operations	$104.0		$111.4	$112.5	$112.6	$115.8	$116.4
Mission Operations Sustainment	$0.0		$0.0	$415.2	$443.8	$459.1	$391.4
Mission Operations Sustainment	$0.0		$0.0	$415.2	$443.8	$459.1	$391.4
Launch Services	$89.4		$81.3	$80.3	$84.6	$87.0	$90.4
Launch Services	$89.4		$81.3	$80.3	$84.6	$87.0	$90.4
Rocket Propulsion Test	$43.3		$43.9	$46.0	$47.1	$47.8	$48.2
Rocket Propulsion Testing	$43.3		$43.9	$46.0	$47.1	$47.8	$48.2
Crew Health & Safety	$8.8		$0.0	$0.0	$0.0	$0.0	$0.0
Crew Health and Safety	$8.8		$0.0	$0.0	$0.0	$0.0	$0.0
Education	**$180.1**	**$182.5**	**$138.4**	**$138.4**	**$138.4**	**$138.4**	**$138.4**
Education	**$180.1**		**$138.4**	**$138.4**	**$138.4**	**$138.4**	**$138.4**
Aerospace Rsch. and Career Development	$70.6		$35.9	$35.6	$35.6	$35.6	$35.6
NASA Space Grant	$45.6		$26.7	$26.5	$26.5	$26.5	$26.5
Experimental Program to Stimulate Competetive Research	$25.0		$9.2	$9.1	$9.1	$9.1	$9.1
STEM Education and Accountability	$0.0		$102.5	$102.8	$102.8	$102.8	$102.8
Minority University Research Education Program	$0.0		$31.4	$28.0	$28.0	$28.0	$28.0
STEM Education and Accountability Projects	$0.0		$71.1	$74.8	$74.8	$74.8	$74.8
Higher Ed. STEM Education	$49.0		$0.0	$0.0	$0.0	$0.0	$0.0
STEM Opportunities (Higher Education)	$8.4		$0.0	$0.0	$0.0	$0.0	$0.0
Minority University Research & Education Program	$30.6		$0.0	$0.0	$0.0	$0.0	$0.0

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Education (continued)							
Global Climate Change Education	$10.0		$0.0	$0.0	$0.0	$0.0	$0.0
K-12 STEM Education	$45.0		$0.0	$0.0	$0.0	$0.0	$0.0
STEM Student Opportunities (K-12)	$15.5		$0.0	$0.0	$0.0	$0.0	$0.0
STEM Teacher Development (K-12)	$16.0		$0.0	$0.0	$0.0	$0.0	$0.0
K-12 Competitive Educational Grant Program	$13.5		$0.0	$0.0	$0.0	$0.0	$0.0
Informal STEM Education	$15.5		$0.0	$0.0	$0.0	$0.0	$0.0
Science Museums and Planetarium Grants	$7.0		$0.0	$0.0	$0.0	$0.0	$0.0
NASA Visitor Centers	$7.0		$0.0	$0.0	$0.0	$0.0	$0.0
NASA Informal Education Opportunities	$1.5		$0.0	$0.0	$0.0	$0.0	$0.0
Cross-Agency Support	**$3,017.6**	**$3,018.8**	**$3,192.0**	**$3,192.0**	**$3,192.0**	**$3,192.0**	**$3,192.0**
Center Management and Operations	**$2,161.2**		**$2,402.9**	**$2,402.9**	**$2,402.9**	**$2,402.9**	**$2,402.9**
Center Management and Operations	$2,161.2		$2,367.7	$2,367.7	$2,367.7	$2,367.7	$2,367.7
Center Institutional Capabilities	$1,678.3		$1,766.3	$1,766.3	$1,766.3	$1,766.3	$1,766.3
Center Programmatic Capabilities	$482.9		$601.4	$601.4	$601.4	$601.4	$601.4
CMO Civil Service Labor and Expenses	$0.0		$35.2	$35.2	$35.2	$35.2	$35.2
Center-wide Training and Other Personnel Cost	$0.0		$35.2	$35.2	$35.2	$35.2	$35.2
Agency Management and Operations	**$766.2**		**$789.1**	**$789.1**	**$789.1**	**$789.1**	**$789.1**
Agency Management	$395.5		$397.5	$397.5	$397.5	$397.5	$397.5
Agency Management	$395.5		$397.5	$397.5	$397.5	$397.5	$397.5
Safety and Mission Success	$196.0		$192.9	$192.9	$192.9	$192.9	$192.9
Safety and Mission Assurance	$51.3		$50.3	$50.3	$50.3	$50.3	$50.3
Chief Engineer	$101.1		$106.5	$106.5	$106.5	$106.5	$106.5
Chief Health and Medical Officer	$3.6		$4.1	$4.1	$4.1	$4.1	$4.1
Independent Verification and Validation	$40.0		$32.0	$32.0	$32.0	$32.0	$32.0
Agency IT Services (AITS)	$145.3		$150.2	$150.2	$150.2	$150.2	$150.2
IT Management	$15.0		$13.6	$13.6	$13.6	$13.6	$13.6
Applications	$75.4		$67.2	$67.2	$67.2	$67.2	$67.2
Infrastructure	$54.9		$69.5	$69.5	$69.5	$69.5	$69.5
Strategic Capabilities Assets Program	$29.4		$29.7	$29.7	$29.7	$29.7	$29.7
Strategic Capabilities Assets Program	$29.4		$29.7	$29.7	$29.7	$29.7	$29.7
AMO Civil Service Labor and Expenses	$0.0		$18.7	$18.7	$18.7	$18.7	$18.7
Agency/HQ Training and Other Personnel Cost	$0.0		$18.7	$18.7	$18.7	$18.7	$18.7
Institutional Investments	**$27.2**		**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
Institutional Construction of Facilities	$23.4		$0.0	$0.0	$0.0	$0.0	$0.0
Institutional Construction Of Facilities	$23.4		$0.0	$0.0	$0.0	$0.0	$0.0
Environmental Compliance and Restoration	$3.8		$0.0	$0.0	$0.0	$0.0	$0.0
Environmental Compliance and Restoration	$3.8		$0.0	$0.0	$0.0	$0.0	$0.0
Congressionally Directed Items	**$63.0**		**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
Congressionally Directed Items	$63.0		$0.0	$0.0	$0.0	$0.0	$0.0
Congressionally Directed Items	$63.0		$0.0	$0.0	$0.0	$0.0	$0.0

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Construction and Environmental Compliance	**$452.8**	**$448.3**	**$450.4**	**$450.4**	**$450.4**	**$450.4**	**$450.4**
Construction of Facilities	**$389.4**		**$397.9**	**$384.0**	**$359.5**	**$362.9**	**$360.0**
Institutional CoF	$249.3		$368.0	$384.0	$359.5	$362.9	$360.0
Institutional CoF	$249.3		$368.0	$384.0	$359.5	$362.9	$360.0
Science CoF	$37.8		$1.0	$0.0	$0.0	$0.0	$0.0
Science CoF	$37.8		$1.0	$0.0	$0.0	$0.0	$0.0
Exploration CoF	$72.6		$0.0	$0.0	$0.0	$0.0	$0.0
Exploration CoF	$72.6		$0.0	$0.0	$0.0	$0.0	$0.0
Space Operations CoF	$26.9		$28.9	$0.0	$0.0	$0.0	$0.0
Space Operations CoF	$26.9		$28.9	$0.0	$0.0	$0.0	$0.0
Aeronautics CoF	$2.8		$0.0	$0.0	$0.0	$0.0	$0.0
Aeronautics CoF	$2.8		$0.0	$0.0	$0.0	$0.0	$0.0
Environmental Compliance and Restoration	**$63.4**		**$52.5**	**$66.4**	**$90.9**	**$87.5**	**$90.4**
Environmental Compliance and Restoration	$63.4		$52.5	$66.4	$90.9	$87.5	$90.4
Environmental Compliance and Restoration	$63.4		$52.5	$66.4	$90.9	$87.5	$90.4
Inspector General	**$36.4**	**$36.4**	**$37.5**	**$37.5**	**$37.5**	**$37.5**	**$37.5**
Inspector General	**$36.4**	**$36.4**	**$37.5**	**$37.5**	**$37.5**	**$37.5**	**$37.5**
IG Program	$36.4	$36.4	$37.5	$37.5	$37.5	$37.5	$37.5
Inspector General	$36.4	$36.4	$37.5	$37.5	$37.5	$37.5	$37.5
NASA FY 2012	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Science	**$4,497.6**	**$4,469.0**	**$5,016.8**	**$5,016.8**	**$5,016.8**	**$5,016.8**	**$5,016.8**
Earth Science	**$1,439.3**		**$1,653.0**	**$1,679.2**	**$1,665.3**	**$1,691.4**	**$1,727.3**
Earth Science Research	$375.8		$409.6	$419.0	$427.3	$436.7	$444.6
Earth Science Research and Analysis	$275.7		$304.0	$311.1	$316.6	$324.2	$330.9
Computing and Management	$100.1		$105.7	$107.8	$110.8	$112.5	$113.7
Earth Systematic Missions	$705.2		$816.5	$838.7	$761.6	$763.2	$810.7
Global Precipitation Measurement (GPM)	$155.0		$83.8	$68.7	$41.4	$27.2	$20.1
Glory Mission	$31.8		$5.3	$3.8	$6.1	$5.9	$6.0
Landsat Data Continuity Mission (LDCM)	$106.0		$152.0	$64.1	$1.5	$1.5	$1.6
NPOESS Preparatory Project (NPP)	$82.1		$13.6	$6.4	$6.3	$6.0	$5.5
Ice, Cloud, and land Elevation Satellite (ICESat-II)	$38.9		$102.1	$159.4	$128.8	$83.1	$28.6
Soil Moisture Active and Passive (SMAP)	$70.0		$135.2	$172.3	$31.1	$29.6	$14.5
Other Missions and Data Analysis	$221.5		$324.6	$364.0	$546.4	$609.9	$734.5
Earth System Science Pathfinder	$128.4		$187.8	$180.6	$229.5	$238.4	$214.3
Aquarius	$22.3		$4.9	$4.6	$4.9	$5.1	$5.2
OCO-2	$62.0		$91.0	$41.0	$13.0	$4.0	$0.0
Venture Class Missions	$6.3		$61.5	$103.9	$179.7	$196.6	$175.7
Other Missions and Data Analysis	$37.9		$30.5	$31.1	$31.9	$32.7	$33.4
Earth Science Multi-Mission Operations	$149.0		$159.9	$158.8	$159.4	$162.9	$166.6
Earth Science Multi-Mission Operations	$149.0		$159.9	$158.8	$159.4	$162.9	$166.6
Earth Science Technology	$45.6		$46.1	$47.9	$51.9	$53.6	$54.2
Earth Science Technology	$45.6		$46.1	$47.9	$51.9	$53.6	$54.2
Applied Sciences	$35.3		$33.1	$34.3	$35.5	$36.7	$36.9
Pathways	$35.3		$33.1	$34.3	$35.5	$36.7	$36.9
Planetary Science	**$1,364.4**		**$1,488.9**	**$1,365.7**	**$1,326.4**	**$1,271.0**	**$1,188.9**
Planetary Science Research	$161.6		$183.9	$196.0	$208.6	$208.4	$210.5
Planetary Science Research and Analysis	$131.5		$134.6	$135.3	$140.0	$142.8	$149.8
Other Missions and Data Analysis	$21.3		$23.7	$25.5	$31.7	$28.2	$23.0
Education and Directorate Management	$3.0		$5.1	$14.7	$16.3	$16.7	$16.5
Near Earth Object Observations	$5.8		$20.4	$20.5	$20.6	$20.7	$21.1
Lunar Quest Program	$94.5		$114.5	$81.2	$48.9	$28.1	$19.5
Lunar Science	$31.4		$50.9	$48.1	$48.9	$28.1	$19.5
Lunar Atmosphere and Dust Environment Explorer	$48.2		$63.2	$33.1	$0.0	$0.0	$0.0
International Lunar Network	$14.9		$0.3	$0.0	$0.0	$0.0	$0.0
Discovery	$184.5		$175.6	$205.1	$245.7	$265.5	$242.8
Gravity Recovery and Interior Laboratory (GRAIL)	$124.1		$40.5	$4.4	$0.0	$0.0	$0.0
Other Missions and Data Analysis	$60.4		$135.1	$200.6	$245.7	$265.5	$242.8
New Frontiers	$279.6		$176.9	$265.8	$245.5	$291.1	$296.3
Juno	$257.1		$31.2	$17.6	$17.9	$16.7	$29.6
Other Missions and Data Analysis							

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Planetary Science (continued)							
Mars Exploration	$438.2		$594.4	$433.1	$408.7	$309.0	$245.9
2009 Mars Science Lab	$258.4		$136.4	$40.5	$37.0	$0.0	$0.0
MAVEN	$48.1		$240.3	$140.6	$34.9	$15.4	$4.7
Other Missions and Data Analysis	$131.7		$217.7	$252.0	$336.8	$293.5	$241.1
Outer Planets	$100.6		$120.8	$80.5	$82.2	$84.1	$88.5
Outer Planets	$100.6		$120.8	$80.5	$82.2	$84.1	$88.5
Technology	$105.5		$122.9	$104.1	$86.6	$84.9	$85.4
Technology	$105.5		$122.9	$104.1	$86.6	$84.9	$85.4
Astrophysics	**$647.3**		**$637.7**	**$708.3**	**$721.0**	**$713.5**	**$741.9**
Astrophysics Research	$149.1		$161.6	$200.1	$211.8	$229.3	$238.6
Astrophysics Research and Analysis	$59.6		$64.3	$82.8	$83.9	$85.1	$88.0
Balloon Project	$28.2		$29.3	$32.8	$33.6	$34.1	$35.3
Other Missions and Data Analysis	$61.3		$67.9	$84.5	$94.3	$110.1	$115.4
Cosmic Origins	$225.3		$219.7	$219.4	$209.9	$195.2	$184.5
Hubble Space Telescope (HST)	$100.8		$94.0	$93.4	$93.1	$88.8	$84.5
Stratospheric Observatory for Infrared Astronomy (SOFIA)	$73.6		$71.4	$73.3	$77.2	$77.4	$75.0
Other Missions And Data Analysis	$50.9		$54.4	$52.7	$39.6	$28.9	$25.0
Physics of the Cosmos	$116.0		$100.3	$112.4	$111.9	$98.1	$96.8
Other Missions and Data Analysis	$116.0		$100.3	$112.4	$111.9	$98.1	$96.8
Exoplanet Exploration	$43.4		$48.2	$65.5	$63.6	$62.1	$69.8
Other Missions and Data Analysis	$43.4		$48.2	$65.5	$63.6	$62.1	$69.8
Astrophysics Explorer	$113.5		$107.8	$110.9	$123.7	$128.7	$152.0
Nuclear Spectroscopic Telescope Array (NuStar)	$56.2		$11.4	$4.0	$1.1	$0.0	$0.0
Gravity and Extreme Magnetism	$3.1		$69.4	$41.0	$20.8	$1.4	$0.0
Other Missions and Data Analysis	$54.2		$27.0	$65.9	$101.8	$127.3	$152.0
James Webb Space Telescope	**$438.7**		**$354.6**	**$359.3**	**$365.3**	**$371.6**	**$371.6**
James Webb Space Telescope	$438.7		$354.6	$359.3	$365.3	$371.6	$371.6
James Webb Space Telescope	$438.7		$354.6	$359.3	$365.3	$371.6	$371.6
Heliophysics	**$608.0**		**$577.9**	**$591.0**	**$612.4**	**$627.2**	**$628.6**
Heliophysics Research	$171.8		$144.5	$147.5	$149.3	$149.5	$150.8
Heliophysics Research and Analysis	$30.4		$30.0	$31.6	$32.3	$32.7	$33.0
Sounding Rockets	$48.7		$45.5	$46.5	$47.3	$47.8	$48.2
Research Range	$18.9		$18.7	$18.9	$19.3	$19.6	$19.7
Other Missions and Data Analysis	$73.8		$50.4	$50.4	$50.3	$49.5	$49.8
Living with a Star	$221.9		$204.7	$202.2	$200.9	$336.3	$354.9
Radiation Belt Storm Probes (RBSP)	$121.0		$91.2	$29.7	$21.5	$8.7	$0.0
Solar Probe Plus	$40.0		$51.8	$103.0	$103.0	$146.7	$232.5
Other Missions and Data Analysis	$60.9		$61.6	$69.5	$76.5	$181.0	$122.4
Solar Terrestrial Probes	$148.0		$163.5	$170.4	$171.9	$50.2	$38.0
Magnetospheric Multiscale (MMS)	$130.1		$146.2	$153.0	$153.0	$30.5	$18.6

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Heliophysics (continued)							
Other Missions and Data Analysis	$17.9		$17.3	$17.4	$18.9	$19.7	$19.4
Heliophysics Explorer Program	$65.1		$65.2	$70.8	$90.2	$91.1	$84.9
IRIS	$41.1		$37.5	$11.2	$6.8	$1.1	$0.0
Other Missions and Data Analysis	$24.0		$27.7	$59.7	$83.4	$90.1	$84.9
New Millennium	$1.2		$0.0	$0.0	$0.0	$0.0	$0.0
New Millennium	$1.2		$0.0	$0.0	$0.0	$0.0	$0.0
SCMD Civil Service Labor and Expenses	**$0.0**		**$304.7**	**$313.2**	**$326.5**	**$342.2**	**$358.6**
SCMD Civil Service Labor and Expenses	$0.0		$304.7	$313.2	$326.5	$342.2	$358.6
SCMD Civil Service Labor and Expenses	$0.0		$304.7	$313.2	$326.5	$342.2	$358.6
Aeronautics	**$497.0**	**$501.0**	**$569.4**	**$569.4**	**$569.4**	**$569.4**	**$569.4**
Aeronautics Research	**$497.0**		**$569.4**	**$569.4**	**$569.4**	**$569.4**	**$569.4**
Aviation Safety	$74.0		$48.5	$47.8	$46.7	$45.4	$44.0
Aviation Safety	$74.0		$48.5	$47.8	$46.7	$45.4	$44.0
Airspace Systems	$79.0		$70.3	$69.4	$67.7	$65.8	$63.8
Airspace Systems	$79.0		$70.3	$69.4	$67.7	$65.8	$63.8
Fundamental Aeronautics	$199.0		$97.2	$95.9	$93.6	$90.9	$88.2
Fundamental Aeronautics	$199.0		$97.2	$95.9	$93.6	$90.9	$88.2
Aeronautics Test	$65.6		$50.7	$50.0	$48.8	$47.4	$46.0
Aeronautics Test	$65.6		$50.7	$50.0	$48.8	$47.4	$46.0
Integrated Systems Research	$56.9		$81.7	$80.6	$78.6	$76.4	$74.1
Environmentally Responsible Aviation	$56.9		$58.4	$57.0	$55.1	$53.1	$50.1
UAS Integration in the NAS	$0.0		$23.3	$23.6	$23.6	$23.3	$24.0
Aeronautics Strategy and Management	$22.6		$24.3	$24.0	$23.4	$22.8	$22.1
Aeronautics Strategy and Management	$22.6		$24.3	$24.0	$23.4	$22.8	$22.1
ARMD Civil Service Labor and Expenses	$0.0		$196.7	$201.7	$210.6	$220.7	$231.3
ARMD Civil Service Labor and Expenses	$0.0		$196.7	$201.7	$210.6	$220.7	$231.3
Space Technology	**$275.2**	**$327.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**
Space Technology	**$275.2**		**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**	**$1,024.2**
SBIR and STTR	$96.0		$177.3	$176.8	$175.6	$174.3	$172.8
SBIR and STTR	$96.0		$177.3	$176.8	$175.6	$174.3	$172.8
Partnerships Dev & Strategic Integration	$20.3		$19.5	$19.4	$19.3	$19.1	$19.0
Partnership Development and Strategic Integration	$20.3		$19.5	$19.4	$19.3	$19.1	$19.0
Crosscutting Space Tech Development	$7.5		$433.3	$432.1	$429.2	$425.8	$422.4
Crosscutting Space Tech Development	$7.5		$433.3	$432.1	$429.2	$425.8	$422.4
Exploration Technology Development	$151.4		$261.3	$259.3	$257.5	$255.5	$253.4
Exploration Technology Development	$151.4		$261.3	$259.3	$257.5	$255.5	$253.4
ST Civil Service Labor and Expenses	$0.0		$132.9	$136.6	$142.6	$149.5	$156.6
ST Civil Service Labor and Expenses	$0.0		$132.9	$136.6	$142.6	$149.5	$156.6

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
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Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Exploration	**$3,625.8**	**$3,594.3**	**$3,948.7**	**$3,948.7**	**$3,948.7**	**$3,948.7**	**$3,948.7**
Human Exploration Capabilities	**$3,287.5**		**$2,605.8**	**$2,591.2**	**$2,581.4**	**$2,570.4**	**$2,560.2**
Multi Purpose Crew Vehicle (MPCV)			$916.3				
Multi Purpose Crew Vehicle (MPCV)			$916.3				
Space Launch Systems (SLS)			$1,689.5				
Space Launch System (SLS)			$1,689.5				
Commercial Spaceflight	**$39.1**		**$792.8**	**$795.0**	**$792.5**	**$789.7**	**$785.5**
Commercial Cargo	$39.1		$0.0	$0.0	$0.0	$0.0	$0.0
Commercial Orbital Transportation Services	$39.1		$0.0	$0.0	$0.0	$0.0	$0.0
Commercial Crew	$0.0		$792.8	$795.0	$792.5	$789.7	$785.5
Commercial Crew	$0.0		$792.8	$795.0	$792.5	$789.7	$785.5
Exploration Research and Development	**$299.2**		**$211.4**	**$214.3**	**$211.2**	**$207.5**	**$203.7**
Human Research Program	$146.3		$143.3	$143.8	$143.0	$142.0	$140.9
Human Research Program	$146.3		$143.3	$143.8	$143.0	$142.0	$140.9
Advanced Explorations Systems	$152.9		$68.1	$70.5	$68.2	$65.5	$62.8
Advanced Explorations Systems	$152.9		$68.1	$70.5	$68.2	$65.5	$62.8
ESMD Civil Service Labor and Expenses	**$0.0**		**$338.7**	**$348.2**	**$363.6**	**$381.1**	**$399.4**
ESMD Civil Service Labor and Expenses	$0.0		$338.7	$348.2	$363.6	$381.1	$399.4
ESMD Civil Service Labor and Expenses	$0.0		$338.7	$348.2	$363.6	$381.1	$399.4
Space Operations	**$6,141.8**	**$6,146.8**	**$4,346.9**	**$4,346.9**	**$4,346.9**	**$4,346.9**	**$4,346.9**
Space Shuttle	**$3,101.4**		**$636.8**	**$65.8**	**$0.0**	**$0.0**	**$0.0**
Space Shuttle Program	$3,101.4		$636.8	$65.8	$0.0	$0.0	$0.0
SPOC Pension Liability	$0.0		$547.9	$0.0	$0.0	$0.0	$0.0
Program Integration	$627.2		$24.8	$21.3	$0.0	$0.0	$0.0
Flight and Ground Operations	$1,115.4		$27.9	$17.0	$0.0	$0.0	$0.0
Flight Hardware	$1,358.8		$36.1	$27.6	$0.0	$0.0	$0.0
International Space Station	**$2,312.7**		**$2,667.0**	**$2,775.8**	**$2,818.0**	**$2,847.3**	**$2,883.8**
International Space Station Program	$2,312.7		$2,667.0	$2,775.8	$2,818.0	$2,847.3	$2,883.8
ISS Systems Operations and Maintenance	$1,555.2		$1,291.4	$1,425.3	$1,385.1	$1,449.6	$1,526.3
ISS Research	$129.5		$189.8	$176.9	$178.8	$186.1	$189.1
ISS Crew and Cargo Transportation	$628.0		$1,185.7	$1,173.6	$1,254.1	$1,211.6	$1,168.5
Space and Flight Support	**$727.7**		**$699.8**	**$1,156.8**	**$1,168.7**	**$1,122.2**	**$1,067.5**
21st Century Space Launch Complex	$0.0		$128.0	$139.1	$130.2	$31.0	$42.9
21st Century Space Launch Complex	$0.0		$128.0	$139.1	$130.2	$31.0	$42.9
Space Communications and Navigation	$482.3		$404.8	$450.2	$460.9	$460.8	$460.8
Space Communications Networks	$363.3		$348.7	$382.5	$401.8	$408.9	$408.3
Space Communications Support	$93.5		$55.1	$56.3	$59.1	$51.9	$52.4
TDRS Replenishment	$25.4		$1.0	$11.4	$0.0	$0.0	$0.0

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Space and Flight Support (continued)							
Human Space Flight Operations	$104.0		$84.1	$85.5	$85.0	$87.3	$87.4
Human Space Flight Operations	$104.0		$84.1	$85.5	$85.0	$87.3	$87.4
Mission Operations Sustainment	$0.0		$0.0	$400.4	$409.4	$459.1	$391.4
Mission Operations Sustainment	$0.0		$0.0	$400.4	$409.4	$459.1	$391.4
Launch Services	$89.4		$46.0	$43.1	$44.1	$44.6	$45.7
Launch Services	$89.4		$46.0	$43.1	$44.1	$44.6	$45.7
Rocket Propulsion Test	$43.3		$36.8	$38.4	$39.0	$39.4	$39.4
Rocket Propulsion Testing	$43.3		$36.8	$38.4	$39.0	$39.4	$39.4
Crew Health & Safety	$8.8		$0.0	$0.0	$0.0	$0.0	$0.0
Crew Health and Safety	$8.8		$0.0	$0.0	$0.0	$0.0	$0.0
SOMD Civil Service Labor and Expenses	**$0.0**		**$343.4**	**$348.5**	**$360.2**	**$377.5**	**$395.6**
SOMD Civil Service Labor and Expenses	$0.0		$343.4	$348.5	$360.2	$377.5	$395.6
SOMD Civil Service Labor and Expenses	$0.0		$343.4	$348.5	$360.2	$377.5	$395.6
Education	**$180.1**	**$182.5**	**$138.4**	**$138.4**	**$138.4**	**$138.4**	**$138.4**
Education	**$180.1**		**$138.4**	**$138.4**	**$138.4**	**$138.4**	**$138.4**
Aerospace Rsch. and Career Development	$70.6		$35.7	$35.7	$35.7	$35.7	$35.7
NASA Space Grant	$45.6		$26.6	$26.6	$26.6	$26.6	$26.6
Experimental Program to Stimulate Competitive Research	$25.0		$9.1	$9.1	$9.1	$9.1	$9.1
STEM Education and Accountability	$0.0		$94.4	$94.2	$93.8	$93.4	$92.9
Minority University Research Education Program	$0.0		$28.0	$28.0	$28.0	$28.0	$28.0
STEM Education and Accountability Projects	$0.0		$66.4	$66.2	$65.8	$65.4	$64.9
Higher Ed. STEM Education	$49.0		$0.0	$0.0	$0.0	$0.0	$0.0
STEM Opportunities (Higher Education)	$8.4		$0.0	$0.0	$0.0	$0.0	$0.0
Minority University Research & Education Program	$30.6		$0.0	$0.0	$0.0	$0.0	$0.0
Global Climate Change Education	$10.0		$0.0	$0.0	$0.0	$0.0	$0.0
K-12 STEM Education	$45.0		$0.0	$0.0	$0.0	$0.0	$0.0
STEM Student Opportunities (K-12)	$15.5		$0.0	$0.0	$0.0	$0.0	$0.0
STEM Teacher Development (K-12)	$16.0		$0.0	$0.0	$0.0	$0.0	$0.0
K-12 Competitive Educational Grant Program	$13.5		$0.0	$0.0	$0.0	$0.0	$0.0
Informal STEM Education	$15.5		$0.0	$0.0	$0.0	$0.0	$0.0
Science Museums and Planetarium Grants	$7.0		$0.0	$0.0	$0.0	$0.0	$0.0
NASA Visitor Centers	$7.0		$0.0	$0.0	$0.0	$0.0	$0.0
NASA Informal Education Opportunities	$1.5		$0.0	$0.0	$0.0	$0.0	$0.0
ED Civil Service Labor And Expenses	$0.0		$8.3	$8.5	$8.9	$9.3	$9.8
ED Civil Service Labor and Expenses	$0.0		$8.3	$8.5	$8.9	$9.3	$9.8

NATIONAL AERONAUTICS & SPACE ADMINISTRATION
President's FY 2012 Budget Request Detail

Separate Labor Allocations

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Cross-Agency Support	**$3,017.6**	**$3,018.8**	**$3,192.0**	**$3,192.0**	**$3,192.0**	**$3,192.0**	**$3,192.0**
Center Management and Operations	**$2,161.2**		**$2,402.9**	**$2,402.9**	**$2,402.9**	**$2,402.9**	**$2,402.9**
Center Management and Operations	$2,161.2		$1,319.6	$1,305.7	$1,257.6	$1,204.3	$1,148.5
Center Institutional Capabilities	$1,678.3		$1,162.1	$1,149.2	$1,106.7	$1,059.6	$1,010.2
Center Programmatic Capabilities	$482.9		$157.5	$156.5	$151.0	$144.8	$138.3
CMO Civil Service Labor and Expenses	$0.0		$1,083.3	$1,097.2	$1,145.3	$1,198.6	$1,254.4
Civil Service Labor and Expenses	$0.0		$1,083.3	$1,097.2	$1,145.3	$1,198.6	$1,254.4
Agency Management and Operations	**$766.2**		**$789.1**	**$789.1**	**$789.1**	**$789.1**	**$789.1**
Agency Management	$395.5		$182.9	$179.7	$170.4	$159.9	$148.9
Agency Management	$395.5		$182.9	$179.7	$170.4	$159.9	$148.9
Safety and Mission Success	$196.0		$144.5	$143.7	$141.3	$138.5	$135.6
Safety and Mission Assurance	$51.3		$38.9	$38.7	$38.1	$37.5	$36.8
Chief Engineer	$101.1		$76.4	$75.9	$74.4	$72.7	$70.9
Chief Health and Medical Officer	$3.6		$4.1	$4.1	$4.1	$4.1	$4.1
Independent Verification and Validation	$40.0		$25.1	$25.0	$24.6	$24.3	$23.9
Agency IT Services (AITS)	$145.3		$136.4	$136.2	$135.5	$134.7	$133.8
IT Management	$15.0		$13.1	$13.1	$13.1	$13.1	$13.0
Applications	$75.4		$57.6	$57.5	$57.0	$56.4	$55.8
Infrastructure	$54.9		$65.7	$65.6	$65.4	$65.2	$65.0
Strategic Capabilities Assets Program	$29.4		$20.4	$20.2	$19.8	$19.3	$18.7
Strategic Capabilities Assets Program	$29.4		$20.4	$20.2	$19.8	$19.3	$18.7
AMO Civil Service Labor and Expenses	$0.0		$304.9	$309.3	$322.2	$336.8	$352.0
AMO Civil Service Labor and Expenses	$0.0		$304.9	$309.3	$322.2	$336.8	$352.0
Institutional Investments	**$27.2**		**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
Institutional Construction of Facilities	$23.4		$0.0	$0.0	$0.0	$0.0	$0.0
Institutional Construction Of Facilities	$23.4		$0.0	$0.0	$0.0	$0.0	$0.0
Environmental Compliance and Restoration	$3.8		$0.0	$0.0	$0.0	$0.0	$0.0
Environmental Compliance and Restoration	$3.8		$0.0	$0.0	$0.0	$0.0	$0.0
Congressionally Directed Items	**$63.0**		**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
Congressionally Directed Items	$63.0		$0.0	$0.0	$0.0	$0.0	$0.0
Congressionally Directed Items	$63.0		$0.0	$0.0	$0.0	$0.0	$0.0
Construction and Environmental Compliance	**$452.8**	**$448.3**	**$450.4**	**$450.4**	**$450.4**	**$450.4**	**$450.4**
Construction of Facilities	**$389.4**		**$397.9**	**$384.0**	**$359.5**	**$362.9**	**$360.0**
Institutional CoF	$249.3		$368.0	$384.0	$359.5	$362.9	$360.0
Institutional CoF	$249.3		$368.0	$384.0	$359.5	$362.9	$360.0
Science CoF	$37.8		$1.0	$0.0	$0.0	$0.0	$0.0
Science CoF	$37.8		$1.0	$0.0	$0.0	$0.0	$0.0
Exploration CoF	$72.6		$0.0	$0.0	$0.0	$0.0	$0.0
Exploration CoF	$72.6		$0.0	$0.0	$0.0	$0.0	$0.0

Budget Authority, $ in millions	Actual FY2010	Ann. CR FY2011	FY2012	FY2013	FY2014	FY2015	FY2016
Construction of Facilities (continued)							
Space Operations CoF	$26.9		$28.9	$0.0	$0.0	$0.0	$0.0
Space Operations CoF	$26.9		$28.9	$0.0	$0.0	$0.0	$0.0
Aeronautics CoF	$2.8		$0.0	$0.0	$0.0	$0.0	$0.0
Aeronautics CoF	$2.8		$0.0	$0.0	$0.0	$0.0	$0.0
Environmental Compliance and Restoration	**$63.4**		**$52.5**	**$66.4**	**$90.9**	**$87.5**	**$90.4**
Environmental Compliance and Restoration	$63.4		$52.5	$66.4	$90.9	$87.5	$90.4
Environmental Compliance and Restoration	$63.4		$52.5	$66.4	$90.9	$87.5	$90.4
Inspector General	**$36.4**	**$36.4**	**$37.5**	**$37.5**	**$37.5**	**$37.5**	**$37.5**
Inspector General	**$36.4**	**$36.4**	**$37.5**	**$37.5**	**$37.5**	**$37.5**	**$37.5**
IG Program	$36.4	$36.4	$37.5	$37.5	$37.5	$37.5	$37.5
Inspector General	$36.4	$36.4	$37.5	$37.5	$37.5	$37.5	$37.5
NASA FY 2012	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**	**$18,724.3**

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NASA FY 2012 Budget Request Executive Summary

Message from the Administrator

It is my privilege to submit President Obama's Fiscal Year (FY) 2012 budget request of $18.7 billion for NASA. Even in these difficult fiscal times, this budget supports all elements of the bipartisan NASA Authorization Act of 2010, along with the President’s agenda of *innovation, education, and infrastructure*. However, tough choices had to be made. That is why this budget prioritizes urgent needs, while continuing the Agency's focus on a reinvigorated path of exploration, innovation, and technological development leading to an array of challenging destinations and missions. Today, we begin to win the future.

The dedicated NASA workforce across the Nation is energized to continue our missions throughout the cosmos and here on Earth. The Agency continues to develop a capability-driven framework for affordable, sustainable, and realistic exploration, and this budget aligns our plans with the Authorization Act in a long-term, affordable, and sustainable manner.

Our priorities are to: safely fly out the Space Shuttle this year and maintain safe access for humans to low Earth orbit as we fully utilize the International Space Station; facilitate safe, reliable, and cost effective U.S.-provided commercial access to low Earth orbit for crew and cargo as soon as possible; begin to lay the ground work for expanding human presence into deep space through development of a powerful rocket and modern crew capsule; and pursue technology development to carry humans farther into the solar system even as we extend our reach with robots and observatories and make the most of technological breakthroughs to improve life here at home.

Building on President Obama's charge to all Federal agencies, we will carry out programs of innovation to support long-term job growth and a dynamic economy by increasing investment in research and technology. We will educate the next generation of technology leaders through vital programs in science, technology, engineering, and mathematics education. We will build the future through those investments in American industry to create a new job-producing engine for the U.S. economy while we remain committed to Federal goals to be stewards of our communities and make progress in our use of clean energy at our facilities.

The FY 2012 budget sets ambitious but achievable goals that foster America's continued leadership in space and forges deeper and more effective partnerships with the growing number of nations that are taking part in the space exploration enterprise. The space program remains a great value for the American taxpayer. The Agency's FY 2012 budget helps NASA to be more nimble and responsive to opportunity and encourages us to embrace a crosscutting approach to our thinking and planning that builds on the connections between our diverse missions.

NASA is at the forefront of a bright future for America—a future in which we challenge ourselves to create a global space enterprise with positive ramifications across the world. The FY 2012 budget provides the resources for NASA to innovate and discover on many fronts, and we look forward to implementing it.

Charles F. Bolden Jr.
NASA Administrator

Agency Summary

For more than 50 years, NASA has envisioned the future, making the impossible possible. Since 1958, the Agency has made giant leaps in exploring the cosmos and Earth, designed and built some of the greatest machines ever made, enabled people to walk on the Moon, and imaged the vastness of deep space, providing clues to the origin of the universe. NASA's Earth observing satellites and remote sensing systems have helped to identify natural and human-induced environmental changes that may impact climate, weather, and the health of the planet. The aeronautics research done by NASA has advanced air travel, making it possible for millions of people to fly the skies each day, moving quickly and safely across the globe. NASA also engineered the development, construction, and international cooperation efforts necessary to make a permanently crewed outpost in space, the International Space Station (ISS), a reality. The ISS provides scientists the opportunity to conduct cutting-edge research in a microgravity environment and also serves as an unprecedented model for international cooperation and human goodwill. What NASA does enables people to reach new heights and reveal the unknown for the benefit all humankind.

In FY 2012, NASA will strengthen the Nation's human space flight activities by transitioning from an engineering focus on building the ISS to an emphasis on scientific research and technology development—essential building blocks for a long-term human space exploration program. The ISS is the centerpiece of NASA's planning for extended space missions, as it serves as a research laboratory and technology test bed for basic and advanced studies in life sciences, human health, material sciences, Earth science, and fundamental physics. A new independent non-profit organization is being established to coordinate and oversee all of these research and technology efforts.

Technologies conceived by the world's greatest innovators will be tested in the space environment, proving their potential value in advancing exploration, and sparking ideas for products and services that benefit society here on Earth. These technologies will spur economic growth as new markets are developed, creating new jobs, and expanding international trade. Advances in scientific research, successful solutions to engineering challenges, and new technologies will help ignite student interest in science, technology, engineering, and mathematics (STEM) academic disciplines and careers. Industry and government employers will increase demand for skilled workers as the U.S. repositions itself for technological leadership on a global scale.

NASA actively seeks the engagement of industry in this achievable strategy for exploration. NASA plans to stimulate a competitive commercial market in which academia, non-profit research organizations, and corporations develop and mature aerospace-related technologies, processes, and services. Economic principles of supply, demand, and competition will drive this commercial market and ultimately result in reliable, low cost options for access to, and operations in, space. Public and private partnerships, collaborations with Federal agencies and other nations, and Federal grant awards to innovators at U.S. universities and research centers will initially help to strengthen competition and drive innovation in the aerospace industry. As part of this strategy, NASA will continue architecture planning for a Multi-Purpose Crew Vehicle (MPCV) capable of taking human explorers to distant locations throughout the inner solar system. The Space Launch System (SLS) Program will develop the heavy lift vehicle that will launch the MPCV, other modules, and cargo for these missions.

NASA will continue to expand the scientific understanding of Earth and the universe by pursuing the answers to humankind's most profound science questions. NASA uses the priorities set by the Nation's best scientific minds through the National Academies' decadal surveys in Earth science, heliophysics, planetary science, and astronomy and astrophysics to develop, operate, and mine data from science missions that will have a global impact on humanity's understanding of the universe. NASA's portfolio of space missions and mission-enabling programs includes suborbital missions, technology development, research and analysis, and data archival and distribution to sustain progress toward the Agency's science goals. We will make investment choices based on scientific merit through open competition and peer review for both space mission development and research tasks.

NASA's aeronautics research focuses on the most appropriate cutting-edge research and technologies to overcome aeronautics challenges that affect the Nation's current and future air transportation system. The Agency addresses these challenges by exploring early-stage concepts and ideas, developing new technologies and operational procedures through foundational research, and demonstrating the potential of promising new vehicles, operations, and safety technology for air transportation. The advances made through aeronautics research will expand airspace capacity, enable fuel-efficient flight planning, reduce the overall environmental footprint of aviation, diminish delays on the ground and in the sky, and improve the ability of aircraft to operate safely in all weather conditions.

NASA strives for sound budgeting and scheduling for all missions and programs since realistic planning is the foundation on which success is built. Schedules and budgets must include a complete cost analysis from concept design to the end of the life cycle. To the greatest extent possible, development risks must be identified, planning impacts assessed, and resources to mitigate the risks and impacts must be available when they are needed. Aggressive management controls and oversight, a full understanding of costs and benefits, and improved coordination and communication at all support levels will lessen risks and improve the likelihood of mission success within cost and funding allowances. Increasing the Agency's accountability and transparency will help reassure the public that NASA remains a good steward of taxpayer dollars.

FY 2012 Budget Highlights

NASA works to solve the questions and challenges of global science and engineering communities. These organizations envision and make real the otherwise unimaginable scientific missions and engineering feats for which the Agency is known. They actively engage with research communities, develop plans of action, build essential instruments and equipment, implement flight missions, and complete the cycle by communicating results back to researchers. The workforce, facilities, and missions of the organizations in the following descriptions represent NASA doing what it does best—exploring, discovering, enhancing the technological leadership of the United States, safeguarding the future for the Earth and generations to come, and, as always, pursuing excellence in all that the Agency does.

Answers to enduring questions about space

NASA's Science Mission Directorate works to expand human scientific understanding of Earth, the Sun, the solar system, and the universe. This knowledge helps identify and predict global climate change, space weather, the origins of the universe, and the likelihood of life elsewhere. The FY 2012 budget request for the Science Mission Directorate is $5,016.8 million.

Using a fleet of spacecraft equipped with radar and lasers, spectrophotometers, radiometers, magnetometers, telescopes, and other sophisticated instruments, NASA's science missions gather information to help researchers understand and respond to national and international disasters, develop innovative technologies that energize the national economy, and inspire the next generation of scientists and engineers.

In FY 2012, NASA will launch the NPOESS Preparatory Project (NPP), the Mars Science Laboratory (MSL), the Nuclear Spectroscopic Telescope Array (NuSTAR), and the Radiation Belt Storm Probes (RBSP). NuSTAR and Swift will continue the search for black holes, and the Great Observatories (Hubble, Chandra, and Spitzer), along with Fermi, will map out the earliest and most interesting structures of the universe. NASA will begin new studies of the Martian surface with the MSL rover, a mobile suite of sophisticated scientific instruments designed to collect data on the environment and geologic history of Earth's nearest neighbor. Radiation Belt Storm Probes (RBSP) will examine Earth's radiation belts to help understand how the Sun affects life on Earth. NASA will add to its fleet of climate-monitoring spacecraft by beginning operations of Glory, Aquarius, and NPP. The Glory mission will provide scientists with data to enable better weather and climate predictions. Data from these missions will inform strategies and policy discussions on global climate change and possibly help to identify ways to mitigate human impacts on the environment that may affect climate. Under the restructured civilian portion of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) now called the Joint Polar Satellite System, NASA will be working as NOAA's acquisition agent to develop and launch the satellite system necessary for civil weather and climate measurements. Similarly, NASA will support the Landsat program at USGS, to help ensure the continuity of this historic and valuable national resource.

Air transportation for today and tomorrow

Aeronautics research advances the safety, capacity, and efficiency of air travel. The FY 2012 budget request for the Aeronautics Research Mission Directorate is $569.4 million.

Through fundamental and applied research, NASA continues to lead improvements in aviation, including safety, air traffic capacity, optimized flight procedures, and aircraft design. Research includes strategies and designs that reduce fuel consumption, air pollution, and noise, making aviation more environmentally responsible. A major initiative is re-envisioning a next generation air transportation system, or NextGen, which will enable more capacity than the current system. Lost capacity equals fewer flights and less revenue, increased operating costs, impaired consumer confidence, and lack of job growth. NASA and its partners in the interagency Joint Planning and Development Office will continue to work together on the next generation air transportation system.

Technology enabling exploration and discovery

Space Technology creates new space technologies that enable exploration, scientific discovery, and a stronger economic future. The FY 2012 budget request for Space Technology is $1,024.2 million.

Technology improves our lives every day, and yet, U.S. leadership in technology development is under attack, a fact that has serious implications for the Nation’s global competiveness and economy. Recognizing that a technology-based economy is a robust one, the President has challenged Federal agencies to strengthen their investments in new technology development and innovation. NASA’s Space Technology develops critical space technologies through multi-phased technology development efforts, demonstrations, competitive opportunities, and partnerships. These strategies engage the creativity and problem-solving nature of the Nation’s brightest minds, whether they work in Government, industry, academia, or a backyard workshop. Space Technology provides the technological advances required for NASA's future missions in science and exploration while also creating advances that can lower costs and improve capabilities of other government agency and commercial space activities. These investments will stimulate the economy and build the Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs.

NASA history of technology transfer proves that that space-derived technologies, tools, and processes have applications for commercial markets. NASA’s Small Business Innovation Research and Small Business Technology Transfer programs encourage small businesses to participate in the Agency’s technology research and development work. In FY 2012, NASA will increase maximum award levels to $150,000 for Phase 1 research, and to $1 million for Phase 2 activities. This increased Agency commitment to engaging small business in research and development will encourage creativity and innovation in companies that might not otherwise be drawn to NASA and space exploration. Increased engagement by U.S. industry will improve the technological position of the U.S. and help to build a robust space commercial market.

Humanity’s destiny in space

Space Operations and Exploration lead the Nation’s current and future human space exploration efforts while encouraging development and growth of a commercial launch capability. The FY 2012 budget request for the Space Operations Mission Directorate is $4,346.9 million and the request for the Exploration Systems Mission Directorate is $3,948.7 million.

Supporting basic and applied research by government, private, and academic organizations, the ISS is set to take center stage in NASA’s plans for long-duration human space flight beyond low Earth orbit. NASA will use the unique environment and research equipment of the ISS to advance knowledge of human health risks in space and appropriate countermeasures, materials science, fundamental physics, and other disciplines essential for space travel. The ISS will also provide a test bed for testing exploration-enabling technologies as they mature. As an orbiting, fully crewed National Laboratory, NASA’s portion of the ISS will support the research interests of other Federal agencies, private, and academic organizations.

To oversee and coordinate this research, NASA is pursuing a plan for managing ISS research through an independent non-profit organization, or NPO. In FY 2011, NASA will award a cooperative agreement for the NPO to further develop national uses of the ISS and oversee all research involving organizations other than NASA. Transfer of current NASA research to the NPO will occur in future years, as Space Operations oversight of existing research projects is phased out. Specifically, the NPO will co-select and manage new peer-reviewed projects. As NASA research project offices complete ongoing work in future years, extension/renewal decisions will be made exclusively by the NPO. In this way, the NPO will create opportunities and facilitate planning for organizations that successfully propose to conduct experiments using the resources on the ISS.

NASA is reaching out to industry for support of a human space flight program that meets both near- and far-term objectives and provides flexibility in missions that expand the human presence across the solar system. This strategy for human space flight capitalizes on the ability of industry to be “nimble,” leveraging it with the steady methodical development approaches used by NASA. Research, development, and operational activities are balanced, in terms of work done by NASA and the commercial sector, to be responsive to priorities outlined in the NASA Authorization Act of 2010. In FY 2012, NASA will continue architecture planning for a Multi-Purpose Crew Vehicle (MPCV) capable of taking human explorers to distant locations throughout the inner solar system. The Space Launch System (SLS) Program will develop the heavy lift vehicle that will launch the MPCV, other modules, and cargo for these missions. NASA will invest nearly $3 billion in FY 2012 on MPCV and SLS, combined. NASA will also continue to stimulate the development of commercial crew and cargo transportation systems to the ISS and other future destinations. The Administration supports enabling this new industrial market, as it will provide a realistic solution to the challenges of acquiring affordable and reliable access to space.

After nearly forty years of service, the Space Shuttle will complete its mission and the program will retire. Space Shuttle transition and retirement activities will accelerate in FY 2012, as the Agency continues transitioning key workforce, technology, facilities, and operational experience to a new generation of human space flight and exploration activities. The disposition of most of the Space Shuttle assets will be completed in FY 2012.

Education essential to a strong future workforce and economy

Education programs capitalize on NASA’s missions to inspire students, educators, and the public. The FY 2012 budget request for Education is $138.4 million.

NASA has a long history of supporting STEM education. The Agency provides materials and resources that help teachers improve their STEM knowledge and inspire their students. Hands-on experiences enable students, throughout the pipeline from elementary school to graduate school, to question, reason, test, analyze, and communicate their findings. Educational investments in higher education, such as the National Space Grant College and Fellowship Program, the Experimental Program to Stimulate Competitive Research, and the Minority University Research and Education Program, support the preparation of a highly skilled and well-trained STEM workforce for the Agency and the Nation. Projects like the Summer of Innovation support Administrative initiatives, like “Educate to Innovate,” and “Race to the Top.” In FY 2012, NASA will respond to the recommendations of the Agency’s Education Design Team, by strengthening partnerships with national, state, and local education providers, to better meet the needs of schools, teachers, students, and communities. Organizational changes within the Agency’s Education Theme will enhance the Agency’s ability to make programmatic adjustments based on needs analysis, changing customer demand, and assessments of program effectiveness.

Excellence in operations for mission success

NASA's investments in Cross-Agency Support, and Construction and Environmental Compliance and Restoration provide essential institutional operations and facilities necessary for conducting aeronautics and space activities. The FY 2012 budget request for Cross-Agency Support is $3,192.0 million, and the request for Construction and Environmental Compliance and Restoration is $450.4 million.

Cross-Agency Support delivers a diverse range of services, including business operations, technical and safety oversight, facilities, and tools and resources that allow NASA to share with the public the challenges, results, and successes of the Agency's missions. In FY 2012, NASA will continue aligning the skill mix of the Agency's workforce with changing mission requirements. Further, planned operating system upgrades will improve the utility of information technology services, electronic business applications, the NASA Web portal, and improve NASA's participation in E-Government and transparency initiatives.

Construction and Environmental Compliance and Restoration ensures that mission essential facilities are built, revitalized, or decommissioned; and manages environmental compliance and restoration activities. In FY 2012, NASA will install a new 34-meter antenna at the Canberra Communications Complex of the Deep Space Network, improving communications with data sensing satellites. Three major environmental cleanups will continue, including soil and water remediation at the Santa Susana Field Laboratory so that the property can be dispositioned responsibly.

Operational efficiencies

NASA facilities cover 124,494 acres and the Agency directly employs approximately 18,500 civil servants. In keeping with broader Administration themes, the NASA's budget request supports a number of efforts to make NASA operate more efficiently. Today, over 80 percent of NASA's buildings are beyond their design life. The FY 2012 budget request strengthens the Agency's recapitalization fund, enabling NASA to replace or modernize inefficient buildings, and to eliminate or demolish others, providing jobs to local communities, and leading to increasingly efficient use of taxpayer dollars. In FY 2012, NASA will continue to implement energy savings initiatives, consolidate activities, and streamline or defer some Center Management Operations activities.

The Agency's FY 2012 budget request proposes new authority for NASA to enter into innovative partnerships with utility companies to provide clean energy to NASA Centers and the communities that surround them. NASA is working to meet energy intensity reduction requirements of three percent per year and 30 percent by 2015, from the FY 2003 baseline. To assist Centers with administering their energy management programs, NASA Headquarters annually conducts Energy and Water Management Functional Reviews at a third of NASA Centers to help Centers improve their management systems and identify and implement energy conservation measures.

In addition to facilities-related savings, the FY 2012 budget request proposes to save over $100 million in administrative costs by streamlining Agency operations. Streamlining efforts will focus on areas such as travel and printing costs.

Moreover, the Agency is improving the skills base in its workforce through certain hiring limitations and an increased focus on attracting new talent in the early stages of their careers.

Notes on NASA's Budget Request

With the direction provided in the bipartisan 2010 NASA Authorization Act (P.L. 111-267), NASA has begun to implement the key elements of this important law, as is reflected in the NASA FY 2012 budget request. Additionally, the FY 2012 budget proposes several structural adjustments and workload balance measures to improve the management of Agency resources, better align the Agency's work, and provide increased efficiencies and instruments. These items are discussed in greater detail below.

Budget Implications Related to NASA's 2010 Authorization Act

Congress passed the 2010 NASA Authorization Act in September 2010, after the submission of the FY 2011 President's Budget. In addition, at the time of printing of NASA's FY 2012 budget, there is no final appropriation for FY 2011. Therefore, NASA's budget request provides implementation of the key elements of the Authorization Act, while accounting for the uncertainties surrounding the FY2011 appropriation. All tables in the FY 2012 NASA budget request include a column for FY 2011 reflecting the annualized level provided by the current Continuing Resolution (P.L. 111-242) and an additional column reflecting the FY 2011 column of the 2010 NASA Authorization Act. In addition, In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

The 2010 NASA Authorization Act calls for robust programs in science, exploration, aeronautics, technology development, commercial launch capabilities development, and education. NASA has embraced the guidance set forth in the Act and has moved forward with plans to carry out its direction. With respect to human space flight and exploration, the Agency will fly the STS-135 Shuttle flight if funding is available and is developing plans and processes to ensure use of the ISS through 2020, including allocating research capability as part of a new National Laboratory. NASA is developing heavy lift capabilities and a Multi-Purpose Crew Vehicle capable of supporting exploration beyond low Earth orbit to a variety of destinations. Planning and support for development of commercial providers for crew and cargo transportation services to the ISS is underway, as the Act specifies that the "United States must develop, as rapidly as possible, replacement vehicles capable of providing both human and cargo launch capability to low-Earth orbit and to destinations beyond low-Earth orbit."

Merger of Space Operations and Exploration Systems Mission Directorates

To promote more effective and efficient development and operation of NASA's human space flight goal to extend and sustain human activities across the solar system, planning is underway to merge the Space Operations and Exploration Systems Mission Directorates. The new, integrated organization will be able to more effectively implement NASA's human space flight goals to achieve a safe, reliable, and affordable program that will sustain human space exploration efforts over the long term. By combining the efforts of these two human space flight organizations, NASA will ensure that knowledge and lessons learned from current Space Shuttle and ISS activities and contracted services (Space Operations) are leveraged with the Agency's forward-looking engineering design and capabilities development (Exploration Systems). Benefits of the merger will include integrated commercial transportation programs for the ISS; simplified external relationships with industry and international partners, including integrated global cooperation in human space exploration; and streamlined internal efforts between NASA Centers for more efficient operations. The new organization will realize improved human capital and infrastructure management as NASA transitions from the Space Shuttle and Constellation Systems to new human space flight programs. Restructuring the current budget will be evaluated and proposed, if appropriate, in a future NASA budget request.

Exploration's Technology Development Program Moved to Space Technology

NASA's FY 2012 budget for Space Technology reflects a $310 million transfer from the Exploration Systems Mission Directorate budget. This realignment of funds is due to the movement of a significant portion of the Exploration Technology Development (ETD) Program to Space Technology. Exploration Systems will focus on the development of the Space Launch System, Multi-Purpose Crew Vehicle, and commercial crew and cargo capabilities. The technology objectives of ETD will be largely incorporated into the overall Agency technology development portfolio, better leveraging the practices, readiness assessments, integration, and acquisition strategies established within Space Technology. For traceability, the transferred activities have been consolidated into a specific budgetary element within Space Technology. Some elements of exploration technology efforts, such as life support, extravehicular activity, and habitation development, will remain in Exploration Systems due to their engineering development nature and strong coupling to exploration crew vehicle systems.

In addition, in the FY 2012 budget request, NASA has proposed a distinct account for Space Technology as specified under the 2010 NASA Authorization Act. Previously, Space Technology was included in the Aeronautics Research account.

Separate Allocations for Civil Service Labor and Expenses

The FY 2012 NASA budget is presented both using the full-cost method of allocating all costs and with labor funding for the Agency's civil service workforce consolidated within eight theme- or program-level labor allocations titled "Civil Service Labor and Expenses (CSLE)." At present, with the exception of employees performing administrative or institutional functions, NASA allocates funds for its civil service workforce to the projects that use that labor (the "full-cost" method). Going forward, however, NASA intends to administer labor funding in a new manner, consolidating those funds within a labor allocation in each of the appropriations. With this change, employees working on (for example) aeronautics projects would be funded by the consolidated Aeronautics CSLE theme in the Aeronautics account.

NASA has initiated this change in administration of labor funding because NASA's current approach can be difficult to administer during the year of execution, especially as employees move from project to project. Consolidated accounts also provide some Center flexibility to redeploy workforce across projects within an appropriation account in response to new or changing requirements. Moreover, as NASA now transitions from its current portfolio of programs to the new direction authorized in the NASA Authorization Act of 2010, it may become especially difficult to ensure that all workforce and labor funding is properly allocated to individual projects as the project portfolio changes over time. By contrast, a consolidated labor account structure ensures that sufficient labor funding is accessible to fund the workforce and allows managers greater flexibility to assign workforce, allocate labor, and match skills with project work.

At the same time, NASA remains committed to tracking utilization of workforce and CSLE funding at the project level. The Agency will collect information on actual CSLE project funding through NASA's employee time and attendance system, and formulate all project plans both with, and without, CSLE expenditures. NASA also remains committed to tracking the full cost of all major projects.

Explanation of Budget Tables

NASA works to achieve the best display of the information in this budget request to enhance reader understanding. For most of the tables in this budget and where authorized levels were specific, an additional column for FY 2011 is included to provide comparability. The following assumptions have been made:

- The FY 2011 appropriation for NASA was not enacted at the time the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111–242, as amended). The amounts in all tables included for FY 2011 reflect the annualized level provided by the Continuing Resolution.

- The "Auth. Act FY 2011" column in all tables represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

- In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

- The FY 2010 actual column reflects NASA's last FY 2010 Operating Plan, submitted July 21, 2010.

- Adjustments were made in all years to reflect the movement of the Innovative Partnerships Program and most Exploration Technology Development activities into Space Technology.

Within the body of NASA's budget submission, budget tables are presented in tiers, aligned to NASA's programmatic management, from the top-level Mission Directorate, to increasingly detailed levels of Theme, Program, Projects in Development, and Projects in Formulation. Within NASA's budget submission, column contents may take on slightly different meanings depending on the management tier. Table footnotes applied at one level (e.g., Mission Directorate) are consistent throughout the document. However, footnotes may vary between management levels within the same Mission Directorate. Readers are advised to review footnotes when reviewing tables.

Overview

NASA's Science Mission Directorate (SMD) conducts scientific exploration enabled by the use of space observatories and space probes that view the Earth from space, observe and visit other bodies in the solar system, and gaze out into our galaxy and beyond. NASA's science program seeks answers to profound questions that touch us all:

- How and why are Earth's climate and the environment changing?

- How and why does the Sun vary and affect Earth and the rest of the solar system?

- How do planets and life originate?

- How does the universe work, and what are its origin and destiny?

- Are we alone?

From space, NASA satellites can view the Earth as a planet and enable its study as a complex, dynamic system with diverse components: the oceans, atmosphere, continents, ice sheets, and life itself. The Nation's scientific community can thereby observe and track global-scale changes, connecting causes to effects. They can study regional changes in their global context, as well as observe the role that human civilization plays as a force of change. Through partnerships with agencies that maintain forecasting and decision support systems, NASA improves national capabilities to predict climate, weather, and natural hazards; manage resources; and craft environmental policy.

NASA extends humankind's virtual presence throughout the solar system via robotic space probes to other planets and their moons, to asteroids and comets, and to the icy bodies of the outer solar system. SMD is completing humankind's first basic reconnaissance of the solar system by sending one mission to fly by Pluto and another that will visit two planet-sized asteroids, Ceres and Vesta. SMD is also in the midst of a large-scale investigation of Mars, launching a series of ever more capable orbiters, landers, and rovers, with the long-term goal of a sample return mission and eventual human exploration. In addition, SMD is focusing on certain moons of the giant planets where current NASA missions see intriguing signs of surface activity and of liquid water within, knowing that on Earth, where there is water and an energy source there is also life.

The solar system is governed by the Sun, a main-sequence star midway through its life. The Sun's influence is wielded through its gravity, radiation, solar wind, and magnetic fields, all of which interact with the masses, fields, and atmospheres of planetary and small bodies. Through the eyes of multiple spacecraft, the scientific community sees the solar system as a "heliosphere," another kind of interconnected system with diverse components. Using a fleet of sensors on various spacecraft in Earth orbit and throughout the solar system, SMD seeks to understand how and why the Sun varies, how planetary systems respond, and how human activities are affected. The science of heliophysics enables the space weather predictions necessary to safeguard the outward journeys of human and robotic explorers.

Some of the greatest minds of the last century discovered wondrous things about the physical universe: the Big Bang and black holes, dark matter and dark energy, and the interrelated nature of space and time. Their theories challenge scientists and NASA to use observations from space to test the limits of our understanding of fundamental physics. Having measured the age of the universe, the scientific community now seeks to explore its ultimate extremes: its birth, the edges of space and time near black holes, and the mysterious dark energy filling the entire universe. Scientists also seek to understand the relationship between the smallest of subatomic particles and the vast expanse of the cosmos. With hundreds of planets around other stars now known, scientists are using current NASA missions in conjunction with ground-based telescopes to seek Earth-like planets in other solar systems.

This is NASA's science vision: to achieve a deep scientific understanding of Earth, other planets and solar system bodies, our star system in its entirety, and the universe beyond. SMD lays the intellectual foundation for the robotic and human expeditions of the future while meeting today's needs for scientific information to address national concerns on global change, space weather, and education.

For over 40 years, NASA has also developed satellites on a reimbursable basis for other civilian Federal agencies. In FY 2012, NASA will continue development of the Geostationary Operational Environmental Satellite weather satellites, the Joint Polar Satellite System weather satellites and ground system, instruments for the Jason 3 sea surface monitoring satellite, and will begin development of the Landsat 9 satellite. These activities are included in the Department of Commerce and Department of the Interior budget requests.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**4,497.6**	**4,469.0**	**5,005.7**	**5,016.8**	**5,016.8**	**5,016.8**	**5,016.8**	**5,016.8**
Earth Science	1,439.3	-	-	1,653.0	1,679.2	1,665.3	1,691.4	1,727.3
Planetary Science	1,364.4	-	-	1,488.9	1,365.7	1,326.4	1,271.0	1,188.9
Astrophysics	647.3	-	-	637.7	708.3	721.0	713.5	741.9
James Webb Space Telescope	438.7	-	-	354.6	359.3	365.3	371.6	371.6
Heliophysics	608.0	-	-	577.9	591.0	612.4	627.2	628.6
SCMD Civil Service Labor and Expenses	0.0	-	-	304.7	313.2	326.5	342.2	358.6

Note: The budget request table reflects the elevation of the James Webb Space Telescope to a separate theme within SMD, rather than a project within the Astrophysics theme.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Science

Earth Science

New Initiatives:

No new initiatives are included.

Major Changes:

Continued funding for the global climate initiative, a major addition in the President's FY 2011 budget proposal, is included at a reduced level.

Major Highlights for FY 2012

The National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) is scheduled to launch in early FY 2012, continuing selected climate data records and becoming an integral part of the Nation's operational meteorological satellite system for weather prediction.

Release of the second Venture Class Announcement of Opportunity in FY 2011 will lead to selection of new science instruments and small missions in FY 2012.

The Glory mission will release its first global set of calibrated and validated aerosol measurements. The first A-Train fusion data products integrating Glory data with measurements from the rest of the A-Train will be produced.

The Aquarius instrument on the Argentine SAC-D mission will deliver its first global ocean salinity measurements to the science community.

The Orbiting Carbon Observatory 2 (OCO-2), Landsat Data Continuity Mission (LDCM), and the Global Precipitation Measurement (GPM) missions will be conducting integration and testing, in preparation for planned launches in FY 2013.

The first two decadal survey missions, Soil Moisture Active/Passive (SMAP) and the Ice, Cloud, and land Elevation Satellite-2 (ICESat-2), will both enter into development.

The budget supports robust Research and Analysis, Applied Science, and Technology programs.

New Initiatives:

No new initiatives are included.

Major Changes:

There are no major programmatic changes. In early 2011, NASA is expecting the results from the next National Academies' Decadal Survey for Planetary Science. This may lead to changes in planning and preparation for next year's FY 2013 budget proposal.

Major Highlights for FY 2012

The Mars Science Laboratory (MSL) will launch in early FY 2012 and arrive at Mars in August 2012.

The Juno mission, following launch in August 2011, will continue towards arrival at Jupiter in 2016.

The Gravity Recovery And Interior Laboratory (GRAIL) mission, following launch in September 2011, will enter lunar orbit and complete its prime mission. GRAIL will help determine the structure of the lunar interior from crust to core, and advance understanding of the thermal evolution of the Moon. As a secondary objective, GRAIL will enable scientists to extend knowledge gained from the Moon to the other terrestrial planets.

The MErcury Surface, Space ENvironment, GEochemistry and Ranging (MESSENGER) mission will complete its first year in Mercury orbit in March 2012. MESSENGER's instruments will map nearly the entire planet in color, image the surface in high resolution, and measure the composition of the surface, atmosphere, and nature of the magnetic field and magnetosphere.

The Discovery Program supports low-cost missions that enhance our understanding of the solar system by exploring the planets, their moons, and small bodies such as comets and asteroids. Following a Discovery Announcement of Opportunity released in June 2010, and a step 1 or concept study selection in early 2011, NASA will make final mission selection(s) in the summer of 2012.

The budget supports robust Research and Analysis and Technology programs.

Astrophysics

New Initiatives:

No new initiatives are included.

Major Changes:

The budget for the James Webb Space Telescope (JWST) is now carried under its own Theme. This is consistent with management changes implemented in FY 2011 to improve management oversight and control over the project, following release of the Independent Comprehensive Review Panel's (ICRP) report in November 2010.

The budget reflects the scientific priorities of the National Academies' decadal survey for astronomy and astrophysics. Specifically, early technology funding for missions beyond JWST is included, while work on the Space Interferometry Mission (SIM) and Joint Dark Energy Mission (JDEM) has been terminated. The budget includes additional funding for the Explorer mission selection planned for 2012, and increased investments in research and technology as recommended by the decadal survey.

Major Highlights for FY 2012

The Stratospheric Observatory For Infrared Astronomy (SOFIA) will complete its open door flight testing and conduct the first competed science observations.

The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will launch in early 2012.

The budget supports robust Research and Analysis and Scientific Balloon programs.

James Webb Space Telescope

New Initiatives:

No new initiatives are included.

Major Changes:

JWST was elevated to its own Theme to reflect management changes implemented in FY 2011 to improve oversight and control over the project in response to the release of the Independent Comprehensive Review Panel's (ICRP) report in November 2010. The project, which was previously managed within the Science Mission Directorate's Astrophysics Division within NASA Headquarters, as part of the Cosmic Origins Program, is now managed via a separate program office also at NASA Headquarters. The Program Manager of JWST at Headquarters now reports directly to NASA's Associate Administrator and the Associate Administrator of the Science Mission Directorate (SMD). The lead Center for developing JWST, Goddard Space Flight Center (GSFC) has also implemented changes, with project management now reporting directly to the Center Director.

Note that the technical content of the JWST project has not changed as a result of any of these management changes, and in fact the changes have been made in recognition of the high importance of this mission for the Agency and the astrophysics community.

Major Highlights for FY 2012

JWST was again included as a high priority in the most recently released National Academies decadal survey for astronomy and astrophysics entitled "New Worlds, New Horizons in Astronomy and Astrophysics" (National Academies, 2010). The project remains an integral part of the Science Mission Directorate's portfolio of bold new Astrophysics initiatives that open the universe to reveal new discoveries. JWST was the top priority of earlier decadal surveys, and helps to provide the foundational science upon which the new projects of the latest survey depend.

During 2010, JWST identified cost growth and schedule issues, which resulted in the formation of the Independent Comprehensive Review Panel (ICRP). The ICRP charter was to determine the technical, management and budgetary root causes of cost growth and schedule delay on JWST, to estimate the minimum cost to launch JWST, and to assess the associated launch date and budget profile. The ICRP report concluded that the problems causing cost growth and schedule delays on the JWST project are associated with cost estimation and program management. The panel recommended several managerial changes at Headquarters and GSFC, and some of these have already been implemented. The JWST project budget and schedule will be re-evaluated as part of a re-planning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

Heliophysics

New Initiatives:

No new initiatives are included.

Major Changes:

Funding for the next Explorer mission selection, planned for 2012, has been increased to enable selection of up to two full missions, as well as (potentially) instruments to fly on non-Explorer spacecraft. Half of the available funding has been transferred to the Astrophysics Explorer Program, reflecting the potential selection of one full mission from each Theme.

Major Highlights for FY 2012

The Radiation Belt Storm Probe (RBSP) mission will launch.

The Solar Probe Plus mission will enter into preliminary design (Phase B).

The budget supports robust Research and Analysis, and Sounding Rocket operations programs.

Theme Overview

NASA's Earth Science Theme advances knowledge of the integrated Earth system, the global atmosphere, oceans (including sea ice), land surfaces, ecosystems, and interactions between all elements, including the impacts of humans. Sustained, simultaneous observations of many quantities are needed to unravel the complexity of the global Earth system. Maintaining balance continues to be a hallmark of NASA's Earth Science Theme: Flight Programs develop satellite missions and provide observations; Research redeems the investment in flight by analyses to increase scientific understanding and identify the foci for future missions; Technology develops new measurement approaches; and Applied Sciences provides direct societal benefit by advancing the use of Earth science measurements and scientific understanding to undergird environmental policy decisions.

The President's Budget advances key elements of the program established in NASA's 2010 Climate Initiative. The budget enables launch of the first two Tier 1 decadal survey missions, Soil Moisture Active-Passive (SMAP) and Ice, Cloud, and Land Elevation Satellite (ICESat)-2, by CY 2016 and expands the Venture-class competitive program with annual solicitations for facility-class instruments and alternating biannual solicitations for small missions and airborne investigations. The budget supports continued development of options for the decadal survey's Tier-1 Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI) Radar satellite. Two climate-focused Tier-2 decadal survey missions--Surface Water and Ocean Topography (SWOT) for insight into the movement and distribution of fresh surface water, and Active Sensing of Carbon dioxide Emissions over Nights, Days and Seasons (ASCENDS) for atmospheric column carbon dioxide (CO2) abundance--have been initiated for launch in 2019-2020. Recognizing the broad societal and policy impact of NASA's Earth observations, NASA will continue to develop the Orbiting Carbon Observatory (OCO)-2 for launch in 2013, begin building OCO-3 as a mission of opportunity, and initiate missions to continue climate time series. NASA will refurbish a Stratospheric Aerosols and Gas Experiment III (SAGE III) instrument for flight on the ISS as early as 2014, develop the Pre-Aerosols, Carbon and Ecosystems (PACE) mission for ocean color, and initiate a Gravity Recovery and Climate Experiment (GRACE) Follow-on gap-filler mission for launch in 2016 (in collaboration with the German space agency, DLR) to continue the measurements, including observations of changes in terrestrial water storage and ice mass, now made by the aging GRACE mission.

NASA Earth Science operates 13 satellite missions making calibrated global observations with high spatial and temporal resolution. Two missions (ICESat, QuikSCAT) recently ended their main scientific missions after extended lifetimes. The ICESat spacecraft was deorbited flawlessly, including a successful experiment to acquire GPS data during its descent. More than 11 years after launch, QuikSCAT is still being used as a transfer standard to enhance the utility of data from international scatterometers. NASA has seven missions in formulation and development, of which Glory, Aquarius, and the NPOESS Preparatory Project (NPP) are scheduled for launch in 2011.

NASA aircraft and surface instruments calibrate, complement, and expand the value of satellite measurements. NASA supports computing capability and capacity for Earth system modeling. NASA missions produce nearly 4 terabytes of data daily, and NASA maintains the world's largest scientific data and information system for processing, archiving, and distributing Earth system data to worldwide users. International collaborations including collaborative space missions, joint research efforts, and information/education programs such as Global Learning and Observations to Benefit the Environment (GLOBE) and SERVIR are essential for the Earth Science Theme.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**1,439.3**	**-**	**1,653.0**	**1,679.2**	**1,665.3**	**1,691.4**	**1,727.3**
Earth Science Research	375.8	-	409.6	419.0	427.3	436.7	444.6
Earth Systematic Missions	705.2	-	816.5	838.7	761.6	763.2	810.7
Earth System Science Pathfinder	128.4	-	187.8	180.6	229.5	238.4	214.3
Earth Science Multi-Mission Operations	149.0	-	159.9	158.8	159.4	162.9	166.6
Earth Science Technology	45.6	-	46.1	47.9	51.9	53.6	54.2
Applied Sciences	35.3	-	33.1	34.3	35.5	36.7	36.9

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Earth Science Research

SMD will issue Research Opportunities in Space and Earth Science 2011 (ROSES-11), a research announcement covering all of its planned solicitations, including Earth Science Research. The FY 2012 budget will fund research competitively selected in FY 2011 under this ROSES call. About 33 percent of the Earth Science Research budget is competed each year through ROSES, with successful investigations funded usually through three-year grants. Thus many of the research activities carried out in FY 2012 will be tasks initiated in FY 2010 and FY 2011 based on solicitations included in ROSES-09 and ROSES-10. Selections based on ROSES-09 and -10 solicitations are on-going and are addressing diverse Earth Science research areas, including biodiversity, ocean salinity, hurricane and precipitation science, remote sensing of water quality, atmospheric composition, and interdisciplinary science.

NASA will continue implementation of the airborne IceBridge campaign to acquire essential polar ice data during the gap between the ICESat and ICESat-2 missions. This activity, focusing on changes in Greenland and Arctic ice, will continue in FY 2012 and each year until ICESat-2's launch in 2016.

In addition, the Research Program develops and tests experimental techniques and algorithms that contribute to future satellite missions. The FY 2012 President's Budget enhances support for interdisciplinary science and NASA observational- and model-based contributions to national and international climate assessments, as well as provides increased key investments in scientific computing and space geodesy.

Plans for FY 2012

Earth Systematic Missions

In FY 2012, the President's Budget accelerates or initiates Systematic Missions recommended by the National Academies' 2007 decadal survey. Implementation of SMAP and ICESat-2 missions will continue with launches in late CY 2014 and CY 2016, respectively. Phase A formulation activities will be completed for the DESDynI mission, with the NASA effort focusing on the radar satellite while seeking partner contributions for the Lidar element. The DESDynI launch date will be determined based on Phase A studies conducted in FY 2011. Pre-Phase A studies will continue for the remaining Tier-1 decadal survey mission, the Climate Absolute Radiance and Refractivity Observatory (CLARREO). In addition, in conjunction with the U.S. Global Change Research Program (USGCRP), NASA has identified two key climate-related Tier-2 decadal survey missions and will continue pre-formulation activities toward a CY 2019 launch.

The following other activities will be undertaken or accomplished in FY 2012:

- The Global Precipitation Measurement (GPM) project will complete its Systems Integration Review (SIR) and Key Decision Point (KDP)-D;

- The NPOESS (National Polar-orbiting Operational Satellite System) Preparatory Project (NPP) will complete all pre-launch activities, launch, and conduct the initial on-orbit check out and instrument calibration and validation;

- The Glory spacecraft will complete its on-orbit check out and deliver the first calibrated and validated Aerosol Polarimetry Sensor (APS) data products;

- The Landsat Data Continuity Mission (LDCM) will complete the Flight Operations Review (FOR);

- LDCM will complete the integration and testing of the observatory and the observatory Pre-Ship Review;

- Soil Moisture Active and Passive (SMAP) will complete the mission Critical Design Review (CDR);

- ICESat-2 will complete KDP-B and initiate the spacecraft contract;

- DESDynI will complete its Phase A formulation activities;

- The new Gravity Recovery and Climate Experiment (GRACE) Follow-on continuity mission will complete a pre-formulation phase and enter into Phase A formulation;

- The Stratospheric Aerosol and Gas Experiment (SAGE) III instrument will complete its International Space Station (ISS) accommodation assessment and initial instrument refurbishment;

- The Tier II missions Surface Water Ocean Topography (SWOT) and Active Sensing of CO2 Emissions over Nights, Days, and Seasons (ASCENDS) will complete their pre-Phase A activities and enter into formulation with the completion of KDP-A for each; and

- The 13 operating missions will implement the direction from the Senior Review conducted in FY 2011.

Plans for FY 2012

Earth System Science Pathfinder

The Earth System Science Pathfinder (ESSP) Program plans for FY 2012 include:

- The Aquarius/ Satellite de Aplicaciones Cientificas (SAC)-D mission will complete its on orbit checkout and begin sustained observations;

- The OCO-2 mission will see delivery of the spacecraft and the completion of the mission SIR, leading to a target launch readiness date of February 2013;

- Continuation of the Earth Venture-class (EV)-1 sustained airborne science campaigns;

- Selection of the winning proposals for EV-2, the first complete small mission Announcement of Opportunity (AO) (following release of the EV-2 AO in FY 2011);

- Release of the first EV-Instrument AO for a facility class Earth Science Instrument of Opportunity and selection of the winning proposal(s); and

- Continued on-orbit operation of GRACE, Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO), and CloudSat as determined by the 2011 Senior Review.

Earth Science Multi-Mission Operations

The Earth Science Multi-Mission Operations Program will continue to operate the Earth Observing System Data and Information System (EOSDIS), the Distributed Active Archive Centers (DAACs) and their accompanying functions, as well as Core System Science Data Processing Systems. The maintenance and operations of these systems are important to the collection of data from Earth Science satellites in orbit, as well as to the continuity of Earth science research efforts. NASA plans to continue support of the EOSDIS Evolution efforts to enable a service-oriented architecture between now and FY 2015, and to enable incorporation of the new, developing, and planned missions and Venture class aircraft investigations.

Five-year Making Earth Science Data Records for Use in Research Environments (MEaSUREs) Projects began work in FY 2008 to continue NASA support of the development of multi-instrument Earth System Data Records, including Climate Data Records. An Advanced Collaborative Connections for Earth System Science (ACCESS) solicitation was released in ROSES-09, and ACCESS projects begun in FY 2010 will be completed in 2012. A new program, Earth System Data Records Uncertainty Analysis, has projects that are beginning in FY 2011. These Cooperative Agreements are proving valuable for keeping research and modeling communities actively involved with the EOSDIS architecture and informing core infrastructure evolution decisions.

Plans for FY 2012

Earth Science Technology

The Earth Science Technology Program (ESTP) will plan and implement development of new remote-sensing and information systems technologies for infusion into future science missions in order to enable, or dramatically enhance, measurements and data system capabilities. A key goal of the program is to support the core Earth Science missions as defined by the decadal survey, along with other climate-monitoring missions that are part of the architecture plan. ESTP will identify technology needs based upon measurement priorities established by the science community, leading to systematically developed technology requirements and assessments of risk. The program may conduct studies to assess measurement options for meeting technology performance requirements. Ideas to address technology requirements will be solicited through an open, competitive process. The program provides rigorous management of the tasks selected for award such that costs and risks are minimized. There are three technology focus areas supported by ESTP: Instrument Incubator, Advanced Information Systems, and Advanced Technology Initiatives. The FY 2012 President's Budget supports expansion of currently planned activities.

For FY 2012, ongoing investigations will be managed in the Instrument Incubator, Advanced Information Systems Technology, and Advanced Component Technology areas. These investigations resulted from ROSES solicitations that occurred during FY 2010 and FY 2011. Each solicitation supported the expanded and accelerated mission set enabled by the President's Budget, including the Climate Initiative.

Applied Sciences

In FY 2012, the Applied Sciences Program will continue or initiate projects across a range of application areas, including health and air quality, water resources, disasters, and ecological forecasting. These projects are competitively selected through NASA's ROSES solicitations. In FY 2012, the program will pursue increased joint projects with end-user organizations, representation in satellite mission teams, and continuation of capacity building efforts to build skills and capabilities for accessing and applying Earth observations data to benefit society. The FY 2012 President's Budget enables the program to initiate new solicitations, improve end-user involvement in early phase mission planning, support services provided by the NASA/USAID joint-funded SERVIR network, and improve the communication of results.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's Earth Science Program uses unique capabilities in global Earth observations and models to discover scientific knowledge about the integrated Earth system. NASA provides the bulk of the global observations and research of USGCRP,and much of the observations and research that forms the basis for international scientific assessments of climate change. NASA activities contribute substantially to three Presidential initiatives (Integrated Global Earth Observations, the Ocean Policy Task Force, and the Climate Change Adaptation Task Force), three Congressional Initiatives (National Oceanographic Partnership Program, Global Change Research Act, and Clean Air Act Amendments), and two United Nations Assessments (Intergovernmental Panel on Climate Change and Ozone Depletion). NASA is the largest funding contributor to the 13-agency USGCRP and a participating agency in the National Climate Assessments. NASA is working to implement recommendations made in the National Academies' decadal survey report, "Earth Observations and Applications from Space: National Imperatives for the Next Decade and Beyond" (2007), which expresses the priorities of the U.S. science community.

NASA coordinates with the U.S. Geological Survey (USGS) on LDCM, a partnership that is evolving in keeping with the maturity of land cover remote sensing. Future Landsat missions will be funded through the USGS, with NASA serving as its acquisition agent. Similarly, NASA is a long-term partner with the National Oceanic and Atmospheric Administration (NOAA) for building and launching U.S. civilian weather satellites under reimbursable agreements. With the President's FY 2011 budget request, the Administration announced a restructuring of the NPOESS program. NASA and NOAA will take responsibility for the satellites operating in the afternoon orbit. The new Joint Polar Satellite System (JPSS) will be funded by NOAA, with NASA serving as the acquisition agency. NASA is also collaborating with NOAA to acquire key climate measurements and transition them into the operational satellite system.

Relevance to the NASA Mission and Strategic Goals:

Earth Science research supports NASA's Strategic Goal 2, to "Expand scientific understanding of the Earth and the universe in which we live."

Relevance to education and public benefits:

NASA consistently supports and develops programs to improve public understanding of the complexity of the global integrated Earth system and educate and train the next generation of scientists and engineers to ensure a robust workforce for this national endeavor. NASA is the largest contributor to GLOBE, an international program that involves students in making hands-on observations of Earth's environment and sharing them as part of an international community of learners. Infusing NASA Earth observations and scientific results, NASA supports innovative projects in formal and informal education to stimulate science, technology, engineering, and mathematics (STEM) learning in schools and engage the public. The DEVELOP Program (not an acronym) is a national high school and university student-led, student-run internship activity. NASA's Earth System Science Fellowship Program trains graduate students, while the New Investigator Program targets early-career scientists and engineers. NASA Earth science discoveries are reported almost daily through the world's media to engage students and the public to appreciate the complexity of the Earth system and global environment.

Guided primarily by the 2007 National Academies' decadal survey for Earth science, NASA is executing an ambitious plan to answer questions regarding why and how the environment is changing, define the impacts of environmental change on humans, and identify how humans can mitigate the impact of environmental hazards. Through its work with other Federal agencies to improve their operational services, NASA Earth science advances capabilities in such areas as weather and air quality forecasting, climate prediction, and natural hazard and land use assessment.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.1	**Advance Earth system science to meet the challenges of climate and environmental change.**	
Objective 2.1.1	**Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**	
Performance Goal 2.1.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.1.1: ES-12-1	Demonstrate planned progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.1.1.2	***By 2015, launch at least two missions in support of this objective.***	
APG 2.1.1.2: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth System Science Pathfinder
APG 2.1.1.2: ES-12-3	Complete the Earth Venture 1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder
Objective 2.1.2	**Enable improved predictive capability for weather and extreme weather events.**	
Performance Goal 2.1.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.2.1: ES-12-4	Demonstrate planned progress in enabling improved predictive capability for weather and extreme weather events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.1.2.2	***By 2015, launch at least two missions in support of this objective.***	
APG 2.1.2.2 ES-12-5	Complete the Global Precipitation Mission (GPM) Pre-Environmental Review.	Earth Systematic Missions
APG 2.1.2.2: ES-12-3	Complete the EV-1 Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Objective 2.1.3	**Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity.**	
Performance Goal 2.1.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.3.1: ES-12-6	Demonstrate planned progress in quantifying, understanding, and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.1.3.2	***By 2015, launch at least two missions in support of this objective.***	
APG 2.1.3.2 ES-12-7	Complete the Landsat Data Continuity Mission (LDCM) Systems Integration Review.	Earth Systematic Missions
APG 2.1.3.2: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth System Science Pathfinder
APG 2.1.3.2: ES-12-3	Complete the Earth Venture 1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder
Objective 2.1.4	**Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.**	
Performance Goal 2.1.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.4.1: ES-12-8	Demonstrate planned progress in quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.1.4.2	***By 2015, launch at least two missions in support of this objective.***	
APG 2.1.4.2: ES-12-5	Complete the Global Precipitation Mission (GPM) Pre-Environmental Review.	Earth Systematic Missions
APG 2.1.4.2: ES-12-9	Successfully complete the Soil Moisture Active-Passive (SMAP) Critical Design Review.	Earth Systematic Missions
Objective 2.1.5	**Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.**	
Performance Goal 2.1.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.5.1: ES-12-10	Demonstrate planned progress in understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
APG 2.1.5.1: ES-12-11	Achieve mission success criteria for the Ocean Surface Topography Mission (OSTM).	Earth Systematic Missions

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Performance Goal 2.1.5.2	***HPPG: Study Earth from space to understand climate change, weather, and human impact on our planet by launching at least two missions by 2015.***	
APG 2.1.5.2: ES-12-12	Launch the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP).	Earth Systematic Missions
Performance Goal 2.1.5.3	***By 2015, launch at least three missions in support of this objective.***	
APG 2.1.5.3: ES-12-13	Complete the ICESat-2 Preliminary Design Review.	Earth System Science Pathfinder
APG 2.1.5.3: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth System Science Pathfinder
Objective 2.1.6	**Characterize the dynamics of Earth's surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.**	
Performance Goal 2.1.6.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.6.1: ES-12-14	Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.1.6.2	***By 2015, launch at least one mission in support of this objective.***	
APG 2.1.6.2: ES-12-7	Complete the Landsat Data Continuity Mission (LDCM) Systems Integration Review.	Earth Systematic Missions
Objective 2.1.7	**Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.**	
Performance Goal 2.1.7.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.1.7.1: ES-12-15	Advance at least 25 percent of decision-support projects at least one Applications Readiness Level.	Applied Sciences
APG 2.1.7.1: ES-12-16	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science Research
APG 2.1.7.1: ES-12-17	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research

Uniform and Efficiency Measures:

Measure #	Description
Earth Science Theme	
APG EFF 2.1.7.1: ES-12-16	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.
APG EFF 2.1.7.1: ES-12-17	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.
APG EFF: ES-12-20	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: ES-12-21	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: ES-12-22	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: ES-12-23	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

Performance Achievement Highlights:

Using nearly a decade of NASA satellite ocean measurements from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS), a study appearing in the April issue of Ecology showed that the classic North Atlantic bloom, an explosive ocean plant growth, does not begin in the spring, as thought for 100 years, but rather in the middle of winter, and is the result of ocean mixing interfering with predator-prey interactions of marine ecosystems. The massive high-latitude phytoplankton blooms supporting fisheries and ocean uptake of CO2 have been discovered to begin in midwinter when low light, low temperatures, and severe storms make growing conditions poorest. Stormy winter conditions initiate biological productivity and may be dampened by climate change, thus reducing ocean CO2 uptake and impacting fisheries. This finding overturns a century-old paradigm on blooms, and suggests that future climate warming could be devastating to these economically and environmentally important ocean regions.

Researchers have analyzed time series data from Terra's Moderate Resolution Imaging Spectroradiometer (MODIS) in combination with climate data and reported a slight ten-year decline in global terrestrial plant productivity of one percent from 2000 through 2009 (a six percent increase was reported for 1982 through 1999 in 2003). The analysis shows that since 2000, high-latitude northern hemisphere forests have continued to benefit from warmer temperatures and a longer growing season. However, warming-associated drought limited growth in the southern hemisphere and offset the increases in the northern hemisphere, resulting in a net global loss of productivity. A continued decline in global productivity will weaken the terrestrial carbon sink and intensify the pressures on ecosystems for food, fiber, and biofuel production. Continued monitoring will be essential to explain whether this new trend is an example of decadal variability or a turning point to overall declines in productivity.

During an airborne campaign in spring 2010, nicknamed GloPac, NASA's Global Hawk unmanned aerial system (UAS) carried 11 instruments to sample the chemical composition of air in Earth's two lowest atmospheric layers (the stratosphere and troposphere), profile the dynamics and meteorology of both, and observe the distribution of clouds and aerosol particles. The instruments are operated by scientists and technicians from seven science institutions and are funded by NASA and the NOAA. The GloPac mission showed that the Global Hawk aircraft is a revolutionary tool for Earth science research, proven to be a science platform that can fly to altitudes of 65,000 feet for long-duration flights approaching 30 hours. This successful experiment was followed by another equally successful mission called the Genesis and Rapid Intensification Processes (GRIP) experiment, designed to bring new insight into how hurricanes form and intensify. NASA enjoyed a historic day for its hurricane research on September 2, 2010, as flew the Global Hawk over hurricane Earl, marking the first time the unmanned drone flew over a fully formed hurricane. The Global Hawk was piloted and based from NASA's Dryden Flight Research Center (DFRC), in Palmdale, California, while flying for up to 20 hours in the vicinity of hurricanes in the Atlantic and Gulf of Mexico. The GRIP campaign was the first multi-platform field campaign using a UAS; other platforms included the NASA WB-57F and DC-8, as well as aircraft from other agencies flown in coordination with NASA's. In order to determine how a tropical cyclone will behave, the instruments gathered data to analyze many factors, including cloud droplet and aerosol concentrations, air temperature, wind speed and direction in storms and on the ocean's surface, air pressure, humidity, lightning, aerosols, and water vapor. The data both complement and validate the observations from NASA's satellites.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council (NAC)	09/2010	NASA Advisory Council (NAC) Science Committee - Review science strategy and implementation strategy for the Earth Science programs.	2011
Relevance	National Academies	N/A	National Academies - per Authorization Act of 2005, perform a quinquennial review of scientific progress against decadal survey recommendations.	2011
Relevance	National Academies	01/2007	National Academies - Decadal survey of effectiveness and quality of the Earth Science programs. First time a decadal survey was developed for Earth science. For more information: http://www.nap.edu/catalog.php?record_id=11820.	2016

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	375.8	-	409.6	419.0	427.3	436.7	444.6
Earth Science Research and Analysis	275.7	-	304.0	311.1	316.6	324.2	330.9
Computing and Management	100.1	-	105.7	107.8	110.8	112.5	113.7

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The Earth Science Research Program aims to advance understanding of the Earth system, its components and their interactions, its changes, and the consequences of these changes for life. Earth system processes occur on a continuum of spatial and temporal scales and affect weather, climate, air quality, water resources, biodiversity, and other environmental aspects. The program pioneers the use of remote sensing data, primarily space-based, in new and innovative ways, and leverages NASA's unique capabilities in global Earth observation.

Earth Science Research sponsors basic disciplinary and interdisciplinary research, Earth system modeling efforts, the Airborne Science project (which provides access to aircraft and unmanned aircraft systems), and supercomputing efforts supporting a variety of programs, as well as education and outreach.

For more information, please see http://nasascience.nasa.gov/earth-science/.

Plans For FY 2012

The Research and Analysis (R&A) project constitutes the core of the program and accounts for about half of its total budget. It is mostly competed via the annual SMD ROSES solicitations. ROSES-11, released in February 2011, will result in grants funded with FY 2012 funding and two subsequent years. The project will also continue funding research tasks solicited in ROSES-10 and ROSES-09 as they progress into their second and third years, respectively. The research portfolio includes the Interdisciplinary Science project, also competed in ROSES, with a focus on research in interdisciplinary areas such as sea level change, water and energy cycle impacts of biomass burning, and integrated Earth system responses to extreme disturbances. Other competitive grant projects are the carbon cycle science team and the Earth science education and outreach activity. The remaining activities include directed funding to NASA Centers for Space Geodesy (for development and operation of the geodetic networks), high-end computing and scientific computing, and global modeling and data assimilation.

The FY 2012 President's Budget enhances support for interdisciplinary science, for observational and model-based contributions to national and international climate assessments, for work towards a Carbon Monitoring System (CMS), specifically the development of two pilot products, and for a scoping study and increased investment in scientific computing and space geodesy. The two pilot products from CMS are a terrestrial biomass pilot product and an integrated emission/uptake (flux) pilot product. The terrestrial biomass pilot product utilizes satellite and in situ data, produces national quantitative estimates (and uncertainties) of above-ground terrestrial vegetation biomass and assesses the ability of these results to meet the nation's need for monitoring carbon storage and sequestration. NASA will demonstrate how well biomass can be quantified with high quality remotely sensed data (e.g., airborne lidar) taken at fine spatial resolution for selected sites representative of U.S. forest types and conditions. Sites with intensive inventory measurements will be selected so that comparisons with county, state, and national carbon and biomass inventory products can be made. The accuracy of and uncertainties within the national biomass map product will be evaluated using these high-resolution products for validation. The integrated emission/uptake (flux) pilot product combines satellite data with modeled atmospheric transport initiated by observationally constrained terrestrial and oceanic models to tie the atmospheric observations to surface exchange processes and estimates the atmosphere-biosphere CO2 exchange processes.

Project Descriptions and Explanation of Changes

Earth Science Research and Analysis

The Earth Science Research Program area consists of multiple projects and science teams that support the diverse R&A goals.

Research and Analysis: The Earth Science project is the core of the research program and funds the analysis and interpretation of data from NASA's satellites, as well as a full range of underlying scientific activity needed to establish a rigorous base for the satellite data and their use in computational models (for both assimilation and forecasting). The complexity of the Earth system, in which spatial and temporal variability exists on a range of scales, requires an organized approach for addressing complex, interdisciplinary problems, taking care to recognize the objective of integrating science across the programmatic elements towards a comprehensive understanding of the Earth system. The resulting structure comprises six interdisciplinary and interrelated science focus areas: climate variability and change; atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; water and energy cycles; weather; and Earth surface and interior. Additionally, the R&A project addresses the Earth system and the interactions between its components, characterizing them on a broad range of spatial and temporal scales to understand the naturally occurring and human-induced processes that drive the overall system.

Airborne Science: Airborne Science funds NASA's Earth science manned and unmanned aircraft. The project supports the operation of a range of NASA-owned and leased aircraft, including the ER-2, DC-8, WB-57, P-3, Twin Otter, B-200, and the Global Hawk and other UAS. These assets are deployed in campaigns conducted around the world to investigate extreme weather events (e.g., hurricanes), observe Earth system processes, obtain data for Earth science modeling activities, and calibrate instruments flying aboard Earth science spacecraft. NASA will continue IceBridge, an Airborne Science campaign, conducted to bridge the gap between ICESat and ICESat-2 observations. This activity, focusing on changes in Greenland, Arctic, and Antarctic ice, will continue each year until ICESat-2's launch in 2016.

Interdisciplinary Science: Interdisciplinary Science supports science investigations and calibration and validation activities that ensure the utility of spaceborne measurements. In addition, it supports focused field work (e.g., airborne campaigns) and specific facility instruments that are heavily relied upon in field work.

Carbon Cycle Science: The Carbon Cycle Science project funds research on the distribution and cycling of carbon among the Earth's active land, ocean, and atmospheric reservoirs.

Global Modeling and Assimilation Office: The Global Modeling and Assimilation Office, located at Goddard Space Flight Center (GSFC), creates global climate and Earth system component models using data from Earth science satellites and aircraft. These products can then be used by investigators worldwide to further their research.

Ozone Trends Science: The Ozone Trends Science project has the overall goal of producing a consistent, calibrated ozone time series that can be used for trend analyses and other studies.

Earth Science Research and Analysis (continued)

Education and Outreach Activity: The Education and Outreach Activity supports NASA's educational goals and communicate the results from Earth science missions and research. It also continues the worldwide implementation and U.S. coordination of the GLOBE Program.

Fellowships and New Investigators: The Fellowships and New Investigators project supports graduate and early-career research, respectively, that is relevant of Earth system research and applied science.

Space Geodesy: The Space Geodesy project provides global geodetic positioning and supports the establishment of needed geodetic reference frames in support of climate change and geohazards research and applications and their associated missions. The FY 2012 President's Budget will support the construction of the prototype for the next generation ground station for this network, whose development has been underway for several years.

Computing and Management

The Computing and Management area consists of three projects:

High-End Computing Capability - The High-End Computing Capability (HECC) project at Ames Research Center is focused around the Columbia and Pleiades supercomputer systems and the associated network connectivity, data storage, data analysis, visualization, and application software support. SMD currently funds and manages HECC resources, which serve the supercomputing needs of all NASA Mission Directorates as well as principal investigators at universities. SMD funding supports the operation, maintenance, and upgrade of NASA's supercomputing capability, while the Strategic Capabilities Assets Program exercises oversight and insight functions. In 2010, approximately 29,000 processors were added to the Pleiades supercomputer system. This system, with a total of about 82,000 processors, supports NASA's aeronautics, exploration, space operation, and science missions.

Scientific Computing - Scientific Computing funds NASA's Earth Science "Discover" computing system, software engineering, and user interface projects at GSFC, including assessment modeling carried out at the Goddard Institute for Space Studies. Scientific Computing supports Earth science modeling activities based on data collected by Earth science spacecraft. An additional 14,400 processors were added to the Discover cluster to accommodate increasing requirements in modeling and data analysis. The FY 2012 President's Budget provides increased support for hardware procurement and development of software systems designed to facilitate use of NASA computational hardware.

Directorate Support - The Directorate Support project contributes to the SMD institutional budget. It funds Directorate cross-cutting activities (i.e., National Academies, NASA Peer Review, printing and graphics, IT budget, NASA Postdoctoral program, working group support, independent assessment studies, and other Directorate administrative tasks).

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Issue competed, peer-reviewed research awards.	Research and Analysis; Airborne Science (flight opportunities)	
Maximize resource utilization (i.e., computing cycles) in supercomputer projects.	Scientific Computing; HECC	
Competitively selected airborne mission teams.	Continue operation ICEBridge	
Competitively selected shipborne mission team.	ICEScape (deployment #2)	
Competitively selected airborne mission teams.	Mid-latitude Airborne Cirrus Properties Experiment (MACPEX)	
Support National Climate Assessments	Support data products, investigators and workshops	
Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science Research	
Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research	

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24)	Phase	Beg	End
R&A, IDS Science, Carbon Cycle Science, Ozone Trends, Global Modeling and Assimilation Office, Space Geodesy, Education and Outreach, Fellowships and New Investigators (all ongoing research efforts)		Tech		
		Form		
		Dev		
		Ops		
		Res	Jan-90	Dec-23
Airborne Science		Tech		
		Form		
		Dev		
		Ops	Jan-90	Dec-23
		Res		
Scientific Computing		Tech		
		Form		
		Dev		
		Ops	Jan-95	Dec-23
		Res		
HECC		Tech		
		Form		
		Dev	Jan-05	Aug-05
		Ops	Sep-05	Dec-23
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Research

Program Management

The Earth Science Theme manages the research program. GSFC implements scientific computing and the Ames Research Center (ARC) implements HECC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
R&A	Earth Science Theme, Science Mission Directorate	Mostly competitive awards	USGCRP participating agencies and Subcommittee on Ocean Science and Technology (SOST) participating agencies
Interdisciplinary Science	Earth Science Theme, Science Mission Directorate	Mostly competitive awards	USGCRP participating agencies and SOST participating agencies
Carbon Cycle Science Team	Earth Science Theme, Science Mission Directorate	GSFC, Jet Propulsion Laboratory (JPL), ARC	USGCRP participating agencies and SOST participating agencies
Ozone Trends Science	Earth Science Theme, Science Mission Directorate	GSFC and Langley Research Center (LaRC)	USGCRP participating agencies and SOST participating agencies
Airborne Science	Earth Science Theme, Science Mission Directorate	GSFC/Wallops Flight Facility, DFRC, and ARC are the primary Centers involved in this project.	The Federal Aviation Administration, the Department of Defense, the Department of Energy, the National Science Foundation, and NOAA (Department of Commerce)
High-End Computing Capability	Earth Science Theme, Science Mission Directorate	NASA Advanced Supercomputing, ARC	Department of Energy and the Department of Defense
Scientific Computing	Earth Science Theme, Science Mission Directorate	NASA Center for Computational Sciences, GSFC	Department of Energy and the Department of Defense
Global Modeling and Assimilation Office (formerly Data Assimilation Office)	Earth Science Theme, Science Mission Directorate	GSFC	None
Space Geodesy	Earth Science Theme, Science Mission Directorate	GSFC, JPL	None
Earth Science Education and Outreach Activity	Science Mission Directorate	N/A (various non-NASA organizations)	National Science Foundation's Component of the Global Learning and Observations to Benefit the Environment (GLOBE)
Fellowships and New Investigators	Science Mission Directorate	N/A (various non-NASA organizations)	None

Acquisition Strategy

The Earth Science Research Program is based on full and open competition. Proposals in response to NASA ROSES and other related announcements are peer reviewed and selected based on defined criteria.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC Earth Science Subcommittee (ESS)	2011	The NASA Advisory Council ESS reviews progress towards Earth Science objectives in the NASA Strategic Plan annually. During its 2010 meeting, the ESS reviewed and rated the ESD science metrics based on submitted accomplishments and peer-reviewed publications for FY 2010 in support of reporting requirements of the Government Performance and Results Act of 1993. All six science focus areas were rated "green" as documented in the FY 2010 Performance and Accountability Report.	2012

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**705.2**	**-**	**816.5**	**838.7**	**761.6**	**763.2**	**810.7**
Global Precipitation Measurement (GPM)	155.0	-	83.8	68.7	41.4	27.2	20.1
Glory Mission	31.8	-	5.3	3.8	6.1	5.9	6.0
Landsat Data Continuity Mission (LDCM)	106.0	-	152.0	64.1	1.5	1.5	1.6
NPOESS Preparatory Project (NPP)	82.1	-	13.6	6.4	6.3	6.0	5.5
Ice, Cloud, and land Elevation Satellite (ICESat-II)	38.9	-	102.1	159.4	128.8	83.1	28.6
Soil Moisture Active and Passive (SMAP)	70.0	-	135.2	172.3	31.1	29.6	14.5
Other Missions and Data Analysis	221.5	-	324.6	364.0	546.4	609.9	734.5

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Program Overview

The Earth Systematic Missions Program (ESMP) is responsible for developing facility (non-Principal Investigator (PI)-led) Earth observing research satellite missions, supporting and overseeing the operation of NASA facility research missions once on orbit, and producing standard mission products in support of NASA and national research, applications, and policy communities. In contrast with the PI-led missions in the Earth System Science Pathfinder (ESSP) Program, which are generally smaller and have highly focused scientific objectives, Earth Systematic Missions are designed to provide measurements and support for a wide a range of NASA science foci. Eight of the 13 presently on-orbit research missions for which NASA had development responsibility are operated under ESMP oversight (the U.S. Geological Survey operates Landsat-7, operational responsibility for OSTM/Jason-2 was transferred to NOAA as planned during FY 2009, and the Earth System Science Pathfinder (ESSP) program manages GRACE, CloudSat, and CALIPSO). Four of the five foundational missions presently in development are in the Earth Systematic Mission program (Glory, NPP, LDCM, and GPM). The National Academies' Earth science and applications decadal survey identifies 15 additional systematic NASA research missions that will be developed in the ESMP. Of these decadal survey missions, the President's FY 2012 budget provides funds for developing the first two Tier-1 systematic missions, SMAP and ICESat-2, for launch in 2014 and 2016, respectively. A third Tier I mission, DESDynI, will complete its pre-formulation pre-Phase A analysis of developmental option in FY 2012, during this time NASA will determine the most effective implementation approach for the combined Radar + Lidar mission. NASA will continue pre-phase A studies for the remaining Tier I mission, CLARREO, Additionally, the President's Budget allows expansion of the ESMP mission portfolio to include the development of the SAGE-III instrument for observing from the ISS (flight-ready in 2014), the development and launch of a GRACE-FO (follow-on) gapfiller mission in collaboration with DLR (2016 launch), the development and launch by FY 2020 of the PACE ocean color and aerosol mission, and advancement of twoTier-II Decadal Survey missions, SWOT and ASCENDS, selected for acceleration by NASA in consultation with USGCRP.

Interagency and international partnerships play key roles in the ESMP. Seven of the on-orbit missions provide data products in near-real time for use by U.S. and international meteorological agencies and disaster responders. Five of the on-orbit missions involved significant international or interagency collaboration in development, and the five-satellite A-Train formation-flying constellation (Aqua, CloudSat, CALIPSO, Aura, Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar (PARASOL)) consists of both NASA and international missions. Two of the four ESMP foundational missions presently in development involve interagency collaboration (NPP, LDCM), while GPM is a joint development between NASA and the Japanese Aerospace Exploration Agency (JAXA). Finally, the upcoming climate missions GRACE FO and Pre-Aerosol, Clouds, and ocean Ecosystem (PACE), and SWOT, a Tier II decadal survey mission, include significant international collaboration, as well. Partnering opportunities for DESDynI will be examined.

For more information, see http://science.hq.nasa.gov/missions/earth.html.

Plans For FY 2012

The President's Budget enables a wide range of ESMP activities during FY 2012. The Glory mission will be conducting its initial on-orbit checkout and validation in FY 2012, including the integration of the satellite into the A-Train constellation and the first evaluation of merged constellation data products and observations with Glory. The NPP mission will launch at the start of FY 2012 (October 2011) and will complete its initial on-orbit check out and calibration and validation activities. The Tier-1 decadal survey missions will pursue pre-formulation, formulation and implementation activities and milestone reviews targeting launches in November 2014 for SMAP and 2016 for ICESat-2. The launch plans for the DESDynI mission will be informed by the critical Phase A trade studies focused on implementation options and partnership possibilities. Increases in ESMP activities will be consistent with the focused expansion of the mission portfolio enabled by the budget, including initiation of the GRACE follow-on (GRACE FO) mission (2016 launch target), the PACE ocean color mission (FY 2020 target), and refurbishment activities to allow the SAGE-III instrument to be ready for flight on the ISS by CY 2014). The ASCENDS and SWOT Tier II decadal survey and selected continuity missions identified by NASA and the U.S. Global Change Research program for accelerated launches in the CY 2017-2020 time frame will also be entering into formulation in FY 2012.

The following specific activities will be undertaken or accomplished in FY 2012:

- Glory will complete its checkout and scientific validations, and begin routine data acquisition;
- GPM will complete its PER, SIR, and KDP-D and begin observatory level environmental testing;
- NPP is scheduled to launch October 2011 and will complete its initial on-orbit validation;
- LDCM will complete its spacecraft integration and test, and the Thermal Infrared Sensor (TIRS) and Operational Land Imager (OLI) instruments will be delivered to the spacecraft and KDP-D will be held;
- LDCM will conduct the majority of the Observatory level environmental testing and the FOR;
- SMAP will complete CDR;
- ICESat-2 will complete its mission Preliminary Design Review (PDR) and complete its confirmation review;
- DESDynI will complete its pre-Phase A activities;
- The GRACE FO mission will complete its Phase A formulation period and KDP-B;
- The SAGE III instrument will complete ISS accommodation assessment and will begin refurbishment;
- The PACE mission will complete pre-formulation activities and enter into Phase A;
- The decadal survey Tier-II SWOT mission will complete its pre-formulation activities and enter into Phase A early in FY2012;
- The decadal survey Tier II ASCENDS mission will complete its pre-formulation activities and enter into Phase A at the end of FY 2012; and
- The operating missions will continue with operations as directed following the FY 2011 bi-annual Senior Review.

Project Descriptions and Explanation of Changes

Global Precipitation Measurement (GPM) Mission

Extending precipitation measurements beyond the current TRMM, the foundational mission GPM will provide detailed, frequent measurements of precipitation including rain rates and droplet size distributions. A joint mission between NASA and JAXA, GPM's two instruments will make valuable direct precipitation measurements and allow precise characterization of many other on-orbit NASA and partner instruments, enabling first-ever, accurate, near-global precipitation maps to be produced. GPM data will contribute to improved operational meteorological predictions, as well as to advances in the NASA science focus areas of climate variability and change, water and energy cycles, and weather. Additional GPM information is available under the Project in Development section of this document.

Glory Mission

Glory will provide unique measurements of the global distributions and scattering properties of natural and anthropogenic aerosols, as well as continue the nearly 30-year time series of total solar irradiance measurements. The NASA science focus areas advanced by Glory data include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability, and change; and water and energy cycles. Additional Glory information is available under the Project in Development section of this document.

Landsat Data Continuity Mission (LDCM)

LDCM, a collaboration between NASA and the U.S. Geological Survey, will provide moderate-resolution (15-120 meter, depending on spectral frequency) measurements of Earth's terrestrial and polar regions in the visible, near-infrared, and thermal infrared. LDCM will provide continuity with the 38-year long Landsat land imaging data set. In addition to widespread routine use for water use monitoring, land use planning and monitoring on regional to local scales, and support of disaster response and evaluations, LDCM measurements directly serve NASA research in Earth surface and interior, and carbon cycle, ecosystems, water cycle, and biogeochemistry focus areas. NASA's LDCM responsibilities include development of the LDCM visible/near-infrared and thermal infrared instruments, provision of the spacecraft and launch vehicle, and design/implementation of the USGS-funded Mission Operations Element. LDCM is being managed to a target December 2012 launch date, while reporting an external commitment date of June 2013. Additional LDCM information is available under the Project in Development section of this document.

NPOESS Preparatory Project (NPP)

NPP is a NASA research mission involving a collaboration between NASA, NOAA, and DoD, designed to extend selected scientific data sets initiated by the NASA Earth Observing System and to serve as risk reduction demonstrations for key instruments to be used in the Nation's future operational meteorological satellite systems. NPP is scheduled to launch in October 2011 and will ensure critical continuity in the nation's operational meteorological measurements from the afternoon orbit. The five instruments on NPP will provide visible and infrared multi-spectral global imagery, atmospheric temperature and moisture profiles, total ozone and stratospheric ozone profiles, and measurements of Earth's radiation balance. In addition to a wide range of applications studies, the NASA science focus areas served by NPP will include: atmospheric composition; climate variability and change; carbon cycle, ecosystems, and biogeochemistry; water and energy cycles; and weather. Additional NPP information is available under the Project in Development section of this document.

Ice, Cloud, and land Elevation Satellite-2 (ICESat-2)

ICESat-2, a Tier-1 decadal survey mission that entered into formulation in FY 2010 and is being developed for a target launch in 2016, will continue the time series of precision ice topography measurements initiated by ICESat and extended in selected areas by the IceBridge campaigns. Time series of land ice topography in particular address a key open issue in climate modeling and prediction, the detailed mechanisms controlling ice sheet dynamics, and how these may change with changing climate. ICESat-2 measurements of land ice topography, sea ice extent and freeboard, and vegetation canopy height will address a range of NASA science investigations in the areas of cryospheric science; climate variability and change; and carbon cycle, ecosystems, and biogeochemistry. ICESat-2 is the planned follow-on mission to ICESat, measuring elements of ice-sheet mass balance and land surface topography to quantify the contribution to the current and recent sea level changes from changes in ice quantities and to establish linkages to climate change. Additional ICESat-2 information is available under the Project in Formulation section of this document.

Soil Moisture Active and Passive (SMAP)

The SMAP mission, a Tier-1 decadal survey mission, will provide new global measurements of soil moisture and land its freeze/thaw state at high latitudes, enabling new advances in hydrospheric science and applications. Direct measurements of soil moisture and freeze/thaw state are needed to improve understanding of regional and global water cycles, terrestrial ecosystems, and the processes that link the water, energy, and carbon cycles. Soil moisture and freeze/thaw information provided by SMAP will lead to improved weather forecasts, flood and drought forecasts, and predictions of agricultural productivity and climate change, as well as improved understanding of the sources and sinks of carbon. Additional SMAP information is available under the Project in Formulation section.

Deformation, Ecosystem Structure, and Dynamics of Ice (DESDynI)

The DESDynI mission is a Tier-1 decadal survey mission that is intended to make global measurements using an L-band Synthetic Aperture Radar (SAR) instrument and a vegetation lidar on two separate spacecraft. The overall DESDynI radar/lidar mission will greatly advance studies and understanding of climate through measurements of ice sheet velocities and quantification of terrestrial vegetation biomass, critically important for closing the global carbon cycle. The mission's interferometric SAR data will be vital to investigation of solid Earth processes and natural hazards such as earthquakes and volcanoes by observing accumulated stresses in the solid Earth. The President's FY 2012 Budget supports continued pre-formulation activities for the DESDynI mission, with the studies focused on defining an appropriate collaboration mission utilizing a NASA radar satellite and a partner-contributed lidar satellite. The mission launch readiness date (LRD) target and initial implementation approach will be determined by the end of FY 2012.

Climate Absolute Radiance and Refractivity Observatory (CLARREO)

The CLARREO mission, a Tier-1 decadal survey mission, is intended to make precision, stable measurements of the Earth's radiation budget for detection of long-term changes in the climate system and its radiation-related feedback mechanisms during the mission lifetime. The President's FY 2012 Budget provides for an extended Phase A period for the mission definition. During this extended Phase A the mission and science team will work to identify implementation options for obtaining elements of the measurement suite outside of a dedicated series of CLARREO satellites.

Surface Water and Ocean Topography (SWOT)

The SWOT mission is a Tier II decadal survey mission that will revolutionize knowledge of the surface water inventory on the continents by precisely measuring of water levels in some three million lakes and water bodies and the discharge of all major rivers. Likewise, SWOT sea surface topography data will illuminate ocean circulation as never before, aiding climate modeling and prediction. SWOT is a partnership mission with CNES, the French space agency. In FY 2012 NASA will complete the pre-formulation activities and enter in Phase A formulation.

Stratospheric Aerosol and Gas Experiment (SAGE III) on the ISS

The SAGE III instrument is an existing grating spectrometer that measures ultraviolet/visible energy. In 2009, the SAGE-III instrument was removed from storage and successfully passed initial aliveness tests. The President's FY 2012 Budget provides an opportunity to refurbish and recalibrate the instrument for possible flight on the ISS by CY 2014. Observing from the ISS, SAGE III will provide near-global, long-term measurements of key components of the Earth's atmosphere. The most important of these are the vertical distribution of aerosols and ozone from the upper troposphere through the stratosphere. In addition, SAGE III will also provide unique stratospheric and mesospheric temperature measurements of temperature in the stratosphere and mesosphere and profiles of trace gases such as water vapor and nitrogen dioxide that play significant roles in atmospheric radiative and chemical processes. In FY 2012 NASA will complete an ISS accommodation assessment and initial instrument refurbishment.

Active Sensing of CO2 Emissions over Nights, Days, and Seasons (ASCENDS)

The ASCENDS mission was recommended by the National Academies' Earth Science decadal survey as the next technological advancement of CO2 observations from space after the operation of OCO. ASCENDS is designed to sample the total column abundance of CO2 around the planet with precision and accuracy sufficient to improve our understanding of the sources and sinks of atmospheric CO2. ASCENDS is an active system, currently being designed to use the same spectral channels used on OCO-2, using on-board lasers as the light source, and measuring the back reflectance of the laser signals to monitor changes in CO2. The measurements from the active ASCENDS instruments will continue and complement the OCO-2 measurements. In FY2012, NASA will continue the pre-Phase A work started in FY 2011 and will define the acquisition and implementation strategy with the completion of the Acquisition Strategy Planning Meeting.

Pre-Aerosol, Clouds, and Ecosystem Mission (PACE)

The PACE mission will make global ocean color measurements essential for understanding the carbon cycle and how it both affects and is affected by climate change, as well as polarimetry measurements to provide extended data records on clouds and aerosols. Global ocean color measurements will be made by a radiometer instrument while a polarimeter instrument will extend data records on aerosols and clouds using the approach begun by the French PARASOL mission. The President's FY 2012 budget request enables PACE's development for launch by about 2020. The mission will extend key climate data records.

Gravity Recovery and Climate Experiment - Follow On (GRACE FO)

The GRACE mission, launched in March 2002, has acquired precision measurements of the Earth's time-varying gravitational field with a precision that led to great discoveries in understanding the Earth system including significant keys to climate change research and future climate adaptation. GRACE FO will continue to map the Earth's gravitational field and its monthly variability by making accurate measurements of the distance between its two satellites, using GPS and a microwave ranging system. It is being designed and developed as a NASA-DLR partnership, following the successful approach used to launch and operate the original GRACE mission. In FY 2011, the GRACE FO mission will complete its Acquisition Strategy Planning Meeting and its pre-Phase A activities. It will complete its KDP-A gate review and enter into formulation in FY 2012, completing the KDP-B transition at the end of FY 2012.

Other Missions and Data Analysis

Ocean Surface Topography Mission (OSTM) (also known as Jason-2) - OSTM measures sea surface height to an accuracy of less than four centimeters every ten days. The science focus areas served by OSTM include climate variability and change and water and energy cycles. This mission is a follow-on to Jason, and is currently in its prime phase through June 2011.

Terra - Terra collects global data on the state of the atmosphere, land, and oceans, as well as their interactions with solar radiation and with one another. The science focus areas served by Terra include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; Earth's surface and interior; water and energy cycles; and weather. Terra is a joint mission with Japan and Canada.

Aqua - Aqua monitors atmospheric, land, ocean, and ice variables for improved understanding of Earth's water cycle and improved understanding of the intricacies of the climate system. The science focus areas served by Aqua include: atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; climate variability and change; water and energy cycles; and weather. Aqua is a joint mission with Brazil and Japan.

Aura - Aura measures atmospheric chemical composition, tropospheric/stratospheric exchange of energy and chemicals, chemistry-climate interactions, and air quality. The science focus areas served by Aura include: atmospheric composition; climate variability and change; and weather. Aura is a joint mission with the Netherlands, Finland, and the United Kingdom.

TRMM - TRMM measures precipitation, clouds, lightning, and radiation processes over tropical regions. TRMM is one of several spacecraft currently extending the long-term radiation budget record begun in the mid-1980s. The science focus areas served by TRMM include: climate variability and change; water and energy cycles; and weather. TRMM is a joint mission with Japan.

Other Missions and Data Analysis (continued)

Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat) - ACRIMSat monitors total solar irradiance. The science focus areas served by ACRIMSat include: climate variability and change; and water and energy cycles. Because ACRIMSAT has continued to operate beyond its original planned base mission, it now provides similar measurements to its operating follow-on mission, the Solar Radiation and Climate Experiment (SORCE).

Quick Scatterometer (QuikSCAT) - QuikSCAT measures global radar backscatter and ocean surface wind speed and direction under nearly all-weather conditions, using the SeaWinds instrument. QuikSCAT is now more than five years beyond its design life, and the rotating antenna has stalled due to normal aging of the lubricant and bearings of the spin mechanism. Even with the antenna stalled, backscatter cross-section data are still being collected for several research investigations in the areas of climate variability and change and weather, although no vector wind measurements are possible. The on-orbit attitude of the QuikSCAT spacecraft has been modified slightly to match the geometry of the QuikSCAT radar backscatter measurements with those of newly launched Indian Space Agency's OSCAT scatterometer instrument, which operates at the same frequency as QuikSCAT; QuikSCAT is thus also serving as the transfer standard to allow the calibration of OSCAT and to provide a consistent, multi-mission climate data record.

Earth Observing-1 (EO-1) - The EO-1 spacecraft collects data to allow paired scene comparisons between the EO-1 Advanced Land Imager (ALI) and the Landsat-7 Enhanced Thematic Mapper Plus (ETM+). The science focus areas served by EO-1 include: carbon cycle, ecosystems, and biogeochemistry; and Earth surface and interior.

Jason-1 - The Jason-1 mission (and OSTM/Jason-2, as well) makes precise measurements of ocean height to support the study of ocean circulation and sea level rise. The science focus areas served by both Jason missions include: climate variability and change; and water and energy cycles. The Jason missions are collaborations between NASA, NOAA, the Centre National d'Études Spatiales (CNES), and (for Jason-2) EUMETSAT.

SORCE - SORCE measures the total and spectral solar irradiance incident at the top of Earth's atmosphere. The science focus areas served by SORCE include atmospheric composition, climate variability and change, and water and energy cycles.

Instrument and mission Science Teams - Instrument science teams help define the scientific requirements for their respective instruments and generate the algorithms used to process the data into useful data products for the investigations. Additionally, the science teams are responsible for validating their own algorithms and data products. ESMP is supported by the Precipitation Science Team, the Ocean Winds Science Team, and the Landsat Science Project Office.

Earth Systematic Missions Senior Review - NASA's Earth Science Division uses senior reviews, which are held every two years, to assess the continued science value of missions in operation. These reviews are comprehensive, evaluating the technical status of the satellites and the value and quality of the data they produce. The senior review helps inform decisions related to extending the missions into the future and the funding level appropriate for each.

Earth Science Program Management - Provides program management support for Earth Science missions, investigations, and activities. Additionally, it provides funding for the ESMP Office and ESSP Program Office, which assist in the overall management and execution of the Earth Science missions.

Earth Observation Systems (EOS) Research - The EOS research project funds science for the EOS missions, currently Terra, Aqua, Aura, ICESat, and Landsat missions. These individual investigator, competitively selected research projects analyze data from the missions to address related science questions. Some funded projects continue algorithm improvement and validation for the EOS Instruments data products, while overall the selected activities focus on science data analyses and the development of Earth System Data Records (ESDRs), including Climate Data Records (CDRs), relevant to NASA's research program. Studies using ICESat and CryoSat-2 were solicited in the ROSES 2009 sub-element.

Earth Systematic Missions (ESM) Research - The ESM Research project funds science teams for the Earth Systematic missions, currently the NPP and Glory missions. These are individual investigator competitively selected research to analyze data from the missions to address related science questions. In particular, the NPP science investigations are focused on developing climate data records from EOS observations continued by the NPOESS operational observing system.

Ocean Vector Winds Science Team (OVWST) - This project utilizes scientific data received from the QuikSCAT (Quick Scatterometer) satellite which measures ocean surface wind vectors by sensing ripples caused by winds near the ocean's surface. From these data, scientists can compute the winds' speed and direction, acquiring hundreds of times more observations of surface wind velocity each day than can ships and buoys. Previously, this project was associated with the Earth Systematic Mission area wherein the QuikSCAT mission is managed.

Ocean Surface Topography Science Team (OSTST) - This project utilizes scientific data received from the OSTM satellite, which measures global sea surface height. Previously this project was associated with the ESM area wherein the OSTM mission is managed.

Precipitation Science Team - This project utilizes scientific data received from the TRMM satellite to improve the forecasting of weather and severe storm events. Previously this project was associated with the ESM area wherein the TRMM is managed. This science team also supports development of supporting algorithms for the GPM mission.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete planned operations of currently operating missions.	Operating missions	No change
Complete the Glory Launch Readiness Review.	Glory	Launch in FY 2011
Launch NPP.	NPP	Launch in FY 2012
Achieve mission success criteria for OSTM.	OSTM	
Successfully complete the SMAP Critical Design Review.	SMAP	
Complete the GPM Pre-Environmental Review.	GPM	
Complete the LDCM Systems Integration Review.	LDCM	

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Implementation Schedule

Project	Phase	Beg	End
Global Precipitation Measurement Mission (GPM)	Tech		
	Form	Jul-02	Nov-09
	Dev	Dec-09	Jun-13
	Ops	Jul-13	Jul-16
	Res		
Glory	Tech		
	Form	Oct-03	Nov-05
	Dev	Nov-05	Feb-11
	Ops	Feb-11	Feb-14
	Res		
Landsat Data Continuity Mission (LDCM)	Tech		
	Form	Oct-03	Nov-09
	Dev	Dec-09	Jun-13
	Ops	Jun-13	Jun-18
	Res		
SMAP	Tech		
	Form	Sep-08	Nov-10
	Dev	Dec-11	Nov-14
	Ops	Dec-14	Dec-17
	Res		
ICESat-2	Tech		
	Form	Dec-09	Apr-12
	Dev	May-12	Oct-15
	Ops	Jan-16	Jan-19
	Res		
Ocean Surface Topography Mission (OSTM)	Tech		
	Form	Dec-02	Mar-06
	Dev	Mar-06	Jun-08
	Ops	Jul-08	Jul-11
	Res		
NPOESS Preparatory Project (NPP)	Tech		
	Form	Mar-00	Nov-03
	Dev	Dec-03	Oct-11
	Ops	Oct-11	Jan-16
	Res		
Terra	Tech		
	Form		
	Dev		
	Ops	Oct-99	Sep-11
	Res		Sep-11
Aqua	Tech		
	Form		
	Dev		
	Ops	May-02	Sep-11
	Res		Sep-11
Aura	Tech		
	Form		
	Dev		
	Ops	Jul-04	Sep-11
	Res		Sep-11
Tropical Rainfall Measuring Mission (TRMM)	Tech		
	Form		
	Dev		
	Ops	Nov-97	Sep-11
	Res		Sep-11
Active Cavity Radiometer Irradiance Monitor Satellite (ACRIMSat)	Tech		
	Form		
	Dev		
	Ops	Dec-99	Sep-09
	Res		Sep-11
Quick Scatterometer (QuikSCAT)	Tech		
	Form		
	Dev		
	Ops	Jun-99	Sep-11
	Res		Sep-11

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Project	Phase	Start	End
Earth Observing-1 (EO-1)	Tech		
	Form		
	Dev		
	Ops	Nov-00	Sep-11
	Res		
Jason	Tech		
	Form		
	Dev		
	Ops	Dec-01	Sep-11
	Res		
Ice, Clouds, and Land Elevation Satellite (ICESat)	Tech		
	Form		
	Dev		
	Ops	Jan-03	Sep-11
	Res		Sep-11
Solar Radiation and Climate Experiment (SORCE)	Tech		
	Form		
	Dev		
	Ops	Jan-03	Sep-11
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions

Program Management

GSFC manages NPP, LDCM, Glory, GPM, Terra, Aqua, Aura, TRMM, EO-1, SORCE, ICESat, and ICESat-2. JPL manages OSTM, ACRIMSat, SMAP, QuikSCAT, DESDynI, CLARREO, and Jason.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
GPM	GSFC	GSFC	JAXA - provides the dual frequency precipitation radar and a launch vehicle for GPM.
Glory	GSFC	GSFC	None.
LDCM	GSFC	GSFC	USGS - provides data processing/distribution and on-orbit operations for LDCM.
SMAP	JPL	JPL/GSFC	TBD
ICESat-2	GSFC	GSFC	TBD
DESDynI	JPL	JPL, GSFC	TBD
CLARREO	LaRC	LaRC, GSFC	TBD
OSTM	JPL	JPL	CNES - provides spacecraft, 2 core instruments, and data processing for OSTM. NOAA provides data processing/distribution, ground stations, and on-orbit operations. EUMETSAT provides a ground station and data processing/distribution.
NPP	GSFC	GSFC	NOAA/IPO - provides 3 of 4 instruments and ground system for NPP.
Terra	GSFC	GSFC	Japan's Ministry of Economy, Trade and Industry (METI) provided the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER). The Canadian Space Agency provided the Measurements of Pollution in The Troposphere (MOPITT) instrument.
Aqua	GSFC	GSFC	The National Space Development Agency (NASDA, now part of the Japan Aerospace Exploration Agency, or JAXA) provided the Advanced Microwave Scanning Radiometer for the Earth Observing System (AMSR-E) instrument. Brazil's Instituto Nacional de Pesquisas Espaciais (INPE, the Brazilian Institute for Space Research) provided the Humidity Sounder for Brazil (HSB) instrument.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aura	GSFC	GSFC	The National Environmental Research Council of the United Kingdom funded the High Resolution Dynamics Limb Sounder (HIRDLS); the instrument was designed by universities and laboratories in the U.K. and the U.S., including the University of Colorado, Oxford University, the National Center for Atmospheric Research (U.S.), and the Rutherford Appleton Laboratory (U.K.). The University of Edinburgh (U.K.) contributed to data processing algorithms and validation for the Microwave Limb Sounder (MLS). The Ozone Monitoring Instrument (OMI) was built by Dutch Space and TNO TPD in the Netherlands in cooperation with Finnish VTT and Patria Advanced Solutions Ltd. KNMI (Royal Netherlands Meteorological Institute) is the Principal Investigator Institute. Overall responsibility for OMI lies with the Netherlands Agency for Aerospace Programmes (NIVR), with the participation of the Finnish Meteorological Institute (FMI).
TRMM	GSFC	GSFC	The Japan Aerospace Exploration Agency (JAXA) provided the Precipitation Radar (PR) instrument and the launch vehicle (an H-II F6).
ACRIMSat	JPL	JPL	None.
QuikSCAT	JPL	JPL	None.
EO-1	GSFC	GSFC	None.
Jason-1	JPL	JPL	The French Centre National d'Etudes Spatiales (CNES, the National Center for Space Studies) is responsible for the Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS) instrument; THALES built the instrument, and SMP provided the ground beacons. The CNES is also responsible for the Poseidon-2 nadir-viewing radar altimeter; Alcatel Space Industries was prime contractor for the instrument.
ICESat	GSFC	GSFC	None.
SORCE	GSFC	GSFC	None.

Acquisition Strategy

The LDCM instrument was selected through open competition in FY 2007. The Ball Aerospace and Technologies Corporation is building the Operational Land Imaging (OLI) instrument for LDCM. LDCM spacecraft used Rapid Spacecraft Development Office (RSDO) selection, and selected General Dynamics (now Orbital Sciences Corp). The Thermal Infrared Sensor (TIRS) instrument was a directed development, assigned to the GSFC and being built in-house at GSFC.

NPP: Spacecraft, ATMS, and CERES were procured competitively. The VIIRS, OMPS, and CrIS were procured competitively via the NPOESS Integrated Program Office. The procurement award for each element was as follows:

- Ball Aerospace: Spacecraft and Ozone Mapping Profile Suite (OMPS) Development;
- NG Electronic Systems: Advanced Technology Microwave Sounder (ATMS) Development;
- ITT Aerospace: Cross-track Infrared Sounder (CrIS) Development;
- Raytheon: Visible/Infrared Imaging Radiometer Suite (VIIRS) Development;
- NG Space Technology: Clouds and the Earth's Radiant Energy System (CERES) Development; and
- Raytheon: Ground systems and operations.

The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technologies Corporation is building the GPM Microwave Imager (GMI) instrument for GPM. The GPM Core Spacecraft is an in-house development at GSFC. The Dual-frequency Precipitation Radar (DPR) instrument and launch vehicle for the Core Spacecraft will be provided by a foreign partner, JAXA.

The SMAP mission and spacecraft is being developed in house at JPL, with an instrument component developed at by GSFC.

The ICESat-2 mission is being developed with an in-house GSFC instrument, with elements of the instrument to be procured. The spacecraft is expected to be an RSDO procured bus.

Senior Reviews are held every two years to assess the continued science value of missions in operation past their prime mission phase. Preparations are underway for the 2013 Senior Reviews in which all missions then in operation (currently 13) will be evaluated.

The SWOT mission acquisition approach will be defined in FY 2011 and codified in the Acquisition Strategy Meeting completed at the start of FY 2012.

The ASCENDS acquisition approach will be developed in FY 2011 and codified in the Acquisition Strategy Meeting completed by the end of FY 2012.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	4/2011	To determine whether Earth Systematic Missions should enter or continue as an extended mission.	04/2013

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	356.4	31.8	-	5.3	3.8	6.1	5.9	6.0

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

In spring 2009, a problem with the Maxwell-supplied spacecraft computer had emerged and NASA changed the baseline Maxwell computer to a BAE Rad750 Single Board Computer, delaying the Glory launch readiness date to November 2010. By May 2010, the BAE unit was delivered and successfully integrated to the Glory Observatory.

The November 2010 LRD was replanned for February 2011 to allow for completion of the Taurus XL launch vehicle's Return to Flight activities, further risk reduction related to spacecraft subsystems, and resolution of launch range manifest conflicts with other scheduled launches. The approved life cycle cost remained the same and costs associated with the LRD change were covered within the project's existing cost reserves.

The mission was also impacted by the repair of a Solar Array Drive Assembly. In August 2010, an inspection revealed excessive wear to its slip ring assembly and it was deemed not flight-worthy. By November 2010, the SADA was repaired, tested, and successfully integrated to the Glory observatory. The November 2010 LRD was changed to February 23, 2011.

The risk associated with the readiness of the Taurus XL launch vehicle was retired following conclusion of the Mishap Investigation Board (MIB) that reviewed the failure of the Taurus XL fairing system, which resulted in the loss of the Orbiting Carbon Observatory. NASA developed a corrective action plan that incorporated the Mishap Investigation Board recommendations. Once all corrective actions had been closed out, NASA's Flight Planning Board approved the Taurus XL for Return to Flight. By this time, however, the LRD was delayed. The new LRD of February 23, 2011, accommodated this delay concurrent with the spacecraft's solar array drive assembly recovery.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Purpose

The Glory mission will contribute to NASA's research on atmospheric conditions that influence climate and will improve understanding of the natural and human-made factors that contribute to climate change. It will also enable a greater understanding of the seasonal variability of aerosol properties. Both advances are essential components of predicting climate change. Aerosols interact with atmospheric conditions in complex ways that can have large effects on climate.

The mission will also provide precision measurements of the solar irradiance; solar radiation is the dominant, direct energy input into the terrestrial ecosystem, affecting all physical, chemical, and biological processes.

Glory's science objectives are specifically to:

- Determine the global distribution, microphysical properties, and chemical composition of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate; and

- Continue measurement of the total solar irradiance to determine the Sun's direct and indirect effect on Earth's climate.

For more on the scientific questions addressed by Glory, visit http://glory.gsfc.nasa.gov/.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Parameters

The Glory mission will operate two scientific instruments aboard a modified, preexisting NASA spacecraft. It will fly in NASA's low Earth orbit Afternoon, or A-Train, constellation to enhance the utility of the mission data through synergistic observations from the other satellites. The A-Train constellation currently includes five spacecraft flying in close temporal proximity to each other. The Glory spacecraft will be the sixth satellite in the A-Train when it joins the constellation in FY 2011.

The APS is an advanced polarimeter that will provide measurements to increase our understanding of black carbon soot and other aerosols as causes of climate change. The APS will provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the direct and indirect effects of aerosols on climate. The APS was developed by Raytheon Space and Airborne Systems in El Segundo, CA. As of March 2009, the APS was delivered and successfully integrated to the Glory Observatory.

The TIM instrument provides continuity for the 31-year solar irradiance data record by extending the measurement currently provided by (SORCE. University of Colorado's Laboratory for Atmospheric and Space Physics is developing the TIM sensor, the instrument's Sun pointing platform, and the TIM science operations center.

Orbital Science Corporation in Dulles, VA, is developing the spacecraft and the ground system/mission operations center, and integrated the instruments. Orbital also provides mission systems engineering support and performs mission operations.

Kennedy Space Center is responsible for Glory launch services. The mission will launch on a Taurus XL from Vandenberg Air Force Base, CA.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Commitments

Glory will launch in February 2011 to begin a three-year prime mission (with a five-year goal) to gather scientific measurements of atmospheric aerosols and solar irradiance.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
APS	Raytheon	Provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols	Same	Same
TIM	U of Colorado LASP	Maintain an uninterrupted solar irradiance data record	Same	Same
Spacecraft	Orbital	Refurbishment of the Vegetation Canopy Lidar (VCL) mission bus	Same	Same
Launch vehicle	Orbital	Taurus XL	Same	Same
Ground System Ops, TIM Science Ops, APS Science Ops	Orbital / Colorado University-Boulder LASP /GSFC Institute for Space Studies	Combination of the commercial ground stations and the networks that connect them	APS: full data processing for 1 yr w/ 2 addt'l yrs of archiving. TIM: full data processing for 3 yrs	Same
Mission Ops	Orbital	Operations of the spacecraft and the generation of command uplink	Same	Same
Data Archive	GSFC Earth Science Distributed Active Archive Center (GES DAAC)	Archival and distribution of mission data	Same	Same

Schedule Commitments

Glory was confirmed for development on December 13, 2005.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Confirmation Review	12/2005	12/2005	12/2005
Mission Pre-ship review	8/2008	7/2010	12/2010
Launch	12/2008	11/2010	2/2011

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Glory Mission

Project Management

Goddard Space Flight Center has project management responsibility. The Science Mission Directorate Program Management Council has program oversight responsibility.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
APS	GSFC	GSFC	None
TIM	GSFC	GSFC	None

Acquisition Strategy

All major procurements for the directed Glory mission were sole-source awarded to meet the objective for an accelerated mission:

Aerosol Polarimetry Sensor: Raytheon Space and Airborne Systems;

Total Irradiance Monitor: University of Colorado Laboratory for Atmospheric and Space Physics; and

Spacecraft/spacecraft support: Orbital Science Corporation.

There are no remaining major procurements, as all instrument and spacecraft contracts are in place.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NASA HQ	N/A	Mission Readiness Review (MRR) - Final pre-flight review of the operational readiness of the mission	02/2011
Performance	NASA HQ	N/A	Launch Readiness Review (LRR) - Final pre-launch review of the launch vehicle readiness	02/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch Services Impact of Taurus XL Launch Failure on Glory	If Taurus T-8 (used on OCO mission) launch failure findings and / or corrective actions impact T-9 (Glory) schedule, then the Glory LRD will be impacted.	In October 2010, NASA's Flight Planning Board approved the closure of the KSC/Launch Services program's Return to Flight activities. At this point, the Return to Flight activities had impacted the November 22, 2010 launch readiness date by two months. The new LRD of February 22, 2011, accommodated this delay concurrent with the spacecraft's SADA recovery.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	631.2	82.1	-	13.6	6.4	6.3	6.0	5.5

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The changes to the NPP budget are due to the launch delay from September 2011 until October 2011 caused by late delivery to NASA of the VIIRS instrument and CrIS by the NPOESS Integrated Program Office.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Purpose

NPP is a joint mission with NOAA and the U.S. Air Force to extend key environmental measurements for weather prediction and research. The satellite will measure atmospheric and sea surface temperatures, humidity profiles, land and ocean biological productivity, cloud and aerosol properties, and earth radiation budget quantities.

The NPP mission has two objectives: Provide a continuation of select global change observations following the Earth Observing System missions Terra and Aqua; and provide the Nation's operational meteorological satellite system with risk-reduction demonstration and validation for critical sensors, algorithms, and ground processing. Due to NPOESS program delays propagated to the successor Joint Polar Satellite System (JPSS; see "Project Management") program, NPP data will be used operationally to avoid gaps in operational weather data.

For more information, please visit: http://jointmission.gsfc.nasa.gov.

Project Parameters

The NPP spacecraft is based on a modified Ball Commercial Platform 2000 bus with a five-year design life. The NPP orbit is a polar, Sun-synchronous orbit at a nominal altitude of 824 kilometers. Four of the instruments are newly developed sensors based on heritage NASA sensors. The ATMS has been developed by NASA, and three of the instruments (VIIRS, CrIS, and OMPS) were developed by the NPOESS Integrated Program Office (IPO). A fifth sensor, CERES was a spare sensor developed by NASA for the EOS Program.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Commitments

NPP is being managed for a target launch in October 2011 and will undertake the following scientific measurements over its five-year operating life: atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, cloud and aerosol properties, and Earth radiation budget measurements. NASA's commitment is for an LRD of February 2012 including an additional $35 million mission development costs. The commitment launch readiness date, lifecycle cost, and development cost reflect residual uncertainty with the NPP partner-provided instruments and the ground system development. The commitment LRD considers as well the effects of the crowded launch manifest in late 2011, should an LRD slip be required. Funds will not be reprogrammed unless the actual launch date slips beyond the internal date.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
VIIRS	Raytheon SBRS	Provide global imagery in visible and infrared frequency bands: 0.3 to 14 microns / 400 m resolution.	Same	Same
OMPS	Ball Aerospace	Collection of total column and vertical profile ozone data with 300-380 nm / LIMB 290-1000 nm .	Same	Same
CrIS	ITT Aerospace	Temperature and moisture profiles at 3.9-15.4 microns.	Same	Same
ATMS	NG Electronic Systems	Temperature and moisture profiles at 22 channels / 23-183 ghz.	Same	Same
CERES	NG Space Technology	Provide Earth radiation budget measurements in shortwave (0.3-5micron) and longwave (8-12 micron) bands	Same	Same
Spacecraft	Ball Aerospace	5-year design life, mass is 2228 kg, Power 1400 watts.	Same	Same
Launch vehicle	Boeing	Delta II 7920.	Same	Same
Ground system	Raytheon	Command, Control, and Communication Segment (C3S) and Interface Data Processing Segment (IDPS).	Same	Same

Mission Directorate: Science
Theme: Earth Science
Program: Earth Systematic Missions
Project In Development: NPOESS Preparatory Project (NPP)

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
CrIS Flight Model Delivery	Oct 2005	June 2010	Same
ATMS Flight Model Delivery	Apr 2005	Oct 2005	Same
OMPS Flight Model Delivery	Sep 2005	Aug 2008	Same
VIIRS Flight Model Delivery	Nov 2005	Dec 2009	Same
CERES Flight Model Delivery	N/A	Oct 2008	Same
Operations Readiness Review	Jun 2006	Apr 2011	Same
Launch	Oct 2006	Sep 2011	Oct 2011

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	NPOESS Preparatory Project (NPP)

Project Management

GSFC is responsible for NPP project management. Agency PMC has program oversight responsibility. NOAA/DOD IPO is responsible for managing development of OMPS, CrIS, and VIIRS instruments. Responsible official is the Earth Science Division Director.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	None	None
ATMS Development	GSFC	None	None
OMPS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
CrIS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
VIIRS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
CERES Refurbishment	GSFC	LaRC	NOAA
Data archive and storage	GSFC	None	NOAA
Ground Systems and Ops	NPOESS-IPO	None	NOAA

Acquisition Strategy

Spacecraft, ATMS, and CERES were procured competitively. The VIIRS, OMPS, and CrIS were procured competitively via the NPOESS Integrated Program Office.

The procurement award for each element was as follows:
- Ball Aerospace: Spacecraft and OMPS Development;
- NG Electronic Systems: ATMS Development;
- ITT Aerospace: CrIS Development;
- Raytheon: VIIRS Development;
- NG Space Technology: CERES; and
- Raytheon: Ground systems and operations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NPP IRT	N/A	Operations Readiness Review	4/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Command, Control, and Communcation Segment (C3S) Ground System Development Delay	If the C3S is not ready to support satellite testing, a launch delay may result.	Coordinate closely with partner (NOAA) to ensure all necessary resources are applied to complete C3S development in parallel with satellite testing.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Global Precipitation Measurement (GPM)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	349.2	155.0	-	83.8	68.7	41.4	27.2	20.1

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The changes to the project's budget reflect the deletion of a second GPM Microwave Imager (GMI-2), which would have been available to fly on a future Low-Inclination Observatory (LIO).

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Global Precipitation Measurement (GPM)

Project Purpose

The GPM mission will advance the measurement of global precipitation, making possible high spatial resolution precipitation measurements available at a three-hour or less refresh rate over much of the globe. A joint mission with JAXA, GPM will provide the first opportunity to calibrate measurements of global precipitation (including the distribution, amount, rate, and associated heat released) across tropic, mid-latitude, and polar regions.

The GPM mission has the following scientific objectives:

- Advance precipitation measurement capability from space through combined use of active and passive remote-sensing techniques. These advanced measurements will be used to calibrate dedicated and operational passive microwave sensors, with the goal of achieving global sampling;

- Advance understanding of global water/energy cycle variability and fresh water availability. Improved measurements of the space-time variability of global precipitation will substantially close the water/energy budget and elucidate the interactions between precipitation and other climate parameters;

- Improve climate prediction by providing the foundation for better understanding of surface water fluxes, soil moisture storage, cloud/precipitation microphysics and latent heat release in Earth's atmosphere;

- Advance Numerical Weather Prediction (NWP) skills through more accurate and frequent measurements of instantaneous rain rates with better error characterizations, and the development of improved assimilation methods; and

- Improve flood-hazard and fresh-water-resource prediction capabilities through better temporal sampling and wider spatial coverage of high-resolution precipitation measurements, and innovative designs in hydro-meteorological modeling.

For more information see http://gpm.gsfc.nasa.gov/.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Global Precipitation Measurement (GPM)

Project Parameters

The GPM project includes a Core Observatory Spacecraft and a robust set of spare GMI instrument subsystems to ensure the GMI instrument, NASA's instrument contribution to the Core Observatory, is ready on schedule. The Core Observatory will leverage passive microwave measurements from other operating and planned "satellites of opportunity" by calibrating their measurements to its own. The resulting sampling rate over different areas of the globe will depend on the number and orbits of the satellites of opportunity, but given the prevalence of passive microwave instruments on operational satellite systems, the global sampling will be robust.

The NASA Core Observatory will fly in a 65 degree inclined orbit at an altitude of 407 kilometers; the 65 degree orbit provides improved latitude coverage over TRMM (whose orbit was inclined 35 degrees). The Core Observatory's two scientific instruments will provide active and passive microwave measurements of precipitation.

The JAXA-supplied Dual-frequency Precipitation Radar (DPR) instrument has cross-track swath widths of 245 and 120 kilometers, in Ku-band and Ka-band, providing three-dimensional observation of rain and an accurate estimation of rainfall rate. The KuPR (13.6 GHz) subsystem of the DPR is an updated version of the highly successful radar flown on TRMM.

The GMI instrument is a conically-scanning radiometer that will provide significantly improved spatial resolution compared to the TRMM Microwave Imager (TMI).

The Core Observatory Spacecraft will be launched from Tanegashima Space Center, Japan, on an H-IIA launch vehicle. The DPR and GMI data will be relayed using the TDRSS multiple access and single access service.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Global Precipitation Measurement (GPM)

Project Commitments

The GPM Core Observatory is planned for a launch in July 2013 to begin a three-year prime mission (five-year goal). When calibrated with existing and planned passive microwave measurements from other satellites, GPM will provide global measurements of precipitation with a sampling frequency of three hours or less over much of the globe.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Core Observatory	GSFC	Provides platform for the GMI and JAXA-supplied DPR instruments.	Same	Same
Low-Inclination Observatory	N/A	N/A	Changed to be partner-provided	Second GMI instrument deleted
Dual-frequency Precipitation Radar (DPR)	JAXA	Provides cross-track swath widths of 245 and 120 kilometers, for the Ku precipitation radar (KuPR) and Ka-band precipitation radar (KaPR).	Same	Same
GMI	GSFC	Provides 13 microwave channels ranging in frequency from 10 GHz to 183 GHz; four high frequency, millimeter-wave, channels about 166 GHz and 183 GHz. 1.2 meter diameter antenna.	Same	Same
Launch Vehicle	JAXA	H-IIA	Same	Same

Schedule Commitments

GPM entered formulation in July 2002. The below milestone dates reflect the December 2009 KDP-C commitments.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	Dec 2009	Dec 2009	Dec 2009
Core Observatory LRD	Jul 2013	Jul 2013	Jul 2013

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Global Precipitation Measurement (GPM)

Project Management

GSFC has project management responsibility. The Agency Program Management Council has program oversight responsibility.

The Earth Sciences Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Core Observatory	GSFC	GSFC	None
Core Observatory: GMI	GSFC	GSFC	None
Core Observatory: DPR	GSFC	GSFC	JAXA
Launch vehicle and services: Core Observatory	GSFC	None	JAXA
Ground Systems	GSFC	GSFC	None

Acquisition Strategy

The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technologies Corporation (BATC) will build the GMI instrument for GPM. The GPM core spacecraft will be an in-house development at GSFC. The DPR instrument and launch vehicle for the Core Observatory will be provided by a foreign partner (JAXA).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ and GSFC	12/2009	System Integration Review (SIR)	5/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Non-NASA Constellation elements	Expanded global sampling depends on data from "spacecraft of opportunity" that are not part of this project.	NASA is developing data algorithms that allow GPM to make the broadest possible use of microwave instruments on other spacecraft; NASA participates in interagency and international planning processes for operational Earth observation measurements to maximize the leverage opportunities for GPM.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Landsat Data Continuity Mission (LDCM)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	434.5	106.0	-	152.0	64.1	1.5	1.5	1.6

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The LDCM project, which was approved to proceed with development in December 2009, now has a fully integrated budget including the development and accommodation of TIRS.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Landsat Data Continuity Mission (LDCM)

Project Purpose

Unprecedented changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy, human health, and society. The Landsat data series, begun in 1972, is the longest continuous record of changes in Earth's surface as seen from space and the only satellite system designed and operated to repeatedly observe the global land surface at moderate resolution. Landsat data are available at an affordable cost, providing a unique resource for people who work in agriculture, geology, forestry, regional planning, education, mapping, and global change research.

The purpose of LDCM is to extend the record of multi-spectral, moderate resolution Landsat-quality data, and to meet U.S. Government operational and scientific requirements for observing land use and land change.

For additional information, visit the LDCM mission Home Page: http://ldcm.nasa.gov/.

Project Parameters

LDCM is being developed for an LRD that will minimize a potential data gap in the archive due to the fuel-limited life of Landsat-7. Recent analyses by the USGS and NASA have estimated the Landsat-7 mission should continue to operate through at least the end of 2012. The LDCM mission completed its Confirmation Review on November 30, 2009, and its KDP-C transition review on December 16, 2009. Due to the high national importance of the mission and the need to maintain the continuity of the Landsat data record, NASA and USGS will implement the LDCM mission for a December 2012 launch, providing necessary budget and other resources to ensure all mission elements are ready for this launch date. A probabilistic analysis has determined that the launch date could move as far as June 2013, driven by the late addition of the TIRS instrument. However, the LDCM project has been directed to execute all necessary contracts and actions to accomplish the December 2012 Launch Readiness Date.

LDCM consists of a two science instruments (the Operational Land Imager and the Thermal Infrared Sensor), a spacecraft, and a mission operations element. The LDCM is in implementation and system level requirements are baselined to provide the following system-level performance parameters:

- Earth Spatial-Temporal Coverage: 16-day repeat coverage of the global land mass;

- Spatial Resolution: 30 meters (visible, NIR, SWIR), 120 meters (thermal); 15 meters (panchromatic);

- Radiometric Performance: accuracy, dynamic range, and precision sufficient to detect land cover change using historic Landsat data;

- Data: 185-kilometer cross track-by-180-kilometer along track multi-spectral image of Earth's surface; and

- Mission Life: five years.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Landsat Data Continuity Mission (LDCM)

Project Commitments

After launch, the spacecraft and OLI instrument will operate for a minimum of five years. The TIRS instrument will operate for a minimum of three years.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
OLI	Ball Aerospace and Technology Corporation	Provide Landsat-equivalent data to extend the Landsat data of Earth's land surface for five years.	Same	Same
TIRS	GSFC	Provide Landsat-equivalent thermal data to extend the Landsat data of Earth's land surface for three years.	New	Same
Spacecraft	General Dynamics	Provide performance and reliability commensurate with OLI and TIRS data requirements.	Same	Same
Launch Vehicle	ULA	Provide launch service access to space.	Same	Same
Mission Operations Element	Hammers Corporation	Provide capability for command and control, mission scheduling, long-term trending and analysis, and flight dynamics analysis.	Same	Same

Schedule Commitments

LDCM completed its spacecraft CDR and mission CDR in FY 2010. Due to the high national importance of the mission and the need to maintain continuity of the Landsat data record, NASA and USGS will strive to launch LDCM in December 2012. The LDCM project has been directed to execute all necessary contracts and actions to accomplish the December 2012 launch. Consistent with NASA policies regarding commitments to cost and schedule, the LDCM launch shall be no later than June 2013.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Formulation			
Award OLI contract	July 2007	July 2007	July 2007
Confirmation Review	Dec 2009	Dec 2009	Dec 2009
Critical Design Review (CDR)	Apr 2010	Apr 2010	Apr 2010
PSR	Sep 2012	Sep 2012	Sep 2012
Launch	Jun 2013	Jun 2013	Jun 2013
Handover of Operations to USGS	Sep 2013	Sep 2013	Sep 2013

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Development:	Landsat Data Continuity Mission (LDCM)

Project Management

LDCM is under the Earth Systematic Missions program within the Earth Science Division (ESD) of SMD. The NASA Associate Administrator (AA) is the decision authority; the ESD Director is the responsible official; and GSFC is the lead management organization.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Operational Land Imager	GSFC	GSFC	None
Thermal Infrared Sensor	GSFC	GSFC	None
Spacecraft	GSFC	GSFC	None
Ground System	GSFC	GSFC	U.S. Department of Interior-U.S. Geological Survey
Mission Operations	GSFC	GSFC	U.S. Department of Interior-U.S. Geological Survey

Acquisition Strategy

NASA's acquisition plan includes acquiring separate elements of the LDCM mission through open competition, with GSFC acting as the mission integrator and leading the element source selections. NASA has issued competitively selected contracts for the following major elements: Ball Aerospace and Technology Corporation for the development of the Operational Land Imager in July 2007; General Dynamics Corporation for the development of the spacecraft in April 2008; and Hammers Corporation for the development of the Mission Operations Element (MOE) in September 2008. The Thermal Infrared Sensor will be designed and built in-house at GSFC utilizing civil servants and support contractor personnel.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ and GSFC	9/2008	Systems Requirement Review - Successful	N/A
Performance	HQ and GSFC	7/2009	Mission Preliminary Design Review - Successful	N/A
Performance	HQ and GSFC	5/2010	Mission Critical Design Review	N/A
Performance	HQ and GSFC	N/A	Systems Integration Review	08/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Thermal Infrared Sensor (TIRS) development risk	The TIRS instrument has an aggressive development schedule due to late addition to the instrument complement and there is a risk that TIRS will not be delivered on schedule to meet the LDCM launch readiness date.	The LDCM project will develop alternative observatory integration and test scenarios to allow for late arrival of TIRS. In the event that TIRS cannot be delivered in time to meet the LDCM launch date, a flyable mass model will be developed.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Ice, Cloud, and land Elevation Satellite-2

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	38.9	-	102.1	159.4	128.8	83.1	28.6

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Purpose

ICESat-2 will continue the measurements begun with the ICESat mission, measuring elements of ice-sheet mass balance, sea ice freeboard and large-scale biomass to quantify polar ice sheet contributions to current and recent sea level change and linkages to the climate state. In addition ICESat-2 will quantify regional ice sheet changes to assess mechanisms driving that change and improve predictive ice sheet models. The science focus areas served by ICESat-2 include climate variability and change, Earth surface and interior, and water and energy cycles. The ICESat-2 mission is one of four first-tier missions recommended by the National Academies' decadal survey, titled "Earth Science and Applications from Space: National Imperatives for the Next Decade and Beyond." The ICESat-2 mission will draw lessons learned from the original ICESat satellite launched in FY 2003 and operated through CY 2009.

For more information see http://nasascience.nasa.gov/missions/icesat-ii.

Project Preliminary Parameters

The ICESat-2 observatory employs a dedicated spacecraft with a multi-beam photon-counting surface elevation lidar. It will be launched into a 450 kilometer, 94-degree, 91-day repeat orbit.

Pursuant to Senate Report 111-34, incorporated by reference into the Statement Accompanying the Consolidated Appropriations Act, 2010 (PL 111-117) and as required by NASA standard project formulation processes, the ICESat-2 project is working toward a mature [Technology Readiness Level - 6] baseline instrument concept in preparation for formal mission confirmation at the end of FY 2012. This includes the photon-counting approach to provide cross-track measurement capabilities identified in Senate Report 111-34. As part of this engineering process, the project will use an airborne instrument to simulate the space-based measurements to optimize the final instrument design and to develop algorithms to meet all Level 1 requirements. Based on cost and schedule analysis of the ICESat-2 preliminary design, a baseline budget and launch readiness date will be established at mission confirmation.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Ice, Cloud, and land Elevation Satellite-2

Estimated Project Deliverables

ICESat-2 is in formulation and does not yet have an official launch date; however, the Phase A target launch date is January 2016 with a notional three-year prime mission.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	TBD	Competitively selected	Same	Same
Lidar Instrument	TBD	Multi-beam micro-pulse laser with photon-counting detector	New	Same
Launch Vehicle	TBD	Competitively selected	Same	Same

Estimated Project Schedule

ICESat-2 is in formulation. Milestone dates beyond the formulation phase are preliminary estimates pending completion of formulation.

Milestone Name	Formulation Agreement Estimate	FY 2011 PB Request	FY 2012 PB Request
Formulation			
Formulation			
KDP-A	N/A	September 2009	December 2009
Launch readiness date (LRD)	N/A	Late 2014/Early 2015	January 2016

Project Management

GSFC has project management responsibility. The Science Mission Directorate Program Management Council has programmatic oversight. The Earth Sciences Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	TBD	TBD
Lidar	GSFC	GSFC	None
Mission Operations	GSFC	TBD	TBD
Launch Vehicle	GSFC	TBD	TBD

Acquisition Strategy

The ICESat-2 lidar instrument will be designed and tested at GSFC using component procurements from industry. The spacecraft vendor will be competitively selected. The approach for the mission operations element has not yet been determined. The source and selection method for launch services will be determined during formulation.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Ice, Cloud, and land Elevation Satellite-2

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	ICESat-2 Independent Review Team	02/2009	Mission Concept Review/Requires Delta Review	11/2009
Performance	ICESat-2 Independent Review Team	11/2009	Mission Concept Review /Successfully completed	
Performance	Standing Review Board	N/A	System Requirements Review (SRR) and Mission Definition Review (MDR)	03/2011

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Soil Moisture Active and Passive (SMAP)

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**70.0**	**-**	**135.2**	**172.3**	**31.1**	**29.6**	**14.5**

Note:

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Project Purpose

The SMAP mission will provide unique information on global soil moisture and its freeze/thaw states to enable advances in hydrospheric science/applications and climate research. It is one of the four Tier-1 NASA missions recommended by the Earth science and applications decadal survey. Direct measurements of soil moisture and freeze/thaw states are needed to improve understanding of regional and global water cycles, terrestrial ecosystems, and the processes that link the water, energy, and carbon cycles. Obtaining global soil moisture measurements every three days, SMAP's data will lead to improved weather forecasts, flood and drought forecasts, and predictions of agricultural productivity and climate change, as well as improved understanding of the sources and sinks of carbon. SMAP mission data will contribute to the goals of four Earth Science focus areas (carbon cycle, ecosystem, weather, and climate). SMAP is based on the soil moisture and freeze/thaw mission concept developed under the ESS) Program Hydrosphere State (Hydros) project and builds on the Hydros formulation and technology risk mitigation studies conducted in 2003 through 2005.

For more information see http://nasascience.nasa.gov/missions/smap.

Project Preliminary Parameters

The SMAP observatory employs a dedicated spacecraft and will be launched into a near-polar, sun-synchronous orbit on an expendable launch vehicle. The baseline SMAP instrument suite includes a radiometer and a synthetic aperture radar operating in the L-band range (1.20-1.41 GHz) designed to make coincident measurements of soil emission and backscatter to sense the top five centimeters of soil through moderate vegetation cover. These measurements will be analyzed to yield estimates of soil moisture and freeze/thaw state. Data will be acquired for a period of three years and a comprehensive validation program will be used to assess random errors and regional biases in the soil moisture and freeze/thaw estimates.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Soil Moisture Active and Passive (SMAP)

Estimated Project Deliverables

SMAP is planned for a launch in November 2014 for a three-year prime mission. SMAP will make soil moisture measurements around the entire Earth every three days.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	JPL	Provides platform for the instrument	Same	Same
L-Band SAR	JPL	Combined with Radiometer provides soil moisture measurements in the top 5 cm of soil through moderate vegetation cover	Same	Same
L-Band Radiometer	GSFC	Combined with SAR provides soil moisture measurements in the top 5 cm of soil through moderate vegetation cover	Same	Same
Launch Vehicle	TBD	TBD	Same	Same

Estimated Project Schedule

Milestone Name	Formulation Agreement Estimate	FY 2011 PB Request	FY 2012 PB Request
Formulation			
Formulation			
KDP-C	April 2010	December 2010	Mid-to-Late 2011
Launch readiness date (LRD)	Mid CY 2015		November 2014

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
Project In Formulation:	Soil Moisture Active and Passive (SMAP)

Project Management

JPL has project management responsibility for SMAP. The Science Mission Directorate Program Management Council has program oversight responsibility.

The Earth Sciences Division Director is the responsible official.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	JPL	None
L-Band SAR	JPL	JPL	None
L-Band Radiometer	JPL	GSFC	None
Launch Vehicle	JPL	To be determined	To be determined

Acquisition Strategy

The SMAP spacecraft will be built in-house at JPL. The SMAP instrument, combining the SAR and radiometer, will be integrated by JPL. The SAR will be built by JPL and the radiometer by GSFC. The deployable antenna/boom and instrument spin assemblies will be procured through open competition. The source and selection method for launch services will be determined later in formulation.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SMAP Standing Review Board (SRB)	05/2009	Mission Design Review-successfully completed.	Mid 2011

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**128.4**	**-**	**187.8**	**180.6**	**229.5**	**238.4**	**214.3**
Aquarius	22.3	-	4.9	4.6	4.9	5.1	5.2
OCO-2	62.0	-	91.0	41.0	13.0	4.0	0.0
Venture Class Missions	6.3	-	61.5	103.9	179.7	196.6	175.7
Other Missions and Data Analysis	37.9	-	30.5	31.1	31.9	32.7	33.4

Note:
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Program Overview

ESSP includes a series of relatively low-to-moderate cost, small-to-medium sized, competitively selected, PI-led missions. These missions complement the larger and more broadly capable missions in ESMP. ESSP missions have focused scientific objectives to support a selected subset of studies of the atmosphere, oceans, land surface, polar ice regions, or solid Earth. Investigations include development and operation of remote-sensing instruments and the conduct of investigations using data from these instruments. In FY 2012, NASA will continue the accelerated development of an Orbiting Carbon Observatory reflight mission (OCO-2) with the objective to launch in February 2013. With the successful OCO-2 progress, NASA will begin the initial design phase of the OCO-3 instrument mission of opportunity, culminating in a KDP-B gate review transition for OCO-3 by the end of FY 2012. In FY 2012, NASA will continue the five airborne science investigations selected through the initial Venture Class solicitation (EV-1) in FY 2010 and started in FY 2011. ESSP will complete the evaluation and selection of winning proposals from two additional Earth Venture AO calls. The second Earth Venture AO call, EV-2, for small complete satellite missions will be released in FY 2011, and the initial annual call (EV-Instrument) for instruments of opportunity in support of the Climate Initiative will be released early in FY 2012. The winning proposals for each call will be selected during FY 2012. The target small mission launch date will be no more than five years after selection, and the anticipated instrument delivery as early as FY 2016 or FY 2017 (depending on the complexity of the instrument selected). Annual EV-Instrument calls are an integral part of the Climate Initiative and are supported in the President's Budget. The ESSP currently has two missions in development, OCO-2 and Aquarius; three operating missions, GRACE, CloudSat, and CALIPSO; and five EV-1 airborne science investigations underway.

For more information see http://earth.nasa.gov.

Plans For FY 2012

The ESSP Program plans for FY 2012 include:

- On orbit checkout and calibration/validation of the Aquarius/SAC-D mission;

- Completion of the OCO-2 Phase C and the KDP-D transition of this mission into Acceptance, Test, and Launch Operations (ATLO) activities;

- Completion of the initial design phase of the OCO-3 instrument mission of opportunity, culminating in a KDP-B phase transition by the end of FY 2012;

- Initial science data acquisitions from the selected EV-1 investigations;

- Evaluation and selection of the winning proposal from the EV-2 small-mission AO;

- Evaluation and selection of the winning proposal(s) from the first annual EV-Instrument AO, soliciting significant Earth-observing instruments for flights of opportunity; and

- Continued operations of the GRACE, CloudSat, and CALIPSO missions based on the direction of the 2011 Senior Review.

Project Descriptions and Explanation of Changes

Aquarius

Aquarius will observe and model seasonal and year-to-year variations of sea-surface salinity and how these variations relate to changes in the water cycle and ocean circulation. The science focus areas served by Aquarius will include: climate variability and change; and water and energy cycles. Aquarius is currently in Phase D with a manifested launch date of June 2011 and three years of prime mission life. Additional detail can be found in the Aquarius development section of this document.

Orbiting Carbon Observatory - 2

OCO-2 is a replacement for the original OCO, which failed to reach orbit in February 2009 due to a launch vehicle anomaly. OCO-2 will utilize OCO's implementation approach to the greatest degree practical to reduce mission development risk. The OCO-2 mission objectives are identical to those for OCO. OCO-2 employs a dedicated spacecraft with a single instrument, designed to measure CO2 and O2 near-infrared absorptions from reflected sunlight. Additional detail can be found in the OCO-2 section of this document.

Venture Class Missions

"Venture-class" Earth System Science Pathfinder missions have been established in response to the National Academies' Earth science decadal survey. Venture-class missions will be small, competed science investigations, and will include suborbital payloads; instruments to be flown as missions of opportunity on host spacecraft (e.g., non-NASA spacecraft or ISS); and small, focused satellites.

Other Missions and Data Analysis

Included in this line item are three operating spacecraft:
- GRACE, launched in FY 2002, measures Earth's gravity field and its variations with time;
- CloudSat, launched in FY 2006, measures cloud characteristics to increase understanding of the role of optically thick clouds in Earth's radiation budget; and
- The CALIPSO mission, launched in FY 2006, measures the vertical distribution of clouds and aerosols in the atmosphere.

In addition, this line includes the ESSP research project providing funds for the science teams for the ESSP missions. The science teams are comprised of competitively selected individual investigators who analyze data from the missions to address the related science questions.

Orbiting Carbon Observatory-3 Instrument

OCO-3 is an instrument to be built from the spare parts residual from the OCO-2 instrument and mission development. The instrument will be modified from the OCO-2 design to allow it to be compatible with multiple possible payloads. The OCO-3 instrument capabilities will be consistent with those of the OCO-2 instrument and mission.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete Senior Reviews (SRs) to make recommendations on mission extensions.	GRACE, CloudSat, and CALIPSO	
Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	OCO-2	
Complete the ICESat-2 Preliminary Design Review.	ICESat-2	
Complete the Earth Venture 1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder	

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24	Phase Dates	Beg	End
Aquarius		Tech		
		Form	Oct-03	Sep-05
		Dev	Oct-05	Jun-11
		Ops	Jun-11	Jul-14
		Res		
Orbiting Carbon Observatory - 2		Tech		
		Form	Feb-10	Sep-10
		Dev	Oct-10	Jan-13
		Ops	Feb-13	Feb-15
		Res		
Gravity Recovery and Climate Experiment (GRACE)		Tech		
		Form		
		Dev		
		Ops	Mar-02	Sep-11
		Res		
CloudSat		Tech		
		Form		
		Dev		
		Ops	Apr-06	Sep-11
		Res		
Cloud-Aerosol Lidar and Infrared Pathfinder Satellite (CALIPSO)		Tech		
		Form		
		Dev		
		Ops	Apr-06	Sep-11
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder

Program Management

The Agency Program Management Council has program oversight responsibility. The Earth Science Division Director is responsible for program oversight.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aquarius	JPL	JPL	Argentina's Comision Nacional De Actividades Espaciales (CONAE), National Oceanic and Atmospheric Administration, Naval Research Laboratory, National Center for Atmospheric Research.
Orbiting Carbon Observatory - 2	JPL	JPL	N/A
GRACE	Earth Science Division	JPL	Deutches Zentrum fur Luft- und Raumfahrt (DLR, the German Aerospace Center); Office National d'Etudes et de Recherches Aerospatiale (ONERA) of France; GeoForschungsZentrum (German National Research Centre for Geosciences); National Oceanic and Atmospheric Administration; National Geospatial-Intelligence Agency.
CloudSat	Earth Science Division	JPL	Canadian Space Agency; U.S. Air Force; Department of Energy.
CALIPSO	Earth Science Division	LaRC	France's Centre National d'Etudes Spatiales (CNES, the National Center for Space Studies) and Alcatel; SODERN; Institut Pierre Simon Laplace, France.

Acquisition Strategy

ESSP Program missions are selected competitively via AO. The AO process uses peer review for the science content of the proposed missions, as well as thorough independent review of their technical, management, and cost elements. Evaluations and selections will be completed for the second Venture Class call, EV-2, and for the first instrument only AO, EV-I1. OCO-2 is a NASA-directed mission, but remains under the ESSP Program, as the original OCO was selected under an AO. NASA will seek to duplicate the OCO acquisition strategy to the greatest degree practical.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	05/2009	CALIPSO, GRACE, and CloudSat were reviewed as part of the Earth Science biennial Senior Review process. All three missions were approved for extended operations through the end of FY 2011.	04/2011
Performance	SRB	09/2010	OCO-2 will be subject to a KDP-C Confirmation Review to establish the mission development baseline.	02/2012

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**221.5**	**22.3**	**-**	**4.9**	**4.6**	**4.9**	**5.1**	**5.2**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The FY 2011 budget for Aquarius reflected the cost for a launch no earlier than December 2010. Spacecraft development delays at NASA's foreign partner, Argentina's National Committee of Space Activities (CONAE) spacecraft have set the launch to no earlier than June 2011.

Project Purpose

The Aquarius mission will investigate the links between the global water cycle, ocean circulation, and climate. It will observe and model variations of sea surface salinity, and how these relate to changes in the water cycle and ocean circulation. This will yield an unprecedented view of the oceans' role in climate and weather. For more information visit: http://aquarius.gsfc.nasa.gov/.

Project Parameters

Aquarius is an instrument on Argentina's CONAE spacecraft, Satellite de Aplicaciones Cientificas-D (SAC-D). The combined NASA and CONAE instruments and spacecraft form the Aquarius/SAC-D observatory. This observatory will be launched into a polar, Sun-synchronous orbit that allows global coverage of ice-free ocean surfaces consistent with Aquarius/SAC-D science observational targets. The Aquarius instrument includes an L-band microwave radiometer (1.413 GHz) and scatterometer (1.26 GHz). The radiometer will measure the surface brightness temperature, which is related to the surface emissivity and physical temperature of the seawater. The surface emissivity is determined by the dielectric constant of seawater, which is related to salinity. The scatterometer is required to provide coincident information of sea surface roughness, a critical correction term for retrieval of sea surface salinity.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Project Commitments

Aquarius is manifested to launch no earlier than June 2011 to begin a three-year prime mission to measure sea surface salinity with the precision, resolution, and coverage needed to characterize salinity variations and investigate the linkage between ocean circulation, Earth's water cycle, and climate variability.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Aquarius Instrument (integrated radiometer/ scatterometer)	JPL	L-band microwave radiometer at 1.413 GHz; scatterometer at 1.26 GHz; SSS measurements with root-mean-sq random errors and systematic biases <= 0.2 psu on 150 km sq scales over ice-free oceans.	Same	Same
Spacecraft	CONAE	SAC-D	Same	Same
Launch Vehicle	Boeing	Delta II	Same	Same
Data Management	GSFC	N/A	Same	Same
Operations	CONAE	Command and telemetry	Same	Same

Schedule Commitments

The Aquarius mission entered a Risk Mitigation Phase (RMP) in July 2002. Following the RMP, the project was authorized to proceed to a formulation phase in December 2003. The Aquarius mission was authorized by the NASA Science Mission Directorate to proceed to development on October 12, 2005. In November 2007, the NASA Science Mission Directorate Program Management Council approved a replan of Aquarius, including a launch delay to May 2010. In December 2009, the NASA Science Mission Directorate Program Management Council approved another replan of Aquarius, including a launch delay manifesting the Aquarius/SAC-D mission for a January 2011 launch. In September 2010, NASA, in coordination with CONAE, made the decision to delay the launch readiness date to June 2011 based on the progress on SAC-D testing and assessment of the remaining schedule. The replan of the Aquarius project for this change is scheduled to take place in March 2011.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Confirmation Review	September 2005	September 2005	September 2005
Mission CDR	August 2007	July 2008	July 2008
Aquarius Instrument Pre-ship Review [FY 2008 APG]	May 2008	May 2009	May 2009
Launch	March 2009	January 2011	June 2011

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Aquarius

Project Management

The Jet Propulsion Laboratory is responsible for project management. The Science Mission Directorate Program Management Council is responsible for program oversight. The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Vehicle	KSC	KSC	None
Ground System	JPL	GSFC	None
Aquarius Instrument	JPL	JPL	None
Spacecraft	CONAE	None	CONAE
Radiometer	JPL	GSFC	None
Data management	GSFC	GSFC/JPL	None
Mission operations	CONAE	None	CONAE

Acquisition Strategy

Aquarius was competitively selected from proposals submitted in response to ESSP AO 3. All elements of the project were included in that selection, and there are no other planned major procurements.

The launch vehicle procurement was awarded to Boeing. GSFC and JPL were selected for the remaining project elements not provided by CONAE.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Aquarius Standing Review Board	7/2010	Aquarius Replan Review -- Determined readiness of Aquarius instrument integration with the SAC-D Observatory (Phase D). Recommendation to proceed to Phase D.	3/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft Development Delays	Further delays could impact launch date.	Monitor Comision Nacional De Actividades Espaciales (CONAE) progress and confirm commitments; reassess available schedule reserves.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory-2 (OCO-2)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	29.1	62.0	-	91.0	41.0	13.0	4.0	0.0

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory-2 (OCO-2)

Project Purpose

Data received from OCO-2 will support climate research by enabling an improved understanding of natural, distributed CO2 sources and sinks and ocean/atmosphere and land/atmosphere CO2 exchange processes. OCO-2 measurements will initiate a global time series of atmospheric CO2 for direct support of policy development and verification of regulations and environmental treaties. Rapid development and launch of OCO-2 is a key element of the President's Budget.

OCO-2 replaces the original OCO, which failed to reach orbit in February 2009 due to a launch vehicle anomaly. OCO-2 will utilize OCO's detailed design and implementation approach to the greatest possible degree to reduce risk. The mission objectives of OCO and OCO-2 are identical.

Project Parameters

The OCO-2 mission consists of a dedicated spacecraft with a single instrument, flying in a near-polar, Sun-synchronous orbit launched by an expendable launch vehicle. The orbit's early afternoon equator crossing time maximizes the available signal and minimizes diurnal biases in CO2 measurements associated with photosynthesis. The OCO-2 flight system uses hardware components, software, and processes with space flight heritage, in particular drawing from the spacecraft and mission design implemented for the OCO mission. The spacecraft structure is made of honeycomb panels that form a hexagonal shape. This structure houses the instrument and the spacecraft bus components. Panels with solar cells are attached and stowed such that the whole structure fits inside the small fairing of the Taurus XL launch vehicle. For the OCO-2 mission, the spacecraft has been elongated to accommodate the instrument, and the instrument has been embedded into the structure of the spacecraft, exactly as was done for the OCO spacecraft. The instrument consists of a single telescope feeding three high-resolution grating spectrometers. The optics will be cooled to approximately 270 Kelvin (K) and the Focal Plane Arrays (FPAs) to approximately 120 K. The instrument will measure CO2 and O2 near-infrared absorptions from reflected sunlight. Remote sensing retrieval algorithms will process these data to yield estimates of the column-averaged CO2 dry air mole fraction, XCO2. The total weight of the observatory is about 530 kilograms. The original OCO successfully completed qualification of this configuration prior to launch.

Project Commitments

The OCO-2 is planned to launch in February 2013 to begin a two-year mission. OCO-2 will provide atmospheric CO2 measurements with near global coverage of the sunlit portion of Earth on a 16-day repeat cycle.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	Orbital Sciences Corp	Provides platform for the instrument	New	Same
OCO-2 Instrument	JPL	Three channel, high-resolution grating spectrometer measuring CO2 and O2 near-infrared absorptions from reflected sunlight	New	Same
Launch Vehicle	Orbital Sciences Corp	Taurus XL	New	Same

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
Project In Development:	Orbiting Carbon Observatory-2 (OCO-2)

Schedule Commitments

Based on design maturity due to the heritage of OCO, OCO-2 entered Formulation in February 2010. Completion of KDP-C and transition to Development occurred in September 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	N/A	December 2010	September 2010
LRD	N/A	February 2013	February 2013

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Project Management

JPL has project management responsibility for OCO-2. The Science Mission Directorate Program Management Council has program oversight responsibility. The Earth Sciences Division Director is the responsible official.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	None	None
Instrument	JPL	JPL	None
Ground System	JPL	JPL	None
Launch Vehicle	JPL	KSC	None

Acquisition Strategy

The OCO-2 spacecraft will be built by Orbital Sciences Corporation. A sole source procurement is being pursued to maintain the same configuration as OCO. The OCO-2 instrument will be built in-house at JPL.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	OCO-2 SRB	09/2010	OCO-2 will complete a KDP-C Confirmation Review, to establish the mission development baseline.	02/2012

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch Vehicle Failure	If Taurus XL launch vehicle failure occurs, then there will be a loss of mission.	NASA is employing a rigorous Return-to-Flight program on the Taurus XL launch vehicle for the Glory mission. The OCO team is being provided insight into these results.
Single String Component Failure	If an OCO-2 single string (i.e. no redundancy) component fails, then there may be a loss of mission.	OCO-2 (based on the competed OCO design) was designed to have some single string components. Thorough analyses and testing is being performed to mitigate this risk as much as possible.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**149.0**	**-**	**159.9**	**158.8**	**159.4**	**162.9**	**166.6**
Earth Science Multi-Mission Operations	149.0	-	159.9	158.8	159.4	162.9	166.6

Note:
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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Program Overview

The Earth Science Multi-Mission Operations program acquires, preserves, and distributes observational data to support Earth Science focus areas in conformance with national science objectives. The Earth Science focus areas are: climate variability and change; atmospheric composition; carbon cycle, ecosystems, and biogeochemistry; water and energy cycles; weather; and Earth surface and interior. Facilities involved in this undertaking include data handling, data processing, and archiving systems.

NASA's principal Earth Science information system is EOSDIS, which has been operational since August 1994. EOSDIS acquires, processes, archives, and distributes Earth science data and information products created from satellite data, which arrive at the rate of more than four trillion bytes (four terabytes) per day. Having successfully created this system, NASA is using advances in information technology to expand its capabilities while providing continuous service to the user community. The successful completion of the Evolution of EOSDIS Elements (EEE) effort has increased efficiency and operability and increased data usability by the research, application, and modeling communities. EOSDIS provides services and tools to enable use of NASA's Earth science data in next-decadal models, research results, and decision support system benchmarking and improved support for end users. The budget request for FY 2012 incorporates cost savings that result from this effort and supports upcoming missions including GLORY, OCO-2, and GPM. EOSDIS project management is working with decadal survey mission teams to understand their mission data characteristics and guide further improvements and system evolution. A system plan for 2015 and beyond will take into account evolution needs for new missions being developed in response to the National Academies' decadal survey. Small investments will enable the system to keep technologically current, and incorporate new research data and services.

NASA Earth science information is archived at eight Distributed Active Archive Centers (DAACs) located across the United States. The DAACs specialize by topic area, and make their data available to researchers around the world. For more information, please see http://eos.nasa.gov/eosdis.

Research opportunities related to EOSDIS are available through ACCESS at http://access-projects.gsfc.nasa.gov/.

MEaSUREs is available at http://measures-projects.gsfc.nasa.gov/. Participants in these programs are solicited through the ROSES opportunities.

Plans For FY 2012

The Earth Science Multi-Mission Operations program will continue operation of EOSDIS, the DAACs and their accompanying functions, and Core System Science Data Processing Systems. The maintenance of these systems is important to collection of data from Earth Science satellites in orbit, as well as the continuity of Earth science research efforts.

NASA plans to continue supporting the EEE effort to enable a service-oriented architecture between now and 2015. EOSDIS personnel will continue working with decadal survey mission team data and mission operations representatives.

Five-year MEaSUREs projects began work in FY 2008 to continue development of multi-instrument Earth System Data Records, including Climate Data Records. An ACCESS solicitation will be released in NASA's ROSES-2011 and selections for new ACCESS Projects are planned in FY 2012. Projects from the third program solicitation, Earth System Data Records Uncertainty, will be in their second year. These projects, performed under Cooperative Agreements are proving very valuable for maintaining active involvement of the research and modeling communities involved with the EOSDIS architecture and informing core infrastructure evolution decisions.

Project Descriptions and Explanation of Changes

EOSDIS

EOSDIS is the central data handling system for NASA's Earth science efforts. EOSDIS components funded in the project include:

- Production of EOS standard science data products, using algorithms and software developed by EOS investigators;

- Active archive of all NASA Earth science data, as well as ordering, distribution, and data management, ensuring also the preservation of data, products, related algorithms, and system-configuration history;

- Information management, enabling researchers to rapidly locate and retrieve data critical to their work; and

- User support for research scientists, educators, students, and users in public agencies responsible for operational applications of the data, as well as for the general public.

The Precipitation Processing System (PPS) is a measurement-based data and information system at GSFC that evolved from the TRMM Science Data and Information System (TSDIS). PPS continues to support the TRMM Science Team with analyzed rainfall data from TRMM as well as data from other precipitation instruments, and is also developing further to support the upcoming GPM mission to be launched in FY 2013. PPS, beginning with the core software architecture of TSDIS, is being generalized from a system coded for a single mission to one capable of processing data from multiple satellites. The level 1 algorithm code from TRMM is being extended and enhanced to work with GPM Microwave Imager. Tasks, such as unique GPM packet de-segmentation and multiple precipitation instruments near-real-time, are being added. To support long-term precipitation needs; extendibility, flexibility, and portability are being added to the base architecture.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Earth Science Multi-Mission Operations

This project funds the Elements of EOSDIS Evolution, aimed at improving the efficiency and effectiveness of EOSDIS while reducing the cost, and the Distributed Active Archive Centers, which collect, disseminate, and archive Earth science data at eight centers across the Nation:

- The Alaska SAR Facility, which collects Synthetic Aperture Radar data, and information on sea ice, polar processes, and geophysics;

- The GSFC Earth Sciences Data and Information Services Center, which collects information on atmospheric composition, atmospheric dynamics, global precipitation, ocean biology, ocean dynamics, and solar irradiance;

- The Langley Research Center DAAC, which collects data on Earth's radiation budget, clouds, aerosols, and tropospheric chemistry;

- The Land Processes DAAC, which collects land processes data;

- The National Snow and Ice Data Center, which collects snow and ice data, as well as information about the cryosphere and climate;

- The Oak Ridge National Laboratory DAAC, which collects data on biogeochemical dynamics and ecological data for studying environmental processes;

- The Physical Oceanography DAAC, which collects information on oceanic processes and air-sea interactions; and

- The Socioeconomic Data and Applications Center, covering population, sustainability, multilateral environmental agreements, natural hazards, and poverty.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Provide services and tools for use of NASA's Earth Science data in next-decadal models, research results, and decision support system benchmarking.	EOSDIS and DAACs	None
Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science Efficiency Measure	None
Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Efficiency Measure	None

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Multi-Mission Operations

Implementation Schedule

Project	Prior	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Phase	Beg	End
EOSDIS and Multi-Mission Operations (including DAACs)																	Tech		
																	Form		
																	Dev		
																	Ops	Aug-94	Dec-15
																	Res		
Elements of EOSDIS Evolution (phased start-up beginning in FY 2008)																	Tech		
																	Form	Nov-04	Nov-05
																	Dev	Dec-05	Mar-08
																	Ops	Apr-08	Dec-20
																	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Science Mission Directorate and the Program Management Council have oversight responsibility for this program. The Earth Science Data and Information System Project Office at GSFC has primary responsibility for the program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
PPS	GSFC	GSFC	NASA operates and is further developing the PPS to provide analyzed data from the TRMM and GPM missions. Both TRMM and GPM are joint missions of NASA and JAXA, a key stakeholder.
ACCESS, MEaSUREs, Earth System Data Records Uncertainty Analysis (peer-reviewed data research	SMD	NASA Headquarters	None.
Multi-Mission Operations (operations and maintenance of Core EOSDIS systems; DAACs, Evolution of EOSDIS	GSFC	Earth Science Data and Information Systems Office, Goddard Space Flight Center	Key participants in the Multi-Mission Operations project include the space agencies of Europe, Canada, Germany, France, and Japan. Other U.S. agency partners include the National Oceanic and Atmospheric Administration (Department of Commerce), U.S. Geological Survey (Department of the Interior), and the Department of Defense.

Acquisition Strategy

The EOSDIS Core System is a high-performance software system that provides science data ingest, archive and distribution capabilities for a multitude of Earth science instruments. Maintenance and operations for this system, utilized by three DAAC's post-Step 1 EEE, is performed under contract procured by GSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Earth Science Subcommittee	10/2009	The Earth Science Subcommittee reported that they were impressed by the success and clear sense of direction of this program.	TBD
Quality	DAAC Data Priority Workshops	ongoing	DAAC archive holdings peer reviewed for scientific merit. Multiple reviews related to individual research areas, all successful; several recommendations in work.	annual

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**45.6**	**-**	**46.1**	**47.9**	**51.9**	**53.6**	**54.2**
Earth Science Technology	45.6	-	46.1	47.9	51.9	53.6	54.2

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

Advanced technology plays a major role in enabling Earth research and applications programs by advancing our technical capabilities for improving understanding of the total Earth system and its effects of natural and human-induced changes on the global environment. The Earth Science Technology Program (ESTP) supports the Earth Science Division by enabling previously unforeseen and infeasible science investigations, enhancing existing measurement capabilities, and reducing the cost, risk, and development times of Earth science measurements. The Earth Science Technology Office (ESTO) coordinates with the new Agency-wide technology program through the Science Mission Directorate's Assistant Director for Innovation and Technology; this person is a member of the NASA Technology Executive Council hosted by the Office of the Chief Technologist.

ESTO manages ESTP to provide strategic, science-driven technology assessments and requirements development. The office implements a science-focused technology program by pursuing promising scientific and engineering concepts through open competition solicitations.

For more information, please see: http://esto.nasa.gov.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Plans For FY 2012

ESTP will plan and develop new remote-sensing and information systems technologies for infusion into future science missions in order to enable, or dramatically enhance, measurements, and data system capabilities. Planning will start with measurement priorities established by the science community, leading to systematically developed technology requirements and priorities. Studies may be conducted to assess measurement options for meeting technology performance requirements. Implementation will be performed by selecting and funding tasks from competed solicitations in the three project areas: Instrument Incubator, Advanced Information Systems, and Advanced Technology Initiatives. Ongoing activities in these areas are described in more detail in the project description section of this document.

For FY 2012, ongoing investigations will be managed in the Instrument Incubator, Advanced Information Systems Technology, and Advanced Component Technology program elements. These investigations resulted from FY 2010 and 2011 ROSES solicitations. Both solicitations supported the expanded and accelerated mission set enabled by the President's Budget including the Climate Initiative.

Project Descriptions and Explanation of Changes

Instrument Incubator

This element develops new and innovative instruments and measurement techniques at the system level, including laboratory development and airborne validation.

A solicitation for new instrument technologies was released in FY 2010 and resulted in 16 new awards for sensors measuring atmospheric trace gases, aerosols, clouds, gravity fields, ocean topography, tropospheric winds, thermal land imaging, Earth radiation balance, precipitation, ocean color, snow, and vegetation. Instrument technologies include imagers, spectrometers, lidars, microwave sounders, and radars. These projects began in FY 2011 and will continue through FY 2014.

Among the 35 projects already ongoing in FY 2010, notable Instrument Incubator projects included the development of an instrument for highly accurate measurements of carbon dioxide, which will benefit future decadal survey missions. Another project made significant progress for measurements in a broad spectral range from ultraviolet to visible to infrared. The program also supported the development of a unique type of lidar that could one day be used to make three-dimensional wind measurements.

Advanced Information Systems Technology

This element develops end-to-end information technologies that enable new Earth-observation measurements and information products. The technologies are used to process, archive, access, visualize, communicate, and understand science data. The next solicitation is part of ROSES-11, with selections expected in the first quarter of FY 2012.

The earlier solicitation released in June 2008 awarded 20 projects that began in early FY 2009, focused on three areas needed to support future Earth science measurements: Sensor System Support (to incorporate autonomy and rapid response in the sensing process and improve the science value of data); Advanced Data Processing (to improve or enhance the information extracted from the data stream); and Data Services Management (to better manage the growing body of Earth science data and allow for efficient exchange).

For example, one project team developed techniques for validating space-borne soil moisture measurements that will be used by a future decadal survey mission. The Real-Time Mission Monitor, a science decision support tool that uses cutting-edge information technology, was deployed in the GRIP field campaign. Also in support of a future mission, a project team is streamlining data acquisition to reduce downlink data volume through the use of on-board processing.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Science Technology

Advanced Technology Initiatives

The Advanced Technology Initiatives element provides for the development of critical component and subsystem technologies for instruments and platforms, mostly in support of the Earth science decadal survey. The most recent solicitation for advanced component technologies occurred under ROSES-10 and focused on such areas as space-qualified laser transmitters, passive optical technologies, and microwave and calibration technologies.

During FY 2010 there were 16 active projects. One notable investment was development of a new approach for mirror telescope arrays. An unconventional type of material was introduced that substantially reduced the cost and turnaround time for the development of the mirror. This technology will likely prove useful for a number of planned flight missions that make use of lidars. Another successful project was development of a radiometer receiver module that will enable efficient space-borne ocean altimeters. Other awards support measurements of solar radiance, ozone, aerosols, and atmospheric gas columns for air quality and ocean color for coastal ecosystem health and climate emissions.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Annually advance a portion of funded technology developments by one technology readiness level.	ESTP	None
Annually mature several technologies to the point of readiness for demonstration.	ESTP	None
Annually enable or improve one new science measurement capability.	ESTP	None

Program Management

The Earth Science Division within the Science Mission Directorate has oversight responsibility of the technology program office.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument Incubator	ESTO	GSFC, JPL, LaRC, ARC, GRC , JSC	None.
Advanced Info Systems	ESTO	GSFC, JPL, LaRC, ARC, GRC, MSFC	None.
Advanced Tech Initiatives	ESTO	GSFC, JPL, LaRC	None.

Acquisition Strategy

Tasks are procured primarily through full and open competition, such as the annual ROSES announcements.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NAC - Earth Science Sub Committee	10/2009	The Earth Science Subcommittee reviewed the Earth Science Technology program for infusion of new technologies and participation of universities in developing the new generation of technologists. The committee was overall pleased with the technology program; it wanted to ensure that tasks focus on being able to reduce cost in missions and are directed towards enabling/enhancing specific measurements.	10/2012

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**35.3**	**-**	**33.1**	**34.3**	**35.5**	**36.7**	**36.9**
Pathways	35.3	-	33.1	34.3	35.5	36.7	36.9

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The NASA Applied Sciences Program leverages NASA Earth Science satellite measurements and new scientific knowledge to enable innovative and practical uses by public and private sector organizations. The Applied Sciences program supports applied research and applications projects to enable near-term uses of Earth science knowledge, discover and demonstrate new applications, and facilitate adoption of applications by non-NASA stakeholder organizations. Applied research and applications projects are designed to improve decision-making activities to help the Nation better manage its resources, improve quality of life, and strengthen the economy. NASA develops Earth science applications in collaboration with end-users in public, private, and academic organizations. Examples include improved public health tracking systems for infectious diseases with the Centers for Disease Control; advances in accuracy of volcanic ash advisories for airplane pilots with the National Weather Service and the Federal Aviation Administration; improved wildfire smoke predictions with the U.S. Forest Service to reduce downwind public exposure; advances in assessing impacts of climate change on U.S. National Park ecosystems and improving land management strategies; improved assessment of flooding and landslide conditions with International Red Cross to plan mitigation and response activities; development of drought indicators with National Drought Mitigation Center to support end users' conservation and agriculture decisions; and international disaster management support with the U.S. Agency for International Development (USAID). The program's primary outcomes are the routine, sustained uses of NASA Earth science products in user organizations' policy, business, and management decisions to serve society; the impacts are the resulting socioeconomic benefits from the improved decisions. The program enables operational users to imagine and anticipate possible applications from upcoming satellite missions and to provide input to mission development teams to increase the societal benefits of NASA missions.

For more information, please see: http://AppliedSciences.nasa.gov.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

Plans For FY 2012

In FY 2012, the Applied Sciences Program will continue or initiate projects across a range of application themes, including health and air quality, water resources, disasters, and ecological forecasting. These projects are competitively selected each year through NASA's ROSES solicitations. In FY 2012, the program will feature joint solicitations with research and end-user organizations, contributions to mission science teams to ensure consideration and incorporation of applications requirements throughout the mission design process, and continuation of efforts to build skills and capabilities for accessing and applying Earth observations data to benefit society. The FY 2012 President's Budget enables the program to initiate new solicitations, strengthen end-user involvement in early-phase mission planning, improve the communication of results, and support products and services provided by the NASA/USAID jointly funded SERVIR network.

Project Descriptions and Explanation of Changes

Applied Sciences

In FY 2012, the Applied Sciences Program will sponsor several solicitations and competitively-selected projects across the range of applications themes described above, including topics that cut across these themes:

- Decision Support projects: These are three- to four-year projects that are carried out collaboratively with end user organizations to integrate Earth observations data into their decision-making activities and enable the organizations' sustained use of the Earth observations data.

- Applications Feasibility projects: These are short-term, proof-of-concept projects to generate and test preliminary ideas for applications of Earth science products to determine their potential value and readiness for a more in-depth project.

- Applied Sciences Teams: These are multiple-year efforts by teams of applications specialists and scientists to address key applications-oriented challenges and develop critical data products needed by the applied community and end users.

The program supports joint solicitations with the Earth Science Research Program and supports some applications-oriented projects that are identified in solicitations managed by the research program's science focus areas, especially science mission teams. The projects also include a small number of activities that cut across and support such tasks, including capacity building projects, workshops, and outreach activities.

In FY 2012, the Applied Sciences Program will continue the expanded SERVIR network and enhance both its scientific capabilities across a broader set of NASA Earth science products and its service as a test bed for innovative applications.

Performance Evaluation

In FY 2012, the Applied Sciences Program will use an Applications Readiness Level metric to assess the performance of the program's aggregate activities. The Applications Readiness Level is a nine-point scale that articulates the expected maturation of an application along a continuum from basic research to use in an operational setting. The program will begin to use this metric to assess the difficulty of individual stages as a way to identify critical success factors for applications projects.

Mission Directorate:	Science
Theme:	Earth Science
Program:	Applied Sciences

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Issue competed peer reviewed research awards.	Applied Sciences	None
Maximize resource utilization through streamlining processes and operations across the program.	Applied Sciences	None
Conduct impact evaluation on mature projects.	Applied Sciences	None
Advance at least 25 percent of decision-support projects at least one Applications Readiness Level.	Applied Sciences	None

Program Management

Applied Sciences program responsibility resides within the Earth Science Division of the Science Mission Directorate.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Earth Science Applications	NASA HQ	GSFC, LaRC, SSC, JPL, MSFC, and ARC	EPA, NOAA, USDA, FAA, DOE, DOI, CDC, USAID ; state agencies, and regional organizations such as the Western Governors Association, American Water Resources Association, Gulf of Mexico Alliance. Private sector and universities. Non-Profit and intergovernmental organizations, such as United Nations Food and Agriculture Organization.

Acquisition Strategy

The Earth Science Applications program is based on full and open competition. Grants are peer reviewed and selected based on NASA Research Announcements and other related announcements. The program emphasizes cost-sharing in projects, especially decision support projects.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Academies	10/2007	The Applied Sciences program strategy and implementation.	2013
Relevance	Applied Sciences Analysis Group	11/2010	Applied Sciences program strategy and implementation.	11/2011

Mission Directorate:	**Science**
Theme:	**Planetary Science**

Theme Overview

Planetary Science ascertains the content, origin, and evolution of the solar system and the potential for life elsewhere. The scientific imperative for Planetary Science, the quest to understand our origins, is universal. How did we get here? Are we alone? What does the future hold? These overarching questions lead to more focused, fundamental science questions about our solar system: How did the Sun's family of planets, satellites, and minor bodies originate and evolve? What are the characteristics of the solar system that lead to habitable environments? How and where could life begin and evolve in the solar system? What are the characteristics of small bodies and planetary environments and what potential hazards or resources do they hold?

To address these science questions, NASA relies on various flight missions, research and analysis, and technology development. Seven Planetary Science programs support an integrated and mission-balanced strategy.

- The Research Program supports planetary Research & Analysis (R&A) including sample curation; data archiving; dissemination and analysis; Near-Earth Object Observation; and Rosetta, instruments operating on the European Space Agency (ESA) comet-bound spacecraft.
- The Lunar Quest Program includes an operating mission, Lunar Reconnaissance Orbiter (LRO); one mission in development, the Lunar Atmosphere and Dust Environment Explorer (LADEE); and potential future small spacecraft missions, the Lunar Science Institute, and lunar-related R&A.
- The Discovery Program has two spacecraft in prime mission operations, MErcury Surface, Space ENvironment, GEochemistry, and Ranging (MESSENGER) and Dawn; an instrument operating on an ESA Mars Express mission, the Analyzer of Space Plasma and Energetic Atoms (ASPERA-3); a mission in development through September 2011, the Gravity Recovery And Interior Laboratory (GRAIL); one mission of opportunity, Strofio; one investigation using re-purposed spacecraft, New Exploration of Comet Tempel 1 (NExT), hosted on the Stardust; and Discovery 12, currently in the evaluation and selection process.
- The New Frontiers Program includes: one currently operating spacecraft, New Horizons; Juno, which will begin its operations phase in September 2011; and the soon-to-be-selected New Frontiers 3 mission.
- The Mars Exploration Program comprises two orbiting spacecraft, Odyssey and Mars Reconnaissance Orbiter (MRO), and two rovers, Spirit and Opportunity, all in operation; two missions in development phase, Mars Science Laboratory (MSL) and Mars Atmosphere and Volatile EvolutioN (MAVEN); and R&A and program management. Additionally, the NASA/ESA 2016 ExoMars Trace Gas Orbiter (EMTGO) is in pre-formulation phase.
- The Outer Planets Program includes research, one operating mission, Cassini, and an Outer Planets flagship mission study and formulation.
- The Technology Program includes In-Space Propulsion (ISP) systems, advanced power generation, NASA-Department of Energy (DOE) cost sharing of Plutonium Restart, and the Advanced Multi-Mission Operations System (AMMOS).

Planetary Science data furthers NASA's exploration agenda. Science data from many Planetary missions provides critical information for future human missions. Robotic Mars orbiters are mapping resources (e.g., water and minerals) on or near Mars' surface. In its hunt for asteroids that are potential impact hazards to Earth, the NEO Observations program will find and characterize a subset of these NEOs, those that present the best targets for human exploration. NASA's human Exploration Program has occasionally provided experiments to be flown on robotic planetary spacecraft. Such experiments address requirements unique to human exploration, such as measuring the radiation environment at Mars. Planetary Science continues to work closely with the Human Exploration Program to enhance and enable future human expansion into the solar system.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**1,364.4**	**-**	**1,488.9**	**1,365.7**	**1,326.4**	**1,271.0**	**1,188.9**
Planetary Science Research	161.6	-	183.9	196.0	208.6	208.4	210.5
Lunar Quest Program	94.5	-	114.5	81.2	48.9	28.1	19.5
Discovery	184.5	-	175.6	205.1	245.7	265.5	242.8
New Frontiers	279.6	-	176.9	265.8	245.5	291.1	296.3
Mars Exploration	438.2	-	594.4	433.1	408.7	309.0	245.9
Outer Planets	100.6	-	120.8	80.5	82.2	84.1	88.5
Technology	105.5	-	122.9	104.1	86.6	84.9	85.4

Note: The new Planetary Science decadal survey, developed by the National Academies, will be released in March 2011. The decadal survey is designed to broadly canvas the field of planetary science to determine the current state of knowledge and then identify and prioritize the most important scientific questions and associated missions during the 2013-2022. NASA will re-examine all elements of the Planetary Science program and may modify future budget and content to better align with the findings and recommendations of the report.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Planetary Science Research

The Research and Analysis (R&A) program will continue to release research announcements and make research project and grant selections. The Planetary Data System will continue to archive and release planetary science data to the science community in a timely manner, enabling further scientific analysis. The Astromaterial Curation project will continue its efforts on curation and distribution of solar system samples returned by NASA planetary missions such as Stardust and Genesis. The Rosetta project will continue toward its arrival at comet Churyumov-Gerasimenko (January 2014). The expanded Near-Earth Orbit Observation (NEOO) program will improve and increase its efforts to detect Earth approaching asteroids and comets that may provide resources for our exploration of the inner solar system, or could become potential impact hazards to the Earth. It will also expand efforts to characterize their nature, both to better understand their composition and provide information for study of potential hazard mitigation techniques.

Lunar Quest Program

LADEE was confirmed to proceed into implementation (Phase C) in August 2010. It is scheduled to complete its Critical Design Review (CDR) in fiscal year (FY) 2011, and will start assembly, test, and launch operations in FY 2012. LRO has been successfully transitioned from the Exploration Systems Mission Directorate, and it will continue to perform science and measurements throughout FY 2012. The Surface Science Lander Technology project will continue its risk reduction efforts during FY 2012. Research announcements for Lunar Research and Analysis will be released annually, to be followed by selections and awards.

Discovery

MESSENGER Mercury orbit insertion is scheduled for March 2011, and will make measurements and perform data analyses throughout FY 2012. The Dawn spacecraft is scheduled for Vesta orbit insertion in July 2011, where it will spend a year at Vesta, performing data collection and analysis. It will then continue onto Ceres. ASPERA-3, an instrument on the ESA Mars Express spacecraft, will continue to collect data throughout FY 2012. Stardust NexT will encounter Tempel 1 in February 2011 and enable comparative analysis of the recent findings to those of the 2005 Deep Impact mission. GRAIL is currently scheduled to launch in September 2011. The spacecraft will perform lunar orbit insertion in January 2012, to be followed by science measurement and data analysis. Strofio, an instrument selected to fly on ESA's BepiColombo spacecraft is scheduled to launch in 2014, and will complete CDR by the end of FY 2012. NASA plans to make concept study selections in late FY 2011, to be followed by a down-selection to one mission in FY 2012.

New Frontiers

Juno is currently scheduled to launch in August 2011. The spacecraft will spend five years cruising and performing periodic deep space maneuver as it makes its way to Jupiter. The New Horizons mission will continue on its course toward Pluto and its moons, with periodic spacecraft and instrument checkouts as it cruises. New Frontiers 3 mission is scheduled to be down-selected in late CY 2011, and will proceed into Phase B in FY 2012.

Plans for FY 2012

Mars Exploration

MSL is currently scheduled to launch in November 2011. The rover, named Curiosity, will land on the surface of Mars in August 2012 and will start surface operations and measurements. MAVEN was confirmed to proceed into implementation phase in October 2010. It will complete CDR by the end of FY 2011, and will enter into ATLO phase by the end of FY 2012. Odyssey has been successfully moved to its new orbit and will continue to detect minerals on the surface of Mars while conducting relay operations for the Spirit and Opportunity Mars rovers. MRO will continue with hi-resolution imaging and, if technically possible, both Spirit and Opportunity rovers, will continue to explore and perform data analysis throughout FY 2012. Having successfully finalized the negotiation with ESA on the 2016 ExoMars Trace Gas Orbiter (EMTGO), the project will complete PDR by the end of FY 2011, to be followed by a CDR by the end of FY 2012, and ESA has already passed their system-level PDR in December 2010.

Outer Planets

NASA Cassini project completed its Equinox mission in July 2010, and started the Solstice mission in August 2010. The Cassini project will operate through Saturn's northern summer solstice and will perform data analysis through March 31, 2018. The Agency will continue to negotiate the details of potential partnerships with ESA and other international partners for future outer planet missions.

Technology

The ISP will continue toward completion of the NASA's Evolutionary Xenon Thruster (NEXT) electric propulsion life validation, and will initiate technology study and feasibility on the Mars Ascend Vehicle (MAV). The Radioisotope Power Systems (RPS) program, working with the DOE, will start the flight development of the Advanced Stirling Radioisotope Generator (ARSG) that would support a flight in 2016 or 2017. The AMMOS project will continue to provide and develop multi-mission software tools for spacecraft navigation and mission planning throughout FY 2012. NASA will continue work, in partnership with the Department of Energy, to re-establish a domestic capability to produce plutonium-238 for use in radioisotope power systems.

Mission Directorate:	**Science**
Theme:	**Planetary Science**

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Planetary Science program is guided by the 1958 National Aeronautics Space Act, subsequent legislation, U.S. National Space Policy, and related policies that call on NASA to conduct robotic missions throughout the solar system. The program follows NASA's tradition of establishing its science priorities through consultation with world-class experts via the National Academies' decadal survey process. The most recent planetary science decadal survey was published in 2002, and the next one is scheduled for release in March 2011. Planetary Science also receives tactical-level advice from the external science community via the Planetary Science Subcommittee of the NASA Advisory Council.

Planetary Science seeks to achieve both near and long-term science goals by studying solar system objects and phenomena primarily in situ, but also by returning samples for study in laboratories on Earth. Planets and satellites of the solar system and the ancient icy bodies far from the Sun are effectively "Rosetta stones," or objects that facilitate interpretation. The Rosetta stones of interest to NASA can tell unique stories about the origin and evolution of the solar system. As researchers learn more about the origins of living organisms on Earth and about the solar system's planets and moons, they may learn if life has arisen in places beyond Earth.

Robotic explorers gather data to help scientists understand the nature and evolution of asteroids, comets and other small bodies in the solar system, how the planets formed, what triggered different evolutionary paths among planets, and how Earth formed, evolved, and became habitable. To search for evidence of life beyond Earth, scientists use these data to map zones of habitability, study the chemistry of alien worlds, and unveil the processes that lead to conditions necessary for life. Robotic exploration will generate knowledge about the elements of our solar system--information needed to identify the most promising human exploration missions. This knowledge will help enable safer human space exploration in the forbidding environments they will encounter and may aid in the mitigation of hazards to life here on Earth.

Relevance to the NASA Mission and Strategic Goals:

Planetary Science programs support NASA's achievement of Strategic Plan 2, to "Expand scientific understanding of the Earth and the universe in which we live."

Emphasis is on the Agency objective, to "Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere."

Relevance to education and public benefits:

Planetary Science uses its missions, research programs, and the human resources of the space science community to enhance the quality of American science, technology, engineering, and mathematics (STEM) education. As an example, many of our missions are using mission data to create authentic education experiences and engage students from secondary school through graduate school. Additionally, the Robotics Alliance project (RAP) provides students the opportunity to engage with government, industry and university experts for hands-on, realistic exposure to engineering and technical professions, and it serves as a concrete example of the Planetary Science program's contribution to education. NASA's Planetary Science theme is dedicated to sharing the excitement of discoveries and knowledge generated by space science missions and research with the public, thus contributing to educating and inspiring the next generation of STEM employees needed for the 21st century.

The innovative nature of planetary science projects also creates an impetus for new techniques and technologies that later benefit the public. Public benefits from Planetary Science include a growing understanding of the solar system and Earth's significance within it. Comparative planetology leads to an understanding of Earth's past geologic history and potential future environment; for example, Venus has undergone a runaway greenhouse effect, and Mars, which was once much warmer and wetter, is now cold and dry.

NASA's robotic science missions are paving the way for understanding the origin and evolution of the solar system and working to identify past and present habitable locations.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.3	**Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.**	
Objective 2.3.1	**Inventory solar system objects and identify the processes active in and among them.**	
Performance Goal 2.3.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.1.1: PS-12-1	Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.3.1.2	***By 2015, launch at least two missions in support of this outcome.***	
APG 2.3.1.2: PS-12-2	Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers
APG 2.3.1.2: PS-12-3	Complete the Discovery 12 mission concept studies.	Discovery
Objective 2.3.2	**Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.**	
Performance Goal 2.3.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.2.1: PS-12-4	Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
APG 2.3.2.1: PS-12-5	Complete MESSENGER mission success criteria.	Discovery
Performance Goal 2.3.2.2	***By 2015, launch at least three missions in support of this outcome.***	
APG 2.3.2.2: PS-12-2	Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers
APG 2.3.2.2: PS-12-6	Complete the Lunar Atmosphere and Dust Environment Explorer (LADEE) Systems Integration Review.	Lunar Quest Program
Objective 2.3.3	**Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.**	
Performance Goal 2.3.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.3.1 : PS-12-7	Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Performance Goal 2.3.3.2	***By 2015, launch at least two missions in support of this outcome.***	
APG 2.3.3.2: PS-12-10	Complete the Mars 16 Mission Confirmation Review.	Mars Exploration
APG 2.3.3.2: PS-12-8	Complete the Mars Science Laboratory (MSL) Launch Readiness Review.	Mars Exploration
APG 2.3.3.2: PS-12-9	Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Systems Integration Review.	Mars Exploration
Objective 2.3.4	**Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.**	
Performance Goal 2.3.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.4.1 : PS-12-11	Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Objective 2.3.5	**Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.**	
Performance Goal 2.3.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.3.5.1: PS-12-12	Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.3.5.2	***Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.***	
APG 2.3.5.2: PS-12-13	Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.	Multiple Programs

Uniform and Efficiency Measures:

Measure #	Description
Planetary Science Theme	
APG EFF: PS-12-14	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: PS-12-15	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: PS-12-16	Peer-review and competitively award at least 95 percent, by budget, of research projects.
APG EFF: PS-12-17	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

Performance Achievement Highlights:

Data from NASA's two Mars rovers, along with orbiters Mars Odyssey, MRO, and the ESA/NASA Mars Express (all of which have continued to operate beyond their prime mission) show that the planet had a relatively wet environment. Evidence indicates that the climate evolved, with the planet passing through a major transition during which water on or near its surface became ephemeral and acidic. Early Mars produced diverse mineralogy deposits, such as clays, that may be evidence for ancient lakes, springs, or groundwater. MRO and the rover Spirit found carbonate deposits, which would have been destroyed by acidic conditions if acidity were globally prevalent. Another revelation, from radar and high-resolution imagery, has been the discovery of near subsurface ice at the mid-latitudes. This is evidence of episodic large-scale changes in the Martian climate. The purported variability in methane indicates that the planet is still very active, and may provide an environment for possible microbial life on Mars, even today.

The concept of the Moon as a very dry destination shifted in 2010 with the confirmation of the presence of water by the M3 instrument aboard the Indian Space Research Organisation (ISRO) Chandrayaan-1 spacecraft. Its data show hydroxyl and water molecules are present on the surface of the Moon in the polar regions at very small, but surprisingly high levels (based on current Lunar origin theories). Other observations, from LRO and M3 showed the entire lunar surface to be hydrated during some portions of the day.

Near-Earth asteroids are often portrayed as impact hazards, massive rocks that destroy plant and animal life. However, life on Earth has persisted, despite asteroid bombardments throughout its history. Leading theories derived from NASA research show that asteroids and comets may have provided early Earth with the essential elements needed for the Earth to become a living planet. Recent findings of water ice on comets and some asteroids suggests that a period of asteroid bombardment delivered much of the water and other building blocks for life.

New research on Europa and its oceans shows that tidal forces appear to push fresh ice upward from below in a cycle that forms double ridges on at least half of Europa's surface. As ridges pile on top of ridges, older oxygenated material gets buried, shoving oxygen-rich matter downward toward the liquid water. Scientists have estimated that after one or two billion years, this process could deliver enough oxygen-rich material to Europa's ocean to reach the same concentration levels as those of Earth's oceans. This oxygen could provide the necessary environment to nurture life.

Cassini observations improve our understanding of Enceladus and Titan. Icy material is ejected from the vents of a near-surface of Enceladus, like cold versions of the Old Faithful geyser in Yellowstone National Park. Scientists discovered evidence of sodium salts in the ice grains comprising the plumes, representing evidence that there are liquid subsurface lakes or an ocean on tiny Enceladus. Cassini observations of Titan have found a major methane "hydrological" cycle in operation. Methane rain is currently falling from the southern hemisphere of Titan, contributing to the increase in size of the southern methane lakes. This cycle, along the discovery of ice volcanoes, shows that Titan is larger than the planet Mercury, may be an excellent "early-Earth" analog.

Research in NASA's Astrobiology program may have found an alternative biochemistry of life, and opened up a new approach for life detection experiments on NASA's planetary missions. Microbes in California's Mono Lake were found to substitute arsenic for phosphorous in their DNA. Arsenic, which is chemically similar to phosphorus, is poisonous for most life on Earth. The implication is phosphorus may not be as essential for life as previously thought.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	NASA Advisory Council	07/2010	Reviews science and program implementation strategies and relevancies to the NASA strategies and goals. Findings from review included: NASA has made significant progress toward implementing the recommendations of the NRC's decadal survey and Mars architecture report; and that NASA's current planetary exploration program is highly productive, carrying out exciting missions and making fundamental discoveries.	2/2011
Relevance	National Academies	12/2003	Published priorities in a decadal report entitled "New Frontiers and the Solar System: An Integrated Exploration Strategy." The current decadal survey began in 2009 and it is to be completed by March 2011.	03/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**161.6**	**-**	**183.9**	**196.0**	**208.6**	**208.4**	**210.5**
Planetary Science Research and Analysis	131.5	-	134.6	135.3	140.0	142.8	149.8
Other Missions and Data Analysis	21.3	-	23.7	25.5	31.7	28.2	23.0
Education and Directorate Management	3.0	-	5.1	14.7	16.3	16.7	16.5
Near Earth Object Observations	5.8	-	20.4	20.5	20.6	20.7	21.1

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The Planetary Science Research Program is where the data retrieved from missions is combined with observations in ground-based laboratories to improve our understanding of the content, origin, and evolution of Earth's solar system and planetary systems in general. It does this by supporting the development of theoretical tools and laboratory data needed to analyze flight data, inventing new and better instruments to fly on future missions, and providing analysis of the data returned.The program represents an essential complement to flight missions, providing the scientific research and the theoretical foundation to allow the Nation to plan and fully utilize the unique data sets returned from the missions exploring the solar system. It is also NASA's primary interface with university faculty and graduate students in this field as well as the research community in general. The research program achieves this goal by supporting research grants solicited annually and subjected to a careful peer review before award.

For further information see: http://nasascience.nasa.gov/planetary-science.

Plans For FY 2012

In pursuit of fundamental science that guides planetary exploration, competitive announcements will again be released soliciting R&A proposals for selection. Planetary Science will continue data archiving and distribution of this vital data to the science community in a timely manner for further scientific analysis. Likewise, curation and distribution of solar system samples (astromaterials) returned by NASA planetary missions such as Stardust, Genesis, and Apollo will continue.

Support will also continue for the Rosetta mission toward its arrival at comet Churyumov-Gerasimenko (January 2014). The remaining data from the Hayabusa mission will be archived by the Planetary Data System, and curation of returned samples will be started in FY 2011. NASA will continue to expand Near Earth Object Observation (NEOO) efforts at finding and characterizing asteroids and comets approaching Earth that may be destinations and resources for our exploration of the solar system, or could become potential impact hazards to Earth.

Project Descriptions and Explanation of Changes

Planetary Science Research and Analysis (R&A)

The scope of R&A is very broad, as the project provides the foundation for the formulation of new scientific questions and strategies, as well as maximizing the return on the investments the nation has already made in robotically exploring the solar system. R&A must provide new theories and instrumentation that enable the next generation of flight missions. Discoveries and concepts developed in the R&A project are the genesis of scientific priorities, missions, instrumentation, and investigations. R&A supports research tasks in areas such as: astrobiology and cosmochemistry; the origins and evolution of planetary systems; and the atmospheres, geology, and chemistry of the solar system's planets, other than Earth. R&A provides for instrument and measurement concepts, and supports the initial definition of mission concepts and development of instruments for future Discovery, New Frontiers, Mars, or outer planets missions.

Other Missions and Data Analysis

Rosetta, an comet rendezvous mission launched in March 2004 through a partnership between ESA and NASA, will arrive at comet Churyumov-Gerasimenko in FY 2014. Rosetta will enable study of the nature and origin of comets, the relationship between cometary and interstellar material, and the implications of comets with regard to the origin of the solar system. The Rosetta spacecraft will be the first to undertake the long-term exploration of a comet at close quarters. It comprises a large orbiter, which is designed to operate for a decade at large distances from the Sun, and a small lander. Each of these elements carries a large complement of scientific experiments and examinations designed to complete the most detailed study of a comet ever attempted. Rosetta will allow scientists to look back 4,600 million years to a time when no planets existed and only a vast swarm of asteroids and comets surrounded the Sun.

With its successful return to Earth in 2010, the Hayabusa (MUSES-C), a mission primarily operated by the Japanese space agency, JAXA, has completed its mission. The spacecraft launched in May of 2003 and landed on the asteroid Itokawa in November 2005. Hayabusa observed Itokawa's shape, geographical features, reflectance, mineral composite, and gravity from an altitude of 3 to 20 km, and clarified Itokawa's structure as a "pile of rubble." In April 2007, the spacecraft began its return to Earth with an asteroid sample and successfully landed in the Australian Outback on June 14, 2010. The sample is now in curation and analysis to reveal the composition of the near-Earth asteroid, Itokawa.

The Planetary Data Systems (PDS) and Astromaterials Curation projects support data archives; sample processing and storage facilities; and analysis tools needed to perform research. PDS is the active data archive for NASA's Planetary Science theme. The Astromaterials Curation Facility at Johnson Space Center provides services for all returned planetary materials that do not require planetary protection laboratories.

Education and Directorate Management

The Directorate Management project supports SMD-wide administrative and programmatic requirements.

The Robotics Alliance Project (RAP) is dedicated to increasing interest in STEM disciplines among youth in the United States. Annual activities and events expose students to challenging applications of engineering and science. RAP supports national robotic competitions in which high school students team with engineers from government, industry, and universities to gain hands-on experience and mentoring from engineering and technical professionals.

Near Earth Object Observations (NEOO)

The NEOO project detects and tracks at least 90 percent of the near Earth objects (NEOs)--asteroids, and comets that come within 1.3 astronomical units of the Sun. It's long term goal is to find those of at least 140 meters in size that have any potential to collide with Earth and do significant damage to the planet. In the course of this effort, initial characterization of NEOs that could be viable targets for robotic and crewed exploration will also occur. In accordance with the findings and recommendations of the January 2010 NRC study on the NEO hazard, NEOO will continue to:

- Collect, archive, and analyze the small body data collected by NASA's WISE mission, and support increased follow-up and analysis of this data;

- Enable collection of NEO detection and characterization data by ground-based systems, including the U.S. Air Force's (USAF) Panoramic Survey Telescope and Rapid Reporting System (Pan-STARRS) and investigate the use of other USAF space surveillance assets for this mission;

- Support the continued operation of planetary radar capabilities at the NSF's Arecibo and NASA's Goldstone facilities; and

- Investigate both ground and space-based concepts for increasing capacity to detect, track and characterize potentially hazardous objects down to sizes 140 meters and below.

More information on NASA's NEO program is available at http://neo.jpl.nasa.gov/.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Release of research announcements soliciting R&A proposals (annual selections)	Research and Analysis (R&A)	Same
Meeting commitments to the international partners as agreed to in formal agreements	Hayabusa	Missions completed
Meeting commitments to the international partners as agreed to in formal agreements	Rosetta	Same
Archive and release mission data to the science community within six months of downlink	Planetary Data System (PDS)	Same
Store new samples of astromaterials and distribute them as requests are approved by CAPTEM	Astromaterials Curations	Same
Improve the search for hazardous NEOs, asteroids, and comets down to 140 meters in size that may pose an impact threat. Add elements for upgrading search and characterization of NEOs on NASA, NSF and USAF assets.	NEOO	Same

Implementation Schedule

Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24

Project	Phase	Beg	End
R&A, PDS, Curation	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-68	Sep-24
Rosetta	Tech		
	Form		
	Dev		Mar-04
	Ops	Mar-04	Sep-17
	Res	Sep-08	Sep-17
NEOO	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-07	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Planetary Science Research

Program Management

NASA HQs is responsible for R&A. JPL is responsible for the operations of the NASA instruments in the ESA Rosetta spacecraft and the NEOO Program Office. GSFC is responsible for PDS project management. JSC is responsible for Astromaterial Curation.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research & Analysis	HQ	Multiple (NASA Centers, Universities, industries, etc.)	n/a
Rosetta	JPL	JPL	The European Space Agency (ESA) built the spacecraft, provided the launch vehicle, and operates the spacecraft.
Planetary Data System (PDS)	GSFC	JPL and ARC	n/a
Astromaterials Curation	JSC	JSC and DFRC	NSF and Smithsonian Institution for Antarctic meteorites.
NEOO	HQ	JPL and GSFC	n/a

Acquisition Strategy

The R&A budget will fund competitively selected activities from the Research Opportunities in Space and Earth Science (ROSES) omnibus research announcement. All major acquisitions for Rosetta, PDS, and Astromaterials Curation are in place. NEOO data processing nodes are located at the Minor Planet Center (Cambridge, MA) and the Sentry high precision orbit determination node at JPL.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	CAPTEM Panel	11/2010	Curation and Analysis Planning Team for Extraterrestrial Materials (CAPTEM) reviews ongoing curation activities and future plans. Curation of Genesis, Stardust, and Apollo lunar samples are on track and meeting distribution requests. The Curation project is performing well overall. The panel reviewed and approved distribution of samples; reviewed plans for the upgrade of JSC curation facilities; and efforts to work with Constellation on curation of samples on the Moon.	03/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**94.5**	**-**	**114.5**	**81.2**	**48.9**	**28.1**	**19.5**
Lunar Science	31.4	-	50.9	48.1	48.9	28.1	19.5
Lunar Atmosphere and Dust Environment Explorer	48.2	-	63.2	33.1	0.0	0.0	0.0
International Lunar Network	14.9	-	0.3	0.0	0.0	0.0	0.0

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The Lunar Quest Program (LQP) addresses prioritized science objectives by conducting science exploration of the Moon through research and analysis and through the development of a series of small-medium satellite and possibly surface missions. LQP addresses the science priorities identified in the National Academies report, "The Scientific Context for Exploration of the Moon" (SCEM) and fits within NASA's Space Exploration Policy to scientifically explore the solar system. LQP complements other lunar missions sponsored by NASA and international agencies. LQP objectives are to:

- Provide opportunities to conduct lunar-focused science missions and research;

- Re-establish lunar science and a lunar science community;

- Facilitate the application of enhancing or enabling technologies to support flight missions; and

- Enhance science opportunities in the implementation of NASA's lunar exploration goals.

LQP is a loosely coupled multi-element science program that includes both flight missions and research opportunities. Each LQP project is independent, but they have interrelated objectives and a common management and funding structure. LQP flight opportunities consist of small-medium robotic science spacecraft or landers.

Plans For FY 2012

LADEE has been confirmed to proceed into implementation phase (key decision point (KDP)-C or KDP-C). The project plans to successfully complete CDR by the end of FY 2011, and plans to start ATLO by the end of FY 2012.

LRO has successfully completed its ESMD objectives and began its science mission in September 2010. The project will continue its science operations and perform data analysis throughout FY 2012.

The Science Mission Directorate/Planetary Science Division will continue to release lunar science research announcements and make research project and grant selections throughout FY 2012.

Project Descriptions and Explanation of Changes

Lunar Science

LQP management provides management and oversight of selected flight missions.

Surface Science Lander Technology and International Lunar Network (ILN)/Decadal Priority consist of continued technology development associated with small lunar landers.

The LRO Science mission will devote the capabilities of its instruments to five scientific topics:

- The bombardment history of the Moon;

- Lunar geologic processes and their role in the evolution of the crust and lithosphere;

- the processes that have shaped the global lunar regolith;

- The types, sources, sinks, and transfer mechanisms associated with volatiles on the Moon; and

- How the space environment interacts with the lunar surface, in order to advance our understanding of the origin and evolution of the Moon.

Lunar R&A will enhance participation and collaboration within the lunar science community. It is composed of competed research and analysis opportunities that include:

- National Lunar Science Institute (NLSI), a virtual institute of geographically dispersed researchers and institutions, directed by the Ames Research Center (ARC) for management and implementation;

- Lunar Advanced Science and Exploration Research (LASER), a lunar-only element in the ROSES NASA Research Announcement (NRA); and

- Lunar Data, which supports lunar data archives and distribution to the science community for analysis.

Lunar Atmosphere and Dust Environment Explorer (LADEE)

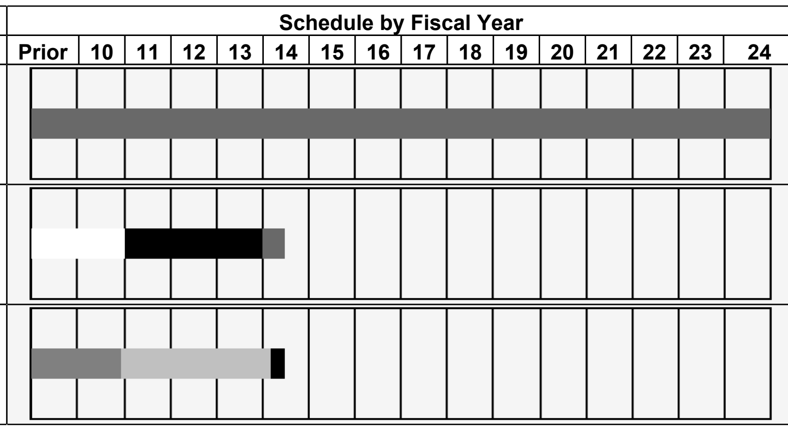
Currently in the implementation phase, LADEE, the first mission developed under LQP, is a cooperative effort between ARC and GSFC. The LADEE mission addresses high priority science goals as identified by the SCEM report, i.e., to determine the global density, composition, and time variability of the fragile lunar atmosphere. LADEE's measurements will also determine the size, charge, and spatial distribution of electrostatically transported dust grains. LADEE will carry the optical laser communications package to be provided by the Space Operations Mission Directorate (SOMD), which will technically demonstrate high bandwidth communication from the Moon. NASA plans to launch LADEE in November 2013. The nominal science mission is 100 days in length. Additional details can be found in the LADEE project development section of this document.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Conduct scientific investigations to achieve SMD lunar science goals and objectives in the "Scientific Context for Exploration of the Moon"	Lunar Quest Program	Same
Complete the Lunar Atmosphere and Dust Environment Explorer (LADEE) Systems Integration Review.	LADEE	

Implementation Schedule



Project	Phase	Beg	End
Lunar Science (R&A)	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-08	Sep-24
Lunar Reconnaissance Orbiter (LRO) Science Mission	Tech		
	Form		
	Dev		
	Ops	Sep-10	Sep-13
	Res	Sep-10	Mar-14
Lunar Atmosphere and Dust Environment Explorer (LADEE)	Tech		
	Form	Mar-08	Aug-10
	Dev	Aug-10	Nov-13
	Ops	Nov-13	Mar-14
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

Scientific mission priorities and assignment responsibilities reside with SMD. Marshall Space Flight Center (MSFC) has LQP management responsibility.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research & Analysis	HQ	ARC, GSFC, MSFC, JPL, JSC	N/A
LRO Science Mission	GSFC	GSFC, JSC, JPL	N/A
LADEE	ARC	ARC, GSFC/WFF, HQ/USAF	N/A
Surface Science Lander Technology/ILN/Future Decadal Priority	MSFC	MSFC	N/A

Acquisition Strategy

The LQP acquisition strategy is to direct development of flight projects including the spacecraft bus to NASA Centers and competitively select instruments and science team participation through the ROSES NRA, and the Stand Alone Missions of Opportunity (SALMON) NRA.

Major acquisitions for the LADEE, the Surface Science Lander Technology, and the LRO science missions are in place. ARC and GSFC will provide the spacecraft for LADEE. Three science instruments have been selected for LADEE: Neutral Mass Spectrometer (NMS), UV Spectrometer (UVS), and Lunar Dust EXperiment (LDEX). The NMS instrument will be provided by GSFC; ARC will provide UVS; and the University of Colorado/ Laboratory for Atmospheric and Space Physics (LASP) will provide LDEX. MIT/ Lincoln Laboratory (LL) and GSFC will provide the SOMD Lunar Laser Communications Demonstration (LLCD) contribution. USAF/Orbital Sciences will provide the launch services and vehicle.

GSFC will continue to operate the LRO science mission, along with its performing partners (Johns Hopkins University-Applied Physics Laboratory (JHU-APL), JSC, and JPL).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	12/2009	Standing Review Board (SRB) was assigned to first perform a Program Acceptance Review (PAR) assessing the program's readiness to enter implementation. Following approval to enter implementation, the SRB will thereafter conduct biannual Program Implementation Reviews (PIRs) throughout implementation to assure the program is operating according to the program plan and that it is successfully meeting the program objectives.	02/2012

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**35.3**	**48.2**	**-**	**63.2**	**33.1**	**0.0**	**0.0**	**0.0**

Note: Consistent with the August 23, 2010 KDP-C decision, funding for SOMD-sponsored Lunar Laser Communications Demonstration (LLCD), $65.3 million, is not included in the above number.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

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Explanation of Project Changes

LADEE was confirmed to proceed into development phase on August 23, 2010, supporting a November 2013 launch date. The project's development and life cycle cost estimates and schedule in this document are consistent with the KDP-C memo and its baseline report.

Project Purpose

LADEE, the first mission developed within LQP, is a cooperative effort between ARC and GSFC. LADEE will address high-priority science goals, as identified by the NRC, that determine the global density, composition, and time variability of the fragile lunar atmosphere. LADEE's measurements will also determine the size, charge, and spatial distribution of electrostatically transported dust grains. LADEE will carry an optical laser communications demonstrator to be provided by SOMD. The optical laser will technically demonstrate high-bandwidth communication from the lunar orbit.

Project Parameters

The LADEE spacecraft design is based on a reusable common bus concept, and will be the first spacecraft based on this bus design.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

Project Commitments

The spacecraft is planned a near circular, lunar equatorial orbit at approximately 50 km. After launch in November 2013, science operations are planned for 100 days.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	NASA ARC	Small spacecraft based on reusable design	New	Same
Integrated Payload	NASA GSFC	3 science Instruments (UVS, NMS, LDEX)	New	Same
Launch Vehicle	U.S. Air Force's Orbital/Suborbital Program (OSP) Orbital Sciences Corporation	Medium Class/Minotaur V	New	Nomenclature of rocket (IV+ to V)

Schedule Commitments

SMD announced the LADEE project in April 2008 and assigned leadership of the mission to ARC. The LADEE project was confirmed to proceed into development phase on August 23, 2010, supporting a November 2013 launch date.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	08/23/2010	11/2010	08/23/2010
SIR	11/2012	N/A	11/2012
LRD/IOC/IC	11/2013	1/2013	11/2013
End of Prime Mission	03/2014	N/A	03/2014

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

Project Management

LADEE operates under the LQP of the SMD Planetary Science Division. The decision authority is the SMD Associate Administrator.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project Management	Overall, day-to-day management	ARC	N/A
Spacecraft	Design, build and deliver the spacecraft	ARC	N/A
Neutral Mass Spectrometer (NMS) Instrument	Design, build and deliver the NMS instrument. Also responsible for integrating of LDEX and UVS	GSFC	N/A
UV Spectrometer (UVS) Instrument	Design, build, and deliver	ARC	N/A
Lunar Dust EXperiment (LDEX) Instrument	Design, build, and deliver	University of Colorado, LASP	N/A
Launch Vehicle	Integrate vehicle and provide launch service	TBD	N/A

Acquisition Strategy

All major acquisitions are in place. The spacecraft bus was directed to ARC (UVS) in partnership with GSFC (NMS). LDEX was competitively selected through SALMON and awarded to the University of Colorado/LASP. The USAF Orbital/Suborbital Program and Orbital Sciences Corporation are providing the launch vehicle.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	07/2010	Reviewed implementation plan, technical readiness, schedule, costs. Passed Preliminary Design Review (PDR), and confirmed to proceed into implementation phase (C). Critical Design Review (CDR) will be the next independent review.	08/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
Project In Development:	Lunar Atmosphere and Dust Environment Explorer

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft design outgrows mass margin allocation	Spacecraft design may outgrow launch vehicle performance if alternative components are required in the spacecraft design as mass margins are extremely limited.	Mitigate through spacecraft design planning, including management of margins and contingencies per LADEE System Engineering Master Plan, carefully watch Min V performance margins through frequent updates from launch vehicle provider.
Minotaur V launch loads unknown	Delay of launch vehicle contract delayed coupled loads analysis which may impact CDR.	Coupled loads analysis is currently under contract for delivery immediately prior to CDR peer reviews. Small residual risk of short delay in CDR.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**184.5**	**-**	**175.6**	**205.1**	**245.7**	**265.5**	**242.8**
Gravity Recovery and Interior Laboratory (GRAIL)	124.1	-	40.5	4.4	0.0	0.0	0.0
Other Missions and Data Analysis	60.4	-	135.1	200.6	245.7	265.5	242.8

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Program Overview

Robotic space exploration holds tremendous opportunity for exploration and discovery. With the vast amount of knowledge gained since exploration of the solar system began, there come many unanswered questions about the origin and evolution of our own solar system. NASA's Discovery Program provides relatively frequent opportunities to utilize innovative missions that help explain the mysteries of the solar system. It provides highly focused planetary science investigations designed to increase our understanding of the solar system and its evolution. The Discovery Program offers the scientific community the opportunity to assemble and lead cross-functional teams to design and implement exciting science investigations that complement NASA's larger planetary science missions.

Completed Discovery missions have achieved groundbreaking science, with each taking a unique approach to space exploration. Completed missions include: NEAR, Mars Pathfinder, Lunar Prospector, Deep Impact, Stardust, Genesis, Moon Mineralogy Mapper, and EPOXI.

Current Discovery missions continue this approach and include: MESSENGER, Dawn, ASPERA-3, StardustNExT, Exospheric Sampling of Mercury's Surface Composition (Strofio), and Gravity Recovery and Interior Laboratory (GRAIL).

For more information regarding the Discovery Program, see http://discovery.nasa.gov.

Plans For FY 2012

The MESSENGER spacecraft completed its third flyby of Mercury in September 2009. It is preparing for its Mercury orbit insertion in March 2011 and will take measurements throughout FY 2012.

The Dawn spacecraft will encounter and orbit Vesta for about ten months, starting in July 2011.

ASPERA-3 continues to collect data on its extended mission aboard ESA Mars Express spacecraft.

The repurposed Stardust NExT mission will approach and accomplish the re-encounter with comet Tempel 1 in February 2011 to detect any changes since the July 2005 Deep Impact mission.

GRAIL will complete ATLO as it prepares for launch, scheduled in September 2011. GRAIL will perform lunar orbit insertion in January 2012, to be followed by science measurements and data analysis.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Project Descriptions and Explanation of Changes

GRAIL

GRAIL was selected in December 2007 and given approval to proceed into its development phase (Phase C) on January 28, 2009. GRAIL continued its implementation phase through FY 2011, is scheduled to launch in September 2011, and will begin its operating phase during FY 2012. GRAIL consists of two spacecraft inserted in low lunar orbit in order to perform high-quality gravity field mapping of the Moon to determine its interior structure. This mission will provide the most accurate global gravity field to date for any planetary body in the solar system, including Earth. GRAIL will enable the public to directly interact with observations through cameras on each dedicated to public outreach and education.

Additional details can be found in the GRAIL development section of this document.

Other Missions and Data Analysis

The Dawn mission, now in its operational phase, is on its journey to the two largest and most massive asteroids in our solar system, Vesta and Ceres. Vesta's physical characteristics reflect those of the inner planets, whereas Ceres' are more like the icy moons of the outer planets. By studying these contrasts and comparing these two minor planets, scientists will develop an understanding of the transition from the rocky inner regions to the icy outer regions of the solar system. The Dawn mission marks the first time a spacecraft will orbit a body in the main asteroid belt and the first time a spacecraft will orbit two sequential targets, enabling a detailed and intensive study of both. Dawn launched in September 2007. The Dawn spacecraft will encounter and orbit Vesta for about ten months starting in July 2011, then after almost a year of Vesta orbit operations, it will travel an additional three years to reach and orbit Ceres.

MESSENGER, a mission to orbit Mercury, launched on August 3, 2004, and will have completed its cruise operations phase and entered Mercury orbit in March 2011. During the three Mercury flybys that prepared the spacecraft for orbit insertion, it collected images that provide coverage of all but two percent of the planet. MESSENGER carries seven scientific instruments and a radio science experiment to accomplish an ambitious objective: return comprehensive data from Mercury orbit for the first time. The miniaturized payload, designed to work in the extreme environment near the Sun, will image all of Mercury for the first time, as well as gather data on the composition and structure of Mercury's crust, its geologic history, the nature of its active magnetosphere and thin atmosphere, and the makeup of its core and the materials near its poles.

As a result of the 2006 Discovery missions of opportunity selected on June 19, 2007, Stardust spacecraft was repurposed for new science missions. The New Exploration of Tempel (NExT) will use the existing Stardust spacecraft for another flyby of comet Tempel 1 in February 2011 in order to image more of the comet's surface and evaluate the extent of surface erosion since the last flyby in FY 2005. The analysis of the returned data will continue through FY 2012.

ASPERA-3, a mission of opportunity, is in a third extension of its operational phase. It is one of seven instruments aboard the ESA Mars Express spacecraft in orbit around Mars, with a goal to study the interaction of the solar wind and Martian atmosphere. The measurements taken by this instrument will help answer the question of how strongly the interplanetary plasma and electromagnetic fields affect the Martian atmosphere.

The M3 project was part of the scientific payload for the ISRO Chandrayaan-1 mission, which launched October 2008 from India, and whose operations were terminated in August 2009. Primary objectives of M3 are to assess the mineral resources of the Moon and characterize and map the composition of the surface at high spatial resolution. The M3 science team will continue to process and analyze the data collected during the shortened mission through FY 2012.

Other Missions & Data Analysis (Continued)

Strofio (Exospheric sampling of Mercury's surface composition), now in its implementation phase, will be part of the ESA mission to Mercury and BepiColombo. Strofio will provide valuable information about Mercury's exosphere and its interaction with the magnetosphere and surface. Strofio completed its confirmation review in May 2010 and is scheduled to deliver in early FY 2012 for launch in August 2014.

The Discovery Research Program supports: Discovery Data Analysis program (DDAP) on archived data collected on Discovery missions; Laboratory Analysis of Returned Samples (LARS), which enables development of new instruments in terrestrial laboratories to analyze samples returned from NASA Planetary Science missions; and participating scientists for the MESSENGER and Dawn missions.

DDAP enhances the scientific return of the completed Discovery missions by broadening the science participation in the analysis of data collected and samples returned. Specifically, the DDAP allows scientists not previously associated with Discovery missions an opportunity to perform analysis of the data archived in the PDS. Data access through Discovery Research allows a much broader, and perhaps more objective, analysis of the data and samples, and also allows research to continue for many years after the mission has been completed. Areas for additional data analyses are proposed by scientists throughout the U.S. planetary community and are competitively selected with major input from science community peer review.

The Discovery Future budget provides funds for future Discovery flight missions to be selected via a competitive announcement of opportunity (AO). The Discovery 2010 AO process will result in selection of a new mission in FY 2012.

Discovery program management provides for the management oversight of the portfolio of Discovery flight missions in implementation. This line also provides for the development of AOs and supports independent panel reviews and the mission selection process.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Launch an average of one mission per 24 months	Discovery Program	Same
Complete current prime and funded extended operating missions	Dawn, MESSENGER, ASPERA-3 and StardustNExT	M3 mission ended early due to loss of ISRO's spacecraft; EPOXI mission successfully completed
Complete design and begin spacecraft or instrument development and assembly	Strofio	Same
Complete MESSENGER mission success criteria.	MESSENGER	
Complete the Discovery 12 mission concept studies.	Discovery	

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 10–24)	Phase	Beg	End
MESSENGER		Tech		
		Form	Jul-99	Jun-01
		Dev	Jun-01	Aug-04
		Ops	Aug-04	Mar-13
		Res		
ASPERA-3		Tech		
		Form		
		Dev	Sep-00	Jun-03
		Ops	Jun-03	May-14
		Res		
Dawn		Tech		
		Form	Dec-01	
		Dev	Feb-04	Sep-07
		Ops	Sep-07	Nov-16
		Res		
Moon Mineralogy Mapper (M3)		Tech		
		Form	Mar-05	Feb-06
		Dev	Mar-06	Mar-08
		Ops	Mar-08	Aug-09
		Res	Aug-09	Sep-12
EPOXI		Tech		
		Form		
		Dev		
		Ops	Jun-07	Oct-11
		Res		
Stardust NExT		Tech		
		Form		
		Dev		
		Ops	Jun-07	Feb-11
		Res	Feb-11	Sep-12
GRAIL		Tech		
		Form	Oct-07	Mar-09
		Dev	Mar-09	Sep-11
		Ops	Oct-11	Jul-12
		Res		
Strofio		Tech		
		Form	May-09	Jul-10
		Dev	Jul-10	Sep-14
		Ops	Sep-14	Aug-20
		Res		
Discovery Management		Tech		
		Form		
		Dev		
		Ops		
		Res	Oct-99	Sep-24
Discovery Research		Tech		
		Form		
		Dev		
		Ops		
		Res	Oct-99	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

MSFC is responsible for Discovery program management. Scientific mission priorities and assignment of responsibilities reside with SMD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MESSENGER	Johns Hopkins University-Applied Physics Laboratory (JHU-APL)	GSFC, JPL	None
ASPERA-3	South West Research (SwRI)	MSFC	Sweden; European Space Agency (ESA)
Dawn	JPL	JPL	German Aerospace Center (DLR); Los Alamos National Labs (LANL); Italian Space Agency; and Max-Planck
M3	JPL	JPL	ISRO Chandrayan spacecraft, USGS
Stardust-NExT (Stardust-New Exploration of Tempel)	JPL	JPL	None
GRAIL	JPL	GSFC, JPL, KSC	None
Strofio	SwRI	GSFC	European Space Agency (ESA) BepiColombo Spacecraft

Acquisition Strategy

The Discovery Program solicits proposals for full planetary missions and missions of opportunity. The proposals are put together by teams led by a principal investigator, or PI, and may include firms, small businesses, government and universities. The initial phase of each competitive selection is a concept study, and several missions and missions of opportunity are generally selected for this phase. At the completion of the study phase, one or more concepts may be selected for development, based on their continued scientific merit, technical, management and cost viability, and the availability of funding.

With the exception of future NASA announcements of opportunity, all major acquisitions are in place.

SwRI employs the PI and Lead Scientist for ASPERA-3 and Strofio.

The University of California at Los Angeles sponsors the PI and lead scientist for the Dawn mission.

Brown University sponsors the PI and lead scientist for M3. SAIC, University of Hawaii, and University of Tennessee are also participants.

The Department of Terrestrial Magnetism at the Carnegie Institution of Washington employs the PI and lead scientist for MESSENGER.

Cornell University employs the PI for the Stardust New Exploration of Tempel 1 (NExT) mission of opportunity.

The Massachusetts Institute of Technology (MIT) employs the PI and leads the GRAIL mission.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	06/2010	Verified compliance with Agency requirements for program implementation and alignment with Agency strategic goals and objectives. Found that the Discovery program provides effective technical and schedule analysis support to the projects and continues to actively use risk-based insight as part of its oversight of the projects. The AO process has proven to be a well-defined, disciplined process that is viewed by the science community as fair and effective.	06/2013

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	221.2	124.1	-	40.5	4.4	0.0	0.0	0.0

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

NASA confirmed GRAIL to proceed into implementation phase (KDP-C or Phase C/D) on January 28, 2009, and entered ATLO in July 2010. GRAIL approved baseline development ($427 million) and the life cycle cost ($496.2 million) numbers remain unchanged since KDP-C.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Project Purpose

GRAIL was selected in December 2007 under the 2006 Discovery AO. The overarching scientific goal of the GRAIL mission is to determine the structure of the lunar interior from crust to core. The GRAIL mission will also advance our understanding of the thermal evolution of the Moon and extend our knowledge gained from the Moon to the other terrestrial-type planets.

GRAIL has six lunar science objectives:

- To map the structure of the crust and lithosphere;

- To study the Moon's asymmetric thermal evolution;

- To determine the subsurface structure of impact basins and the origin and of masons (i.e., high-gravity areas);

- To study the temporal evolution of crustal brecciation and magmatism;

- To study affect on the structure of the deep lunar interior from lunar tides; and

- To understand the size of the possible lunar inner core.

Project Parameters

GRAIL will achieve its science objectives by placing twin spacecraft in a nearly circular low altitude (50 kilometer) polar orbit. The two spacecraft will perform high-precision range-rate measurements between them. Analysis of changes in the spacecraft-to-spacecraft range-rate data caused by gravitational differences will provide direct and high-precision measurements of the lunar gravity. GRAIL will ultimately provide a global, high-accuracy (<10 mGal), high-resolution (30 kilometer) gravity map of the moon. The instrument is based on the successful Earth orbiting Gravity Recovery and Climate Experiment (GRACE) mission.

Project Commitments

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Flight System	Lockheed Martin	2 spacecraft with s/c separation of 175-225 km, conducting 90-day science phase	Same	Same
Lunar Gravity Ranging System	JPL	Ka-band ranging system determines the precise instantaneous relative range-rate of the two s/c	Same	Same
E/PO MoonKam	Sally Ride Science (SRS)	Taking images of the moon, the data will enrich the middle school space science education	Same	Same
Launch Vehicle	ULA	CLIN23 - Delta II Heavy	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Development (Phase C/D or KDP-C)	January 28, 2009	Same	Same
Critical Design Review (CDR)	November 2009	Same	Same
System Integration Review	June 2010	June 2010	Same
Launch Readiness Review	September 2011	Same	Same
End of Prime Mission	June 2012	same	same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
Project In Development:	Gravity Recovery and Interior Laboratory

Project Management

GRAIL is part of the Discovery program managed by MSFC. The PI from MIT has delegated day-to-day project management to JPL.

Acquisition Strategy

GRAIL was selected competitively on December 13, 2007, under a Discovery program AO (AO-NNH06ZDA001O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB/IPAO	05/2010	Assess cost, schedule, and risk status of the project. The findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	06/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single String Spacecraft	Both GRAIL spacecraft are primarily single string for major components. If there is an in flight failure, then there is no ability to switch over to a total redundant component.	The mission is of relatively short duration and the single string risks are mitigated by use of proven designs, high reliability parts, and additional testing of critical systems, consistent with the cost and schedule constraints of the project.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**279.6**	**-**	**176.9**	**265.8**	**245.5**	**291.1**	**296.3**
Juno	257.1	-	31.2	17.6	17.9	16.7	29.6
Other Missions and Data Analysis	22.4	-	145.7	248.2	227.6	274.4	266.7

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The New Frontiers Program, comprised of medium to large-sized missions, constitutes a critical element of NASA's solar system exploration capability that will perform high-quality focused scientific investigations. Initiated in 2003, the New Frontiers program was defined to pursue high-quality planetary missions that require resources beyond those available in the Discovery Program. Unlike the Discovery Program, the choice of destinations and the science goals for each New Frontiers opportunity are limited to the NRC recommended science targets. The National Academies-recommended science targets for the New Frontiers program include Pluto and the Kuiper Belt, Jupiter, Venus, Io, Ganymede, Trojan/Centaurs, and sample returns from Earth's Moon, an asteroid, and a comet nucleus.

New Horizons is currently on its way to its primary target, Pluto, and is the first peer-review selected mission of the New Frontiers program. It will conduct reconnaissance of Pluto and its moons Charon, Nixa, and Hydra. The dwarf planet Pluto has been revealed to be a multi-object system of small and large moons, never before seen up close. This mission will tell us a lot about how the Kuiper belt orbits form and their role in the early formation of the solar system.

Juno, the second New Frontiers mission with an overarching scientific goal to understand the origin and evolution of Jupiter and planetary formation, is currently under development. The third New Frontiers AO was released in April 2009. Three mission concept studies were awarded on December 29, 2009. Selection of the final mission is expected by the end of CY 2011, allowing the New Frontiers 3 mission to proceed into Phase B in FY 2012.

For more information on the New Frontiers program, see http://newfrontiers.nasa.gov/index.html.

Plans For FY 2012

The Juno mission continues its ATLO (Phase D) phase. All Juno mission hardware will be fully tested and be delivered to Cape Canaveral in preparation for a launch in August 2011. The project will spend five years cruising toward Jupiter as it periodically performs deep space maneuvers and instrument checkouts.

The New Horizons spacecraft remains on track for a July 2015 arrival at Pluto. The project will continue its cruise period throughout FY 2012. Work during the cruise period will include annual spacecraft and instrument checkouts and dress rehearsals for the Pluto flyby.

The third New Frontiers AO was released in April 2009. Selection of New Frontiers 3 proposals for funded mission Phase A concept studies occurred on December 29, 2009. Down-selection of one mission to proceed to the subsequent phases is expected in third quarter to late CY 2011. The project will then proceed to Phase B in FY 2012.

Project Descriptions and Explanation of Changes

Juno

Juno, now in ATLO (Phase D), is a mission to Jupiter scheduled to launch in August 2011. The Juno science goals are to: determine the oxygen to hydrogen ratio to determine water abundance and estimate core mass in order to decide among alternative theories of planetary origin; understand Jupiter's interior structure and dynamic properties, including internal convection and the size and mass of its core, through mapping of its gravitational and magnetic fields with unprecedented accuracy; map variations in atmospheric composition, temperature, cloud opacity and dynamics to depths greater than 100 bars at all latitudes; and characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras. Juno uses a simple, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure by flying under Jupiter's radiation belts at perijove and outside them at apojove. Juno's baseline orbit remains continuously in sunlight, resulting in benign and stable thermal conditions. Spin stability eliminates complex, power-hungry attitude control components such as reaction wheels.
Additional detail can be found in the Juno project development section of this document and at http://newfrontiers.nasa.gov/missions_juno.html.

Other Missions and Data Analysis

The New Frontiers Future project provides funds for future New Frontiers space missions to be selected via a competitive AO process. The third announcement of opportunity (NF-3) was released for competition in April 2009. The science targets for this NF-3 AO are those identified in the National Academies' report, "Opening New Frontiers in Space: Choices for the Next New Frontiers Announcement of Opportunity" (2008). Three mission concept studies were awarded on December 29, 2009. These concept missions probe the atmosphere and crust of Venus; return a piece of a near-Earth asteroid for analysis; or drop a robotic lander into a basin at the moon's south pole to return lunar rocks back to Earth for study. The 12-month studies began during 2010, and the selected mission must be ready for launch no later than December 30, 2018. Down-selection to one mission is currently planned for third quarter to late CY 2011.

New Frontiers Research provides for the Jupiter Data Analysis project (JDAP), which broadens the science community participation in the analysis of mission data, and allows scientists outside the selected flight team to analyze the data from the mission, do research, and publish their findings. Data access through the New Frontiers Research project allows a much broader and perhaps more objective, analysis of data and samples. JDAP also facilitates new ideas and approaches, getting young people started in science, and broadening participation to get a critical mass of scientific talent working on mission data at the critical time.

On January 19, 2006, the New Horizons mission successfully launched on an Atlas V launch vehicle. New Horizons will reach Pluto and its moons, Charon, Nixa, and Hydra, in July 2015. New Horizons will conduct a reconnaissance of the Pluto-Charon system, map their surface composition and surface temperatures, characterize their geology and the atmosphere of Pluto, search for any atmosphere around Charon, and search for rings and additional satellites around Pluto. The New Horizons spacecraft is now halfway between Earth and Pluto, on approach for a dramatic flight past the icy planet and its moons in July 2015.

New Frontiers program management provides for management oversight of flight missions in implementation, development of AOs, assessments for new missions, and independent management reviews.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Launch an average of one mission per 52 months	New Frontiers program	same
Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers 3	

Implementation Schedule

Project	Schedule by Fiscal Year (Prior, 10–24)	Phase	Beg	End
New Horizons	Ops: Prior–17	Tech		
		Form	Nov-01	Mar-03
		Dev	Mar-03	Jan-06
		Ops	Jan-06	Sep-17
		Res		
Juno	Dev: Prior–11; Ops: 12–18	Tech		
		Form	Jul-04	Aug-08
		Dev	Aug-08	Aug-11
		Ops	Aug-11	Aug-18
		Res		
New Frontiers Research	Res: Prior–24	Tech		
		Form		
		Dev		
		Ops		
		Res	Oct-08	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

MSFC has New Frontiers program management responsibility. Scientific mission priorities and assignment of responsibilities reside with SMD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
New Horizons	MSFC	GSFC, JPL	None
Juno	MSFC	JPL, KSC, GSFC	Italian Space Agency (ASI)
New Frontiers Research	HQ	Multi-Center	None

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers

Acquisition Strategy

Future acquisitions of New Frontiers missions occur under open AO competitions. The New Frontiers Program solicits proposals for an entire mission (including instruments). Proposals are put together by teams, led by a PI, and include contributions from industry, small businesses, government, and academia.

Major acquisitions for the New Horizons (JHU-APL) and Juno (JPL) projects are in place. The PI for New Horizons is at SwRI in Boulder, CO. JHU-APL has project management responsibility.

The Juno PI is from SwRI in San Antonio, TX. JPL provides mission project management and Lockheed Martin Space Systems is building the spacecraft. The Italian Space Agency, ASI, is contributing the Ka-band translator and infrared spectrometer instrument.

New Frontiers Research will be competitively selected from proposals received in response to the ROSES NRA.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	06/2010	Verified compliance with Agency requirements for program implementation and alignment with Agency strategic goals and objectives. The findings from the review include: the program provides effective technical and schedule analysis support to the projects and continues to actively use risk-based insight as part of its oversight of the projects, and that the AO process has proven to be a well-defined, disciplined process that is viewed by the science community as fair and effective.	06/2013

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**485.9**	**257.1**	**-**	**31.2**	**17.6**	**17.9**	**16.7**	**29.6**

Note: Other than the rephasing adjustments, the project remains within its life cycle ($1,107 million) and development ($742.3 million) baseline cost estimates.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The funding profile has been modified consistent with NASA risk management plan and strategy. There are no changes to the Juno approved development ($742.3 million) nor the life cycle cost ($1,107 million) baselines since KDP-C.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Purpose

NASA selected Juno on July 15, 2005, under the New Frontiers AO. The overarching scientific goal of the Juno mission is to improve understanding of the origin and evolution of Jupiter. However, as the archetype of giant planets, Jupiter can also provide knowledge that will improve understanding of both the origin of our solar system and of planetary systems being discovered around other stars. The investigation focuses on four science objectives.

Origin: Determine the oxygen-to-hydrogen ratio to determine water abundance and estimate core mass to decide among alternative theories of planetary origin.

Interior: Understand Jupiter's interior structure and dynamic properties through mapping of its gravitational and magnetic fields with unprecedented accuracy, leading to observations of internal convection and the size and mass of its core.

Atmosphere: Map variations in atmospheric composition, temperature, and cloud opacity and dynamics, to depths greater than 100 bars, at all latitudes.

Magnetosphere: Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

These objectives have been rated very highly in the National Academies' Solar System Exploration decadal survey and Sun-Earth Connections decadal survey. The Astrophysics decadal survey identified the study of star formation, their planetary systems, as well as giant and terrestrial planet birth and evolution as high priority. Juno fulfills key goals outlined in recent NASA and NRC studies.

Project Parameters

Juno achieves the science objectives by using a simple spinning, solar-powered spacecraft to make global maps of the gravity, magnetic fields, and atmospheric composition of Jupiter from a unique elliptical polar orbit with a close perijove. The spacecraft carries precise, high-sensitivity radiometers, magnetometers, and gravity science systems. Juno's 32 polar orbits extensively sample Jupiter's full range of latitudes and longitudes. From its polar perspective, Juno combines in-situ and remote sensing observations to explore the polar magnetosphere and determine the composition and phenomena of Jupiter's auroras.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Commitments

The Juno launch date is August 2011. After a five-year cruise to Jupiter, Juno will enter Jupiter orbit insertion (JOI) during August 2016. Juno will perform one year of science operations.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Waves	University of Iowa	Measures radio and plasma emissions; 4 m electric dipole and search coil	Same	Same
Jupiter Energetic particle Detector Instrument (JEDI)	John Hopkins Applied Physics Lab (JHU-APL)	Measures auroral distributions of electrons and ions; TOF vs. energy, and ion & electron sensors	Same	Same
Gravity Science	Jet Propulsion Lab (JPL)	Maps Jupiter's gravitational field to determine structure of core; X and Ka-band precision Doppler	Same	Same
Flux-Gate Magnetometer (FGM)	GSFC	Maps Jupiter's magnetic field (Vector)	Same	Same
Launch Vehicle	KSC	Atlas 551	Same	Same
UV Spectrometer (UVS)	Southwest Research Institute (SwRI)	FUV spectral imager for auroral emissions	Same	Same
Microwave Radiometer (MWR)	Jet Propulsion Lab (JPL)	6 wavelengths (1.3-50 cm); sounds atmosphere to determine water and ammonia abundances	Same	Same
Spacecraft	Lockheed Martin	Solar-powered, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure	Same	Same
Jovian Auroral Distributions Experiment (JADE)	Southwest Research Institute (SwRI)	Ion mass spectrometer and electron analyzers; measures auroral distributions of electrons and ions	Same	Same
Juno Camera (JunoCam)	Malin Space Studies Institute	EPO instrument that will take auroral images and Jovian atmospheric activity	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR	5/2008	same	same
Development			
CDR	3/2009	4/2009	same
SIR (formerly ATLO)	3/2010	same	4/2010
FRR	7/2011	same	same
Launch	8/2011	same	same
End of Prime Mission	10/2017	same	same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
Project In Development:	Juno

Project Management

Juno is part of the New Frontiers program, with program management at MSFC. The PI, from SwRI, has delegated day-to-day Juno project management to JPL.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project Management	Project Management and Oversight	JPL	N/A
Jupiter energetic particle instrument (JEDI)	Jet Propulsion Lab (JPL)	None	None
Plasma Waves Experiment (WAVE)	Jet Propulsion Lab (JPL)	None	None
Management; Microwave radiometer, and Gravity Science Experiment	MSFC/New Frontiers Program Office		None
Vector Fluxgate Magnetometer (FGM)	Jet Propulsion Lab (JPL)	Goddard Space Flight Center (GSFC)	None
UVS and JADE instruments	JPL/Juno Project Office	JPL	None
Flight System, Integration and Test	Jet Propulsion Lab (JPL)	None	None
Overall responsibility for the development, implementation, operation, and success of the mission	MSFC/New Frontiers Program Office	None	None
JunoCam	Jet Propulsion Lab (JPL)	None	None
KaBand and IR science	Jet Propulsion Lab (JPL)	None	Italian Space Agency (ASI)

Acquisition Strategy

All major acquisitions are in place. Juno was selected competitively on July 15, 2005 under the second New Frontiers program AO (AO-03-OSS-03).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO /SRB	03/2010	Assess cost, schedule, and risk status of project. The findings from the review showed that cost and schedule for the August 2011 launch are consistent with the project's plans. The project received approval to proceed to ATLO.	06/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Jupiter orbit insertion	If Jupiter orbit insertion fails to put the spacecraft in the desired orbit, then science goals will not be obtainable.	Review baseline Phase E plan and compare with previously flown missions. Develop a recommended operational approach consistent with a Category 1, Class B mission to minimize the risk of an orbital insertion anomaly.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**438.2**	**-**	**594.4**	**433.1**	**408.7**	**309.0**	**245.9**
2009 Mars Science Lab	258.4	-	136.4	40.5	37.0	0.0	0.0
MAVEN	48.1	-	240.3	140.6	34.9	15.4	4.7
Other Missions and Data Analysis	131.7	-	217.7	252.0	336.8	293.5	241.1

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

Mars is the most Earth-like planet in the solar system, with land mass approximately equivalent to the Earth's, and having familiar features such as riverbeds, past river deltas, and volcanoes. Mars has the best planetary record of the first billion years of our solar system and holds scientific clues to the development of the solar system, planets, and maybe life itself. The Mars Exploration Program has been developed to conduct a rigorous, incremental, discovery-driven exploration of Mars to determine the planet's physical, dynamic, and geological characteristics.

The twin Mars rovers, Spirit and Opportunity, are seven years into their surface exploration of Mars, and they continue to return a wealth of new results. Opportunity has been moving south to Endurance Crater, twenty times larger than Victoria Crater. Spirit has been conducting further studies in the area of what remains of an ancient hydrothermal system. Although Spirit is hibernating, NASA has an in situ science plan should the rover survive the winter. The Mars Reconnaissance Orbiter (MRO) is in its extended mission operations phase and is continuing to return results highlighting areas showing morphological, and mineralogical evidence of interaction with liquid water, and characterizing landing sites for MSL and future missions. Mars Odyssey's Thermal Emission Imaging System (THEMIS) has found new evidence of evaporites (salt deposits). Meanwhile, the Mars Science Laboratory (MSL) mission continues to achieve technical and schedule progress toward the CY 2011 launch opportunity. MAVEN is the second Mars Scout mission and will study atmospheric processes that will lead to understanding the evolution of the Martian atmosphere. The 2016 ExoMars Trace Gas Orbiter (EMTGO), the first mission in the joint Mars Exploration program between ESA and NASA, will investigate the constituency, sources and processes of trace gases at Mars including methane, as well as refresh the existing telecommunications infrastructure at Mars for any orbital and surface missions to Mars after 2016.

For more information, see http://mars.jpl.nasa.gov.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Plans For FY 2012

The MSL cruise stage and the rover are scheduled for delivery to the KSC in June to support a launch in November 2011. MSL will spend most of FY 2012 cruising toward its destination, and is scheduled to land on the surface of Mars in August 2012 where it will start surface science operations.

MAVEN successfully completed PDR and has been confirmed to proceed into implementation phase (Phase C/D). Additionally, the project plans to complete CDR by the end of FY 2011. Project managers will work toward System Integration Review to enable approval to enter Phase D, including Operational and Flight Readiness Reviews, by the end of FY 2012.

MER, MRO, Odyssey, and ESA's Mars Express will continue to operate, return science data and perform telecom and relay support throughout FY 2012.

NASA selected four instruments to be included in the NASA/ESA 2016 EMTGO in August 2010. The project plans to successfully complete NASA's PDR by end of FY 2011, and will work toward achieving a successful CDR by the end of FY 2012.

Project Descriptions and Explanation of Changes

Mars Science Laboratory (MSL)

Currently in its implementation phase, MSL takes a major step forward in Mars exploration, both technically and scientifically, utilizing a new entry, descent, and landing system, a long-duration rover, and ten payload elements for definitive mineralogical and organics measurements. The primary scientific objective is to explore and quantitatively assess a local region on Mars as a potential habitat for life, and is the transitional mission from the "Follow the Water" theme to "Seeking the Signs of Life" theme. MSL will lay the groundwork for future scientific missions, including Mars Sample Return, and will provide key information for human exploration. Additional detail can be found in the MSL project development section of this document.

Mars Atmosphere and Volatile EvolutioN (MAVEN)

NASA's second Mars Scout mission, MAVEN (openly competed, PI-led), was approved for implementation (Phase C) beginning November 2010. MAVEN, a robotic orbiter mission, will provide a comprehensive study of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. It will deliver key measurements addressing longstanding questions about the climate history and habitability of Mars. GSFC will manage the project. Lockheed Martin of Littleton, CO, will build the spacecraft based on designs from NASA's Mars Reconnaissance Orbiter and 2001 Mars Odyssey missions. Additional detail can be found in the MAVEN project section of this document.

Other Missions & Data Analysis

In its extended mission operation phase, the primary scientific objectives of Odyssey include more sensitive measurement of the mineralogy of the surface, monitoring of inter-annual variations of Mars climate and surface processes, acquiring future mission landing site data, and continuing as a key telecommunications relay at Mars.

Currently in their extended operation phase, both the Spirit and Opportunity rovers continue to explore geological settings on the surface of Mars using a suite of remote sensing and in-situ instruments. Their objective is to expand our understanding of the history and the geological processes that shaped Mars, particularly those involving water.

Currently in its extended mission operation phase, the objective of the ESA and ISA Mars Express mission is to search for sub-surface water from orbit. NASA participates in the scientific analysis of mission data, including the recent investigations into the mysterious and perhaps the youngest deposits of the Medusae Fossae formation that have minimal radar signal.

Currently in its extended operation phase, MRO's science objectives include: providing high resolution spectral maps and images for interpretation of the geology of the Martian crust; using ground-penetrating radar to map compositional discontinuities and layering under the surface; and creating planetary-scale maps of critical atmospheric properties. MRO has been critical in characterizing landing sites for MSL and will be instrumental in identifying them for future landed missions as well. MRO is also the key telecommunications relay for the first half of the next decade at Mars.

Mars Mission Operations (MMO) provides management and leadership for the development and execution of Mars multi-mission operations. MMO supports and provides operational capabilities at a lower cost and risk to all current Mars projects.

Once missions have concluded their primary mission phase, further funding for extended operations is allocated based on the findings of a senior review board. Their review of each mission enables them to make recommendations for the allocation of the extended operations budget based on scientific merit.

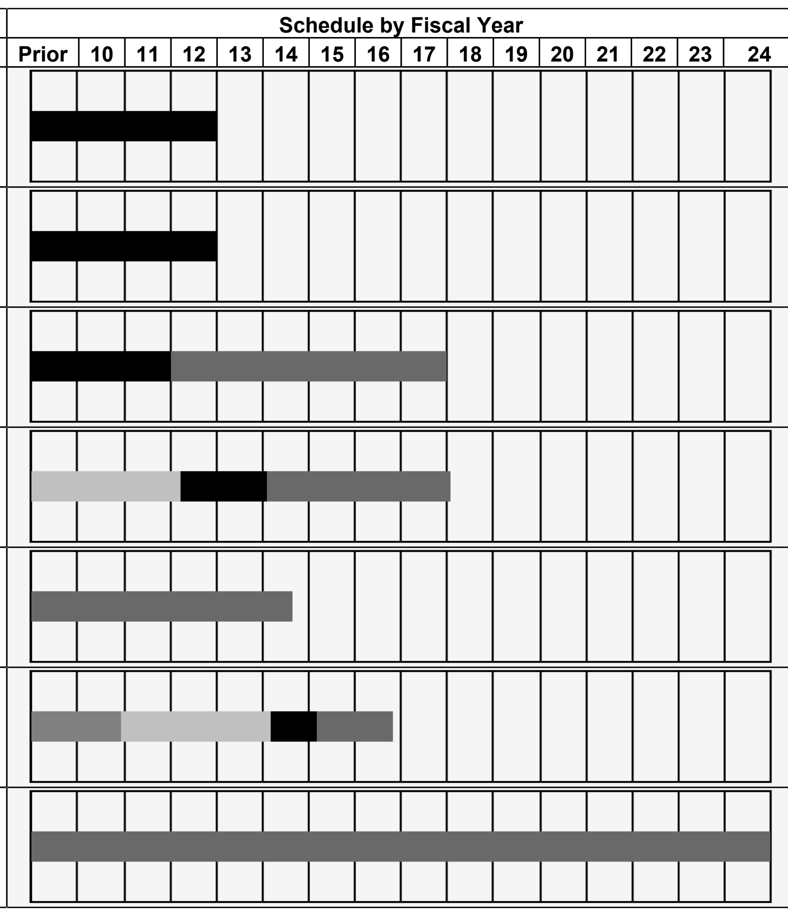
NASA invests in research and analysis of Mars mission data in order to understand how geologic, climatic, and other processes have worked to shape Mars and its environment over time, as well as how they interact today.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
MEP will provide continual operational presence on Mars	Mars Exploration	Same
At least one Mars mission will be launched at every opportunity (every 26 months)	Mars Exploration	Same
Complete the Mars Science Laboratory (MSL) Launch Readiness Review.	MSL	
Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Systems Integration Review.	MAVEN	
Complete the Mars 16 Mission Confirmation Review.	Mars Exploration	

Implementation Schedule



Project	Phase	Beg	End
Mars Odyssey	Tech		
	Form	Apr-97	Apr-99
	Dev	Apr-99	Apr-01
	Ops	Apr-01	Sep-12
	Res		
Mars Exploration Rovers (Spirit and Opportunity)	Tech		
	Form	May-00	Aug-01
	Dev	Aug-01	Jun-03
	Ops	Jun-03	Sep-12
	Res		
Mars Reconnaissance Orbiter (MRO)	Tech		
	Form	Jan-01	Jul-02
	Dev	Jul-02	Aug-05
	Ops	Aug-05	Sep-11
	Res	Oct-11	Sep-17
Mars Science Laboratory (MSL)	Tech		
	Form	Nov-03	Aug-06
	Dev	Aug-06	Dec-11
	Ops	Dec-11	Oct-13
	Res	Oct-13	Oct-17
Mars Express	Tech		
	Form	Jan-00	Sep-00
	Dev	Sep-00	Jun-03
	Ops	Jun-03	Dec-05
	Res	Dec-05	May-14
The Mars Atmosphere and Volatile EvolutioN (MAVEN)	Tech		
	Form	Sep-08	Sep-10
	Dev	Sep-10	Nov-13
	Ops	Nov-13	Dec-14
	Res	Dec-14	Jul-16
Mars R&A	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-00	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration

Program Management

JPL has responsibility for implementation of the Mars Exploration program. Scientific mission priorities and assignment of responsibilities reside with SMD.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Mars Exploration Rovers (MER)	JPL	JPL, ARC, GRC, JSC, GSFC	None
Mars Reconnaissance Orbiter (MRO)	JPL	JPL, ARC, GSFC, JSC, MSFC	Agenzia Spaziale Italiana (ASI)
Mars Science Laboratory (MSL)	JPL	JPL , ARC, GSFC, KSC, GRC, LaRC, JSC	Department of Energy; International partners include Canada, Spain, and Russia.
Mars Atmosphere and Volatile EvolutioN (MAVEN)	JPL	GSFC, KSC, JPL	Centre d'Etude Spatiale des Rayonnements (CESR)
Mars Odyssey	JPL	JPL, MSFC	None
Mars Express (MEX)	JPL	JPL, GSFC	European Space Agency (ESA)
2016 ExoMars Trace Gas Orbiter (EMTGO)	JPL	JPL, ARC, LaRC, GSFC,KSC	European Space Agency (ESA)

Acquisition Strategy

The Mars Exploration program has set a goal of open competition for all missions.

All major acquisitions for MSL are in place. Malin Space Systems, Honeybee Robotics, Lockheed Martin, and Aeroflex are providing support and hardware for the MSL mission.

For the MAVEN mission, the PI is Dr. Bruce Jakosky of the Laboratory for Atmospheric and Space Physics at the University of Colorado at Boulder. GSFC will manage the project, and Lockheed Martin of Littleton, CO, will build the spacecraft.

All Mars research is procured through the ROSES announcement and a competitive, peer review selection process.

Instruments for the 2016 EMTGO were competitively selected via an AO process. ESA will provide the spacecraft, and NASA will provide the launch vehicle. JPL will provide project management and implement the ESA/NASA contributions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	IPAO	10/2006	A Program Implementation Review was conducted in October 2006. Review determined the Mars program was functioning well and continuing to make important contributions to science, but was short on reserve funding. It also found that MSL is critical for future mission science and technology.	3/2011
All	Senior Review Panel	03/2010	Comparative review of Mars operating missions. Missions are ranked in terms of science, engineering capability, and their programmatic roles as they relate to the Mars Exploration program. The findings lead to mission extension for Odyssey, MER, MEX, and MRO, with orbit time change for the Mars Odyssey mission.	03/2012

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	1,744.4	258.4	-	136.4	40.5	37.0	0.0	0.0

Note: Consistent with the SRB, the Directorate Program Management Council and December 9, 2010 Aeropropulsion Management Council recommendations, this budget request includes additional funds to rebuild reserves to a level sufficient to assure the project will achieve its November Launch Readiness Date. This is required due to depletion of reserves in FY 2010, as the cost for final development of the MSL subsystem (avionics, mobility system and drill) and ensuring timely completion of science instruments exceeded expectations.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

The project continues to make technical, cost, and schedule progress. The Sample Analysis of Mars (SAM) instrument has been delivered to the project and difficulties are being resolved for Sample Acquisition, Processing, and Handling (SA/SPaH) drill. To ensure mission success, NASA continues to adopt more conservative posture consistent with NASA risk management plan and strategy. The current life cycle cost is estimated at $2,476.3 million. NASA anticipates reprogramming additional funds to MSL in the initial FY 2011 operating plan to address the technical problems and related issues that have occurred during assembly and testing. The project remains on track to meet its November 2011 launch readiness date (LRD).

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Purpose

The Mars Science Laboratory (MSL) mission is the most technologically challenging interplanetary rover ever designed. It will use new technologies to adjust its flight while descending through the Martian atmosphere, and to set the rover on the surface by lowering it on a tether from a hovering descent stage. Advanced research instruments make up a science payload ten times the mass of instruments on NASA's Spirit and Opportunity Mars rovers. MSL is engineered to drive longer distances over rougher terrain than previous rovers. It will also employ a new surface propulsion system.

MSL will make detailed measurements of element composition, elemental isotopes and abundance, mineralogy, and organic compounds to determine if Mars has, or ever had an environment capable of supporting life within the regions explored by MSL.

MSL has four science objectives:

- Assess the biological potential of at least one selected site on Mars;

- Characterize the geology and geochemistry of the landing region at all appropriate spatial scales;

- Identify planetary processes relevant to past habitability; and

- Characterize the broad spectrum of the Martian surface radiation environment.

For more information, see the MSL homepage at http://marsprogram.jpl.nasa.gov/missions/future/msl.html.

Project Parameters

The MSL is a surface rover that will collect Martian soil and rock samples and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past. MSL will be a long-duration (two years) roving science laboratory that will be twice as long and four times as heavy (900 kilograms) as the Mars Exploration Rovers, Spirit and Opportunity.

Key technologies developed for MSL include: throttle-controlled, high-thrust engines, required during Martian entry, descent, and landing (EDL); sample acquisition and processing equipment used to acquire and distribute samples to the analytic instrument suite; and long-life, high-reliability, thermal-cycle-resistant electronics for use in the rover.

The EDL system will accommodate a wide range of possible latitude and altitude locations on Mars in order to be discovery-responsive and to have the capability to reach very promising, but difficult-to-reach scientific sites.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Commitments

MSL will be ready to launch in November 2011 and will arrive at Mars approximately nine months (August 2012) later. MSL will operate for two Earth years on the surface of Mars and will travel approximately 20 kilometers on the Martian surface.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Rover	JPL	Travel 20 kilometers over the Martian surface.	Same	Same
Stereoscopic and microscopic cameras	Malin Space Systems	Acquire color, stereo images with resolutions up to 0.2 mm/pixel at 2 m range.	Same	Added MastCam zoom capability
Robotic arm tools	Honeybee Robotics	Acquire, process and deliver 75 rock and soil samples to analytic instruments.	Changed the rock grinder to a brush, sample quantity unchanged acquired by drill.	Same
Chemistry camera (ChemCam)	Department of Energy/Los Alamos National Laboratory; France	Remotely measure elemental composition of rocks and soil up to 9m from rover.	Same	Same
Alpha Particle X-ray Spectrometer	Canada (CSA)	Measure with high precision the elemental composition of in situ rocks and soil.	Same	Same
Rover Environmental Monitoring System (REMS)	Spain	Monitor key atmospheric measurements including temperature, pressure, wind speed/direction and humidity.	Same	Same
Dynamic Albedo of Neutrons (DAN)	Russia (IKI)	Measure hydrogen content in subsurface deposits.	Same	Same
Cruise stage and entry system	Lockheed Martin	Transport rover to Martian surface and land with impact speed below 1 m/s	Same	Same
Mission operations and data archive	JPL	Conduct one-year cruise and two-year rover primary mission with remotely located science team.	Same	Same
Sample Analysis at Mars (SAM)	NASA/GSFC	Analysis of elemental and isotopic composition of Mars samples	Same	Same
Sample Cache	ARC	Hockey puck-sized container will collect sample of Martian soil for possible later collection by a Mars sample return mission.	Deleted	Same
Chemistry and Mineralogy Instrument (CheMin)	NASA/ARC	Analysis of mineral and chemical content of Mars samples	Same	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Schedule Commitments

MSL entered formulation phase in November 2004 and proceeded into implementation phase in August 2006. The project is currently scheduled for launch in November 2011, to be followed by landing and surface science operations beginning in August 2012.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Critical Design Review	June 2007	June 2007	Same
System Integration Review (formerly ATLO)	February 2008	February 2008	Same
Launch Readiness Review	September 2009	4QTR CY 2011	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	2009 Mars Science Lab

Project Management

MSL is a JPL-managed in-house project. Instrument implementation has been assigned to JPL.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Rover	JPL	JPL	None
Stereoscopic and microscopic cameras	JPL	None	None
Robotic arm tools	JPL	JPL	None
Chemistry camera (ChemCam)	JPL	None	Department of Energy and France
Alpha Particle X-ray Spectrometer	JPL	None	Canada
Rover Environmental Monitoring System (REMS)	JPL	None	Spain
Dynamic Albedo of Neutrons (DAN)	JPL	None	Russia
Cruise stage and entry system	JPL	JPL, AMES, LaRC	None
Spacecraft	JPL	JPL	None
Sample Analysis at Mars (SAM)	JPL	GSFC	CNES (France)
Chemistry and Mineralogy Instrument (CheMin)	JPL	ARC	None

Acquisition Strategy

All major acquisitions are in place. All major instruments were competitively selected. Malin Space Systems, Honeybee Robotics, Lockheed Martin, and Aeroflex are providing support and hardware for the MSL mission.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ/SRB	11/2010	Assess maturity of MSL design, technical state, and adequacy of resources. Design was deemed adequate to achieve mission science goals, but project needs additional time and resources to work the technical problems and perform adequate testing. The finding resulted in an additional $82.11 million, consistent with NASA risk management plan and strategy, to resolve problems and to ensure mission success.	03/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
MSL Landing Risk	If the MSL spacecraft does not successfully land on the Martian surface, then the science objectives will not be achieved.	To ensure success, conduct thorough verification and validation program that includes simulations of trajectory, approach, and landing operations to validate and refine procedures, and apply lessons learned from Phoenix and MER.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	9.9	48.1	-	240.3	140.6	34.9	15.4	4.7

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

MAVEN received KDP-C decision approval on October 4, 2010. The above funding estimate reflects the October 2010 KDP-C decision, which included Electra and the awarded launch vehicle costs.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Purpose

Mars Atmosphere and Volatile EvolutioN (MAVEN) was selected in September 2008 under the 2006 Mars Scout AO. The MAVEN mission will provide a comprehensive picture of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. MAVEN will deliver answers to long-standing questions regarding the loss of Mars' atmosphere, climate history, liquid water, and habitability. MAVEN will provide the first direct measurements ever taken to address key scientific questions about Mars' evolution.

Specific MAVEN science objectives are to:

- Determine structure and composition of the atmosphere and ionosphere;

- Determine the physical and chemical processes that control loss processes;

- Determine escape rates of neutrals;

- Determine escape rates of ions;

- Determine the external inputs that control upper atmosphere and ionosphere structure and that drive escape; and

- Determine the relative escape rates of the stable isotopes and the resulting isotopic fractionation.

Additional information can be found at http://www.nasa.gov/maven.

Project Parameters

MAVEN will deliver its science using three instrument packages: a stand-alone neutral gas and ion mass spectrometer (NGIMS), capable of measuring thermal neutrals and ions; a stand-alone imaging ultraviolet spectrometer (IUVS); and the Particles and Fields package, consisting of six instruments measuring ionospheric properties, energetic ions, solar wind and solar energetic particles, magnetic fields, and solar extreme ultraviolet irradiance.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Commitments

The MAVEN measurements will be made from an elliptical orbit with periapsis at 150 kilometers and apoapsis at 6220 kilometers (4.5-hour period). MAVEN will use a Sun-pointing, three-axis stabilized spacecraft, with a two-axis gimballed, Mars-pointing platform for the NGIMS, IUVS, and the SupraThermal And Thermal Ion Composition (STATIC) instruments. The spacecraft has a body-mounted high-gain antenna.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Launch Services	United Launch Services	Atlas V Launch Service	New	Same (reported as intermediate class launch service; Atlas V now selected)
Spacecraft	Lockheed Martin	MRO-heritage spacecraft bus and avionic suite, with cross strapping and monopropellant propulsion system	New	Same
Neutral Gas and Ion Mass Spectrometer (NGIMS)	GSFC	Mass Spectrometry Instrument	New	Same
Supra Thermal and Thermal Ion Composition (STATIC)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Solar Energetic Particles (SEP)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Solar Wind Electron Analyzer (SWEA)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Solar Wind Ion Analyzer (SWIA)	SSL	Part of the MAVEN particle and fields instrument package	New	Same
Lanamuir Probe and Waves and EUV (LPW/EUV)	LASP	Part of the MAVEN particle and fields instrument package	New	Same
Magnetometer	GSFC	Part of the MAVEN particle and fields instrument package	New	Same
Imaging Ultraviolet Spectrometer (IUVS)	LASP	Remote-Sensing Instrument package	New	Same
Electra	JPL	UHF Data Relay payload	New	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Schedule Commitments

NASA selected the second Mars Scout mission, MAVEN, for formulation on September 15, 2008. MAVEN was confirmed to proceed into implementation phase on October 4, 2010, with a November 2013 launch date and arrival at Mars in September 2014.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR	07/2010	New	Same
Development			
CDR	07/2011	New	Same
ATLO	07/2012	New	Same
Launch	11/2013	New	Same
Mars Orbit Insertion	09/2014	New	Same

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Management

The MAVEN project is part of the Mars Exploration Program managed for NASA by the Mars Program Office at JPL. The PI for MAVEN is from the University of Colorado and has delegated the day-to-day management of the MAVEN Project to GSFC.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project management, mission systems engineering, safety and mission assurance, and project scientist	GSFC	GSFC	
Neutral gas and ion mass spectrometer (NGIMS)	GSFC	GSFC	
Navigation, trajectory, and orbit maintenance analysis	GSFC	JPL	
Magnetometer (MAG) - Measures interplanetary, solar wind, and ionospheric magnetic fields	GSFC	GSFC	
Payloads	GSFC	GSFC	CNES
Spacecraft	GSFC		
Mission Operations	GSFC		
Launch Vehicle	KSC	KSC	
Ground Systems	GSFC		
Systems Integration and Testing	GSFC	GSFC	
E/PO	HQ	GSFC	
Science	HQ	GSFC	

Acquisition Strategy

All major acquisitions are in place. MAVEN was selected competitively on September 15, 2008, under the Mars Scout 2006 Announcement of Opportunity (AO-NNH06ZDA002O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	07/2010	The MAVEN Project passed the Preliminary Design Review (PDR)/Non-Advocacy Review (NAR) conducted by the independent Standing Review Board in July 2010.	07/2011

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
Project In Development:	Mars Atmosphere & Volatile EvolutioN

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single Point Failures on High Efficiency Power Supply (HEPS) Card	If single point failures on the input of the HEPS card occur, then permanent loss of spacecraft electrical power will result.	The project and Goddard Mission Assurance Office are identifying and understanding HEPS-specific manufacturing techniques; identifying all single point failures to inspect during assembly to mitigate against shorts; developing a plan for insight/oversight of the MAVEN-specific HEPS card build; and reviewing board requirements with an eye towards design robustness and remaining design requirements.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**100.6**	**-**	**120.8**	**80.5**	**82.2**	**84.1**	**88.5**
Outer Planets	100.6	-	120.8	80.5	82.2	84.1	88.5

Note:
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Program Overview

The Outer Planets Program consists of three strategic elements: the ongoing Cassini mission to Saturn; Supporting Research and Technology (SR&T); and a pre-formulation study effort for a future outer planets mission. These elements enable science investigations across a broader array of disciplines and in more depth than smaller, tightly focused competed missions. The science discoveries made by these strategic missions are not expected to be easily displaced with time and are expected to overthrow previous paradigms and create new ones in their place.

Plans For FY 2012

The Senior Review Board recommended the Cassini Solstice mission, the project's third mission extension, to observe seasonal and temporal change in the Saturn system through March 2018.

The recommendations of the next Planetary Science decadal survey, expected in March 2011, will determine the science priority for the next outer planets mission.

Project Descriptions and Explanation of Changes

Outer Planets

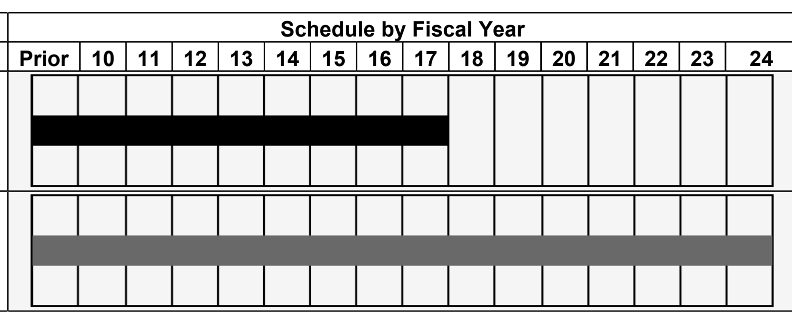
Cassini-Huygens, in its extended operations phase, is an Outer Planets flagship mission to Saturn that has profoundly altered our understanding of that planet, its famous rings, magnetosphere, icy satellites, and particularly the moons, Titan and Enceladus. Cassini-Huygens is an international collaborative effort. It was launched in October 1997 and arrived at Saturn in July 2004 in order to explore the Saturn system in detail, including its rings and moons. A major focus is Saturn's largest moon, Titan, with its dense atmosphere, methane-based meteorology, and geologically active surface. Cassini completed its prime mission in July 2008, completed its Equinox mission in July 2010, and began the Solstice mission in October 2010. The Solstice mission will observe seasonal and temporal change in the Saturn system, especially at Titan, to understand underlying processes, and prepare for future missions. The Cassini Solstice mission will continue to operate and conduct data analysis through March 2018.

The SR&T effort dramatically increases the scientific return of NASA missions and guides current mission operations (e.g., selecting Cassini imaging targets), as well as future mission planning (e.g., mission concept studies for Titan missions). The competitive programs within the SR&T effort increase understanding of the outer solar system and broaden the science community participation in the analysis of data returned by Cassini, Galileo, and other missions.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Deliver science data to Planetary Data Systems (PDS) consistent with science archive plan (in increments within 6 - 9 months)	Cassini	same
Release ROSES and make selections	Research Data Analysis	same

Implementation Schedule



Project	Phase	Beg	End
Cassini	Tech		
	Form		Sep-89
	Dev	Oct-89	Oct-97
	Ops	Oct-97	Sep-17
	Res	Oct-97	Sep-17
Research Data Analysis	Tech		
	Form		
	Dev		
	Ops		
	Res	Oct-97	Sep-24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Outer Planets

Program Management

Management responsibility for the Cassini and pre-formulation of the Outer Planets future mission concept development resides at JPL. Scientific mission priorities for the program and the research efforts reside within SMD/Planetary Science Division.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Cassini	JPL	JPL	The Italian Space Agency provided Cassini's high-gain communication antenna and the Huygens probe was built by the European Space Agency (ESA).
Outer Planets Pre-project Formulation	JPL	JPL	ESA
Research Data Analysis	HQ	Multi-Center	None

Acquisition Strategy

All major acquisitions contracts for Cassini are in place. The acquisition strategy for future Outer Planets missions will be determined in Spring 2011 after receipt of the results of the Planetary decadal survey. The science payloads will be competitively selected for the Outer Planets future mission.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	02/2009	Cassini senior review for the Solstice extended mission recommended approval of the extended mission science.	02/2012

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**105.5**	**-**	**122.9**	**104.1**	**86.6**	**84.9**	**85.4**
Technology	105.5	-	122.9	104.1	86.6	84.9	85.4

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Program Overview

Planetary Science missions demand advances in both power and propulsion systems to enable successful trips to harsh environments, far from the Sun, with highly challenging trajectories and operations. To meet these needs, the Planetary Science Technology program includes the In-Space Propulsion (ISP), Radioisotope Power Systems (RPS), and Advanced Multi-Mission Operations System (AMMOS) projects.

The ISP project develops in-space propulsion technologies that can enable or benefit near- and mid-term NASA missions. These technologies will enhance the performance of planetary science missions by allowing increased science payload mass, reduced launch costs, and decreased mission trip times. The RPS project advances the capabilities of spacecraft power systems, thereby making it possible for missions to travel to destinations distant from the sun, or where sunlight is obscured or infrequent. RPS is developing flight Advanced Stirling Radioisotope Generators (ASRG) for the 2014 time frame. AMMOS provides planetary science missions with a set of operations, navigation and design software tools and services for flight mission training, mission operations, space communications resources allocation, and improved space communication. NASA's portion of the budget for restarting the Nation's plutonium production capacity, shared with DOE, is also included in the program.

In close cooperation with the Office of the Chief Technologist, these technology investments focus on the unique needs of robotic planetary missions, and leverage Agency cross-cutting efforts in space propulsion, power, and automation/operations technologies.

Plans For FY 2012

ISP completed the electric propulsion Hall thruster development task in FY 2011 and starts long duration testing in FY 2012. The Hall system power processing unit continues development in FY 2012. The ISP project will complete electric propulsion life validation testing of NASA's Evolutionary Xenon Thruster (NEXT) in FY 2012. In FY 2012, the ISP project will continue propulsion system component development for a Mars Ascent Vehicle (MAV) capability and will continue lightweight propellant tank development for the Skycrane. In FY 2012, the ISP project will complete the preliminary design of an Earth entry vehicle (EEV) concept and establish EEV heat shield micro-meteoroid/orbital debris characteristics.

In FY 2012, RPS will continue an extended performance testing of the Advanced Stirling Radioisotope Generator (ASRG) engineering unit, and continue the development of a qualification unit to enable delivery of one ASRG flight unit for the 2016-2017 Discovery flight opportunity. RPS will continue the development of advanced radioisotope thermoelectric generator couples by validating lifetime and four couple module power. RPS will also fund DOE safety testing to verify safety models for solid upper stages.

AMMOS will continue to provide multi-mission operations software tools for spacecraft navigation and mission planning, efficient spacecraft communication, and data handling.

In addition, this Planetary Science Technology Program will pursue complimentary collaborations with the new crosscutting Space Technology program within the Office of the Chief Technologist.

Project Descriptions and Explanation of Changes

Technology

ISP will enable access to more challenging and interesting science destinations, including enabling sample return missions. ISP continues to advance several propulsion technologies in support of future Flagship, Discovery, Mars, and New Frontiers missions. The ISP portfolio continues to invest in high-priority technology areas such as the electric propulsion and aerocapture/Earth entry, descent, and landing technologies identified in the Solar System Exploration Roadmap and the 2010 SMD Science Plan. ISP will continue increasing its emphasis on sample return propulsion technology development. The foci will be: continuing propulsion component technology development for a MAV and preparing for MAV flight system development; completing EEV heat shield micro-meteoroid/orbital debris characteristics studies, a preliminary design of a multi-mission Earth entry vehicle (MMEEV) concept and continuing MMEEV technology development; and initiating thruster long duration testing and continuing other subsystem technology developments for the High Voltage Hall Accelerator (HiVHAC) thruster technology applicable to Earth return vehicles (ERV), transfer stages, and low-cost electric propulsion systems for Discovery-class missions. The ISP project will be responsive to the Planetary 2011 decadal survey.

RPS continues low-level investments in advanced Stirling, thermoelectric conversion, and thermal photovoltaic technologies in response to mission needs identified by the Planetary decadal survey. The RPS project also funds cross-cutting multi-mission activities to keep them off the critical path for future RPS mission, such as NEPA process development, multi-mission launch vehicle data book development, safety analysis and testing, and radiological contingency response process improvement. This work is critical to facilitate the application of RPS. RPS is structured to manage both the technology investments and systems development, such as the development and testing of the ASRG. The project transitions acquisition of flight units to a mission-specific user. The project also assumes responsibility for multi-mission RPS studies, sustaining capabilities, and crosscutting launch approval activities. However, funds are not included within the RPS budget for the procurement of nuclear material required to support missions in formulation, or the development of DOE capabilities to produce Plutonium-238.

AMMOS provides multi-mission operations, navigation, design, and training tools for Planetary Science flight missions, and undertakes technology investments for improved communications and navigation technologies.

NASA and DOE have initiated project pre-planning and activities for implementing a Pu-238 production restart. NASA continues to assess the need and schedule for plutonium. Mission studies, conducted by the NASA Radioisotope Power System (RPS) program based on the Planetary decadal survey mission set have revalidated the need for additional Pu-238 supplies.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
HiVHAC Engineering Model (EM) thruster long duration test will be initiated	ISP	New
NEXT long duration test will be completed with a goal of achieving 750Kg of Xenon throughput	ISP	New
Earth Entry Vehicle (EEV) preliminary design complete	ISP	New
Mars Ascent Vehicle (MAV) propulsion system technology development preliminary design complete	ISP	New
Advanced Stirling Radioisotope Generator engineering model will demonstrate extended operations (14,000 hours)	RPS	same
Provide standard interfaces in order to enable interoperability among missions	AMMOS	same

Program Management

SMD provides overall oversight of the Technology program. GRC is responsible for the ISP and RPS projects. JPL is responsible for the AMMOS project.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
ISP	GRC	GRC, MSFC, JPL, LARC, ARC	None
RPS	GRC	JPL, GRC, KSC	Department of Energy
AMMOS	JPL	JPL	None
Plutonium Restart	HQ	GRC	DOE

Acquisition Strategy

Technology activities are solicited using NASA ROSES announcement, and selections are made using a competitive, peer-reviewed process. The Department of Energy completed an acquisition for ASRG flight system development (Lockheed Martin) for RPS. JPL provides management and the navigation and space communication software tools.

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Technology

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Academies	12/2010	Assessing the restart and sustainment of domestic production of radioisotope heat source material for deep space and other exploration missions. Assessing the development of and standards for flight certification of ASRG for flagship and other missions.	TBD
Performance	SRB/IPAO	09/2010	Program Implementation Review. Based on the program readiness and SRB recommendation, subsequent Agency approval was granted to the RPS program on December 9, 2010, by the Agency Program Management Council (APMC).	09/2012

Mission Directorate:	Science
Theme:	Astrophysics

Theme Overview

NASA's goal in astrophysics is to "Discover how the universe works, explore how the universe began and evolved, and search for Earth-like planets." Three broad scientific questions emanate from this goal. How do matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos? How did the universe originate and evolve to produce the galaxies, stars, and planets we see today? What are the characteristics of planetary systems orbiting other stars, and do they harbor life?

The Astrophysics Theme addresses these questions via an integrated strategy incorporating a robust research and technology program, at least nine operating missions and six flight projects in various stages of planning and execution. This year's Astrophysics programmatic strategy is informed by the National Academies' recently released decadal survey titled "New Worlds, New Horizons in Astronomy and Astrophysics." The Astrophysics Theme represents a balance between bold new initiatives that open the universe to new discoveries and support for activities that strengthen the foundations of the research enterprise that are essential to the cycle of discovery.

The Astrophysics programs that support the integrated strategy are as follows:

- The Physics of the Cosmos (POCS) Program contains missions that explore the most fundamental and extreme physical conditions of the universe, from black holes and gravitational waves to dark matter and dark energy. These missions will enable the study of the building blocks of existence at the most basic level: matter, energy, space, and time;

- The Cosmic Origins Program comprises projects that enable the study of how galaxies, stars and planetary systems came into being, how they evolve, and ultimately how they end their lives;

- The Exoplanet Exploration Program contains missions that help search for Earth-like planets around other stars. These missions will explore the origin, structure, and evolution of other planetary systems as they search for other worlds;

- The Astrophysics Explorer Program conducts small principal investigator-led missions. Explorer missions are opportunities for innovative science that fill the scientific gaps between larger missions; and

- The Astrophysics Research Program prepares for the next generation of missions by supporting both theoretical research and applied technology investigations. These research activities use data from current missions and suborbital science investigations to advance NASA science goals, and provide hands-on workforce training of students and early-career scientists and engineers.

The budget for the James Webb Space Telescope (JWST) is now carried under its own Theme. This is consistent with management changes implemented in FY 2011 to improve management oversight and control over the project, following release of the Independent Comprehensive Review Panel's (ICRP) report in November 2010.

For more information, please see http://nasascience.nasa.gov/astrophysics.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**647.3**	**-**	**637.7**	**708.3**	**721.0**	**713.5**	**741.9**
Astrophysics Research	149.1	-	161.6	200.1	211.8	229.3	238.6
Cosmic Origins	225.3	-	219.7	219.4	209.9	195.2	184.5
Physics of the Cosmos	116.0	-	100.3	112.4	111.9	98.1	96.8
Exoplanet Exploration	43.4	-	48.2	65.5	63.6	62.1	69.8
Astrophysics Explorer	113.5	-	107.8	110.9	123.7	128.7	152.0

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Plans for FY 2012

Astrophysics Research

A Senior Review for operating missions will be conducted in the spring of 2012. This review involves a comparative evaluation of all Astrophysics operating missions and is conducted every two years. An independent expert panel evaluates the science output of each operating mission and makes recommendations as to which missions should receive funding for extended operation. A comparative evaluation for all Astrophysics mission data archives will be conducted in 2011.

The Astrophysics Research Program will continue to select peer-reviewed investigations for technology and detector development, suborbital missions, laboratory studies of astrophysical phenomena, theoretical studies and modeling of astrophysical phenomena targeted by past, current, and future missions, as well as limited ground-based observation in direct support of Astrophysics missions. A new program of postdoctoral fellowships will be initiated in FY 2012 for those working in astrophysics technology areas.

The Balloons project will support 16-20 suborbital flights, and will continue development of the new super-pressure balloon, which will be used to carry large scientific experiments to the brink of space for up to 100 days or more.

Cosmic Origins

Hubble Space Telescope will continue operations.

The Stratospheric Observatory For Infrared Astronomy (SOFIA) will continue to ramp up science flight hours and will complete open door flight testing.

The Herschel Space Observatory will continue prime operations.

Physics of the Cosmos

The Planck mission will continue prime operations. The Fermi Gamma-ray Space Telescope will remain in its prime operations phase, and the Chandra X-ray Observatory will continue on in extended operations.

Exoplanet Exploration

The Kepler mission will continue prime operations.

Large Binocular Telescope Interferometer (LBTI) scientific operations will start during FY 2011 and will continue during FY 2012.

Astrophysics Explorer

Astro-H (SXS) will be undergoing final assembly and test prior to shipment to Japan for final spacecraft integration and testing in early FY 2013.

The Nuclear Spectroscopic Telescope Array (NuSTAR) mission will launch in February 2012.

The Gravity and Extreme Magnetism (GEMS) mission will complete mission Critical Design Review (CDR).

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's Astrophysics Theme is guided by the National Aeronautics and Space Act of 1958 and subsequent legislation, the National Space Policy of the United States of America, and related policies that call on NASA to conduct space missions to advance scientific understanding of the universe. In doing so, NASA follows a long-standing tradition of establishing its science priorities through consultation with world-class experts via the National Academies' decadal survey process. The most recent astronomy and astrophysics decadal survey was released in August 2010. Astrophysics also receives tactical-level advice from the external science community via the Astrophysics Subcommittee of the NASA Advisory Council, and advice on cooperative activities from the Congressionally chartered, National Science Foundation (NSF)-managed Astronomy and Astrophysics Advisory Committee.

NASA enables research to understand the structure, content, and evolution of the universe. This research provides information about humankind's origins and fundamental physics that govern the behavior of matter, energy, space, and time. NASA leads the world in space-based research on the most compelling questions of modern physics, such as the nature of dark matter and dark energy, high-energy cosmic rays, tests of gravity and general relativity, and insight into cosmic inflation during the very early universe. NASA works proactively with the NSF and Department of Energy (DoE) in exploring the interfaces between astronomy and physics, and in the search for life in the universe.

Relevance to the NASA Mission and Strategic Goals:

Astrophysics research supports NASA's Strategic Goal 2, to "Expand scientific understanding of the Earth and the universe in which we live."

Relevance to education and public benefits:

Stunning images produced from operating Astrophysics missions continue to inspire the public, revealing the beauty of the universe and the science behind those images. NASA provides the tools to translate science for the classroom and other learning venues in ways that meet educator needs.

Hubble images are featured on the Space Telescope Science Institute's "Amazing Space" Web site, which provides curriculum support tools to classrooms in every state in the Nation. Spitzer's "Cool Cosmos" Web site offers explorations into the world of the infrared spectrum, and Chandra's Web site delivers authentic data sets to educators to enhance lessons by allowing students to use the same data that professional researchers use.

Several of NASA's Astrophysics missions have been featured in a traveling museum exhibit, "Alien Earths," which informs and inspires the public on critical questions related to the search for life elsewhere in the universe. The Astrophysics Exoplanet Exploration Program, in conjunction with the Astronomical Society of the Pacific, has sponsored the creation of "Night Sky Network" amateur astronomy clubs around the Nation. NASA also provides toolkits and professional development training to support these groups of space enthusiasts as they help strengthen the public understanding of astronomy and space science.

Mission Directorate:	**Science**
Theme:	**Astrophysics**

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.4	**Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.**	
Objective 2.4.1	**Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity.**	
Performance Goal 2.4.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.4.1.1: AS-12-1	Demonstrate planned progress in understanding the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.4.1.2	***By 2015, launch at least one mission in support of this outcome.***	
APG 2.4.1.2: AS-12-2	Complete the Nuclear Spectroscopic Telescope Array (NuSTAR) Launch Readiness Review.	Astrophysics Explorer
Objective 2.4.2	**Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.**	
Performance Goal 2.4.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.4.2.1: AS-12-3	Demonstrate planned progress in understanding the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.4.2.3	***Develop and operate an airborne infrared astrophysics observatory.***	
APG 2.4.2.3: AS-12-4	Initiate the Stratospheric Observatory for Infrared Astronomy (SOFIA) Segment 3 Aircraft modifications and upgrades.	Cosmic Origins
Objective 2.4.3	**Generate a census of extra-solar planets and measure their properties.**	
Performance Goal 2.4.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.4.3.1: AS-12-5	Demonstrate planned progress in generating a census of extra-solar planets and measuring their properties. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs

Uniform and Efficiency Measures:

Measure #	Description
Astrophysics Theme	
APG EFF: AS-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: AS-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: AS-12-8	Peer-review and competitively award at least 95 percent, by budget, of research projects.
APG EFF: AS-12-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

Mission Directorate:	**Science**
Theme:	**Astrophysics**

Performance Achievement Highlights:

The High-Resolution Soft X-Ray Spectrometer (SXS) instrument for the Astro-H mission completed its Preliminary Design Review (PDR) on May 20, 2010. This was followed by the confirmation review on June 21, 2010. Astro-H SXS was approved to proceed into the development phase (Phase C).
A critical phase of SOFIA testing was successfully completed in FY 2010, when the SOFIA aircraft with the telescope installed was flight tested through a wide range of flight conditions and altitudes. No flight handling or acoustic anomalies were found in this flight testing, including up to the planned maximum flight altitude of 45,000 feet. Additionally, testing of telescope operations during this flight showed that telescope performance, including telescope pointing stability critical to astronomical observations, was as designed and required for astronomy. The first science instrument was integrated and flown in the SOFIA observatory in FY 2010, and obtained the "first light" image in May 2010.

Using data from the Fermi Gamma-ray Space Telescope, scientists have recently discovered a gigantic, mysterious structure in this galaxy. This feature looks like a pair of bubbles extending above and below the center of the galaxy. Fermi has also provided rare experimental evidence that space-time is as smooth as Einstein predicted.

The Hubble Space Telescope saw past the distance limit for galaxies and uncovered a primordial population of compact and ultra-blue galaxies that have never been seen before. At least one of the newly discovered galaxies lies beyond a redshift of 8.5, or 13.1 billion light-years distant. These discoveries means that the known time of formation of the first galaxies is less than 600 million years after the Big Bang, earlier than previously thought. The deep observations also demonstrate the progressive buildup of galaxies and provide further support for the hierarchical model of galaxy assembly. In this model, small objects accrete mass, or merge, to form bigger objects over a smooth and steady, but still dramatic, process of collision and agglomeration, and these small building blocks fuse into the larger galaxies known today.

The Herschel Space Observatory (Herschel) has made an unexpected discovery: a gaping hole in the clouds surrounding a batch of young stars. A cloud of bright reflective gas known to astronomers as NGC 1999 sits next to a black patch of sky. This patch looks black not because it is a dense pocket of gas but because it is truly empty space. Astronomers theorize that the hole must have been opened when the narrow jets of gas from some of the young stars in the region punctured the sheet of dust and gas that forms NGC 1999. The powerful radiation from a nearby adolescent star may also have helped to clear the hole. Whatever the precise chain of events, it could be an important glimpse into the way newborn stars rip apart their birth clouds.

NASA's Spitzer Space Telescope (Spitzer) has discovered something odd about a distant planet: the planet lacks methane, an ingredient common to many of the planets in Earth's solar system. The discovery brings astronomers one step closer to probing the atmospheres of distant planets the size of Earth. Eventually, a larger space telescope could use the same kind of technique to search smaller, Earth-like worlds for methane and other chemical signs of life, such as water, oxygen, and carbon dioxide. The methane-free planet, called GJ 436b, is about the size of Neptune, making it the smallest distant planet that any telescope has successfully analyzed.

Mission Directorate:	Science
Theme:	Astrophysics

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Senior Review Panel	04/2010	Comparative review of missions currently in operation to rank the scientific merit of their extended mission proposals. In the most recent review, Planck and Chandra missions ranked highest, while Integral and WISE ranked lowest. Results and the report can be found at http://science.nasa.gov/astrophysics/2010-senior-review/.	04/2012
Performance	National Research Council	05/2006	Congressionally mandated review by the National Academies. The resulting letter report found that "It is vital that the strong, balanced science program in astronomy and astrophysics that has served the Nation so well continue to be sustained as any new policy is implemented."	TBD
Relevance	National Research Council	08/2010	Decadal survey to set science and mission priorities for NASA's Astrophysics Program. The report, "New Worlds, New Horizons," concluded that NASA's Astrophysics Program is properly structured to address the science questions identified by the science community, and provided a prioritized list of future Astrophysics missions.	08/2020

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**149.1**	**-**	**161.6**	**200.1**	**211.8**	**229.3**	**238.6**
Astrophysics Research and Analysis	59.6	-	64.3	82.8	83.9	85.1	88.0
Balloon Project	28.2	-	29.3	32.8	33.6	34.1	35.3
Other Missions and Data Analysis	61.3	-	67.9	84.5	94.3	110.1	115.4

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Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Research

Program Overview

The Astrophysics Research Program supports the early development of new technologies for future missions and suborbital flights of experimental payloads on balloons and sounding rockets. It provides funding to analyze the data from NASA missions to understand astronomical events such as the explosion of a star, the birth of a distant galaxy, or the motion of planets around their parent stars. The program also supports basic research for scientists to work out the consequences of their theories, and to understand how they can best use data from NASA missions to develop new knowledge about the cosmos.

The first step in developing new technologies for future NASA missions is to show that the technology can work in the laboratory. A new type of scientific instrument is often flown first on a high-altitude balloon mission, or on a sounding rocket flight that takes it briefly outside Earth's atmosphere. Instruments for balloons and sounding rockets are not as costly as those for an orbital mission, and they can be built quickly to respond to unexpected opportunities. The equipment is usually retrieved after the flightso that novel instruments can be tested, improved, and flown again. These suborbital flights are important in training the next generation of scientists and engineers to compete better in the 21st century, and to maintain U.S. leadership in science, engineering, and technology.

NASA's policy is to make the data from its space science missions available freely to everyone. These data are archived at a few consolidated astrophysics data centers, from which users can download them. The centers also provide tools that enable users to combine different sets of data to examine how the appearance of the sky changes when it is observed with different kinds of light. For example, the remnant of an exploding star (a supernova) looks very different in pictures taken in visible light and in X-rays. More information can be found at http://nasascience.nasa.gov/astrophysics/astrophysics-data-centers.

Over the years, NASA has invested heavily in the development and execution of an extensive array of space astrophysics missions. The magnitude and scope of the archival data from those missions enables science that transcends traditional wavelength regimes and allows researchers to answer questions that would be difficult, if not impossible, to address through an individual observing program. To capitalize on this invaluable asset and enhance the scientific return on NASA mission investments, the Astrophysics Data Analysis Program (ADAP) provides support for investigations whose focus is on the analysis of archival data from NASA space astrophysics missions.

For more information on the Astrophysics Research Program, please see http://nasascience.nasa.gov/researchers/sara/.

Plans For FY 2012

The Astrophysics Research Program has made changes to address the need for technology development, as indicated by the 2010 decadal survey recommendations. Funding has been added to the Astrophysics Research and Enabling Technology program (APRET, formerly APRA, now renamed to indicate its focus more accurately) to enhance development of optics, detectors, and other key technologies, including addressing mid-technology readiness gap identified in the decadal survey. Another addition is to initiate a new postdoctoral fellowship for those working in Astrophysics instrumentation and technology areas. This fellowship would be analogous to the Hubble, Einstein, and Sagan fellowships but is funded for five years since technology development takes longer to complete. Three fellows would be selected each year and would receive up to $0.5 million for equipment purchases.

The decadal survey recommended an increase in suborbital flights and a substantial increase to both the Astrophysics Theory program, and Laboratory Astrophysics funding. The Astrophysics Research Program plans to increase the budget in these two areas significantly over the budget horizon, to best respond to the decadal recommendations.

In 2012, the Balloon program will conduct 16 to 20 flights, including two foreign campaigns. These will follow the corrective action plan developed to respond to the recommendations of the Mishap Investigation Board for the 2010 launch mishap in Australia. In particular, an independent Operations Safety Officer will be on-site throughout each campaign, and a Range Safety Officer will have the authority to terminate each launch at any stage.

In 2012, in addition to the individual-investigator proposals that represent the core of the program, a new component will be introduced to the Laboratory Astrophysics program--consortium awards to support extended, multi-disciplinary teams of scientists that will address grand challenges in astrophysics. Solicitations will address wide-ranging topics that impact the entire field of astrophysics and which are sufficiently broad that they cannot be effectively addressed by individual investigators working independently. In 2012, NASA will solicit consortium proposals that address the grand challenge of understanding carbon and carbon-rich compounds in the universe.

In 2012, the Spitzer Heritage Archive will be transferred into the NASA InfraRed Processing and Analysis Center (IPAC) InfraRed Science Archive (IRSA). All data collected by the Spitzer cryogenic mission will be distributed through IRSA.

In addition to ongoing awards, the Education and Public Outreach project will competitively select approximately 40 new proposals for small awards averaging $10,000 a year, and approximately 15 new proposals for mid-range awards averaging $160,000 a year.

Project Descriptions and Explanation of Changes

Astrophysics Research & Analysis (R&A)

This project solicits basic research proposals for investigations that are relevant to NASA's programs in astronomy and astrophysics, over the entire range of photon energies, gravitational waves, and particles of cosmic origin. The largest element of the R&A project is the Astrophysics Research and Enabling Technology (APRET) program. APRET supports research that addresses the best possible state-of-the-art detector and technology development for instruments that may be proposed as candidate experiments for future space flight opportunities; science and technology investigations with instruments flown on suborbital sounding rockets, stratospheric balloons, or other platforms; and laboratory research and (with restrictions) ground-based observations that are directly applicable to space astrophysics missions.

The Astrophysics Theory Program (ATP) supports efforts to develop the basic theory for NASA's space astrophysics programs. Astrophysics Theory topics include: star formation, supernovae and gamma-ray bursts, large-scale cosmic structures and dark matter, dark energy and the cosmic microwave background, and gravitational wave astronomy.

The 2010 decadal survey recommended substantially more opportunities for suborbital flights, and increased support for Laboratory Astrophysics and the Astrophysics Theory program. The Astrophysics Research Program plans significantly increased funding for technology development and suborbital payloads, and for both Laboratory Astrophysics and the Theory programs, including a new component for large computational networks.

All R&A grants selected for funding by the Astrophysics Theme are broadly competed through NASA's Research Opportunities in Space and Earth Sciences. Grant proposals must relate directly to both Agency and theme goals and objectives. All proposals are peer-reviewed by scientists and technologists from a mix of disciplines and are selected based upon merit.

Balloons

The Wallops Flight Facility manages the NASA Balloon project. The project offers inexpensive, high-altitude flight opportunities for scientists to conduct research and test new technologies prior to space flight application. Balloon experiments cover a wide range of disciplines in astrophysics, solar and heliospheric physics, as well as Earth upper-atmosphere chemistry. Observations from balloons have even detected echoes of the Big Bang, and probed the earliest galaxies. The Balloon project continues to work to increase balloon size and enhance capabilities, including an accurate pointing system to allow detection of planets around other stars, and a super-pressure balloon to allow much longer flight periods at high altitude.

The Columbia Scientific Balloon Facility (CSBF) provides launch services for large (400 feet diameter), unmanned, high-altitude (120,000 feet) research balloons, tracking. On behalf of NASA Centers and universities all over the world, CSBF recovers the scientific experiments suspended beneath the balloons. Domestic flights are launched from Fort Sumner, New Mexico, and Palestine, Texas. Mid-latitude flights are launched from Australia. Balloons operating above the polar regions are deployed from Antarctica and Sweden.

Additional funding has been added in FY 2013 to increase the balloon flight rate and to continue development of super-pressure ballooning.

Other Missions and Data Analysis

Included in this line item are:

- Astrophysics Data Curation and Archival Research (ADCAR): The Astrophysics Theme has established an archive structure beyond the scope of individual missions, to receive data and make them accessible by creating an ensemble of primarily wavelength-specific astrophysics archives. After the completion of a mission, all archive activities are taken over by the relevant active multi-mission archive. ADCAR covers the activities of the Astrophysics Data Centers and NASA's participation in the Virtual Astronomical Observatory. Priorities in FY 2012 and beyond will incorporate the recommendations of the Archival Senior Review that will take place in May 2011. For more information see http://nasascience.nasa.gov/astrophysics/astrophysics-data-centers.

- Astrophysics Data Analysis Program (ADAP): ADAP solicits research whose primary emphasis is the analysis of NASA space astrophysics data that are archived in the public domain at one of NASA's Astrophysics Data Centers. Recent years have seen a dramatic growth in both the size and scope of the archival astronomical data available to ADAP researchers, including data from such major strategic missions as Spitzer and Kepler. These data are already bought and paid for. Every dollar invested in archival research using these data bring additional value to the Nation's investment in that NASA mission. The steady increase in the program budget in coming years is designed to ensure continued effective exploitation of this tremendous scientific resource as data holdings continue to grow.

- Astrophysics Senior Review: This funding will extend the life of operating missions. The Senior Review is conducted every two years as a comparative evaluation of all operating missions (both Explorers and strategic missions) that are in or are about to enter an extended phase past their prime operations phase. A ranking based on science output determines which missions will continue to receive funding for extended operations. Additional funding has been added to ensure a robust suite of extended missions in FY 2013 and beyond.

- Keck Single Aperture (KSA): KSA manages NASA time on the Keck Telescopes by issuing the proposal solicitation, conducting the peer review, communicating selections for investigations, and providing support to observers. KSA also manages the Keck archives for the High Resolution Echelle Spectrometer (HIRES), and the Near Infrared Spectrometer (NIRSPEC) instruments. The HIRES primarily measures the radial velocity data used to find and characterize exoplanets, and NIRSPEC is a general-purpose near-infrared spectrometer widely used by Keck observers.

- Directorate Support, Space Science: This project funds Agency-level services provided to the Science Mission Directorate (SMD). These services include Defense Contract Audit Service contract administration, Defense Contract Audit Agency audit services, and NASA Contract Assurance Services for all of SMD's projects.

- Education and Public Outreach: This project supports development and dissemination of new educational and outreach products based on SMD science discoveries, through competitively selected awards ranging from $10,000-$160,000 per year. Opportunities are provided for students and educators, citizen scientists, and the public to engage in authentic experiences working with NASA data and NASA research communities. The project also supports four science education and public outreach forums that foster engagement of the target audiences through interactive communication and public feedback.

Program Management

SMD provides program management, with individual projects managed at the Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Mission Senior Review Panel	4/2010	A comparative evaluation of all the Astrophysics operating missions. A report ranking the operating missions was released.	4/2012
Quality	Archival Senior Review Panel	05/2008	Comparative review of the efficiency and cost effectiveness of the archives. A report ranking the archives was released.	05/2011

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	225.3	-	219.7	219.4	209.9	195.2	184.5
Hubble Space Telescope (HST)	100.8	-	94.0	93.4	93.1	88.8	84.5
Stratospheric Observatory for Infrared Astronomy (SOFIA)	73.6	-	71.4	73.3	77.2	77.4	75.0
Other Missions And Data Analysis	50.9	-	54.4	52.7	39.6	28.9	25.0

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Program Overview

The Cosmic Origins Program seeks to answer the fundamental question "how did we get here?" by investigating the evolution of the universe and its components, from the cosmic Big Bang to the present. Topics in Cosmic Origins research include the following: When did the first stars and galaxies form? How are stars and planets created? When did the universe first create elements critical for life? How do galaxies, stars and planets change with cosmic time?

Missions within Cosmic Origins have and continue to make important advances on these fronts. Celebrating more than 20 years of operation, the Hubble Space Telescope continues to inspire youth through its exploration of the universe. Hubble images have enabled important discoveries in areas as diverse as the violent and ever-evolving state of the solar system, observing new asteroid collisions, and the universe-wide "warming" that occurred 11 billion years ago when fierce blasts of radiation from voracious black holes stunted the growth of some small galaxies for a stretch of 500 million years. Through its annual call for observing proposals and online data archive, Hubble will serve thousands of astronomers with data over the full scope of Cosmic Origins questions. In addition, NASA's partnership with European Space Agency (ESA) on Herschel, the newest operating Cosmic Origins telescope, has yielded a critical finding about how water is formed in space. Analysis of Herschel data has revealed that ultraviolet starlight is the key ingredient for making water in space. Many more discoveries are expected over the next three years until Herschel's helium cryostat is depleted.

The SOFIA airborne telescope is continuing its early science flights this year and promises to enable optical through far-infrared astronomy for decades. SOFIA is uniquely capable of studying the chemistry of the universe. It will help scientists study the chemical processes in star forming regions within this galaxy. SOFIA's far-infrared instruments will also study distant galaxies. Importantly, SOFIA will allow instrument upgrades through the coming years to take advantage of new technologies and new science aims.

For more information, please see http://nasascience.nasa.gov/about-us/smd-programs/cosmicorigins.

Plans For FY 2012

Hubble Space Telescope (HST) will continue to support spacecraft and science operations, as well as robust Guest Observer grants.

SOFIA will continue to ramp up science flight hours and will complete open door flight testing. The second generation of observatory instruments will be selected through a competitive Announcement of Opportunity.
Spitzer and Herschel will continue operations.

Technology investments will support Hubble de-orbit studies, advanced infrared detectors, technology for possible future SOFIA instruments, and the definition of a future ultraviolet (UV)-optical space capability.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Project Descriptions and Explanation of Changes

James Webb Space Telescope

This project has been moved to its own theme within the Science Mission Directorate. See the JWST Theme pages for detailed project information.

Hubble Space Telescope (HST)

HHST launched in FY 1990 and is currently in an extended operations phase. The fourth servicing mission (SM4), completed in FY 2009, added new batteries, gyros and instruments to extend its life even further into the future. One of NASA's most successful and long-lasting science missions, HST has beamed hundreds of thousands of images back to Earth, shedding light on many of the great mysteries of astronomy. Its gaze has helped scientists determine the age of the universe, the identity of quasars, and the existence of dark energy. Development of the capability to de-orbit safely HST after its mission has concluded is underway within the Cosmic Origins Program. The timing for this activity will be determined by the status of the observatory and the orbital conditions that would drive an uncontrolled reentry. Funding in the HST budget in FY 2012 and out will support mission operations, systems engineering, software maintenance, ground systems support, and Guest Observer science grants. Efforts to reduce the costs of mission operations will continue, and Hubble will enter the Senior Review process in 2012.

Stratospheric Observatory for Infrared Astronomy (SOFIA)

SOFIA, currently in development, is a Boeing 747SP airborne observatory with a 2.5-meter reflecting telescope that will enable the study of the universe in the infrared spectrum. Besides this contribution to science progress, SOFIA technologies will be a major contributor to the development of new observational techniques, new instrumentation and in the education of young scientists and teachers in the discipline of infrared astronomy. The project will be at full operational capability in CY 2014. The SOFIA budget in FY 2012 and out reflects investments in the new instrument selection schedule and science hours and funds risk reduction activities. See the project page of this document for more detail.

Other Missions and Data Analysis

Included in this line item are:

- The Spitzer Space Telescope, now in extended operations, is an infrared telescope utilizing two channels of the Infrared Array Camera instrument to study the atmosphere of exoplanets, looking for the earliest clusters of galaxies, near Earth asteroids and providing a 360 degree map of the galaxy. Spitzer completed its cryogenic mission in FY 2009, and warm operations have been extended through FY 2013, per the recommendation of the 2010 Senior Review but at reduced costs.

- The Herschel Space Observatory is a collaborative mission with ESA and launched on May 14, 2009. It has the largest single mirror ever built for a space telescope and it will collect long-wavelength radiation from some of the coldest and most distant objects in the universe. NASA has contributed to instruments onboard Herschel and will also host U.S. astronomer access to data through the NASA Herschel Science Center.

- Cosmic Origins Supporting Research and Technology supports Hubble fellowships and program-specific research and early technology development efforts. Budget increases have been made in FY 2013 and out to support the study of a future UV-optical space capability and wide-field infrared imaging and spectroscopy, particularly in the area of advanced detector technology, in response to the decadal survey recommendations.

- Cosmic Origins Future Missions funding has been moved to support JWST and future Explorer selections.

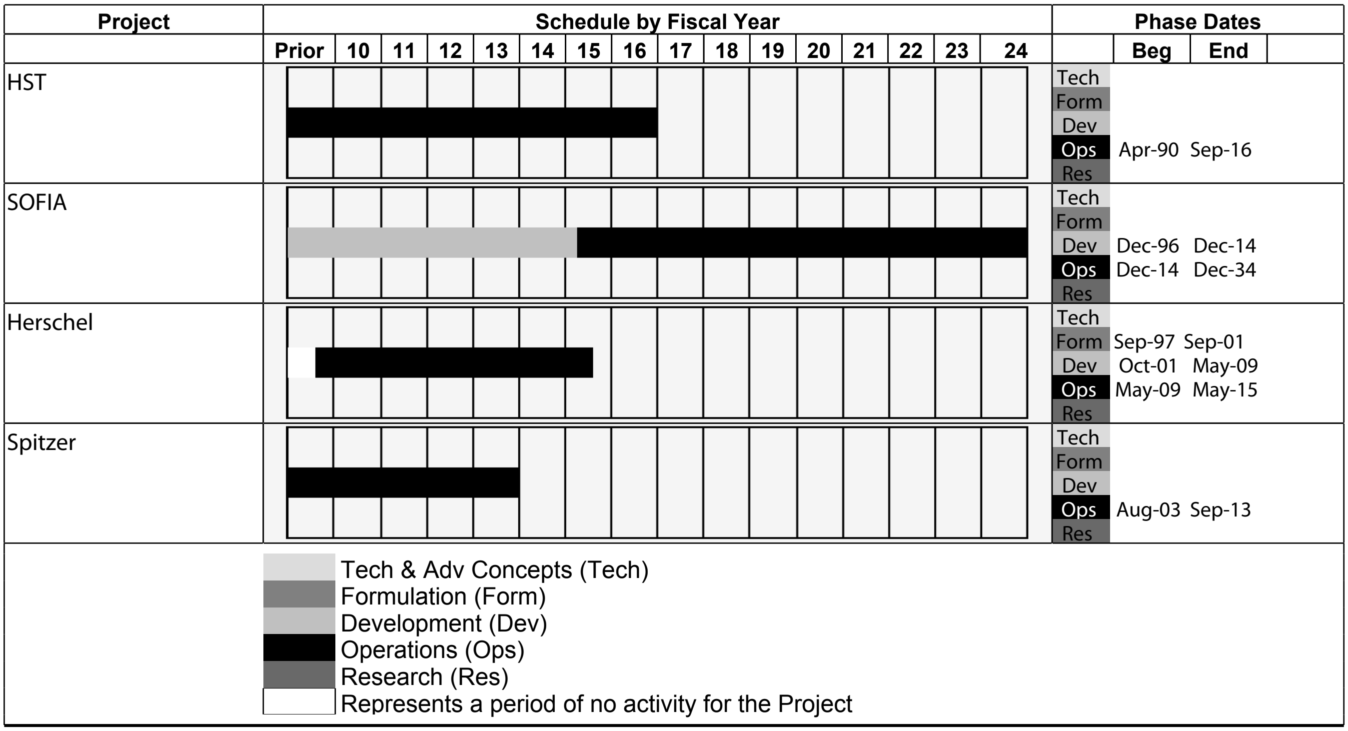
- Cosmic Origins Program management provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services. Funding has been increased to provide more robust program management of missions in development and formulation.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Initiate the Stratospheric Observatory for Infrared Astronomy (SOFIA) Segment 3 Aircraft modifications and upgrades.	SOFIA	

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins

Implementation Schedule



Program Management

Cosmic Origins project management responsibility is as follows:

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
HST	GSFC	GSFC	ESA
SOFIA	DFRC	DFRC, ARC	German Space Agency (DLR)
Spitzer	JPL	JPL	None
Herschel	JPL	JPL	ESA

Acquisition Strategy

The HST Space Telescope Science Institute (STScI) is run under contract to NASA by the Association of Universities for Research in Astronomy. STScI is responsible for the science program selection, planning, scheduling, science data processing and archiving, grant administration, and public outreach activities for HST. The basic period of the HST STScI contract with AURA ended on April 30, 2010, with the first of two contract options being exercised on May 1, 2010 and running through April 30, 2013.

The HST mission operations functions (i.e., flight operations, observatory engineering analysis, and flight and ground software development) are performed under a separate contract. The HST mission operations contract will expire on June 30, 2011. A new five-year HST Missions Operations contract will be awarded to Lockheed Martin on July 1, 2011.

The second generation of instruments for the SOFIA observatory will be solicited through a NASA Announcement of Opportunity. The solicitation will be released in FY 2011 with selections planned for early FY 2012.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**737.5**	**73.6**	**-**	**71.4**	**73.3**	**77.2**	**77.4**	**75.0**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

Additional funds were added to the development budget to preserve the new instrument selection schedule and science hours and to fund risk reduction activities. The operations budget was decreased due to risk reduction activities previously planned for operations being moved into development. The SOFIA milestone Full Operational Capability (FOC) has been redefined as the capability to provide full science operational capability with four available instruments. Outyear budgets reflect NASA's intention to increase the efficiency of the science operations after FOC has been achieved.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Purpose

NASA is developing SOFIA as a world-class airborne observatory that will complement the Hubble, Spitzer, Herschel and James Webb space telescopes, and major Earth-based telescopes. SOFIA features a German-built 2.5 meter (100-inch) diameter far-infrared telescope weighing 20 tons, and mounted in the rear fuselage of a highly modified Boeing 747SP aircraft.

The SOFIA mission will study many different kinds of astronomical objects and phenomena, including: star birth and death, formation of new solar systems, identification of complex molecules in space, planets, comets and asteroids in this solar system, nebulae and dust in galaxies (i.e., ecosystems of galaxies), and black holes at the center of galaxies. The infrared light of these objects is only partially visible from the ground due to water vapor in Earth's atmosphere. However, at high altitudes, the influence of water vapor is negligible, allowing better observation of these astronomical objects.

SOFIA'S reflecting telescope provides astronomers with access to the visible, infrared and sub-millimeter spectrum, with optimized performance in the mid-infrared to sub-millimeter range. During its 20-year expected lifetime, SOFIA will be capable of enabling "Great Observatory" class astronomical science.

SOFIA will be NASA's only far-infrared mission, as Spitzer cryogens have been depleted and Herschel's cryogens will be exhausted by 2013. It is the only mid-infrared mission until JWST becomes operational. SOFIA's ability to reconfigure and flexibility ensures the integration of cutting-edge technology and the ability to address emerging scientific questions. For more information, please see http://www.nasa.gov/mission_pages/SOFIA/index.html.

Project Parameters

SOFIA was designed as a highly modified Boeing 747SP aircraft with a large open-port cavity aft of the wings, housing a 2.5-meter telescope optimized for infrared andsub-millimeter wavelength astronomy. SOFIA will operate in flight at 41,000 feet, and at FOC will have four instruments, with additional instruments available after FOC. SOFIA will ramp up to 960 science hours per year, and flights will last six to eight hours on average.

Germany has provided the telescope assembly and assists with mission operations. NASA has provided, refurbished, and modified the airplane, and provides the Science Operations Center.

The U.S.-developed instruments include High-speed Imaging Photometer for Occultation (HIPO), First Light Infrared Test Experiment CAMera (FLITECAM), Faint Object InfrRed CAmera for the SOFIA Telescope (FORCAST), Echelon-Cross-Echelle Spectrograph (EXES), and High-resolution Airborne Wideband Camera (HAWC). The two German instruments are the German Receiver for Astronomy at Terahetz Frequencies (GREAT) and Field Imaging Far-Infrared Line Spectrometer (FIFI LS).

Technology investments for possible future SOFIA instrumentation are made through the Cosmic Origins Supporting Research and Technology program.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Commitments

SOFIA initiated science observations in December 2011 with the FORCAST instrument. Designed to work for 20 years, SOFIA will reach FOC as an airborne observatory in December 2014.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Platform	DFRC/L3/MPC	Refurbished Boeing 747SP modified to accommodate telescope	Same	Same
Science Operations Center	ARC/USRA	Science Operations Center will schedule observations, and manage data acquisition and processing	Same	Same
Telescope	Germany (DLR)	2.5m diameter, dual mirror	Same	Same
Flight Operations	DFRC/CSC DyneCorp	Flight crew, maintenance, and fuel	Same	Same
HIPO	Lowell Observatory	Simultaneous high-speed time-resolved imaging photometry at two optical wavelengths	Same	Same
FLITECAM	UCLA	Large field-of-view, narrow- and broad-band photometric imaging and low-resolution spectroscopy from 1 to 5.5 µm	Same	Same
FORCAST	Cornell University	Large field-of-view, narrow- and broad-band photometric imaging and moderate-resolution spectroscopy from 4 to 42 µm	Same	Same
EXES	ARC	Echelon Spectrometer, 5-28 microns R=105, 104, or 3000	Same	Same
HAWC	University of Chicago	Far-Infrared Bolometer Camera, 50-240 microns	Same	Same
GREAT	Germany (DLR)	Infrared heterodyne spectrometer, 60-200 microns	Same	Same
FIFI LS	Germany (DLR)	Imaging spectrometer, 42-210 microns	Same	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Schedule Commitments

The development and test plan has been modified to enable earlier science observations by the science community, making it concurrent with the late phases of aircraft flight testing. Initial science observations with a subset of science instruments began in December 2011. Completion of the remaining science instruments and refinement of telescope performance will enable FOC in December 2014.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
First Flight	2000	2007	2007
First Science (Early Science)	N/A	2010	2011
FOC	N/A	2014	2014

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
Project In Development:	Stratospheric Observatory for Infrared Astronomy (SOFIA)

Project Management

The overall SOFIA project and SOFIA airborne system are managed by Dryden Flight Research Center (DFRC). SOFIA science is managed by Ames Research Center (ARC).

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Platform	DFRC	DFRC	Germany - DLR/DSI
Science	ARC	None	Germany - DLR/DSI
Mission Operations and Data Analysis	ARC	None	Germany - DLR/DSI
Instruments	ARC	None	Germany - DLR/DSI

Acquisition Strategy

DFRC manages the program and the platform project (airframe and telescope). DFRC is working with L-3 Communications (Waco, Texas), and MPC Products Corporation (Skokie, Illinois) to support the completion of the development, integration, and test of the airborne platform system. L-3 modified the Boeing 747SP aircraft to install the telescope provided by Germany (DLR/DSI). MPC is developing the telescope cavity door drive system. DFRC is also working with CSC DynCorp (El Segundo, California) to provide aircraft maintenance support.

ARC manages the science project. ARC is working with University Space Research Association (USRA) (Columbia, Maryland) for the SOFIA science planning, ground science facilities, science instrument and technology development, and education and public outreach.

Second generation and later instruments will be solicited through an open competition using a NASA Announcement of Opportunity.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Standing Review Board	4/2010	Early science project review. The board determined that plan for early science had merit.	4/2012

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Loss of science community and DLR support due to late science	Loss of science community support due to delays in science continues to be a concern.	Report program accomplishments as they occur to keep the science community engaged and supportive. Reaction to recent program successes, including the first light accomplishment, has been very positive.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	116.0	-	100.3	112.4	111.9	98.1	96.8
Other Missions and Data Analysis	116.0	-	100.3	112.4	111.9	98.1	96.8

Note:
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Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Program Overview

The universe can be viewed as a laboratory that enables scientists to study some of the most profound questions at the intersection of physics and astronomy. How did the universe begin? What is the universe composed of, and what is its ultimate fate? What are the fundamental laws that govern the workings of space, time, matter, and energy? The POCS Program is aimed at addressing these questions by exploring the most extreme physical conditions of the universe including black holes, dark energy, and the early moments of its creation.

The operating missions within the POCS Program are just beginning to provide answers to these questions. The Fermi mission is searching for signs of new laws of physics and what composes the mysterious dark matter and will help explain how black holes accelerate immense jets of material to nearly the speed of light. Following in the footsteps of the very successful The Wilkinson Microwave Anisotropy Probe (WMAP) mission, Planck is observing the earliest moments of the universe and is providing a high-resolution map of the cosmic microwave background. XMM-Newton has helped scientists solve a number of cosmic mysteries, ranging from enigmatic black holes to the origins of the universe itself. Chandra continues to reveal new details of celestial X-ray phenomena such as the collisions of galaxies that directly detect the presence of dark matter, and has unveiled a population of faint, obscured massive black holes that may provide the early seeds for galaxy formation and growth.

The POCS Program will actively pursue opportunities for vigorous mission partnership and technology investments, following the recommendations of the 2010 National Academies astronomy and astrophysics decadal survey. Also following the recommendations of the decadal survey, the POCS Program looks towards the next decade by continuing to support technology development for several highly ranked missions. Leading this charge is the Laser Interferometer Space Antenna (LISA) that will observe the universe using the completely unexplored spectrum of gravitational waves. Near-term support for LISA focuses on the NASA technology demonstrator payload ST-7 on the ESA-led LISA Pathfinder mission. Also highly recommended is support for the International X-ray Observatory (IXO) that will observe regions near the surfaces of super massive black holes. Finally, this program will develop the most promising technology to detect the imprint of gravitational waves on the cosmic microwave background produced during the first few moments of the universe. For more information see: http://nasascience.nasa.gov/about-us/smd-programs/physics-of-the-cosmos.

Plans For FY 2012

In FY 2012, funds allocated under the Exoplanet Exploration Program, discussed below, will support the early planning of the Wide Field Infrared Survey Telescope (WFIRST), the top priority Large mission of the New Worlds New Horizons decadal survey. Understanding the nature of dark energy, using a variety of investigation techniques, is among WFIRST's recommended science objectives. In parallel, NASA is exploring a potential partnership with the European Space Agency (ESA) on its proposed Euclid dark energy mission that is currently competing in their Cosmic Vision process. NASA will consider partnerships with ESA that are in line with Option B (A Joint WFIRST/Euclid Mission) from the National Research Council's "Report of the Panel on Implementing Recommendations from the New Worlds, New Horizons Decadal Survey."
In FY 2012, Planck will be in full science operations. Planck will complete the first full-sky survey of the cosmic microwave background and will process the science data to produce the first Planck science results. Then the second full-sky survey will provide critical refinement of cosmic microwave background and further science results.

The Fermi Gamma Ray Space Telescope will continue its prime operations phase, making observations selected by peer review.

Chandra will continue extended mission operations, making observations selected by peer review.

Technology funding will support technical studies on the LISA and IXO mission concepts as well as cosmic inflation probe concepts, as recommended by the decadal survey.

NASA will continue to support the spacecraft integration and testing of the ST-7 Disturbance Reduction System on the ESA-led LISA Pathfinder mission in preparation for a 2013 launch.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Physics of the Cosmos

Included in this line item are:

- Planck, launched in May 2009, is an ESA-led mission with substantial NASA contributions. It will reveal the geometry and contents of the universe, how the universe grew immediately after its birth, and how the stage was set for the universe to evolve into structures that are seen today, such as galaxies. It will provide an order of magnitude increase in precision in its measurement of the cosmic microwave background.

- Fermi Gamma-ray Space Telescope is a joint NASA/DoE mission formerly called Gamma-ray Large Area Space Telescope. Fermi launched in June 2008 and is currently in operational phase. It is designed to detect the highest energy gamma-rays ever measured in a space-based mission and is providing a full-sky map filled with thousands of new and previously known gamma-ray sources, increasing the current tally by orders of magnitude.

- Chandra, a flagship X-ray observatory currently in extended operations, has allowed scientists to image complex systems in exquisite detail, and to determine the positions of thousands of distant X-ray sources. Chandra has also provided unique information on diverse subjects ranging from the presence and amount of dark matter in the universe to phenomena occurring near the horizons of black holes. Outyear budget planning reflects NASA's efforts to maximize efficiency while achieving reduced operations costs.

- POCS Supporting Research and Technology (SR&T) supports Einstein Fellowships and program-specific research and early technology development effort including:

    - Responsibility for the ST-7 project (previously under the Heliophysics New Millennium Program) has been transferred to the POCS Program and additional funding has been provided to accommodate the launch slip to the European Space Agency (ESA) LISA Pathfinder mission, now scheduled for 2013. The ST-7 project will validate system-level technologies required for use on future gravity-wave and formation flying missions, such as LISA.

    - Early technical and mission concept activities that will continue on the Laser Interferometer Space Antenna (LISA), a joint mission with the ESA. LISA will provide a first view of the gravitational radiation spectrum from space providing a new and uniquely powerful probe of the extremes of space-time.

    - Early technical and mission concept activities will continue on the IXO, an X-ray observatory with joint participation from NASA, ESA and the Japan Aerospace Exploration Agency (JAXA). Science objectives are the study of black holes and matter under extreme conditions, and the life cycles of matter and energy in the universe.

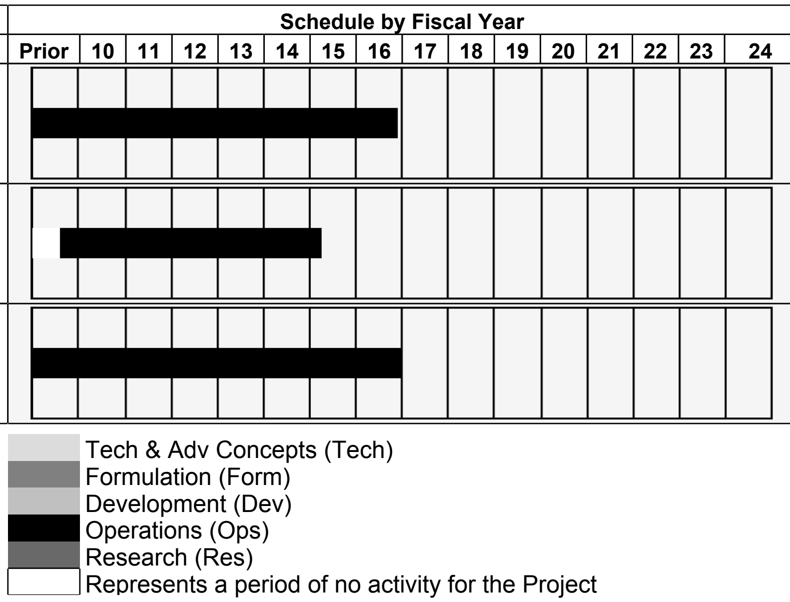
    - Early technical studies for cosmic inflation probe technology and mission concepts, as recommended in the 2010 decadal survey.

- POCS Program management provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services. Funding has been increased to provide more robust program management of missions in development and formulation.

- POCS Future Missions funding has been partially moved to support future Astrophysics Explorer missions and the POCS SR&T activities.

- Support for the Joint Dark Energy mission has been terminated and redirected to other activities recommended by the 2010 decadal survey.

Implementation Schedule



Project	Phase	Beg	End
Fermi	Tech	Jun-98	Dec-99
	Form	Dec-99	Dec-03
	Dev	Dec-03	Jun-08
	Ops	Jun-08	Aug-16
	Res		
Planck	Tech		
	Form	Sep-97	Sep-01
	Dev	Oct-01	May-09
	Ops	May-09	Dec-14
	Res		
Chandra	Tech		
	Form		
	Dev		
	Ops	Jun-99	Sep-16
	Res		

Program Management

GSFC has program management responsibility. Project management is as follows:

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Fermi	GSFC	GSFC	DOE, Japan, Italy, France, Sweden, and Germany
Planck (Instrumentation)	JPL	JPL	ESA
Chandra	MSFC	MSFC	None

Acquisition Strategy

No competitive acquisitions are planned at this time.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	43.4	-	48.2	65.5	63.6	62.1	69.8
Other Missions and Data Analysis	43.4	-	48.2	65.5	63.6	62.1	69.8

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Program Overview

Today humankind stands on the threshold of a voyage of unprecedented scope and ambition, promising insight into one of the most timeless questions. Are we alone? Is Earth unique, or are planets like ours common? One of the most exciting new fields of research within the NASA Astrophysics portfolio is the search for planets, particularly Earth-like planets, around other stars. During the last 15 years, astronomers have discovered over 500 planets orbiting nearby stars. Most of these planets are gas giants, similar in size to the four outer planets in this solar system, and orbit much closer to their parent stars than do the giant planets in this system. NASA's Exoplanet Exploration Program is taking the first steps along a path of discovery that will ultimately lead to a point where scientists can directly study the atmospheres and surface features of habitable, rocky planets like Earth around other stars in the solar neighborhood.

To date, most of the known extrasolar planets, or simply exoplanets, have been discovered with ground-based telescopes. However, the 2009 launch of NASA's Kepler mission (the Agency's first mission dedicated to the study of extrasolar planets) has ushered in a new chapter in the search for planets around other stars. From its unique vantage point of space, Kepler is capable of detecting much smaller planets than are possible with even the most powerful ground based telescopes. Kepler has already shown us that small planets are more abundant than giant planets. Within two years of launch, Kepler will have doubled the number of known exoplanets, including many rocky planets only a few times larger than Earth. By the end of its prime mission, Kepler will enable the first measurements of just how common habitable, Earth-sized planets are in the galaxy.

However, Kepler is just the first component of NASA's Exoplanet Exploration strategy. The technique that Kepler uses to detect exoplanets is most sensitive to large planets on small orbits around their host stars. Noting this measurement bias, the NWNH decadal survey included an exoplanet search using a complimentary detection technique "microlensing" as one of the key components in the science program of its top, large space mission recommendation: the Wide-Field InfraRed Survey Telescope (WFIRST). The microlensing technique is sensitive to small, rocky planets on larger orbits. Thus, together with the Kepler results, WFIRST will give us a clear view of how planetary systems are formed and evolve, and a much clearer understanding of the frequency of habitable, Earth-sized planets in the galaxy.

The ultimate goal for NASA's Exoplanet Exploration Program, as articulated in the decadal survey, is a flagship "New Worlds Mission" that will be capable of imaging and spectroscopy of rocky planets in the habitable zones of stars in the solar neighborhood. This is the mission that will allow NASA to take the pivotal step from identifying an exoplanet as Earth-sized, to determining whether it is truly Earth-like, and possibly even if it bears the fingerprints of life. Recognizing that such an ambitious goal presents numerous significant technological challenges, the decadal survey made "New Worlds Technology Development" its top priority medium-class, space project for the decade. Consequently, an important component of the Exoplanet Exploration effort will be a robust technology development program focused on technologies that feed into the candidate architectures for a future direct-detection mission, and, ultimately, the design and implementation of that mission.

For more information, please see: http://exep.jpl.nasa.gov/.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Exoplanet Exploration

Plans For FY 2012

The Exoplanet Exploration Program will continue the Technology Development for Exoplanet mission's activity to support the development of technologies that feed into candidate architectures for a future direct-detection mission, as recommended by the decadal survey.

Keck Interferometer (KI) will be in its final year of NASA-supported operation, providing U.S. astronomers with access to this unique observational facility in support of NASA astrophysics science goals.

Kepler will be in the third year of operations. The science team will continue to analyze mission data, conduct follow-up observations, and report results in the scientific literature and to the public as they become available.

The Large Binocular Telescope Interferometer will complete integration and testing, and will begin key science operations.

Project Descriptions and Explanation of Changes

Other Missions and Data Analysis

This line item contains the following projects:

- Kepler, launched in March 2009, is specifically designed to survey the distant stars in this region of the Milky Way galaxy to detect and characterize rocky planets in or near the "habitable zone" of their host star. The habitable zone encompasses the distances from a star where liquid water can exist on a planet's surface. As time progresses, smaller and smaller planets with longer and longer orbital periods will begin to emerge from the data.

- Keck Operations is the NASA portion of the Keck Observatory partnership. NASA uses its share of observing time in support of all Astrophysics science programs: Exoplanet Exploration, Cosmic Origins and POCS. Observing time is competed, selected, and managed by the NASA Exoplanet Science Institute. A significant portion of the NASA Keck competed time has been awarded to Keper follow-up observations on potential planet candidates and radio-velocity observations for new exoplanet discoveries.

- The KI is an instrument that connects the two Keck 10-meter telescopes as if they were pieces of a single, 85-meter telescope. With the KI, astronomers are able to study the origins of stars and galaxies, emissions from faint dust clouds around other stars, and the dust and planetary systems around nearby stars. NASA support for the KI has been extended into FY 2012 to allow for a smooth transition of operations from NASA to the California Association for Research in Astronomy (CARA).

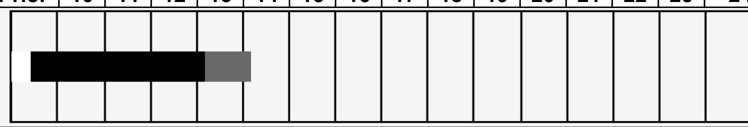
- Exoplanet Exploration SR&T supports the prestigious Sagan Postdoctoral Fellowships, program-specific scientific research, and technology development activities that support and enable future Exoplanet Exploration missions. The activities include maintaining a wide-field infrared imaging and spectroscopy capability relevant to the recommended The Wide-Field Infrared Survey Telescope mission and a New Worlds technology initiative. The objective of the latter of these efforts, as recommended in the 2010 decadal survey, is to achieve a level of maturity in the associated technologies sufficient to select the most promising architecture by the middle of the coming decade; focus subsequent technology investments on that architecture; and development of a robust mission concept by the end of the decade.

- Exoplanet Exploration Program management provides programmatic, technical, and business management, as well as program science leadership and coordination for education and public outreach products and services.

- Exoplanet Exploration Future missions funding has been moved to support future Astrophysics Explorer missions and to the ExEP SR&T activities. The 2010 decadal survey did not prioritize the Space Interferometry Mission, so NASA support for that mission has been discontinued.

- The LBTI is the NASA portion of the Large Binocular Telescope (LBT) partnership. The instrument is currently under development, and will be ready for full science operations in FY 2012. LBTI will study the formation of solar systems and will be capable of directly detecting giant planets outside this solar system. The key science program of LBTI is to determine the amount of dust that is found in nearby planetary systems. This is an important factor to take into consideration for the development of a direct detection mission, one of the primary challenges identified in the astronomy and astrophysics 2010 decadal survey. Development and operation of this instrument have been funded through FY 2015.

Implementation Schedule

Project	Schedule by Fiscal Year	Phase	Beg	End
	Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24			
Kepler		Tech		
		Form	Dec-01	May-05
		Dev	May-05	Mar-09
		Ops	Mar-09	Nov-12
		Res	Nov-12	Nov-13

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

JPL is responsible for program management.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Kepler	ARC	ARC	None

Acquisition Strategy

No competitive acquisitions are currently planned.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Exoplanet Task Force	01/2008	Determine planet-finding research and technology approach and prioritization leading up to the next decadal survey. Report and recommended strategy published and sent to respective agencies. For more information, please see: http://nasascience.nasa.gov/about-us/NAC-subcommittees/nac-documents/2008-01_APS_ExoPTF.pdf.	N/A

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	113.5	-	107.8	110.9	123.7	128.7	152.0
Nuclear Spectroscopic Telescope Array (NuStar)	56.2	-	11.4	4.0	1.1	0.0	0.0
Gravity and Extreme Magnetism	3.1	-	69.4	41.0	20.8	1.4	0.0
Other Missions and Data Analysis	54.2	-	27.0	65.9	101.8	127.3	152.0

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Program Overview

The aim of the Explorers Program is to provide frequent flight opportunities for world-class scientific investigations from space utilizing innovative, streamlined and efficient management approaches within the heliophysics and astrophysics science areas. Explorer missions are highly responsive to new knowledge, new technology, and updated scientific priorities by launching smaller missions that can be conceived and executed in a relatively short development cycle. Priorities are based on an open competition of concepts solicited from the scientific community. The program also enables participation in missions of opportunity provided by other U.S. or international agencies. The program emphasizes missions that can be accomplished under the control of the scientific research community within constrained mission life cycle costs. The program also seeks to enhance public awareness of space science by incorporating educational and public outreach activities into each mission.

The standard Explorer (EX) missions are investigations characterized by definition, development, and mission operations and data analysis costs up to $200 million, not including launch services. Small Explorers (SMEX) may cost up to $120 million, not including launch services. Explorer Missions of Opportunity (MOs) have a total NASA cost of under $55 million and may be of several types. The most common are partner MOs, investigations characterized by being part of a non-NASA space mission (of any size). These missions are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission. Other possible types are new science missions using existing spacecraft, and small complete missions. NASA intends to solicit proposals for missions of opportunity with each Announcement of Opportunity issued for EX and SMEX investigations, and perhaps more frequently. Beginning in FY 2012, funding for future Explorer missions (formerly managed in the Heliophysics Theme) is being split into two pieces. Astrophysics Theme will continue to coordinate with Heliophysics theme and the Explorer Program office at GSFC regarding mission management and future solicitations, but will have responsibility beginning in 2012 for managing its own budgetary resources for future selections to enable a diverse portfolio of stand-alone missions and MO. This split will help enable the implementation of the decadal survey's recommendation to augment the Explorer Program to provide more opportunities to respond rapidly to new science opportunities.

For more information, please see Explorer Program at explorers.gsfc.nasa.gov/missions.html.

Currently, there are two Explorer missions in development: NuSTAR, and the Astro-H Soft X-ray Spectrometer. GEMS is in formulation. Four previously launched Explorer missions are also supported in this program, as they continue to produce world-class science in their extended mission phases.

Plans For FY 2012

NuSTAR will be completing observatory integration and beginning integration to the Pegasus XL launch vehicle in preparation for a February 2012 launch from Kwajalein Island in the Republic of the Marshall Islands.

The high-resolution SXS instrument for the JAXA-led Astro-H mission will be in the final stages of integration and test during FY 2012. Two major flight model subsystems (the x-ray telescope optics and the electrical harness) will be delivered to Japan during FY 2012 in order to facilitate early integration and test of those subsystems. The completed SXS instrument will be shipped to Japan for spacecraft integration and test either late in FY 2012 or early in FY 2013.

The Gravity and Extreme Magnetism Critical Design Review is scheduled in March 2012.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Project Descriptions and Explanation of Changes

Nuclear Spectroscopic Telescope Array (NuSTAR)

NuSTAR, currently in development, is planned for launch in February 2012. NuSTAR will provide a greater capability for using high-energy X-rays to detect black holes than any currently existing instrument. NuSTAR has been designed to answer fundamental questions about the universe. How are black holes distributed through the cosmos? How were the elements of the universe created? What powers the most extreme active galaxies? This mission will expand the ability to understand the origin of cosmic rays and help predict the destinies of stars and galaxies.

Astro-H SXS

Astro-H SXS is a mission of opportunity, currently in development, in which NASA will provide the SXS instrument. Astro-H SXS is scheduled for a 2014 launch onboard the Japanese Astro-H spacecraft. The observatory will carry a suite of four science instruments spanning virtually the entire X-ray energy band. The SXS instrument is a cryogenically cooled high-resolution X-ray spectrometer that will allow the most detailed studies of the high-energy spectra of a wide range of astronomical systems from nearby stars to distant active galaxies. Utilizing this unprecedented capability, the mission will conduct a number of fundamental studies, including: tracing the growth history of the largest structures in the universe; obtaining insights into the behavior of material in extreme gravitational fields; determining the spin of black holes; probing shock acceleration structures in clusters of galaxies; and investigating the detailed physics of jets.

Additional funding has been added in FY 2011 through 2014 based on a 70 percent joint cost and schedule analysis in order to assure adequate reserves through launch, consistent with the decision made by SMD at confirmation review.

Gravity and Extreme Magnetism SMEX (GEMS)

The GEMS mission is currently in formulation and will seek approval to enter development during FY 2011. GEMS will use an X-ray telescope to explore the shape of space that has been distorted by a spinning black hole's gravity. It will probe the structure and effects of the formidable magnetic field around magnetars, dead stars with magnetic fields trillions of times stronger than Earth's.

Funding has been increased in FY 2011 and 2012 (and reduced in the out years) in order to accommodate increased early payments for the launch vehicle.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Other Missions and Data Analysis

Included in this line item are:

- A Future Astrophysics Explorer Missions budget has been created in response to the astronomy and astrophysics 2010 decadal survey recommendation to accelerate the launch rate of Astrophysics Explorer missions. This funding, combined with a portion of future Explorer mission funding previously held in the Heliophysics Theme, will allow for more frequent selection and launch of Astrophysics Explorer missions and MOs. This will enable a rapid response to new discoveries and provide platforms for targeted investigations essential to the breadth of the Astrophysics program. Astrophysics will continue to coordinate with the Heliophysics Theme and Explorer Program office at GSFC regarding mission management and future solicitations, but will have responsibility beginning in 2012 for managing its own budgetary resources for future selections.

- The Wide-field Infrared Survey Explorer (WISE) provided an all-sky survey of galaxies in the infrared light spectrum. During its six-month mission, WISE mapped the sky in infrared light, searching for the nearest and coolest stars, the origins of stellar and planetary systems, and the most luminous galaxies in the universe. WISE's infrared survey provided an essential catalog for JWST science program planning.

- Swift is a multi-wavelength space-based observatory in extended operations phase that studies the position, brightness, and physical properties of gamma-ray bursts. Within seconds of detecting a burst, Swift relays the location of a burst to ground stations. This allows both ground-based and space-based telescopes around the world to observe the burst's afterglow. As a result of the Senior Review 2010, Swift has received additional funding to extend its operational life. Budget planning for Swift reflects reductions to some operating missions and plans to focus Swift observing campaigns on the highest impact activities.

- WMAP studies the early universe by measuring the cosmic microwave background radiation over the full sky. WMAP produced the earliest "baby picture" of the universe, showing temperature variation of microwave light 379,000 years after the Big Bang, over 13 billion years ago. As a result of the Senior Review 2010, WMAP has received additional funding to extend its operational life.

- The Galaxy Evolution Explorer (GALEX) and Suzaku missions will be terminated in FY 2011 and will complete any necessary mission closeout activities in FY 2012.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete the NuSTAR Launch Readiness Review.	NuSTAR	

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Implementation Schedule

Project	Phase	Beg	End
WISE	Tech		
	Form	Apr-02	Oct-06
	Dev	Oct-06	Dec-09
	Ops	Dec-09	Sep-12
	Res		
Swift	Tech		
	Form		
	Dev		
	Ops	Apr-04	Sep-14
	Res		
Suzaku	Tech		
	Form		
	Dev		
	Ops	May-05	Nov-11
	Res		
WMAP	Tech		
	Form		
	Dev		
	Ops	Jun-01	Sep-12
	Res		
GALEX	Tech		
	Form		
	Dev		
	Ops	Apr-03	Nov-11
	Res		
NuSTAR	Tech		
	Form	Feb-08	Nov-09
	Dev	Nov-09	Feb-12
	Ops	Feb-12	Sep-14
	Res		
Astro-H	Tech		
	Form	Jun-08	Aug-09
	Dev	Aug-09	Feb-14
	Ops	Feb-14	Feb-16
	Res		
GEMS	Tech		
	Form	Jun-09	Jul-11
	Dev	Jul-11	Apr-14
	Ops	Apr-14	Jan-15
	Res		

Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer

Program Management

Management of the Astrophysics Explorer Program is assigned to GSFC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
WISE	GSFC	JPL	None
NuSTAR	GSFC	JPL	None
Astro-H	GSFC	GSFC	Japan (JAXA)
Swift	GSFC	N/A	None
WMAP	GSFC	N/A	None
GEMS	GSFC	GSFC	None

Acquisition Strategy

Explorer projects are selected through competitive Announcements of Opportunity from which multiple investigations are selected for initial concept studies. This is followed by a competitive down-select to proceed to the next stage of formulation. Investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

The most recent Explorer Announcement of Opportunity was released on November 1, 2010 with proposals due on February 16, 2011, and final selections expected in late 2012 or early 2013. From this solicitation, NASA expects that at least one full Explorer mission will be selected to proceed into Phase B and subsequent mission phases. The proposed Astrophysics Explorers budget is intended to support selection of one full mission and one or more missions of opportunity.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Nuclear Spectroscopic Telescope Array

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	55.4	56.2	-	11.4	4.0	1.1	0.0	0.0

Note: The FY 2011 LCC number in the table above is overstated by $3.7 million due to the difference between the FY 2010 enacted bill and the pending FY 2012 Passback. Assuming approval of the initial operating plan, the estimated life cycle cost will be $160.6 million, and the estimated development cost will be $109.9 million.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was preparedFor the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

NuSTAR launch has been delayed by one month (to February 2012) due to potential conflicts at the launch site. Funding has been increased slightly for education and public outreach activities.

NuSTAR continues to reach its milestones and in FY 2012 will be completing observatory integration and beginning integration to the Pegasus XL launch vehicle in preparation for a subsequent February 2012 air launch from Kwajalein Island in the Republic of the Marshall Islands.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Nuclear Spectroscopic Telescope Array

Project Purpose

The NuSTAR mission will observe the universe at high X-ray energy levels. By focusing higher energy X-rays, NuSTAR will start to answer several fundamental questions about the universe. How are black holes distributed through the cosmos? How were heavy elements forged in the explosions of massive stars? What powers the most extreme active galaxies?

NuSTAR's primary science goal is to make the first deep observations of regions of the sky in the high energy X-ray band in order to locate massive black holes in other galaxies; locate and examine the remnants of collapsed stars in this galaxy; observe selected very high energy gamma-ray sources; and observe any supernovae of opportunity in the local group of galaxies. NuSTAR's key science products will be sensitive high-energy X-ray survey maps of the celestial sky that will guide the X-ray astronomy community research for several years to come. In addition to its core science program, NuSTAR will offer opportunities for a broad range of science investigations, ranging from probing cosmic ray origins to studying the extreme physics around collapsed stars to mapping microflares on the surface of the Sun. NuSTAR will perform follow-up observations to discoveries made by Chandra and Spitzer, and will team with Fermi to make simultaneous observations.

For more information see: http://www.nustar.caltech.edu/.

Project Parameters

NuSTAR will image the sky in the high- energy X-ray band (6-79 KeV) and the spacecraft will be three -axis stabilized. The primary science instruments will be two identical focusing X-ray telescopes which utilize an extendable 10-meter mast. The launch vehicle will be a Pegasus XL.

Project Commitments

NuSTAR will be launched in February 2012 into a 550 by 600 kilometer orbit around Earth, with an orbital inclination currently planned for six degrees. The prime operations phase is two years.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	Orbital Sciences Corporation	Spacecraft design, fabrication and testing.	N/A	Same
Mission operations, focal plane assembly and instrument electronics	University of California, Berkeley	Aperture stop, active shield module and mechanical enclosures	N/A	Same
X-ray optics	Columbia University, GSFC and the Danish Technical University	Overall optics assembly management and manufacturing	N/A	Same
Mast, canister and instrument structure	ATK	Delivery of mast, canister and instrument structure for the spacecraft	N/A	Same

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Nuclear Spectroscopic Telescope Array

Schedule Commitments

NuSTAR was authorized for mission re-start in September 2007 and was authorized to proceed into Phase B in January 2008. Confirmation to proceed into Phase C (implementation) was approved in August 2009.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Preliminary Design Review	June 2009	same	same
Confirmation Review	August 2009	same	same
Critical Design Review	February 2010	same	same
Launch	January 2012	January 2012	February 2012

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Development:	Nuclear Spectroscopic Telescope Array

Project Management

JPL is responsible for NuSTAR project management. The principal investigator at the California Institute of Technology is responsible for mission science.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Mission Science	JPL	N/A	N/A
Launch Vehicle	KSC	N/A	N/A
Spacecraft, instruments, mast, optics	JPL	GSFC	N/A

Acquisition Strategy

NuSTAR was selected via a NASA Explorers Announcement of Opportunity. The spacecraft is being developed by Orbital Sciences Corporation in Dulles, Virginia. The X-ray optics are being developed by Columbia University in New York City, New York; GSFC; and the Danish Technical University, Denmark. Launch vehicle acquisition is through Kennedy Space Center (KSC).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	6/2009	Preliminary Design Review; received authority to enter Phase C	N/A
Performance	SRB	2/2010	Critical Design Review. NuSTAR design was deemed sufficiently mature to proceed with full-scale fabrication, assembly, integration and testing.	N/A
Performance	SRB	N/A	System Integration Review (SIR). Evaluates the readiness of the project to start flight assembly, test, and integration.	01/2011
Performance	SRB	N/A	Flight Readiness Review (FRR). Determines the overall system readiness for a safe and successful flight.	1/2012

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Observatory Mass Margin	The combined mass of the spacecraft and instrument forces design changes that tax project programmatic resources.	Remove shells from each coated mirror. This would free up about 6-10kg from the instrument.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Formulation:	Gravity and Extreme Magnetism (SMEX 13)

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3.1**	**-**	**69.4**	**41.0**	**20.8**	**1.4**	**0.0**

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Purpose

GEMS will use an X-ray telescope to explore the shape of space that has been distorted by a spinning black hole's gravity, and probe the structure and effects of the formidable magnetic field around magnetars--dead stars with magnetic fields trillions of times stronger than that of Earth.

Current missions cannot accomplish the goals of GEMS because they are not capable of the required angular resolution or, in the case of magnetic field imaging, because magnetic fields are invisible. GEMS will use a new technique to accomplish what has been impossible until now. It will build up a picture indirectly by measuring the polarization of X-rays emitted from these violent regions. This will open new discovery space because GEMS is orders of magnitude more sensitive than previous X-ray polarization experiments.

GEMS will answer some of the most exciting and fundamental questions in astrophysics. How does the spin of a black hole warp space time? What powers pulsars and magnetars? How are cosmic rays accelerated in supernova remnants?

GEMS will be better able to tell the shapes of the X-ray-emitting matter trapped near black holes than existing missions. In particular, GEMS will be able to detect whether matter around a black hole is confined to a flat disk or puffed into a sphere or squirting out in a jet. Since X-rays are polarized by the space swirling around a spinning black hole, GEMS also provides a method of determining black hole spin independent of other techniques.

Project Preliminary Parameters

The nominal science mission is about one year in duration. The X-ray Polarimeter Instrument (XPI) consists of two or three identical, co-aligned telescopes, and will be sensitive from two to 10 kev to polarization amplitude and angle. It's orbit will be 575 kilometer with a 28.5degree inclination. It will have alaunch mass of 267 kilograms, solar arrays at 637 west, articulated, and stabilization on a three -axis.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Formulation:	Gravity and Extreme Magnetism (SMEX 13)

Estimated Project Deliverables

GEMS will study 23 targets including stellar-mass, black holes, seyfert galaxies and quasars, blazars, neutron star pulsars, shell supernovae remnants, and pulsar wind nebulae. The GEMS satellite will be the first observatory to systematically measure X-ray polarization, encoding information about the structure of cosmic sources. Polarization measurements will allow scientists to study scattering magnetic fields and strong gravitational fields.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	Orbital	Small spacecraft based on reusable design	Same	Same
Instrument Payload	GSFC	XPI	Same	Same
Launch Vehicle	TBD	Small Class	Same	Same

Estimated Project Schedule

The GEMS project was selected for formulation in October 2009.

Milestone Name	Formulation Agreement Estimate	FY 2011 PB Request	FY 2012 PB Request
Formulation			
SRR (Mission)	June 2010	June 2010	October 2010
KDP-C	July 2011	July 2011	August 2011
Launch	April 2014	Same	Same

Project Management

GEMS is part of the Explorers Program managed by GSFC.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	None	N/A
X-ray Polarimeter Instrument (XPI)	GSFC	GSFC	N/A
Launch Vehicle	KSC	None	N/A

Acquisition Strategy

The largest portion of the overall project effort has been awarded to Orbital Sciences Corporation. In Phases B/C/D/E, the contract with Orbital Sciences Corporation is of the cost-plus-award fee type.

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Astrophysics Explorer
Project In Formulation:	Gravity and Extreme Magnetism (SMEX 13)

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	N/A	Preliminary Design Review; determine if the project is ready to proceed into development	07/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Late Polarimeter Delivery to Instrument I&T	If the Polarimeter does not meet the delivery date to the Instrument I&T, then the mission schedule will be impacted.	The project plans to develop an Engineering Test Unit of the Polarimeter to mature the technology and test before building the flight unit.

Mission Directorate:	Science
Theme:	James Webb Space Telescope

Theme Overview

The James Webb Space Telescope (JWST) is a flagship mission and essential contributor to NASA's goal in astrophysics to "discover how the universe works, explore how the universe began and evolved, and search for Earth-like planets." JWST contributes to answering a broad scientific question emanating from this goal: How did the universe originate and evolve to produce the galaxies, stars, and planets we see today? By being able to look back into the history of the universe, to see the first light from the first stars, JWST enables the study of how galaxies, stars and planetary systems came into being, how they evolve, and ultimately how they end their lives. Additionally, the mission will make discoveries that will help scientists understand how matter, energy, space, and time behave under the extraordinarily diverse conditions of the cosmos, and the characteristics of planetary systems orbiting other stars.

Because of the significance of the JWST, a new theme was created. The elevation of JWST to its own theme reflects management changes implemented in FY 2011 to improve oversight and control over the project in direct response to the Independent Comprehensive Review Panel's (ICRP) report in November 2010. The project, which was previously managed within the Science Mission Directorate's (SMD) Astrophysics Division within NASA Headquarters, and was part of the Cosmic Origins Program, is now managed via a separate program office at NASA Headquarters. The JWST Project Manager at Headquarters now reports directly to NASA's Associate Administrator and the Associate Administrator of SMD. The lead Center for JWST, Goddard Space Flight Center (GSFC). has also implemented changes, with project management now reporting directly to the Center Director.

Note that the technical content of the JWST project has not changed as a result of any of these management changes, and in fact the changes have been made in recognition of the high importance of this mission for the Agency and the astrophysics community.

JWST was again included as a high priority in the most recently released National Academies decadal survey for astronomy and astrophysics entitled "New Worlds, New Horizons in Astronomy and Astrophysics" (National Academies, 2010). The project remains an integral part of SMD's portfolio of bold new Astrophysics initiatives that open the universe to reveal new discoveries. JWST was the top priority of earlier decadal surveys, and helps to provide the foundational science upon which the new projects of the latest survey depend.

The JWST theme will achieve its objectives via the analysis of scientific data from a 6.5-meter cryogenic telescope launched to the Sun-Earth Lagrangian 2 (L2) point and operated for a minimum of five years.

For more information, please see http://www.jwst.nasa.gov/.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**438.7**	**-**	**354.6**	**359.3**	**365.3**	**371.6**	**371.6**
James Webb Space Telescope	438.7	-	354.6	359.3	365.3	371.6	371.6

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

James Webb Space Telescope

The James Webb Space Telescope will continue fabrication, integration, and testing in support of a launch date to be determined following a comprehensive re-planning of all project cost and schedule elements.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

JWST is guided by the Space Act and subsequent legislation, and by U.S. National Space Policy and related policies, which call on NASA to conduct space missions to advance scientific understanding of the universe. In doing so, NASA follows a long-standing tradition of establishing its science priorities through consultation with world-class experts via the National Academies decadal survey process. The most recent astrophysics decadal survey was released in August 2010, and includes JWST as part of its recommended set of missions. JWST also receives advice from the external science community via the Astrophysics Subcommittee of the NASA Advisory Council, and advice on cooperative activities from the Congressionally chartered, National Science Foundation (NSF)-managed Astronomy and Astrophysics Advisory Committee. JWST remains a high priority within the astrophysics and broader science communities.

Relevance to the NASA Mission and Strategic Goals:

NASA's astrophysics missions seek to discover how the universe works, explore how it began and evolved, and search for Earth-like planets. JWST will contribute substantially to each of these strategic goals. JWST will improve estimates for the Hubble constant and thereby provide tighter constraints on the nature of dark energy. The infrared sensitivity of JWST will allow researchers to study the first stars and galaxies to form after the Big Bang. Using the combination of spectroscopy and coronographic imaging JWST will study exoplanets and their atmospheric compositions.

Relevance to education and public benefits:

JWST has a strong education and public outreach program. JWST is included in the consortium of Astrophysics missions featured in a traveling museum exhibit, "Alien Earths," that informs and inspires the public on critical questions related to the search for life elsewhere in our universe. In addition, JWST's website has educational materials for educators, including lesson plans, activities and programs that enable students to help solve real-world JWST problems, compare simple telescopes to JWST, learn about planets outside our solar system, solve space math problems, understand light and telescopes, learn how JWST's mirrors are built, and understand infrared energy. For more information, see http://www.jwst.nasa.gov/teachers.html.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.4	**Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.**	
Objective 2.4.2	**Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.**	
Performance Goal 2.4.2.2	***Design and assemble James Webb Space Telescope (JWST).***	
APG 2.4.2.2: JWST-12-1	Begin integration of James Webb Space Telescope (JWST) flight optics into Optical Telescope Element (OTE).	James Webb Space Telescope

Performance Achievement Highlights:

JWST is making good technical progress. The JWST Program passed its mission Critical Design Review (CDR) in the Spring of 2010. This is a major milestone for the program and marks the transition into full manufacturing and assembly phase of observatory hardware. All 18 flight Primary Mirror segments have completed initial polishing, and several have completed final polishing and have received reflective coating. The flight Mid-Infrared Instrument (MIRI) instrument successfully completed all vibration testing, and the flight Near Infrared Spectrograph (NIRSpec) instrument is completely assembled and has also successfully completed vibration testing.

One of the recommendations from the CDR was to complete an in-depth evaluation of the integration and testing plan for JWST. The Test Assessment Team (TAT) identified a significant number of opportunities to optimize the Optical Telescope Element/ Integrated Science Module test plan at the Johnson Space Center (JSC) and the Integrated Science Instrument Module testing at GSFC that will better manage the overall technical and programmatic risk to the mission. The TAT also recommended that JWST should quickly establish a new integration and testing leadership position to optimize planning for the remaining tests, and this recommendation has now been implemented.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**438.7**	**-**	**354.6**	**359.3**	**365.3**	**371.6**	**371.6**
James Webb Space Telescope	438.7	-	354.6	359.3	365.3	371.6	371.6

Note:

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Project Descriptions and Explanation of Changes

James Webb Space Telescope

JWST is the only project within this Program and Theme, as a result of the recent changes in management structure to increase management oversight and control of the project. JWST is currently in development phase and will launch on a European Space Agency (ESA)-supplied Ariane 5 rocket for a five-year science mission to study the origin and evolution of galaxies, stars, and planetary systems. The JWST spacecraft will have a large array of mirrors, 21.3 feet in diameter, and a sunshield the size of a tennis court. Neither the mirror assembly nor the sunshield fit into the rocket fully open, so both will fold up and open only after JWST is in space. JWST will reside in space at the Sun-Earth L2 point, which is about one million miles from Earth. The telescope and instruments will operate at cryogenic temperature in order to achieve infrared performance.

Considering the Independent Comprehensive Review Panel's (ICRP) findings and recommendations, NASA is undertaking a re-planning activity to determine a feasible and appropriate the schedule for completing the remaining work on JWST given the budget provided. This new project schedule (and associated determination of a new JWST launch date) will be completed during FY 2011. Items to be highlighted in this revised schedule include a schedule for the remaining modifications to the thermal vacuum Chamber A at the Johnson Space Center (see the Construction of Facilities section for more detail on this project). Final decisions resulting from this replanning activity will be reflected in the President's FY 2013 budget.

Program Management

The new NASA Headquarters JWST Program Director reports directly to the NASA Associate Administrator (AA) and Science AA. At GSFC, the project reports directly to the Center Director.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**2,552.3**	**438.7**	**-**	**354.6**	**359.3**	**365.3**	**371.6**	**371.6**

Note: The JWST budget total will be determined as part of the project replan to be completed in 2011.

For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

During 2010, JWST identified cost growth and schedule issues, which resulted in the formation of the ICRP. The ICRP charter was to determine the technical, management, and budgetary root causes of cost growth and schedule delay on JWST, to estimate the minimum cost to launch JWST, and to assess the associated launch date and budget profile. The ICRP report concluded that the problems causing cost growth and schedule delays on the JWST project are primarily associated with cost estimation and program management. The panel recommended several managerial changes at Headquarters and GSFC and some of these have already been implemented. The schedule for completing the JWST project within the budget provided will be re-evaluated as part of a replanning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

As indicated in NASA's letter to Congress on October 28, 2010, it is certain that the JWST baseline development cost and launch readiness date will be exceeded by more than 15 percent and six months.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Project Purpose

JWST is a large, deployable, space-based infrared astronomical observatory. The mission is a logical successor to the Hubble Space Telescope (HST), extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit infrared light strongly, and where dust obscures shorter wavelengths.

The four main science goals are to:

- Search for the first galaxies or luminous objects formed after the Big Bang;

- Determine how galaxies evolved from their formation until now;

- Observe the formation of stars from the first stages to the formation of planetary systems; and

- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

Hubble has greatly improved knowledge about distant objects, but its infrared coverage is limited. Light from distant galaxies is redshifted by the expansion of the universe into the infrared part of the spectrum (from the visible). By examining light redshifted beyond Hubble's sight, JWST will be able to observe things farther away, as their light has taken longer to reach us. Hence it will be looking back further in time.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. The focus of scientific study will include first light of the universe, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

The telescope will launch from Kourou, French Guiana, on a ESA-supplied Ariane 5 rocket. Its operational location is the L2 point, which is about one million miles from Earth.

For more information, please see: http://www.jwst.nasa.gov.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Project Parameters

JWST will be optimized for infrared astronomy, with some capability in the visible range. JWST's instruments are the Near Infrared Camera (NIRCam), MIRI, NIRSpec, and the Fine Guidance Sensor (FGS).

NIRCam is an imager with a large field of view and high angular resolution. It covers a wavelength range of 0.6 - 5 micrometers and has 10 mercury-cadmium-telluride (HgCdTe) detector arrays. These are analogous to charge coupled devices found in ordinary digital cameras. NIRCam is a science instrument but also a wavefront sensor, which is used to align and focus the optical telescope.

NIRSpec enables scientists to obtain simultaneous spectra of more than 100 objects in a 9-square-arcminute field of view. It provides medium-resolution spectroscopy over a wavelength range from 0.6 - 5 micrometers. NIRSpec employs a micro-electromechanical system "microshutter array" for aperture control, and it has two HgCdTe detector arrays.

MIRI is an imager/spectrograph that covers the wavelength range of 5 - 28 micrometers and it has three arsenic-doped silicon detector arrays. The camera module provides wide-field broadband imagery, and the spectrograph module provides medium-resolution spectroscopy over a smaller field of view compared to the imager. The nominal operating temperature for MIRI is 7 degrees above absolute zero, which is possible through an on-board cooling system.

The FGS is a guider camera that is incorporated into the instrument payload in order to meet the image motion requirements of JWST. This sensor is used for both guide star acquisition and fine pointing. The sensor operates over a wavelength range of 1 - 5 micrometers and has two HgCdTe detector arrays. Its field of view provides a 95 percent probability of acquiring a guide star for any valid pointing direction. The FGS tunable filter camera is a wide-field, narrow-band camera that provides imagery over a wavelength range of 1.6 - 4.9 micrometers, via tunable Fabry-Perot etalons that are configured to illuminate the detector array with a single order of interference at a user-selected wavelength. The camera has a single HgCdTe detector array.

The JWST ground operations, Science Support Center, and archives will be at the Space Telescope Science Institute in Baltimore, MD.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Project Commitments

After launch, JWST will complete six months of on-orbit checkout and commissioning and five years of prime mission operations. JWST has a goal of 10 years of operations.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Observatory	Northrop Grumman Aerospace Systems, Redondo Beach, California	Includes Optical Telescope Element (OTE), Spacecraft, Sunshield, Observatory AI&T and commissioning. The Observatory shall be designed for at least a 5-year lifetime.	Same	Same
Integrated Science Instrument Module (ISIM)	NASA Goddard Space Flight Center	Contains the Science Instruments (SIs) and Fine Guidance Sensor (FGS). Provides structural, thermal, power, command and data handling resources to the SIs and FGS.	Same	Same
Near-Infrared Camera (NIRCam) instrument	University of Arizona; Lockheed Martin	Optimized for finding first light sources, and operating over the wavelength range 0.6-5 microns.	Same	Same
Near-Infrared Spectrometer (NIRSpec)	European Space Agency (ESA)	Operating over the wavelength range 0.6-5 microns with three observing modes.	Same	Same
Mid-Infrared Instrument (MIRI)	ESA; University of Arizona; Jet Propulsion Laboratory	Operating over the wavelength range 5-27 microns, providing imaging, coronagraphy, and spectroscopy.	Same	Same
Fine Guidance Sensor	Canadian Space Agency (CSA)	Provides scientific target pointing information to the observatory's attitude control sub-system.	Same	Same
Launch Vehicle	European Space Agency (ESA)	Ariane V ECA	Same	Same
Science Operations Center and Mission Operations	Space Telescope Science Institute (STScI)	Mission Operations and Science Operations Center	Same	Same

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Schedule Commitments

JWST was approved to enter implementation in July 2008 and completed CDR in April 2010.

The JWST project schedule, given the budget provided, is being re-evaluated as part of a re-planning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Non-Advocate Review/Preliminary Design Review	March,2008	Same	Same
Start phase C/Implementation	July 2008	Same	Same
Critical Design Review	April 2010	Same	Same
Systems Integration Review (SIR)	May 2012	February 2013	TBD
Launch Readiness Date	June 2014	Same	TBD
Start Phase E	December 2014	Same	TBD

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Project Management

Goddard Space Flight Center is responsible for JWST project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Observatory	GSFC	GSFC	None
Mission management and System Engineering	GSFC	GSFC	None
Integrated Science Instrument Module (ISIM)	GSFC	GSFC	None
NIRCam	GSFC	GSFC	None
NIRSpec	ESA	None	ESA
MIRI	GSFC	JPL, ARC	ESA
Fine Guidance Sensor - Tunable Filter (FGS-TF)	CSA	None	CSA
Ariane 5 ESA launch vehicle and launch operations	ESA	None	ESA
Ground control systems and science operations and control center	GSFC	None	None

Acquisition Strategy

JWST is being built by Northrop Grumman Aerospace Systems (Redondo Beach, CA), with major subcontractors including Ball Aerospace (Boulder, CO), ITT (Rochester, NY), and Alliant Techsystems (Edina, MN). Selections were made via a NASA request for proposal.

The Space Telescope Science Institute (STScI), in Baltimore, MD, is developing the Science and Operations Center and associated services.

The Integrated Science Instrument Module (ISIM) is being provided by GSFC.

The University of Arizona at Tucson is providing NIRCam, along with Lockheed Martin's Advanced Technology Center in Palo Alto, CA. The selection was made via a NASA announcement of opportunity.

ESA is providing MIRI, with management and technical participation by ARC and JPL. ARC and JPL were selected for this role after an internal NASA competition. ESA is also providing NIRSpec and an Ariane 5 launch vehicle.

The Canadian Space Agency is providing the Fine Guidance Sensor.

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
Project In Development:	James Webb Space Telescope

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	04/2010	Critical Design Review. SRB found that mission design is mature and recommended a more in depth review of the integration and testing plan.	TBD
Quality	Test Assessment Team	08/2010	The TAT evaluated JWST plans for integration and testing. The TAT recommended several changes to the test plan. See the full report at http://www.jwst.nasa.gov/publications.html.	n/a
Other	Independent Comprehensive Review Panel	10/2010	The ICRP charter was to determine the technical, management and budgetary root causes of cost growth and schedule delay on JWST, and estimate the minimum cost to launch JWST, along with the associated launch date and budget profile, including adequate reserves. The report made 22 recommendations covering several areas of management and performance.	n/a
Performance	SRB	N/A	Systems Integration Review	TBD
Performance	SRB	N/A	Flight Readiness Review	TBD

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
JWST Cost and Schedule Growth	Projected FY 2011 ISIM and Northrop Grumman Aerospace Systems cost growth will exceed available budget, resulting in a work delay, and delaying the LRD. Inclusion of SRB-recommended verification enhancements will further impact cost and schedule.	Project replan is underway and will be complete in 2011.
JWST Sunshield Deployment	If the sunshield fails to deploy to its prescribed operational shape then mission science requirements cannot be met.	Full-scale deployment demonstration test bed will be used to verify all deployment designs. Extensive deployment testing will be conducted at temperature of all sunshield assemblies and components.

Mission Directorate:	**Science**
Theme:	**Heliophysics**

Theme Overview

Earth is immersed in a seemingly invisible yet exotic and inherently hostile environment. Above the protective cocoon of Earth's atmosphere is a plasma soup composed of electrified and magnetized matter entwined with penetrating radiation and energetic particles. The Sun's energy output, which varies on time scales from milliseconds to billions of years, forms an immense structure of complex magnetic fields. Inflated by the solar wind, this colossal bubble of magnetism, known as the heliosphere, stretches far beyond the orbit of Pluto. This extended atmosphere of the Sun drives some of the greatest changes in the local space environment, affecting the magnetosphere, ionosphere, atmosphere, and potentially, Earth's climate.

Heliophysics seeks understanding of the interaction of the large, complex, coupled system comprising the Sun, Earth, and Moon, other planetary systems, the vast space within the solar system, and the interface with interstellar space. Heliophysics flight missions form a fleet of solar, heliospheric, and geospace spacecraft that operate simultaneously to understand the coupled Sun-Earth system.

A robust heliophysics research program is critical to understanding how solar radiation drives the climate system and sustains the biosphere of Earth, and the environment faced by human and robotic explorers venturing into space. Solar particles and fields drive radiation belts, high-altitude winds, heat the ionosphere, and alter the ozone layer. The resulting space weather affects radio and radar transmissions, gas and oil pipelines, electrical power grids, and spacecraft electronics. As a result, scientific research in this area has the potential to return significant value to modern society. An effective research plan incorporates studying the Sun, heliosphere, and planetary environments as elements of a single interconnected system that contains dynamic space weather and evolves in response to solar, planetary, and interstellar conditions. NASA is working to advance this science that enables space weather prediction by answering fundamental questions about this system's behavior:

- What causes the Sun to vary?

- How do the Earth and the heliosphere respond?

- What are the impacts on human society?

Heliophysics strategic goals are achieved through four program lines: two strategic programs, one competed program, and a Research and Analysis program. Solar Terrestrial Probes, a strategic program, provides understanding of the fundamental processes inherent in astrophysical systems and their effects. Living With a Star, the other strategic program, emphasizes the science necessary to understand those aspects of the Sun and space environment that most directly affect life and society and that enable robotic and human exploration of the solar system. The Explorer Program consists of competitively selected small principal investigator-led missions that can be developed relatively quickly, providing frequent flight opportunities for world-class scientific investigations from space. The Heliophysics Research Program supports physics-based data analysis and modeling that has played an increasingly important role both in defining the missions and interpreting their observations.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**608.0**	**-**	**577.9**	**591.0**	**612.4**	**627.2**	**628.6**
Heliophysics Research	171.8	-	144.5	147.5	149.3	149.5	150.8
Living with a Star	221.9	-	204.7	202.2	200.9	336.3	354.9
Solar Terrestrial Probes	148.0	-	163.5	170.4	171.9	50.2	38.0
Heliophysics Explorer Program	65.1	-	65.2	70.8	90.2	91.1	84.9
New Millennium	1.2	-	0.0	0.0	0.0	0.0	0.0

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Heliophysics Research

The research program will continue to operate 17 missions comprising 26 spacecraft through FY 2012. Heliophysics data centers will continue to archive and distribute collected science data.

Living with a Star

Radiation Belt Storm Probes (RBSP) has completed its System Integration Review and begun integration and test in preparation for launch, scheduled in May 2012. Solar Probe Plus will continue Phase B activities in FY 2012. The Solar Orbiter collaboration will transition into Phase B of formulation depending upon European Space Agency (ESA) Class M mission selections. The Solar Dynamics Observatory (SDO) will continue mission operations.

Solar Terrestrial Probes

The Magnetospheric Multiscale Mission (MMS) will continue in implementation. System Integration Review is planned for January 2012, and Key Decision Point (KDP) D review will be held in April 2012. STEREO and Hinode will continue extended mission operations.

Heliophysics Explorer Program

The Interface Region Imaging Spectrograph (IRIS), a Small Explorers mission, held a successful Critical Design Review in FY 2011 and is continuing implementation. IRIS System Integration Review is scheduled for December 2011, and KDP D to follow in January 2012. The IBEX, CINDI, TWINS, AIM, and THEMIS missions will continue extended mission operations. An Announcement of Opportunity for the next Explorer missions was released in FY 2011. Assuming no impact to Explorer Program budget, select missions will continue formulation in FY 2012.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

The Heliophysics Theme is guided by U.S. National Space Policy and follows NASA's tradition of establishing its priorities through consultation with world-class experts. Heliophysics relies on two advisory bodies for scientific assessments and decadal surveys: the National Academies' Space Studies Board and the NASA Advisory Council. Heliophysics missions, such as the Advanced Composition Explorer, provide critical data to the Department of Defense (DOD), the Federal Aviation Administration (FAA), and the National Oceanographic and Atmospheric Administration and help to guard the Nation against space weather impacts. The Living With a Star (LWS) Program targets research and technologies that are relevant to the operational needs of these agencies. The Nation's safety, security, and economy have become increasingly dependent on technologies that are susceptible to the extremes of space weather, i.e. severe disturbances of the upper atmosphere and of the near-Earth space environment that are driven by the magnetic activity of the Sun. Space weather events can damage satellites and power grids, and disrupt air traffic communications. Interagency activities are coordinated through the National Space Weather Program Council within the Office of the Federal Coordinator for Meteorology. Organizations around the world also access heliophysics data via the International Space Environment Service.

Through the Solar Terrestrial Probes Program, Heliophysics is also working to improve understanding of magnetic reconnection, a process that occurs throughout the universe when stressed magnetic field lines suddenly transition to a new shape. The understanding of magnetic reconnection as studied in space can play a critical role in the Department of Energy's efforts to develop fusion energy in a laboratory setting.

Relevance to the NASA Mission and Strategic Goals:

Heliophysics research supports NASA's Strategic Goal 2, to "Expand scientific understanding of the Earth and the universe in which we live."

Relevance to education and public benefits:

Society is increasingly dependent on modern technology, including power grids, global positioning systems, weather forecasting, and satellite communications. The valuable assets that support these technologies are vulnerable to solar activity and space weather events, so the need to predict solar events and mitigate their effect is critical to the public's safety, security, and the Nation's economy. A 2009 report by the National Academies titled "Severe Space Weather Events - Understanding Societal and Economic Impacts," for the first time attempted to quantify the effects of extreme space weather on the Nation. The report concludes that improving forecasting capabilities and raising public awareness are instrumental in mitigating severe consequences. The Heliophysics Program supports the rapid transition of research results, models, and data into operational products that benefit the public and other segments of the U.S. Government.

Heliophysics education programs include the award-winning "Family Science Night" that introduces local communities to a wide range of heliophysics-related topics. The program takes a multidisciplinary approach to educating and informing the public about such topics as light and spectrum, the seasons, and solar power. The IBEX mission has partnered with Adler Planetarium in Chicago to develop a planetarium show that communicates the scientific goals and results of the IBEX mission. The STEREO mission regularly provides selected images and movies to over 250 science centers through outreach programs and through the American Museum of National History in New York City. The Coordinated Modeling Center, a collaborative partnership with the National Science Foundation, National Oceanic and Atmospheric Administration, and the U.S. Air Force , provides the Nation with validation of innovative space weather numerical models. Output is used internationally by a wide variety of research and applications groups.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**	
Outcome 2.2	**Understand the Sun and its interactions with Earth and the solar system.**	
Objective 2.2.1	**Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**	
Performance Goal 2.2.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.2.1.1: HE-12-1	Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.2.1.2	***By 2015, launch two missions in support of this outcome.***	
APG 2.2.1.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Solar Terrestrial Probes
APG 2.2.1.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star
Objective 2.2.2	**Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.**	
Performance Goal 2.2.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.2.2.1: HE-12-4	Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.2.2.2	***By 2015, launch two missions in support of this outcome.***	
APG 2.2.2.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Solar Terrestrial Probes
APG 2.2.2.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Objective 2.2.3	**Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.**	
Performance Goal 2.2.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***	
APG 2.2.3.1: HE-12-5	Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs
Performance Goal 2.2.3.2	***By 2017, launch at least two missions in support of this outcome.***	
APG 2.2.3.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star

Uniform and Efficiency Measures:

Measure #	Description
Heliophysics Theme	
APG EFF: HE-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: HE-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: HE-12-8	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: HE-12-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

Performance Achievement Highlights:

Earth is affected by what happens on the Sun's surface even though Earth is 93 million miles away from the Sun. The Earth recently experienced an extended solar minimum and the Sun's magnetic activity is once again increasing. The Heliophysics fleet of 17 operating missions and the research and analysis (R&A) programs were coordinated to study this dynamic variation, enabling scientists around the world to investigate the behavior of the complex heliospheric system of systems. No 11-year solar cycle is exactly the same as another, and this research showed that sunspot activity during the 2007 - 2009 minimum was surprisingly low compared to cycles of the last century. The NASA observations were incorporated into state-of-the-art prediction models, and it is now believed that the solar cycle currently underway will be significantly different than previous cycles sampled since the start of the space age. This new understanding of the Sun's connection to Earth has provided essential information on space weather effects and will be used to improve the reliability of space weather warnings that affect technologies on Earth and the productivity and safety of explorers in space.

Observations during the recent unusually low solar minimum have resulted in many new discoveries about the underlying physics of the sunspot cycle. For example, NASA's measurements showed that solar wind pressure dropped 20 percent since the mid-1990s. Solar wind helps keep galactic cosmic rays out of the inner solar system: as the solar wind is flagging, more cosmic rays reach Earth and increase health hazards for astronauts. Weaker solar wind also means fewer geomagnetic storms and auroras, the northern and southern (polar) lights seen on Earth. Other NASA measurements showed that the Sun's brightness dimmed 0.02 percent at visible wavelengths and six percent at extreme ultraviolet wavelengths since the previous solar minimum. One effect of this change is that the upper atmosphere is less heated and not as "puffed up," which means that satellites in low Earth orbit experience less atmospheric drag, extending their operational lifetimes.

SDO was launched on February 11, 2010 and the observatory is returning images that demonstrate an unprecedented capability for scientists to understand the sun's dynamic processes. Using a combination of STEREO and the Japanese Hinode spacecraft, new solar atmospheric heating processes were visualized for the first time. The MMS mission completed its critical design review (CDR) and is finishing final design prior to the start of integration and testing. Instrument selections were completed for the Solar Probe Plus mission, which will fly into the Sun's atmosphere (or corona) for the first time. The RBSP completed the System Integration Review and started Phase D, integration and testing.

The IBEX mission, with its new technology, revealed new details of the interface between the solar system and the galaxy. IRIS CDR was held in December 2010 and the mission is continuing in Phase C. The Balloon Array for Radiation Belt Relativistic Electron Losses (BARREL) was confirmed in June 2010, and is now in the implementation phase having successfully completed a test campaign in Antarctica. The Sounding Rockets Program completed 13 suborbital launches. The Wallops Research Range provided telemetry and tracking services for four Shuttle missions, the 13 NASA suborbital launches, and the Ares 1-X test flight. The Range also upgraded several range instrumentation systems, e.g., video networks, range communications, and weather forecasting systems. Construction of the Wallops horizontal integration facility, which supports the Taurus-II missions, neared completion in 2010.

Mission Directorate:	Science
Theme:	Heliophysics

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	National Academies	12/2003	The Decadal Research Strategy assessed the current status and future directions of NASA's programs in solar and space physics research. The report identifies broad scientific challenges that define the focus and thrust of solar and space physics research for the decade 2003 through 2013. It presents a prioritized set of missions, facilities, and programs designed to address those challenges.	12/2013
Relevance	NAC/Helio-physics Subcommittee	09/2010	Release of the new Heliophysics Roadmap including science and program implementation strategies and relevance to the NASA strategies and goals. The roadmap lays out a new paradigm for mission planning and implementation that is expected to help control mission lifetime cost. The subcommittee stated that concerns remain with regard to R&A and Explorer Program level of funding.	10/2013
Performance	NAC/Helio-physics Subcommittee	07/2010	Reviews of selected annual performance goals as documented in Performance and Accountability Report (PAR). Review found that the Heliophysics Program has achieved its annual goals, and made significant progress toward understanding the local space environment and the fundamental science that is beginning to enable a reliable space weather predictive capability.	07/2011
Other	National Academies	03/2009	An ad hoc panel of the NRC conducted a mid-term performance assessment of the NASA Heliophysics Program. The report assessed NASA's progress against the 2003 decadal survey.	03/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**171.8**	**-**	**144.5**	**147.5**	**149.3**	**149.5**	**150.8**
Heliophysics Research and Analysis	30.4	-	30.0	31.6	32.3	32.7	33.0
Sounding Rockets	48.7	-	45.5	46.5	47.3	47.8	48.2
Research Range	18.9	-	18.7	18.9	19.3	19.6	19.7
Other Missions and Data Analysis	73.8	-	50.4	50.4	50.3	49.5	49.8

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Program Overview

NASA's Heliophysics Research Program supports activities that address advancing understanding of the Sun and planetary space environments, including the origin, evolution, and interactions of space plasmas and electromagnetic fields throughout the heliosphere and in connection with the galaxy. Understanding the origin and nature of solar activity and its interaction with the space environment of the Earth is a particular focus. The program seeks to characterize these phenomena on a broad range of spatial and temporal scales, to understand the fundamental processes that drive them, to understand how these processes combine to create space weather events, and to enable a capability for predicting future space weather events.

The Heliophysics Research Program supports investigations of the Sun and planetary space environments from the 17 operating missions involving 26 spacecraft. This fleet of spacecraft is informally termed the "Heliophysics System Observatory," as the aggregation of data from all the spacecraft results in research synergies not possible with single observatories.

The Heliophysics Research and Analysis Program routinely solicits proposals in several broad areas in order to advance knowledge in support of NASA strategic goals. In addition, NASA occasionally offers special solicitations to take advantage of research opportunities that arise from the current solar environment. The research program also funds scientific investigations based on suborbital platforms, such as balloons or sounding rockets, and maintains some of the vital communications infrastructure at Wallops Flight Facility. The research and analysis and guest investigator projects fund more in-depth scientific investigations using all of this collected data via a competitive process that is held each year.

Plans For FY 2012

NASA's Heliophysics Research Program supports flight programs (sounding rockets, balloons, spacecraft) by formulating the theories of the phenomena to be studied; designing the experiments to test these theories; developing the instrument technology needed to execute the experiments; and incorporating results into computational models that can be used to more fully characterize the present state and future evolution of the heliophysics system.

The Supporting Research and Technology Program will hold its annual competition for new awards. Participation will be open to all categories of U.S. organizations, from educational institutions to other government agencies. The Geospace Science and Solar and Heliospheric Science sub-elements will hold annual competition for new awards. These sub-elements support detailed research tasks that employ a variety of research techniques, analysis, interpretation of space data, development of new instrument concepts, and laboratory measurements of relevant atomic and plasma parameters. The Theory Program supports large PI-proposed team efforts that require a critical mass of expertise to make significant progress in understanding complex physical processes with broad importance. The Low-Cost Access to Space (LCAS) sub-element supports scientific investigation and new instrument concepts to be flown on sounding rockets or balloons, as well as to prepare payloads for future sounding rockets and balloon launches.

Heliophysics data centers will be supported to continue the archival and distribution of collected science data. The Guest Investigator competition will support and extend the scientific impact of the currently operating missions. Science Data and Computing Technology will hold its annual competition for the Applied Information Systems Research Program. The Science Data and Computing Technology Program will continue to sustain the National Space Science Data Center.

The Research Range Program will provide launch instrumentation for NASA suborbital programs and projects.

Project Descriptions and Explanation of Changes

Heliophysics Research and Analysis

Supporting Research and Technology comprises an ever-evolving suite of individual PI-proposed investigations that cover the complete range of science disciplines and techniques essential to achieve the Heliophysics Theme objectives and to take full advantage of the scientific data collected by NASA missions. Supporting Research and Technology covers five sub-elements: Heliophysics Theory, Geospace Science, Solar and Heliospheric Science, Low-Cost Access to Space (LCAS), and Instrument Development.

The Heliophysics Theory sub-element is the intellectual compass of the Heliophysics Division. Teams work to consolidate the scientific understanding of previous missions and determine the scientific hypotheses to be tested by future strategic missions. This program supports large PI-proposed team efforts that require a critical mass of expertise to make significant progress in understanding complex physical processes with broad importance.

The Geospace Science sub-element supports studies of the physics of magnetospheres, including their formation and fundamental interactions with plasmas, fields, and particles. (Earth's magnetosphere is emphasized, but studies of the magnetospheres of planets, comets, and other primordial bodies are also supported). Geospace Science deals also with the physics of the mesosphere, thermosphere, ionosphere, and aurorae of Earth, including the coupling of these phenomena to the lower atmosphere and magnetosphere.

The Solar and Heliospheric Science sub-element supports studies that treat the Sun as a typical star, i.e., the dominant, time-varying source of energy, plasma, and energetic particles in the solar system (especially concerning its influence on Earth). This project investigates processes taking place throughout the solar interior and atmosphere: the evolution and cyclic activity of the Sun; the origin and propagation of the solar wind and magnetic field from the Sun to the heliopause (the boundary between the solar wind and the interstellar medium); the acceleration and transport of energetic particles in the heliosphere; and the interface of solar influence with the interstellar medium.

LCAS funds the science investigations that utilize suborbital sounding rockets, commercial reusable suborbital vehicles, or high altitude balloons, as well as proof-tests of new concepts in experimental techniques that may ultimately find application in free-flying heliophysics space missions. These investigations are developed and flown in a rapid turnaround environment. LCAS investigations address open science questions, but serve additional purposes not addressed in other flight programs, such as the training of experimental space physicists and engineers and the development and flight verification of new technology.

Instrument development investigations have as their objective the development of instrument technologies that show promise for use on future heliophysics science missions, including the development of prototypes. The goal is to define scientific instruments to the point where complete instruments may be proposed in response to future Announcements of Opportunity, without significant additional development.

Sounding Rockets

This project funds all suborbital mission activities (e.g., payload integration, launch, and mission operation) that support the science investigations funded in the Heliophysics Research and Analysis Program. Sounding Rockets present unique low-cost platforms that provide direct access to Earth's mesosphere (50-90 kilometers), lower thermosphere (90-120 kilometers), and Earth's magnetosphere (up to 1,500 kilometers). Because of their short duration and access to Earth's upper atmosphere and the space environment, sounding rocket suborbital missions also enable calibration under-flights of orbital missions, repeated proof-of-concept technology demonstration missions, and valuable end-to-end space mission experiences for scientists and engineers learning to develop and execute discovery-oriented orbital missions.

Research Range

The Research Range effort supports NASA's only test range, located at Wallops Flight Facility, for launch of suborbital and orbital vehicles, supporting launch operations, and tracking, telemetry and command (TT&C) capabilities. The Wallops Research Range also supports a mobile TT&C capability to support launches safely from a number of worldwide launch sites. The NASA Research Range is one of the few ranges in the Nation to offer a mobile capability. The range maintains it own airspace and supports a wide variety of small launch vehicles, suborbital missions, and airborne missions utilizing non-FAA-certified vehicles, such as unmanned aircraft systems.

Other Missions and Data Analysis

The research program is responsible for accumulating, archiving, and distributing the data collected by operating spacecraft. Current operating spacecraft include: Cluster II, ACE, Voyager, Wind, RHESSI, SOHO, and TIMED. It is this collective asset that enables the data, expertise, and research results that directly contribute to the national goal of real-time space weather prediction and to fundamental research on solar and space plasma physics. In April 2010, these missions underwent Senior Review. New budgets for FY 2011 and the outyears were determined, consistent with their evolving scientific goals.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Annual peer-reviewed research solicitation for grant opportunities	Research and Analysis	None

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24	Phase Dates	Beg	End
Voyager		Tech		
		Form		
		Dev		
		Ops	Aug-77	Sep-14
		Res		Sep-15
Geotail		Tech		
		Form		
		Dev		
		Ops	Jul-92	Sep-14
		Res		Sep-15
Wind		Tech		
		Form		
		Dev		
		Ops	Nov-94	Sep-14
		Res		Sep-15
Solar and Heliospheric Observatory (SOHO)		Tech		
		Form		
		Dev		
		Ops	Dec-95	Sep-14
		Res		Sep-15
Advanced Composition Explorer (ACE)		Tech		
		Form		
		Dev		
		Ops	Aug-97	Sep-14
		Res		Sep-15
Cluster-II		Tech		
		Form		
		Dev		
		Ops	Jul-00	Sep-14
		Res		Sep-15
Thermosphere, Ionosphere, Mesosphere Energetics and Dynamics (TIMED)		Tech		
		Form		
		Dev		
		Ops	Dec-01	Sep-14
		Res		Sep-15
RHESSI		Tech		
		Form		
		Dev		
		Ops	Feb-02	Sep-14
		Res		Sep-15

- Tech & Adv Concepts (Tech)
- Formulation (Form)
- Development (Dev)
- Operations (Ops)
- Research (Res)
- Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Research

Program Management

NASA Headquarters has program management responsibility for the Heliophysics Research Program.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Research and Analysis	SMD	All NASA Centers	None
Heliophysics Operating Missions	SMD	GSFC, JPL and MSFC	ESA and JAXA
Sounding Rockets and Research Range	SMD	GSFC	None
Science Data and Computing	SMD	GSFC and other NASA Centers	None

Acquisition Strategy

All acquisitions in the Heliophysics programs are based on full and open competition. Proposals are peer reviewed and selected based on NASA research announcements or Research Opportunities in Space and Earth Sciences (ROSES) opportunities. Universities, government research labs, and industry partners throughout the U.S. participate in R&A research projects. The Heliophysics operating missions and instrument teams were previously selected from NASA Announcements of Opportunity. NASA evaluates the allocation of funding among the operating missions bi-annually through the Heliophysics Senior Review. Universities, government research labs, and industry partners throughout the U.S. participate in science data and computing technology research projects.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Senior Review Panel	04/2010	Assess effectiveness of Heliophysics operational activities.	04/2013

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**221.9**	**-**	**204.7**	**202.2**	**200.9**	**336.3**	**354.9**
Radiation Belt Storm Probes (RBSP)	121.0	-	91.2	29.7	21.5	8.7	0.0
Solar Probe Plus	40.0	-	51.8	103.0	103.0	146.7	232.5
Other Missions and Data Analysis	60.9	-	61.6	69.5	76.5	181.0	122.4

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Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Overview

The Living with a Star (LWS) Program seeks to improve understanding of how and why the Sun varies, how the Earth and solar system respond, and most importantly, how this variability and response affect life on Earth. This improved understanding of solar variability (i.e., space weather) and its effects will lead to a reliable predictive capability for space weather. This capability is essential for successful future space exploration and increased use of complex technological systems to improve the safety and quality of life on Earth. LWS accomplishes its goals with a combination of new science missions and yearly science research grant opportunities.

SDO, the first mission of LWS launched in FY 2010, will complement and improve upon major capabilities of the Solar and Heliospheric Observatory (SOHO), launched in December 1995. SDO is designed to help scientists understand the Sun's influence on Earth and near-Earth space by studying the full-disc of the solar atmosphere on small scales of space and time and many wavelengths simultaneously.

The Sun's inconsistent activity produces variability in the Earth's radiation belts. The second LWS mission, the Radiation Belt Storm Probes (RBSP), will analyze these belts in unprecedented detail. Two identical spacecraft in elliptical orbits will make simultaneous measurements of processes that accelerate and transport radiation particles as they transit through Earth's radiation belts. RBSP results will enable the development of models for Earth's radiation belts and for other related but under-sampled planetary environments, such as Mars. Spacecraft and aeronautics engineers will apply the models to improve spacecraft design and to alert spacecraft and aircraft operators and pilots of predicted storms and ionizing radiation that could impact crew health or vehicle operations.

Two additional missions are currently developing mission concepts: SPP and the Solar Orbiter Collaboration (SOC). SPP will explore the Sun from very close range (inside 10 solar radii) to improve understanding of the generation and flow of the solar wind that links the Sun to the Earth and the solar system. SOC, led by ESA, will investigate the links between the solar surface, corona, and inner heliosphere from as close as 45 solar radii, and image the side of the Sun not visible from Earth. If SPP and SOC operations overlap, a unique opportunity will be realized for coordinated measurements in the inner heliosphere that will augment their combined science return.

For more information, please see http://lws.gsfc.nasa.gov/.

Plans For FY 2012

The SDO mission will continue prime operations. RBSP has completed its System Integration Review and started integration and testing (I&T) in preparation for its launch, scheduled for May 2012.

The SOC and SPP missions will develop detailed requirements and further define their mission concepts during formulation. SPP will also continue to retire technology risks and develop instrument and spacecraft systems. The Space Environment Testbed awaits its upcoming launch in FY 2013. The Balloon Array for Radiation-belt Relativistic Electron Losses project will conduct its mission readiness review for its first science campaign in August 2012.

Project Descriptions and Explanation of Changes

Radiation Belt Storm Probes (RBSP)

The RBSP mission will improve the understanding of how solar storms interact with and change particles, fields, and radiation in Earth's Van Allen radiation belts and atmosphere. This knowledge could be applied to planets and moons in the solar system that have a magnetic core. This mission was recently approved to begin Phase D, hardware I&T, and is scheduled to launch in May 2012. Additional detail can be found in the RBSP development section of the NASA budget.

Solar Probe Plus

The SPP mission is currently in formulation. It will perform the first in-situ measurements very close to the Sun (as close as 9.5 solar radii) to improve understanding of the generation and flow of the solar wind that links the Sun to Earth and the solar system. The science instruments were selected in FY 2010 in support of a FY 2018 launch, the earliest possible launch date within funding guidelines and technology capability. Additional detail can be found in the SPP formulation section of the NASA budget.

Other Missions and Data Analysis

SDO: The SDO mission was launched in February 2010 on the Atlas V vehicle. SDO investigates how the Sun's magnetic field is structured, as well as how its energy is converted and released into the heliosphere in the forms of solar wind, energetic particles, and variations in solar irradiance.

Space Environment Testbeds (SET): SET will improve the engineering approach to accommodate and/or mitigate the effects of solar variability on spacecraft design and operations. It has two components: a data mining element that has been completed, and a space flight mission. SET is scheduled to fly on the Air Force Research Lab's Demonstration and Science Experiment mission scheduled for launch in FY 2013.

BARREL: BARREL is a balloon-based mission that will launch a series of science instruments to complement the measurements made on the RBSP mission. BARREL will measure the precipitation of relativistic electrons from the radiation belts. Implementation responsibility has been assigned to the Wallops Balloon Program Office.

SOC: SOC is a joint mission with ESA, wherein ESA provides the spacecraft operations and the majority of the instruments, pending final mission selections no earlier than September 2011. The LWS Program will provide the launch vehicle and up to four science investigations/instruments. These instruments were selected in FY 2009 and will complete formulation work in FY 2011. SOC will provide close-up views of the Sun's polar regions and its far side, and tune its orbit to match the Sun's rotation. This will permit the spacecraft's instruments to observe emissions and solar wind from one specific area for much longer than is currently possible and will provide more insight into the evolution of sunspots, active regions, coronal holes, and other solar features and phenomena than past missions.

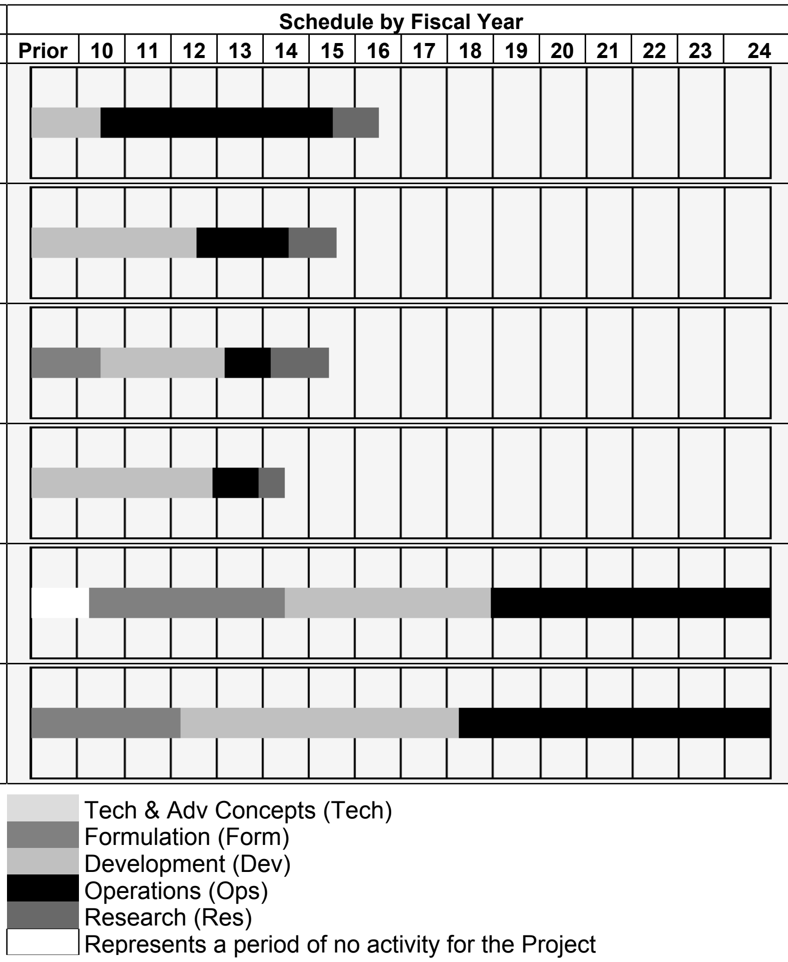
Living with a Star Science: LWS science funds competitively selected proposals that improve the understanding of the physics of the integrated system that links the Sun to the heliosphere and planetary atmospheres. This improved understanding will be achieved through data analysis supporting the development of new or revised theories and numerical models. This step is necessary for development of a predictive capability for space weather.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	RBSP	
Complete the Solar Orbiter Collaboration Confirmation Review.	Living with a Star	

Implementation Schedule



Project	Phase	Beg	End
SDO	Tech		
	Form	Aug-02	Jul-04
	Dev	Jul-04	Apr-10
	Ops	Apr-10	Apr-15
	Res	Apr-15	Apr-16
RBSP	Tech		
	Form	Sep-06	Dec-08
	Dev	Dec-08	May-12
	Ops	May-12	May-14
	Res	May-14	May-15
BARREL	Tech		
	Form	Sep-06	Apr-10
	Dev	Apr-10	Dec-12
	Ops	Dec-12	Dec-13
	Res	Dec-13	Mar-15
SET	Tech		
	Form	Jan-04	Jan-06
	Dev	Jan-06	Sep-12
	Ops	Sep-12	Aug-13
	Res	Sep-13	Apr-14
SPP	Tech		
	Form	Dec-09	Mar-14
	Dev	Apr-14	Aug-18
	Ops	Aug-18	Sep-25
	Res	Sep-25	Sep-26
SOC	Tech		
	Form	Jul-08	Dec-11
	Dev	Jan-12	Dec-17
	Ops	Jan-18	Dec-24
	Res		

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star

Program Management

Program management responsibility for the LWS Program is assigned to the LWS Program Office located at the Goddard Space Flight Center (GSFC).

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
SDO	GSFC	GSFC	None
RBSP	JHU-APL	None	National Reconnaissance Office (NRO)
BARREL	GSFC	GSFC	None
Solar Probe Plus	JHU-APL	None	None
SOC	GSFC	GSFC	European Space Agency, ESA member states
SET	GSFC	GSFC	CNES (French Space Agency), DLR (German Space Agency), UKSA (United Kingdom Space Agency), BIRA (Belgian Space Agency), INAF (Italian National Institute for Astrophysics), MICINN (Spanish Ministry of Science and Innovation), SSO (Swiss Space Office)

Acquisition Strategy

Four instrument suites for RBSP were selected through full and open competition, and one instrument is being provided by the National Reconnaissance Office. The launch vehicle was selected through full and open competition, and the spacecraft are being built in-house at Johns Hopkins University-Applied Physics Laboratory (JHU-APL).

BARREL was selected through full and open competition through the same solicitation as the RBSP instruments. Two SET experiments were selected through full and open competition, and two were contributed by Centre National d'Etudes Spatiales (CNES) and Defense Evaluation and Research Agency.

NASA-led SOC and SPP instruments were selected using full and open competition as were the SPP and SOC launch vehicles. The SPP spacecraft will be built in-house at JHU-APL.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	02/2009	Overall assessment of the life cycle cost, schedule and deliverables of the LWS Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	271.3	121.0	-	91.2	29.7	21.5	8.7	0.0

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Explanation of Project Changes

RBSP was confirmed in FY 2009 to proceed into the development phase, and will launch in May 2012. The total funding for RBSP has not changed.

Project Purpose

The RBSP mission will observe the fundamental processes that energize and transport radiation particles in Earth's inner magnetosphere (the area in and around Earth's radiation belts). These dynamic processes operate throughout the universe at other planets and stars, and they continuously operate within Earth's immediate space environment.

The primary science objective of the RBSP mission is to provide understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun. The RBSP mission lifetime will provide sufficient local time, altitude, and event coverage to improve understanding, and determine the relative significance of the various mechanisms that operate within the radiation belts.

RBSP observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace.

Project Parameters

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and fields.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Commitments

The RBSP project will launch two identical spacecraft in FY 2012 to begin a two-year prime mission.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
EELV	KSC	Deliver a spacecraft to operational orbit	Same	Same
Energetic Particle, Composition and Thermal Plasma Suite (ECT)	University of New Hampshire	Measure the electron and ion spectra, and composition to understand the electron and ion changes	Same	Same
Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE)	New Jersey Institute of Technology	Measure the ring current in the magnetosphere during geomagnetic storms	Same	Same
Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)	University of Iowa	Measure the magnetic fields and plasma waves	Same	Same
Electric Field and Waves Instrument for the NASA RBSP Mission (EFW)	University of Minnesota	Measure the electric fields in the radiation belts	Same	Same
Proton Spectrometer Belt Research (PSBR)	National Reconnaissance Office	Measure the inner Van Allen belt protons	Same	Same
Spacecraft	JHU-APL	Operate science instruments in high radiation; transmit science data to ground	Same	Same
Ground System	Primary ground station at JHU-APL; instrument operation is distributed among investigators	Receive science data from two spacecraft; distribute to archive	Same	Same

Schedule Commitments

The RBSP project was authorized to begin formulation in September 2006 when the selections for science investigations were announced. It was confirmed to proceed into development on December 19, 2009.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Begin Implementation	January 2009	January 2009	January 2009
Critical Design Review	December 2009	December 2009	December 2009
System Integration Review	November 2010	November 2010	October 2010
Launch Readiness Review	May 2012	May 2012	May 2012

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Systems	JHU-APL	None	None
Data Analysis	JHU-APL	None	National Reconnaissance Office
Instrument Development	JHU-APL	None	National Reconnaissance Office
Spacecraft design, integration with instrument, and test	JHU-APL	None	None
Mission Operations	JHU-APL	None	None
Expendable Launch Vehicle	KSC	None	None

Acquisition Strategy

The RBSP spacecraft and ground system are being designed, developed, and tested at the JHU-APL. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the JHU-APL Procurement Office. Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and the University of New Hampshire, as well as contributions from the National Reconnaissance Office and the Czech Republic.

The ground system components were defined during the formulation phases (Phases A and B) and include a mission operations center at the JHU-APL.

The Energetic Particle, Composition and Thermal Plasma Suite (ECT), Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS), Electric Field and Waves Instrument for the NASA RBSP mission (EFW), and Radiation Belt Storm Probes Ions Composition Experiment (RBSPICE) science investigations were procured through announcements of opportunity. The Proton Spectrometer Belt Research (PSBR) instrument is being contributed through an agreement with the National Reconnaissance Office.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	10/2008	Preliminary Design Review. The review concluded that the RBSP design was sufficiently mature to proceed to KDP-C.	N/A
Performance	SRB	12/2009	Critical Design Review: The review concluded that there were no significant issues and the project should continue as planned.	N/A
Performance	SRB	10/2010	System Integration Review: The review concluded that the project was ready to proceed with I&T.	N/A

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Development:	Radiation Belt Storm Probes (RBSP)

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Complete Electric and Magnetic Field Instrument Suite and Integrated Science End-to-End testing	If the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) main Electronics Box Engineering Model 2 (EM2) is not successfully integrated and tested per the EM2 test plan and schedule, then the flight build and delivery will be delayed.	Hold Flight Manufacturing Readiness Reviews. Complete EM 2 environmental testing and characterization. Complete EM2 I&T peer review.
XCVR Qualification program	If the transceiver qualification program does not perform to their re-planned schedule, then the project's I&T schedule will be delayed.	Provide bi-weekly schedule updates to the integrated master schedule. Burn Qualification model on the RTAX, the field programmable gate array. Conduct Engineering Design Review of Qualification model.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	40.0	-	51.8	103.0	103.0	146.7	232.5

Note:

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Project Purpose

Solar Probe Plus (SPP) will be an extraordinary and historic mission, exploring the Sun's outer atmosphere, or corona, as it extends out into space. Approaching as close as 9.5 solar radii, SPP will repeatedly sample the near-Sun environment, revolutionizing knowledge and understanding of coronal heating and of the origin and evolution of the solar wind, answering critical questions in heliophysics that have been ranked as top priorities for decades. Moreover, by making direct, in-situ measurements of the region where some of the most hazardous solar energetic particles are energized, SPP will make a fundamental contribution to the ability to characterize and forecast the radiation environment in which future space explorers will work and live.

For more information about SSP, please see http://nasascience.nasa.gov/missions/solar_probe.

Project Preliminary Parameters

SPP's first near-Sun pass occurs three months after launch, at a heliocentric distance of 35 solar radii. Over the next several years, successive Venus gravity assist maneuvers will gradually lower the spacecraft's near-Sun pass to approximately 9.5 solar radii, by far the closest any spacecraft has ever come to the Sun. An August 2018 launch is the earliest possible launch date within funding guidelines and technology capability. SPP will spend, during its seven year mission, a total of 30 hours inside 10 solar radii, 961 hours inside 20 solar radii, and 2149 hours inside 30 solar radii, sampling the solar wind as it evolves with rising solar activity toward an increasingly complex structure.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Estimated Project Deliverables

SPP will launch from KSC on an EELV in FY 2018 with an expected mission duration of seven years.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
EELV	KSC	Deliver the spacecraft to operational orbit	Same	Same
Ground Systems	JHU-APL	Receive science data and telemetry from spacecraft, command spacecraft, distribute science data to investigator teams	Same	Same
Spacecraft	JHU-APL	Transport instruments to science destination, operate instruments, modify orbit including several Venus gravity assists	Same	Same
Instruments	NASA-funded investigators	Perform in situ measurements and remote observations of the Sun	Same	Same

Estimated Project Schedule

SPP received approval to proceed to Phase A in November 2009 and to solicit science investigations in December 2009. NASA announced these selections in September 2010. Phase B will begin in the fall of 2011 following a successful Mission Definition Review/Preliminary Non-Advocate Review (PNAR).

Milestone Name	Formulation Agreement Estimate	FY 2011 PB Request	FY 2012 PB Request
Formulation			
Mission Definition Review /PNAR	01/2012	04/2012	10/2011
Preliminary Design Review/NAR	01/2014	N/A	01/2014
Critical Design Review	01/2016	N/A	11/2015
Launch	08/2018	08/2018	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
Project In Formulation:	Solar Probe Plus

Project Management

JHU-APL will manage the project. GSFC is responsible for program management and science management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instruments	JHU-APL	None	None
EELV	JHU-APL	KSC	None
Spacecraft	JHU-APL	None	None
Mission Operations	JHU-APL	None	None

Acquisition Strategy

The science instruments will be built by PIs selected through the Announcement of Opportunity. The spacecraft will be built by JHU-APL with the spacecraft subassemblies, components, and parts competitively procured by JHU-APL. The ground system components will be defined during formulation and will be determined by the implementing organization for the project. The Phase E contracts will be managed by GSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	09/2009	SRB approved the project to proceed into Phase A.	10/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
1. Thermal protection system (TPS) thermal performance	If TPS thermal conductivity is greater than required and/or the coating performance is less than required, then the cooling system and spacecraft radiators may not be able to remove sufficient heat, leading to elevated solar array and spacecraft temperature.	- Coating development work. - Early materials characterization. - Early manufacture and test of prototype articles. - Increased TPS thickness.
2. Solar cell and array performance	If solar cell and array performance in the near-Sun environment is less than expected, then the power system performance may not meet requirement and/or cooling system requirements may increase.	- Cell technology development work. - Extensive power system and solar cell modeling and test. - Parallel approaches to development and design. - Margins in power and cooling system design. - Prototype development.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**148.0**	**-**	**163.5**	**170.4**	**171.9**	**50.2**	**38.0**
Magnetospheric Multiscale (MMS)	130.1	-	146.2	153.0	153.0	30.5	18.6
Other Missions and Data Analysis	17.9	-	17.3	17.4	18.9	19.7	19.4

Note:

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

Solar Terrestrial Probes (STP) provide understanding of the fundamental plasma processes inherent in all astrophysical systems. To accomplish this goal, STP investigations focus on specific scientific areas that will help us understand how plasma behaves in the space between the Sun and Earth. STP missions address processes such as the variability of the Sun, the responses of the planets to these variations, and the interaction of the Sun and solar system. STP missions are strategically defined and investigations are competitively selected. Strategic mission lines afford the space physics community the opportunity to plan specific missions to address important research focus areas and thus make significant progress in elucidating the fundamental processes of heliophysics.

For more information please see the STP program at http://stp.gsfc.nasa.gov/.

Plans For FY 2012

The Magnetospheric Multiscale Mission (MMS) will continue the implementation phase . System integration review is planned for January 2012, and KDP D will be held in April 2012. STEREO and Hinode will continue extended mission operations.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes

Project Descriptions and Explanation of Changes

Magnetospheric Multiscale (MMS)

MMS is a four-spacecraft mission planned for launch in March 2015 with a two-year mission life. MMS is designed to study magnetic reconnection in key boundary regions of Earth's magnetosphere. Reconnection is a fundamental process that occurs throughout the universe, by which magnetic energy is converted into heat, radiation, and particle acceleration. The best laboratory for understanding this process is Earth's magnetosphere, where reconnection between Earth's and the Sun's magnetic fields power magnetic storms, and substorms on Earth. The spacecraft will probe the regions of geospace most critical to measuring reconnection. Additional detail can be found in the MMS development section of this document.

Other Missions and Data Analysis

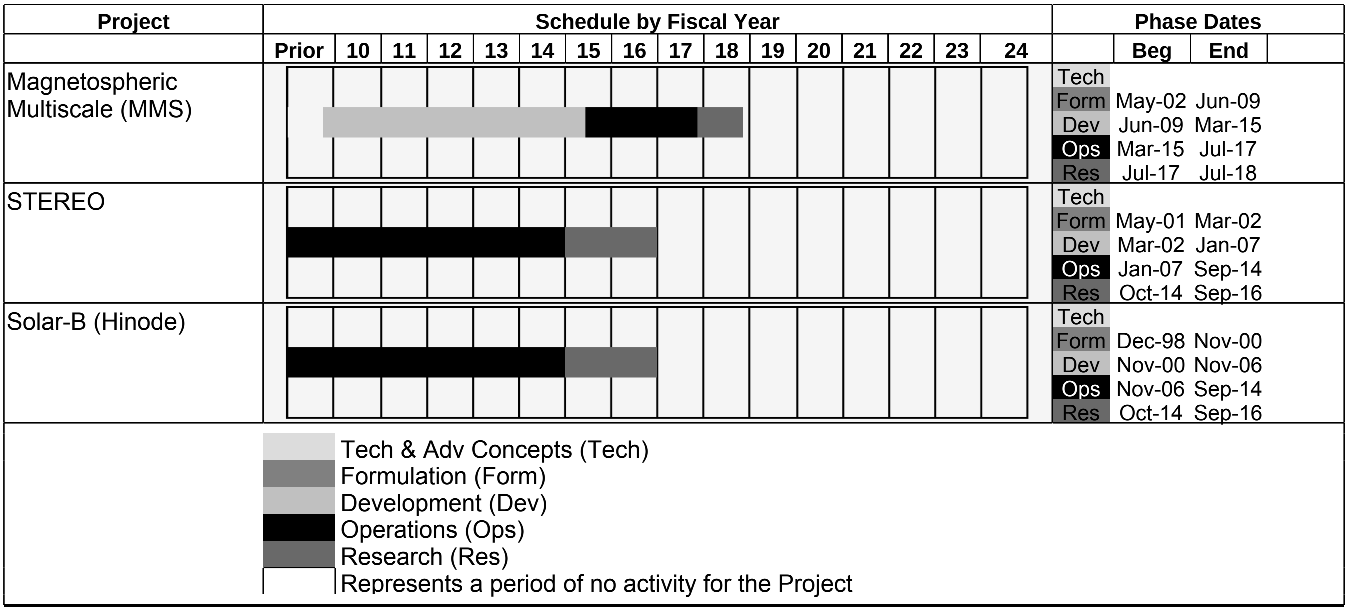
Solar TErrestrial RElations Observatory (STEREO): Launched on October 25, 2006, STEREO is now an operating mission employing two nearly identical observatories to provide three-dimensional measurements of the Sun to study the nature of coronal mass ejections. These powerful eruptions are a major source of the magnetic disruptions on Earth and a key component of space weather, which can greatly affect satellite operations, communications, power systems, the lives of humans in space, and global climate.

Solar B (Hinode): Hinode launched on September 22, 2006, from Japan's Uchinoura Space Center. Its mission is to explore the magnetic fields of the Sun. NASA developed three science instrument components: the Focal Plane Package (FPP), the X-Ray Telescope (XRT), and the Extreme Ultraviolet Imaging Spectrometer (EIS) and provides operations support for science planning and instrument command generation activities. A follow-on to the highly successful Japan/US/UK Yohkoh (Solar-A) satellite that operated between 1991 and 2001, Hinode consists of a coordinated set of optical, Extreme-Ultraviolet (EUV), and X-ray instruments that will investigate the interaction between the Sun's magnetic field and its corona.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	MMS	

Implementation Schedule



Program Management

Program management responsibility for the STP program is assigned to the STP Program Office at GSFC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
MMS	GSFC	GSFC	Austria, France, Japan, Sweden (SNSB)
STEREO	GSFC	None	United Kingdom

Acquisition Strategy

STP missions are strategically defined and investigations are competitively selected. For the acquisition of scientific instruments, spacecraft, and science investigations, including research and analysis, STP uses full and open competitions to the greatest extent possible.

The MMS spacecraft will be built in-house at GSFC. GSFC will also provide the mission operations center. The Southwest Research Institute (SwRI) is the single MMS instrument suite contractor, selected through a full and open competition. All instruments are developed by SwRI, their subcontractors, their international partners, and GSFC.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	08/2010	Overall assessment of life cycle cost, schedule, and deliverables of the STP Program. The review board concluded that this program has met the success criteria and should continue in accordance with their existing plans.	N/A

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**226.0**	**130.1**	**-**	**146.2**	**153.0**	**153.0**	**30.5**	**18.6**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

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Explanation of Project Changes

MMS has no change in life cycle cost. Sweden is not able to deliver the deployment mechanism of their electric field instrument contribution as planned. This mechanism will now be built by NASA through an existing partner institution, the University of New Hampshire.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Project Purpose

MMS will use four identically instrumented spacecraft to perform the first definitive study of magnetic reconnection in space. Reconnection occurs in all astrophysical plasma systems but can be studied efficiently only in Earth's magnetosphere. Magnetic reconnection is thought to be of great importance for energy transfer throughout the universe and is an efficient and fast acceleration mechanism. Reconnection is the primary process by which energy is transferred from the solar wind to Earth's magnetosphere and is the critical physical process determining the size of a space weather geomagnetic storm. MMS will determine why magnetic reconnection occurs, where it occurs, how it varies, how magnetic energy is coupled into heat and particle kinetic energy, and how this energy is coupled into the surrounding plasma.

For more information about MMS, please see http://stp.gsfc.nasa.gov/missions/mms/mms.htm.

Project Parameters

The MMS instrument payload will measure electric and magnetic fields and plasmas within the small-scale diffusion regions where magnetic reconnection occurs. High temporal and spatial resolution measurements will permit direct observation of these physical processes. The four spacecraft and instrument suites have identical design requirements. A two-phase, low-inclination orbit will probe both the dayside magnetopause and the nightside magnetotail neutral sheet where reconnection is known to frequently occur. The primary target of Phase 1 is the dayside magnetopause reconnection region. Phase 2 will focus on the near-Earth neutral line in the nightside magnetotail. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations in the area of interest. The mission design life is two years.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Project Commitments

NASA plans to launch four identically-instrumented spacecraft on an Evolved Expendable Launch Vehicle (EELV) into a highly elliptical Earth orbit in March 2015 and begin two years of scientific measurements that will enable an understanding of fundamental plasma physics processes associated with magnetic reconnection.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Launch Vehicle	KSC	Deliver ~4,000 kg payload consisting of four observatories to a highly elliptical Earth orbit.	Same	Same
Ground Systems	GSFC	Provide during operations minimum science data payback of ~4 Gbits of data per observatory each day.	Same	Same
Spacecraft	GSFC	Deliver high-rate data from instruments to ground station with a high accuracy for two years.	Same	Same
Electric Field Instruments	UNH	Provide measurements of electric fields (time resolution 1 ms) and magnetic fields (time resolution 10 ms)	Same	Same
Fast Plasma Investigation	GSFC	Provide plasma wave measurements (electric vector to 100 KHz).	Same	Same
Energetic Particle Detectors	JHU-APL	Provide high-resolution measurement of energetic particles.	Same	Same
Hot Plasma Composition Analyzers	Southwest Research Institute	Three-dimensional measurements of hot plasma composition (time resolution 10s).	Same	Same
Science Operations Center	University of Colorado/ Laboratory for Atmospheric and Space Physics	Provide science data to the community and archive.	Same	Same

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Schedule Commitments

MMS began formulation in FY 2002. The project's confirmation review was held in June 2009 and the project was approved to enter implementation. As a result of the confirmation review, the launch date was moved to March 2015. The Mission Critical Design Review was successfully completed in August 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Definition Review	September 2007	September 2007	September 2007
Initial Confirmation Review	November 2007	November 2007	November 2007
Confirmation Review	June 2009	June 2009	June 2009
Critical Design Review	August 2010	August 2010	August 2010
System Integration review	January 2012	January 2012	January 2012
Launch	March 2015	March 2015	March 2015

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
Project In Development:	Magnetospheric Multiscale (MMS)

Project Management

The STP Program has program management responsibility for the MMS project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Four Instrument Suites	GSFC, Southwest Research Institute	GSFC	Austrian Space Agency, France (CNES), and Japan (JAXA), Sweden (SNSB)
Launch Vehicle	KSC	KSC	None
Four Spacecraft	GSFC	GSFC	None
Mission Operations	GSFC	GSFC	None
Science Operations	GSFC, LASP	None	None

Acquisition Strategy

The MMS spacecraft is being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local support service contractors. The acquisition of subcontracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the MMS procurement office. Instrument development activities are under contract with SwRI. Instrument development subcontracts include Lockheed Martin, JAXA/MEISEI, University of New Hampshire, JHU-APL, Aerospace Corporation, and a team at GSFC. The Mission Operations Center and the Flight Dynamics Operations Area will be developed and operated at GSFC using a combination of GSFC civil servants and local support service contractors. The Science Operations Center for the instruments will be developed and operated at the Laboratory for Atmospheric and Space Physics at the University of Colorado and is under contract to SwRI.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	08/2010	The Critical Design Review (CDR), an NPR 7120.5D review to assess the technical, cost, and schedule status of MMS. MMS was approved to proceed to manufacturing.	01/2012
All	SRB	N/A	System Integration Review - Evaluate the readiness of the project to start flight system assembly, test, and launch operations.	03/2014
All	SRB	N/A	Flight Readiness Review - Evaluate system assembly, integration, and test, preparing for the flight.	TBD

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	65.1	-	65.2	70.8	90.2	91.1	84.9
IRIS	41.1	-	37.5	11.2	6.8	1.1	0.0
Other Missions and Data Analysis	24.0	-	27.7	59.7	83.4	90.1	84.9

Note: The above budget submit reflects split of the Explorer Future budget for the Heliophysics Theme only.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Overview

The Explorer Program provides frequent flight opportunities for world-class astrophysics and space physics investigations using innovative and streamlined management approaches for spacecraft development and operations. Explorer missions are highly responsive to new knowledge, new technology, and updated scientific priorities by launching smaller missions that can be conceived and executed in a relatively short development cycle. Priorities are based on an open competition of concepts solicited from the scientific community.

The program also enables participation in missions of opportunity provided by other U.S. or international agencies. The program emphasizes missions that can be accomplished under the control of the scientific research community within constrained mission life-cycle costs. The program also seeks to enhance public awareness of space science by incorporating educational and public outreach activities into each mission. All investigations are competitively selected. Full missions can either be medium-class explorers (MIDEX) or small explorers (SMEX). Missions of opportunity space science investigations are typically instruments flown as part of a non-NASA space mission. Missions of opportunity are conducted on a no-exchange-of-funds basis with the organization sponsoring the mission.

Following the commissioning and checkout phase of the spacecraft, NASA Headquarters management responsibility for the operational phase transitions to the Heliophysics Research Program. While the research program assumes management responsibilities, funds for operating missions are provided by the Explorer Program.

The Explorer Program made two full mission selections from its SMEX competition during FY 2009. IRIS is a heliophysics small explorer mission, currently in the development phase, and scheduled for launch in CY 2012. The Gravity and Extreme Magnetism SMEX (GEMS) is an astrophysics small explorer mission selected for launch in FY 2014.

The Interstellar Boundary Explorer (IBEX), launched in October 2008, finished its prime operational phase in October 2010, and is currently in extended Phase E pending the results of the End of Prime Mission review. The Coupled Ion Neutral Dynamics Investigation (CINDI), and Two Wide-angle Imaging Neutral-atom Spectrometers B (TWINS) were also launched in FY 2008. Both CINDI and TWINS missions have gone under successful End of Prime Mission Reviews and the missions are being extended to September 2014.

The Explorer Program also has three Explorer missions currently in the Astrophysics Division. Details and the associated budget can be found in the Astrophysics Division section of the NASA budget.

For more information on any of the Explorer mission and new science discoveries, please see http://explorers.gsfc.nasa.gov/missions.html.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Plans For FY 2012

Explorer missions were conceived in response to the temporary unavailability of mid-range expendable launch vehicles. Explorer missions will accomplish world-class science via spacecraft whose capabilities are expected to fall between the SMEX and MIDEX classes. Access to space will utilize one of the several, lower-cost expendable launch vehicles currently available.

The currently approved Explorer Program planning budget is sufficient to select and execute at least one full Explorer mission to proceed into Phase B and subsequent mission phases. In FY 2011, SMD released an Announcement of Opportunity for new Explorer missions. Proposals are due no later than February 16, 2011. NASA intends to select and execute a second full Explorer mission or one or more mission(s) of opportunity. The decision between these selection options will be based upon the proposals received in response to this Announcement of Opportunity.

In FY 2012, funding for future Explorer missions (previously funded solely under the Heliophysics Explorer Program) is being shared by Heliophysics and Astrophysics. This will have no effect on the current Explorer Announcement of Opportunity for either Astrophysics or Heliophysics proposals, or the management of the program. In addition, this will balance the funding for Explorer missions between Astrophysics and Heliophysics in the future.

The newly selected IRIS mission will continue to progress in the development phase. The IBEX mission will continue its extended science mission of mapping the heliosphere and uncovering the global interaction between the solar wind and the interstellar medium, subject to the outcome of the review. TWINS and CINDI will both enter their fourth year on orbit. THEMIS and AIM will continue their extended Phase E operations.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Project Descriptions and Explanation of Changes

IRIS

IRIS is a SMEX mission selected in June 2009 and expected to launch June 2013. IRIS is currently in the development phase. This mission opens a window of discovery by tracing the flow of energy and plasma through the Sun's chromosphere and transition region into the corona. IRIS will revolutionize understanding of energy transport into the corona and solar wind and provide an archetype for all stellar atmospheres. The unique instrument capabilities, coupled with state of the art 3-dimensional modeling, will fill a large gap in the knowledge of this dynamic region of the solar atmosphere. The mission will greatly extend the scientific output of existing heliophysics spacecraft that follow the effects of energy release processes from the Sun to Earth.

Other Missions and Data Analysis

The primary objective of the Aeronomy of Ice in Mesophere (AIM) mission is to understand why polar mesospheric clouds form and why they vary. AIM will also determine the causes of Earth's highest-altitude clouds, which form in the coldest part of the atmosphere about 50 miles above the polar regions every summer. AIM launched on April 25, 2007, on board a Pegasus XL from Vandenberg Air Force Base. It completed its prime mission in FY 2009 and is currently in extended phase until September 2014. This mission supplies not previously available data, which has led to new science discoveries.

CINDI is a NASA-sponsored mission of opportunity managed by the University of Texas at Dallas (UTD). CINDI will discover the role of ion-neutral interactions in the generation of small- and large-scale electric fields in Earth's upper atmosphere. In addition, the CINDI instruments will provide measurements of the three-dimensional neutral winds and ion drifts. This mission launched April 16, 2008, aboard the Air Force Research Laboratory's Communication/Navigation Outage Forecast System (C/NOFS) spacecraft. Currently CINDI is in extended phase until September 2014.

IBEX allows the first glimpse into the edge of the solar system, where the solar wind interacts with winds from other stars. This region is a breeding ground for anomalous cosmic rays that form a component of energetic particles from beyond the solar system that may pose health and safety hazards for humans exploring beyond Earth's orbit. IBEX will make observations from an elliptical Earth orbit that takes it beyond the interference of Earth's magnetosphere. IBEX launched on October 5, 2008, on a Pegasus XL from Kwajalein Atoll in the Republic of the Marshall Islands. The IBEX spacecraft has made it possible for scientists to construct the first comprehensive sky map of the solar system and its location in the Milky Way galaxy. The new view will change the way researchers view and study the interaction between the galaxy and the Sun. This mission is currently in extended Phase E pending the results of the End of Prime Mission review.

Time History of Events and Macroscale Interactions during Substorms (THEMIS) has provided breakthroughs in understanding of the onset and evolution of magnetospheric substorms. NASA's THEMIS mission uses five identical micro-spacecraft (probes) to answer the fundamental questions regarding magnetospheric substorm instability, a dominant mechanism of transport and explosive release of solar wind energy within geospace. In addition to addressing its primary objective, THEMIS answers critical questions in radiation belt physics and solar wind-magnetosphere energy coupling. THEMIS is a MIDEX mission that launched on February 17, 2007, and is currently operating in extended phase until September 2014.

TWINS-B will provide the second half of the stereo imaging capability of Earth's magnetosphere in conjunction with the TWINS-A mission. The region surrounding the planet is controlled by its magnetic field and contains the Van Allen radiation belts and other energetic charged particles. TWINS-B will enable three-dimensional global visualization of this region, which will lead to a greatly enhanced understanding of the connections between different regions of the magnetosphere and their relation to the solar wind. TWINS-B was launched as a NASA-sponsored Mission of Opportunity in February 2008 and is currently operating in Extended Phase until September 2014.

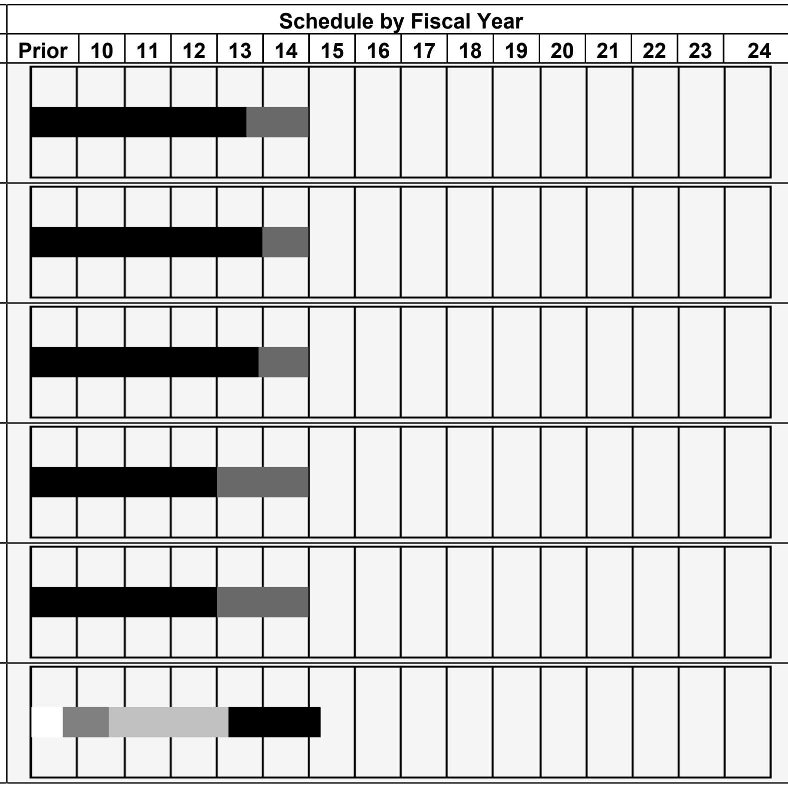
The Explorer Future Missions funds future Heliophysics Explorer mission selections for the MIDEX, SMEX, Missions of Opportunity (MO), and Explorer (EX).

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Selection completed for announcement of opportunity; Start Development Phase on Explorer 1	Explorer Future mission	New

Implementation Schedule



Project	Phase	Beg	End
AIM	Tech		
	Form	Jul-02	Apr-04
	Dev	Apr-04	May-07
	Ops	May-07	May-13
	Res	May-13	Sep-14
IBEX	Tech		
	Form	Jan-05	Mar-06
	Dev	Mar-06	Oct-08
	Ops	Oct-08	Sep-13
	Res	Sep-13	Sep-14
THEMIS	Tech		
	Form	Oct-02	Apr-04
	Dev	Apr-04	Aug-07
	Ops	Aug-07	Aug-13
	Res	Aug-13	Sep-14
CINDI	Tech		
	Form	Sep-00	Nov-01
	Dev	Nov-01	Apr-08
	Ops	Apr-08	Sep-12
	Res	Sep-12	Sep-14
TWINS-B	Tech		
	Form		
	Dev	Apr-99	Feb-08
	Ops	Feb-08	Sep-12
	Res	Sep-12	Sep-14
IRIS	Tech		
	Form	Jun-09	Jun-10
	Dev	Jun-10	Dec-12
	Ops	Dec-12	Jan-15
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program

Program Management

GSFC has program management responsibility for all Heliophysics Explorer programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
AIM	GSFC	None	N/A
IBEX	GSFC	GSFC	N/A
THEMIS	GSFC	None	N/A
CINDI	GSFC	None	DOD
TWINS-B	GSFC	None	DOD
IRIS	GSFC	ARC	N/A

Acquisition Strategy

The Heliophysics Explorer Program has established an acquisition strategy that contracts for the whole mission (concept through delivery of science data and analysis), with emphasis on performance incentives and a cost cap for each mission.

Investigations are selected through Announcements of Opportunity, in which multiple investigations are selected competitively for initial concept studies with a competitive down-select to proceed to the next stage of formulation. The investigations are selected to proceed from one phase to the next through execution of contract options, based on successful technical, cost, and schedule performance in the previous phases.

NASA has selected Lockheed Martin and GSFC/ARC for development of IRIS.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Space Science Support Office	06/2009	Reviewed and evaluated SMEX Announcements of Opportunity proposals for selection. Written evaluations were provided and the IRIS mission was selected for development as the next SMEX mission.	03/2011
Performance	SRB	02/2009	Overall assessment of life cycle cost, schedule and deliverables of the Explorer Program. Review board concluded that these programs have met their success criteria and should continue in accordance with their existing plans.	02/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**15.8**	**41.1**	**-**	**37.5**	**11.2**	**6.8**	**1.1**	**0.0**

Note: For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Purpose

Understanding the interface between the photosphere and corona remains a fundamental challenge in solar and heliospheric science. The IRIS mission will use a solar telescope and spectrograph to explore the solar chromospheres. Recent discoveries have shown the chromosphere is significantly more dynamic and structured than previously thought. The IRIS mission opens a window of discovery into this crucial region by tracing the flow of energy and plasma through the chromosphere and transition region into the corona by using spectrometry and imaging. IRIS will revolutionize understanding of energy transport into the corona and solar wind and provide an archetype for all stellar atmospheres. The unique instrument capabilities, coupled with state of the art 3-dimensional modeling, will fill a large gap in knowledge of this dynamic region of the solar atmosphere. The mission will greatly extend the scientific output of existing heliophysics spacecraft that follow the effects of energy release processes from the Sun to Earth.

Project Parameters

IRIS is a 3-axis stabilized, sun-pointed mission that studies the chromospheres in the Far Ultraviolet (FUV) and Near Ultraviolet (NUV) with 0.33 arcsecond spatial resolution, 0.4 km/s velocity resolution and a field of view of 171 arcsec. This two-year mission fills a critical observational data gap by providing simultaneous, co-spatial and comprehensive coverage from photosphere (~4,500 K) up to corona (<= 10 MK). IRIS consists of a 20cm aperture telescope assembly that feeds an imaging spectrograph and a separate imaging camera system with wavelengths in the FUV and NUV. A spacecraft bus based upon heritage designs supports the science mission and provides pointing, power, and data communications for the mission. The launch vehicle is an Orbital Sciences Corporation Pegasus XL with launch operations out of Vandenberg Air Force Base in California.

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

Project Commitments

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Ground Systems	Lockheed Martin Space Systems Company	Receive science data and telemetry from spacecraft, command spacecraft, distribute science data to investigator teams	N/A	NEW
Spacecraft	Lockheed Martin Space Systems Company	Transport instruments to science destination, operate instruments	N/A	NEW
Instruments	Lockheed Martin Space Systems Company	Perform in situ measurements and remote observations of the Sun	N/A	NEW
Launch vehicle (Pegasus XL)	Orbital Science Corporation	Deliver the spacecraft to operational orbit	N/A	NEW

Schedule Commitments

The IRIS held a confirmation review in June 2010 and launch is planned for June 2013.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
System Readiness Review	01/2010	N/A	01/2010
Preliminary Design Review	04/2010	N/A	04/2010
Confirmation Review	06/2010	N/A	06/2010
Critical Design Review	02/2011	N/A	02/2011
Pre-Environmental Review	10/2011	N/A	10/2011
Pre-Ship Review	07/2012	N/A	07/2012
Launch Readiness Date	06/2013	N/A	06/2013

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Heliophysics Explorer Program
Project In Development:	Interface Region Imaging Spectrograph (IRIS)

Project Management

Lockheed Martin Space Systems is leading the formulation and implementation of the project. GSFC is responsible for oversight and science management including data analysis during operations.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Instrument	GSFC	GSFC, ARC	None.
Launch Vehicle	GSFC	KSC	None.
Spacecraft	GSFC	GSFC, ARC	None.
Mission Operations	GSFC	GSFC, ARC	None.

Acquisition Strategy

IRIS, awarded in June 2009, is a PI-led project that was competitively selected under the SMEX program. The contractor's final proposal for Phases C-E was negotiated in December 2010.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All	SRB	01/2010	System Readiness Review	N/A
All	SRB	05/2010	Preliminary Design Review - received authority to enter Phase C	N/A
All	SRB	07/2010	Confirmation Review - IRIS design was deemed sufficiently mature to proceed into development.	N/A
All	SRB	12/2010	Critical Design Review - successful	N/A
All	SRB	N/A	System Integration Review (SIR) - KDP D	12/2011
All	SRB	N/A	Operations Readiness Review (ORR)	09/2012
All	SRB	N/A	Flight Readiness Review (FRR) - KDP E	11/2012
All	SRB	N/A	Launch Readiness Review (LRR)	11/2012
All	SRB	N/A	Post Launch Assessment Review (PLAR)	TBD
All	SRB	TBD	Decommissioning Review (DR) - KDP F	TBD

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single String Spacecraft	The IRIS spacecraft uses a single string design. If there is an in flight failure, then there is no ability to switch over to a total redundant component.	Single string risks are mitigated by use of proven designs, high reliability parts, additional testing of critical systems, and testing of development models as early as possible, consistent with the cost and schedule constraints of the project.
Communications System	The communication subsystem vendor has not previously flown the proposed transmitter transponder units. If the vendor experiences problems during development of these units, then the IRIS schedule will be impacted.	Additional program manager oversight of the vendor and local quality assurance representative assigned to monitor. Engineering units are being used as a pathfinder for manufacturing and test and will be available for early testing.

Mission Directorate:	Science
Theme:	SMD Civil Service Labor and Expenses

Theme Overview

The SMD CSLE Theme contains labor funding, both salary and benefits, for civil service employees at NASA Centers who are assigned to work on projects in the Science Mission Directorate. These funds support the critical skills and capabilities required to provide the science, technology development, and space flight missions, as outlined in the other themes, within this mission area.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**304.7**	**313.2**	**326.5**	**342.2**	**358.6**
SCMD Civil Service Labor and Expenses	0.0	-	304.7	313.2	326.5	342.2	358.6

Overview

Over the last century, aviation has evolved to become an integral part of the economy and an essential component of everyday life. As the Nation and the world become more dependent on moving people and goods faster and more efficiently via air, important constraints to further growth have emerged. During peak travel times, the air traffic and airport systems in the United States and other nations are stretched to capacity. In 2007, airline delays in the United States cost industry and passengers $32.9 billion.* Environmental concerns such as aircraft noise and emissions limit increased operations and the expansion of airports and runways. These constraints to growth threaten the commercial prospects of the aerospace industry and contribute to continued or worsened airline travel delays.

In response to these challenges, the Nation is pursuing the realization of Next Generation Air Transportation System (NextGen). NextGen will accommodate more aircraft operating within the same airspace, including aircraft with widely varying performance capabilities (e.g., different speeds, altitudes, and maneuverability). The revolutionary changes to the airspace system and the aircraft that fly within it envisioned for NextGen will lead to a safer, more environmentally friendly, and more efficient national air transportation system, characterized by reduced community noise and improved local air quality, water quality, and energy efficiency. This will occur even with the projected increase in air traffic.

To achieve NextGen, the aviation sector needs to capitalize on the convergence of a broad range of multidisciplinary advances in technology. This will include pursuing technologies that are in their infancy today, developing the knowledge necessary to design radically new aviation systems, and enabling efficient, high-confidence design and development of revolutionary vehicles. These improvements must take place without compromise to the current safety record of the aviation industry. Increasing system capacity while maintaining or even improving aviation safety will require the ability to identify and respond to precursors to accidents, instead of today's practice of creating or changing flight rules in response to incidents and accidents.

As the Federal Government's largest civil aeronautics research organization, NASA, through its Aeronautics Research Mission Directorate (ARMD), plays a key role in the discovery and development of the innovative solutions and advanced technologies required for NextGen. NASA performs cutting-edge research on innovative concepts, tools, and technologies that will enable revolutionary advances in future aircraft, as well as to the airspace in which they will fly. This investment portfolio is a balanced mix of foundational and systems-level research, and related test infrastructure addressing aviation safety, energy efficiency, environmental compatibility, airspace capacity, and operational efficiency. NASA's aeronautics programs uniquely address specific aeronautical research needs while taking an integrated approach with respect to critical long-term challenges. It also addresses the long-term research needs in access-to-space technologies required for future space missions.

NASA expands the boundaries of aeronautical knowledge for the benefit of the Nation through partnerships with academia, industry, and other government agencies, helping to foster a collaborative research environment in which ideas and knowledge are exchanged across all communities. These collaborations help ensure the future competitiveness of the Nation's aviation industry.

* "Total Delay Impact Study," October 2010, National Center of Excellence for Airline Operations Research.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**497.0**	**501.0**	**579.6**	**569.4**	**569.4**	**569.4**	**569.4**	**569.4**
Aeronautics	497.0	-	-	569.4	569.4	569.4	569.4	569.4

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Aeronautics Research

Aeronautics

New Initiatives:

None

Major Changes:

The following changes have been made to the Aeronautics budget.

- Research into high-altitude ice crystal effects on aircraft has been increased. The objective of this research is to increase the probability that NASA's capability will support community response to rule-making and thus increase aviation safety in a timely manner.

- Additional research will be conducted into the effects of lightning strikes on composite materials. This research will accelerate development of standardized test procedures to support development of sensor concepts, advanced models, and protection methods.

- NASA also will increase research efforts in composite structures and materials in order to develop new materials and analysis capabilities so that they can be effectively utilized in new designs.

- Alternative fuels research will be increased. This will help to advance the use of alternative fuels (including biofuels) in aircraft, which is a key factor in substantially reducing the impact of aviation on the environment--specifically reducing the gaseous and particulate emissions of aircraft.

- NASA also will increase research into efficient and safe airport surface operations. Technologies will be integrated from the current NASA portfolio to further advance greater utilization of ADS-B application technologies providing optimization of airport surface movements with precise scheduling to reduce surface and en-route traffic delays and enhance safety.

- NASA will also increase flight research that focuses on low-cost, simple, short-term flight demonstrations aimed at enhancing aviation safety and airspace efficiency.

- Hypersonics research is reduced and focused on goals outlined in the National Aeronautics R&D Plan, where NASA possesses unique competencies relied upon by other agencies. This research will be foundational in nature and focused on knowledge development and tool creation.

Major Highlights for FY 2012

In FY 2012, NASA will continue to conduct long-term, cutting-edge research for the benefit of the broad aeronautics community. Each of the six programs within Aeronautics plays a significant role in addressing the challenge of meeting the growing capacity needs of NextGen, contributing to research and development (R&D) challenges in aviation safety, promising new flight regimes and aviation environmental impacts.

- The Aviation Safety Program (AvSP) provides knowledge, concepts, and methods to manage increasing complexity in the design and operation of vehicles and the air transportation system. This includes advanced approaches to enable improved and cost effective verification and validation of flight critical systems. AvSP provides knowledge, concepts, and methods to avoid, detect, mitigate, and recover from hazardous flight conditions and to maintain vehicle airworthiness and health. The program will investigate sources of risk and provide technology needed to help ensure safe flight in and around atmospheric hazards.

- The Airspace Systems Program (ASP) develops and explores fundamental concepts, algorithms, and technologies to increase throughput of the National Airspace System (NAS) and achieve high resource efficiency. The program transitions key technologies from the laboratory to the field by integrating surface, terminal, transitional airspace, and en route capabilities to enable operational enhancements envisioned by NextGen.

- The Fundamental Aeronautics Program (FAP) conducts fundamental research to improve aircraft performance and minimize environmental impacts, explores advanced capabilities and configurations for low boom supersonic aircraft, conducts fundamental hypersonic research to enable new capabilities, and radically improves the civil effectiveness of rotary wing vehicles by increasing speed, range, and payload while decreasing noise and emissions.

- The Integrated Systems Research Program (ISRP) conducts research on promising concepts and technologies at an integrated system level. The program explores, assesses, and demonstrates the benefits of these potential technologies in a relevant environment.

- The Aeronautics Test Program (ATP) ensures the strategic availability, accessibility, and capability of a critical suite of aeronautics ground test facilities and flight operations assets to meet Agency and national aeronautics testing needs.

- The Aeronautics Strategy and Management Program (ASMP) has been established by transferring ongoing activities from ISRP and FAP. The program will explore novel concepts and new processes in aeronautics, funds institutional expenses for the Mission Directorate, fund the ARMD portion of the Joint Planning and Development Office (JPDO) costs, and provide education and outreach opportunities for a wide variety of interested participants of all ages.

Theme Overview

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	497.0	-	569.4	569.4	569.4	569.4	569.4
Aviation Safety	74.0	-	48.5	47.8	46.7	45.4	44.0
Airspace Systems	79.0	-	70.3	69.4	67.7	65.8	63.8
Fundamental Aeronautics	199.0	-	97.2	95.9	93.6	90.9	88.2
Aeronautics Test	65.6	-	50.7	50.0	48.8	47.4	46.0
Integrated Systems Research	56.9	-	81.7	80.6	78.6	76.4	74.1
Aeronautics Strategy and Management	22.6	-	24.3	24.0	23.4	22.8	22.1
ARMD Civil Service Labor and Expenses	0.0	-	196.7	201.7	210.6	220.7	231.3

Note:

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's aeronautics research activities are well aligned with the National Aeronautics Research and Development Policy and Plan that identify national-level principles, goals, and objectives for the Nation's aeronautics R&D enterprise. This guidance was developed under the leadership of the White House Office of Science and Technology Policy, in collaboration with other Federal agencies, and in consultation with the broader aeronautics community. NASA research activities also are specifically identified as critical elements of the interagency work plan developed through JPDO to identify and assess critical research needed for NextGen. Independent reviews involving external subject matter experts and internal systems analyses shape the nature and direction of NASA's research programs to ensure the Agency remains focused on priority challenges.

Interagency coordination committees provide NASA with a collaborative framework during research program execution. Partnerships with Federal agencies such as the Federal Aviation Administration (FAA) and the Department of Defense (DOD) for activities (e.g., joint research, simulations, field trials, infrastructure management, and technology transfer) support effective alignment of research with community needs and facilitate the effective transition of research results. NASA also partners with large and small manufacturers through Space Act Agreements to conduct fundamental research, test novel new concepts and technologies, and transition advancements from the laboratory into the field.

Relevance to the NASA Mission and Strategic Goals:

Aeronautics research supports the Agency's Strategic Goal 4, to "Advance aeronautics research for societal benefit." Aeronautics work also supports NASA Strategic Goal 5, to "Enable program and institutional capabilities to conduct NASA's aeronautics and space activities," specifically objective 5.3, to "Ensure the availability to the Nation of NASA-owned strategically important test capabilities."

Relevance to education and public benefits:

NASA's aeronautics research programs provide direct and indirect benefit to the public. Fundamental research in traditional aeronautical disciplines and relevant emerging fields enable revolutionary changes which lead to a safer, more environmentally friendly, and more efficient national air transportation system to benefit the flying public. NASA research results are disseminated to the widest practicable extent to facilitate transfer of knowledge to the broader aviation community and support the evolution of the U.S. industrial base.

NASA's Aeronautics programs engage students and teachers at all levels of learning through research grants, scholarship programs, internships, design competitions, exhibits, and hands-on activities. Formal and informal educational activities are aimed at ensuring a sufficient quality and quantity of aerospace workforce to fulfill future needs of the Agency and the aerospace community. ARMD targets activities to key constituencies in different age brackets, and those activities are well integrated into the overall NASA education portfolio, including providing subject matter experts and aeronautics-related materials that are complementary to the Agency portfolio and activities. Education programs are designed for elementary through high school students and are linked to national and state standards of learning.

These programs provide an introduction to aeronautics disciplines while supporting the broader science, technology, engineering and mathematics (STEM) education goals of the Administration. Many of these programs provide curriculum and tools that can be brought into the classroom by teachers, acting as a multiplier effect for each dollar invested by NASA. NASA Research Announcements (NRAs) foster collaborative research partnerships among NASA, academia and the private sector while serving as a pipeline for innovative solutions to national challenges.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 4	**Advance aeronautics research for societal benefit.**	
Outcome 4.1	**Develop innovative solutions and advanced technologies through a balanced research portfolio to improve current and future air transportation.**	
Objective 4.1.1	**Develop advanced technologies to improve the overall safety of the future air transportation system.**	
Performance Goal 4.1.1.1	***Transfer knowledge to the aviation community to better manage safety in aviation.***	
APG 4.1.1.1: AR-12-1	Develop first generation engine icing performance degradation parametric simulation capability.	Aviation Safety
APG 4.1.1.1: AR-12-2	Provide static code analysis techniques for certification.	Aviation Safety
APG 4.1.1.1: AR-12-3	Develop concept of operations for an integrated vehicle health assurance system.	Aviation Safety
APG 4.1.1.1: AR-12-4	Demonstrate algorithm to predict at least three anomalies in massive datasets.	Aviation Safety
Objective 4.1.2	**Develop innovative solutions and technologies to meet future capacity and mobility requirements of the Next Generation Air Transportation System (NextGen).**	
Performance Goal 4.1.2.1	***HPPG: Increase efficiency and throughput of aircraft operations during arrival phase of flight.***	
APG 4.1.2.1: AR-12-5	Develop Initial Weather Translation Models.	Airspace Systems
APG 4.1.2.1: AR-12-6	Demonstrate safe Interval Management Procedures to a Single Airport with dependent parallel runways.	Airspace Systems
APG 4.1.2.1: AR-12-7	NASA will provide the results of the human-in-the-loop (HITL) simulations and the field trial to the Federal Aviation Administration (FAA) as they are completed, with the final report being provided in September 2012. (HPPG milestone)	Airspace Systems
Objective 4.1.3	**Develop tools, technologies, and knowledge that enable significantly improved performance and new capabilities for future air vehicles.**	
Performance Goal 4.1.3.1	***Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components that overcome national performance and capability challenges.***	
APG 4.1.3.1: AR-12-10	Validate the effectiveness of Micro-array Flow Control devices for improving performance and flow quality in low-boom supersonic propulsion inlets.	Fundamental Aeronautics
APG 4.1.3.1: AR-12-11	Demonstrate First Generation Integrated Multidisciplinary Simulation Tool for Analysis and Design of Reusable Air-Breathing Launch Vehicles.	Fundamental Aeronautics
APG 4.1.3.1: AR-12-8	Characterize gaseous and particulate emissions of hydro treated renewable jet fuel as a potential carbon dioxide (CO_2) neutral aviation fuel.	Fundamental Aeronautics
APG 4.1.3.1: AR-12-9	Demonstrate drag reduction benefits of active flow control for a representative rotorcraft fuselage configuration.	Fundamental Aeronautics

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Outcome 4.2	**Conduct systems-level research on innovative and promising aeronautics concepts and technologies to demonstrate integrated capabilities and benefits in a relevant flight and/or ground environment.**	
Objective 4.2.1	**Develop advanced tools and technologies that reduce the technical risk associated with system-level integration of promising aeronautical concepts.**	
Performance Goal 4.2.1.1	***Reduce technical risk by conducting research at an integrated system-level on promising aeronautical concepts and technologies in a relevant environment.***	
APG 4.2.1.1: AR-12-12	Demonstrate low-weight, damage-tolerant stitched composite structural concept on curved panel subjected to combined tension and internal pressure loads.	Integrated Systems Research
APG 4.2.1.1: AR-12-13	Develop integrated Human Systems Integration, Communications, and Separation Assurance subproject test concept and Phase 2 test objectives necessary to achieve human-in-the-loop simulation and flight test series milestones supporting the Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project.	Integrated Systems Research
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**	
Outcome 5.3	**Ensure the availability to the Nation of NASA-owned, strategically important test capabilities.**	
Objective 5.3.2	**Ensure that Aeronautics Test Program (ATP) facilities are available and capable of supporting research, development, test and engineering goals and objectives for NASA and national aerospace programs.**	
Performance Goal 5.3.2.1	***Ensure that testing capabilities are available in order to support the research, development, test, and engineering milestones of NASA and Department of Defense (DoD) programs.***	
APG 5.3.2.1: AR-12-14	Achieve ratings greater than 86 percent for overall quality and timeliness of Aeronautics Test Program (ATP) facility operations.	Aeronautics Test

Uniform and Efficiency Measures:

Measure #	Description
Aeronautics Theme	
APG EFF: AR-12-16	Deliver at least 86 percent of on-time availability for operations and research facilities.

Performance Achievement Highlights:

ASP partnered with FAA, Sensis, Boeing, United Airlines, and Continental Airlines to conduct joint simulations of continuous descent approaches in a congested environment with time based metering at the Denver Air Route Traffic Control Center. Using the Efficient Descent Advisor (EDA) decision support tool, the controllers enabled reduced fuel and noise operations through efficient descent procedures under heavy traffic conditions. The results of this simulation will guide the development of the EDA Technology Transition Document for delivery to the FAA in support of investment decisions.

AvSP published guidelines on automation, displays, and alerting technologies for use by designers of future aircraft cockpits, which are needed by the aviation community to safely meet NextGen operational needs. These guidelines are based on data collected via human-in-the-loop studies with real flight crews in simulations of the higher traffic densities and the operation environment of NextGen. By providing these results to industry-wide and FAA-sponsored technical committees, NASA contributes to authorized operational requirements and certification standards for new technologies and procedures.

FAP made progress toward enabling technologies that address many challenges for commercial aircraft with entry-into-service in the 2030-2035 timeframe (N+3). The program worked with industry and academia to explore revolutionary aircraft solutions to address energy efficiency, environmental compatibility, operations and determine high-payoff technologies and research opportunities to enable these solutions. Pivotal analyses resulting from the N+3 Concept Studies will be used to guide NASA's long-term technology investments for future green aviation air vehicles. Important insight was gained in critical technologies including flow control, light-weight and higher temperature materials, and aeroelastic structures that are broadly applicable to commercial aircraft.

ATP developed an ice generation system for the Propulsion Systems Laboratory (PSL) at Glenn Research Center. This system is capable of replicating high-altitude ice crystal ingestion phenomena and will enable testing to help researchers understand conditions associated with in-flight, ice crystal ingestion and accumulation in commercial jet engines at high altitude cruise conditions. Results included the first-ever demonstration of ice crystal generation under conditions that replicate high-altitude cruise conditions. This facility improvement addresses one of the 12 critical shortfalls identified in the National Infrastructure Plan.

ISRP completed the first phase of flight tests on the low speed X-48B Blended Wing Body (BWB) aircraft at the Dryden Flight Research Center. The X-48B is a 500 pound, 8.5 percent-scale aircraft of a potential, full-scale BWB type aircraft that has the silhouette of a manta ray. The vehicle is remotely piloted and enables NASA to assess and validate this advanced vehicle concept as well as key technologies. The 80 flights completed in Phase I provided insight into the handling and flying qualities of such an aircraft at speeds typical of landings and takeoffs.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert	10/2008	An assessment of NASA's aeronautics research portfolio was performed by the National Research Council to determine how NASA is addressing the research challenges identified in the decadal survey of civil aeronautics. It found that NASA is addressing most of the 51 challenge areas but noted concerns about the lack of research in several areas, including unmanned aircraft systems (UAS) integration in the NAS. NASA is addressing this issue with the new UAS Integration in the NAS project.	N/A

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**74.0**	**-**	**48.5**	**47.8**	**46.7**	**45.4**	**44.0**
Aviation Safety	74.0	-	48.5	47.8	46.7	45.4	44.0

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Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Program Overview

AvSP performs research and develops advanced technologies to improve the overall safety of the future air transportation system.

The current U.S. air transportation system is widely recognized as among the safest in the world. Over the past 10 years, the commercial accident rate has continued to drop, a credit to industry and government working together to solve problems and proactively identify new risks. However, the demand for air traffic is expected to continue to increase substantially in the next 15 to 20 years, and while NextGen will meet this demand by making passage through the increasingly crowded skies efficient and speedy, it will come with increased reliance on automation and increased operating complexity. Therefore, the vigilance of the aviation community must continue in order for the United States to meet the public expectations for safety in this complex, dynamic domain. To meet the challenge, AvSP develops cutting-edge technologies to improve the intrinsic safety of current and future aircraft that will operate in NextGen. AvSP's contributions range from providing fundamental research and technologies on known or emerging safety concerns, to working with partners in developing new capabilities for NextGen.

AvSP transfers knowledge and technology to the aviation community for both hardware and software systems. The program increases capabilities to predict and prevent safety issues by developing capabilities to monitor for safety issues and minimize them should they occur; designing safety issues out of complex systems and system behaviors; and analyzing designs and operational data for potential hazards. One objective of the program is to assure system wide safety. To that end, AvSP is pursuing methods and tools to overcome the challenges in verifying and validating that new, complex NextGen systems meet the extremely high levels of safety required. AvSP is also developing methods for discovery of safety issues via data mining, and further developing human performance models to be applied in the design of automation.

Another objective is to advance the state-of-the-art of aircraft safety in key areas. Thus, AvSP is developing ways to maintain and ensure vehicle health and airworthiness, crew-system interaction concepts that provide situational awareness and sound decision making, and methods to detect, avoid and protect against loss-of-control events. A final objective is to address the inherent presence of atmospheric risks (e.g., in-flight icing and other atmospheric effects), accomplished by investigating their sources and providing technologies so that those hazards do not compromise flight safety.

AvSP has developed research plans with milestones and metrics in three technology areas. All areas emphasize proactive methods and technologies and utilize a systems analysis approach for identifying key issues and maintaining a portfolio of activities leading to potential solutions to the issues. To improve its processes to define program goals, prioritize the research portfolio, and maintain close coordination with external agencies, as identified in the findings of the National Research Council's "Advancing Aeronautical Safety" study, AvSP will actively work with the NASA Advisory Committee's (NAC's) Aeronautics Committee and through the annual program review process to review and assess relevance of goals. AvSP will also fully participate in the Mission Directorate's strategic assessment activities to analyze and prioritize future investments across all programs, which will augment AvSP's own systems studies to help prioritization of program investment. AvSP will strengthen coordination with external agencies through more active participation in JPDO, Commercial Aviation Safety Team (CAST), RTCA, Inc., and others in addition to on-going coordination.

Fore more information, please see http://www.aeronautics.nasa.gov/programs_avsafe.htm.

Plans For FY 2012

Highlighted below are key goals for FY 2012.

- AvSP will demonstrate static code analysis techniques for use by software developers and equipment manufacturers to assist in the certification of software. The program will deliver a prototype static analyzer which produces less than 10 percent false positives, publish the algorithms, and submit results in peer-reviewed conferences or journals.

- The program will develop a concept of operations for an integrated vehicle health assurance system. During FY 2012, the program will develop, document, and provide to the aviation user community, an integrated system concept for vehicle health assurance that fully integrates ground-based inspection and repair information with in-flight measurement data for airframe, propulsion, and avionics subsystems.

- AvSP will develop a first-generation engine icing performance degradation parametric simulation capability. In FY 2012, the program will develop an engine system modeling code with simulated ice blockages effects and evaluate its predictive capability of engine performance with anticipated blockage effects due to accretion at assumed altitudes. In addition, the program will check out instruments for scientifically confirming the envelope of high-altitude ice crystal conditions and conduct initial calibration of one-of-a-kind ground test capability. AvSP will also develop a standardized lightning test procedure to support the future development of improved composite protection methods.

- AvSP will incorporate the National Research Council's "Advancing Aeronautical Safety" findings related to program goal definition, internal prioritization, and external coordination with other agencies to continue to strive for continued excellence and improved efficiency in aviation safety research.

Project Descriptions and Explanation of Changes

System-Wide Safety and Assurance Technologies

The goal of system-wide safety and assurance technologies research is to provide knowledge, concepts and methods to proactively manage increasing complexity in the design and operation of vehicles in the air transportation system. To meet this goal, the following challenges are being addressed through 2016:

- Safely incorporating technological advances in avionics, software, automation, and concepts of operation by developing verification and validation tools for manufacturers and certifiers to use to assure flight critical systems are safe in a rigorous and cost- and time-effective manner;

- Understanding and predicting system-wide safety concerns of the airspace system and vehicles by developing technologies that can use vehicle and system data to accurately identify precursors to potential incidents or accidents;

- Predicting the life of complex systems by developing technologies that can reason under uncertainty about root causes, predict faults and remaining useful life across multiple systems, and aid decision making across multiple systems; and

- Improving operator effectiveness within aviation systems by developing understanding of human performance key parameters that mediate human contributions to safety in aviation.

Vehicle Systems Safety Technologies

The goal of vehicle systems safety technologies research is to identify risks and provide knowledge needed to avoid, detect, mitigate, and recover from hazardous flight conditions, and to maintain vehicle airworthiness and health. To meet this goal, the following challenges are being addressed through 2016:

- Assessing the health of aircraft at the material, component, and subsystem level more efficiently and effectively by developing health-management tools and systems to determine, predict, mitigate, and manage the state of degradation for current and future airframe, propulsion, and avionics subsystems;

- Addressing loss-of-control events that may be induced by unintended entry into unusual flight conditions, response to on-board failures, and/or environmental hazards. NASA will develop, assess, and validate methods for avoiding, detecting and resolving conditions that can lead to loss-of-control in current and future vehicle operations; and

- Appropriate operator situational awareness in off-nominal situations (including on the ground) by developing tools and concepts for future flight deck designs that promote effective human-automation interaction and error recovery.

Atmospheric Environment Safety Technologies

The goal of atmospheric environment safety technologies research is to investigate sources of risk and provide technology needed to help ensure safe flight in and around atmospheric hazards. To meet this goal, the following challenges are being addressed through 2016:

- Addressing the atmospheric hazard of in-flight icing, of both engine and airframe, in cooperation with the icing community to characterize the various icing environments, develop remote sensors to detect conditions, understand and model the effects of ice accretion, and support the development of methods to mitigate the conditions; and

- Sensing and mitigating other risks associated with other atmospheric hazards that pose serious threats to aviation.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
In 2014, develop simulation capabilities, tools, and test methods that improve understanding of engine performance under high ice-crystal water content conditions.	Aviation Safety	Updated to reflect program restructure
In 2016, identify and develop tools, methods, and technologies for improving overall aircraft safety of new and legacy vehicles operating in the NextGen.	Aviation Safety	No change

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aviation Safety

Program Management

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD and NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aviation Safety	Program Director	ARC, DFRC, GRC, LaRC	A&P Technology, Alcoa Technical Center, ANSYS, Boeing, Cal Poly Corp, CAST (Commercial Aviation Safety Team), Cessna Aircraft Co., DOD, DLR (Deutsches Zentrum für Luft- und Raumfahrt), easyJet, Environment Canada, ExpressJet, FAA, General Electric Aircraft Engines, Goodrich, Honeywell, INTA (Instituto Nacional de Técnica Aerospacial), JPDO, Luna Innovations, Moog, NLR (National Aerospace Laboratory of the Netherlands), National Oceanic and Atmospheric Administration, NRCC (National Research Council Canada), New Mexico State University, ONERA, Siemens, United Technologies Corp., University of Nebraska, Wichita State University

Acquisition Strategy

AvSP spans research and technology from foundational research to integrated system-level capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NRA is used as the means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. AvSP awards grants, contracts, and cooperative agreements, including renewals of multi-year awards with industry, academia, and non-profit institutions. These awards also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions. The program also utilizes partnerships with cost sharing and in-kind contributions to gain access to system-level research and integration opportunities.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2010	The 12-month review is a formal independent peer review. Experts from other Government agencies report on their assessment of technical and programmatic risk and/or program weaknesses. In the FY 2010 review, the independent review panel rated AvSP as "Very Good" overall.	11/2011
Relevance	National Research Council	7/2010	To assess if AvSP has appropriate research objectives; is coordinated with the FAA and other federal safety programs; has appropriate resources for each objective; and has mechanisms for transitioning program results in a timely manner. Findings show AvSP continues to contribute to aviation safety, but the processes for choosing, prioritizing, and coordination of its areas of research need improvement. Recommendations were incorporated into the reorganized program.	N/A

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

FY 2012 Budget Request

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Airspace Systems	79.0	-	70.3	69.4	67.7	65.8	63.8

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Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Program Overview

Increasing the capacity and efficiency of the air transportation system in a manner that has minimal impact on the environment or aviation safety is critically important to the Nation's economic well being. More than half of the Nation's busiest airports are already at capacity or are expected to reach capacity limits in the next 10 to 20 years. Creating new capacity en route or on the airport surface is extraordinarily expensive and can take decades to complete, particularly when environmental constraints and safe aircraft separation standards are at issue.

Despite capacity constraints, air traffic is expected to continue to increase substantially over the next twenty years. The associated environmental impact and economic inefficiencies have been predicted to cost the Nation tens of billions of dollars annually. The risk of accidents caused by aircraft coming too close to one another, during airborne or ground operations, could increase as the volume of air traffic exceeds the capacity of the airspace and airports to safely and efficiently accommodate the increased growth.

ASP, in collaboration with other member agencies of JPDO, directly addresses the air traffic management research needs of NextGen. NASA collaborates with other Government agencies, industry, and academic partners to bring the best and the brightest talent and ideas to address the technical challenges and improve technology transfer to the users of its research products.

These new technologies will allow significant increases in capacity, efficiency, and flexibility of the NAS and support the guidelines in the National Aeronautics Research and Development Policy and Plan. These advanced concepts and technologies will determine future roles and responsibilities for air traffic management functions performed by humans and automation in the aircraft and on the ground. The concepts will reduce delays caused by adverse weather. The research will reduce noise, emissions, fuel consumption, and delays through automation, which will provide the most optimum aircraft flight paths and non-stop taxiing. In addition, system safety will be enhanced on the ground through automated aircraft based runway/taxiway collision avoidance and in the air through automated signaling and recommendations for avoidance of conditions in which aircraft come too close to one another and compromise safety. Furthermore, the research will enable the seamless operation and utilization of the full potential capabilities of new aircraft types such as advance rotorcraft, UAS, supersonic aircraft, and hybrid wing body.

For more information, please see http://www.aeronautics.nasa.gov/programs_asp.htm.

Plans For FY 2012

ASP conducts NextGen concepts and technology development, and the corresponding systems analysis, integration, and evaluation.

NextGen concept and technology development research focuses on developing capabilities in traffic flow management, dynamic airspace configuration, separation assurance, super density operations, and airport surface operations. Key aspects include optimization for traffic scheduling and route planning, and balanced allocation of resources to maximize airspace productivity in response to arrival, departure, and surface traffic demands. Selected off-nominal situations (e.g., weather impacts) will be studied. Technical concepts included in this activity are continuous descents, runway balancing, precision terminal area scheduling and control, surface optimization, efficient flow management, and merging and spacing. In FY 2012, ASP will develop initial weather translation models for incorporation in traffic flow management decision support tools to better manage the weather-impacted traffic capacity.

NextGen systems analysis, integration, and evaluation will focus on transitioning key systems concepts from the laboratory to the field. The NextGen concept and technology development area will provide operational benefits and demonstrate these integrated capabilities in relevant flight environments. Through systems analysis, key concepts will be down-selected based on their potential benefit to improve operational efficiency and then matured and tested in laboratory simulations to determine their technical viability. A subset of these integrated concepts will be further demonstrated and evaluated through field tests integrating both air and ground capabilities. Coordination with the FAA, JPDO, and Research Transition Teams (RTT) will ensure transition of NASA concepts, technologies, and procedures to the field to enable transition of today's air transportation system to NextGen. In FY 2012, ASP will evaluate interval management procedures that enable aircraft to self-manage arrival merging and spacing to a single airport with dependent parallel runways.

Both research areas described above contribute to the Agency's High Priority Performance Goal to increase efficiency and throughput of aircraft operations during arrival phase of flight. In FY 2012, ASP will deliver the EDA technology transition documentation to FAA. The EDA prototype supports real-time decision making by presenting speed and path adjustment advisories to air traffic controllers. EDA helps save hundreds of pounds of fuel and carbon dioxide emissions per participating flight, while reducing noise over surrounding communities by selecting optimal descent speeds and paths for arriving aircraft under heavy traffic conditions. EDA is a key component of FAA's 3D-Path Arrival Management Program and NextGen. The primary mechanism for transfer is the NASA-FAA RTT.

Acceleration of air traffic management technology transition through advanced development and demonstrations has been identified as key to meeting the Nation's air transportation needs by the National Aeronautics R&D Plan, NextGen Integrated Work Plan, and other Federal stakeholders. In FY 2012, ASP will initiate an industry and government collaborative effort to further advance greater utilization of Automatic Dependent Surveillance-Broadcast application technologies. The target opportunity will involve integration of technologies from ASP's current portfolio to provide optimization of airport surface movements with precise scheduling to reduce both surface and en-route traffic delays. Candidate technologies will be vetted through discussion of system benefit potential with airspace users. Focus of the work will be maintained on delivering validated operational improvements employing low-cost, simple, short-term, high-fidelity simulations and field trials.

Project Descriptions and Explanation of Changes

NextGen Concepts and Technology Development

Researchers of NextGen concepts and technology develop and explore fundamental concepts that address the optimal allocation of ground and air automation technologies necessary for NextGen. Research in ASP addresses four-dimensional trajectory operations from strategic planning stages to separation assurance, including advances in the science and applications of multi-aircraft trajectory optimization that takes into account weather information and forecast uncertainties across the spectrum of time horizons. The program also conducts research to explore dynamic airspace configuration that addresses the technical challenges of migrating from the current structured, static homogenous airspace to a dynamic, heterogeneous airspace that adapts to user demands and meets changing constraints of weather, traffic congestion, and a highly diverse aircraft fleet. Ultimately, the roles and responsibilities of humans and automation influence every technical area and will be addressed thoroughly. The program responds to the need to achieve the maximum possible productivity in the combined use of gates, taxiways, runways, terminal airspace, and other airportal resources. Specific technical goals include:

- Increasing capacity through dynamic allocation of airspace structure and controller resources;
- Effectively allocating demand through departure-time management, route modification, adaptive speed control, etc., in the presence of uncertainty;
- Developing algorithms, automation prototypes, and procedures that relieve the capacity constraints imposed by human-controlled separation of aircraft in transition and cruise airspace;
- Quantifying the performance-enhancing effects of emerging airborne technologies;
- Optimizing airport surface traffic operations to enable capacity enhancements;
- Maximizing the capacity of individual runways and multiple runways with airspace and taxi interactions (i.e., closely-spaced parallel and converging or intersecting runways);
- Minimizing runway incursion threats in all weather conditions; and
- Balancing arrival and departure traffic management to enable capacity improvements.

NextGen Systems Analysis, Integration, and Evaluation

The high-level goal of the NextGen systems analysis, integration, and evaluation research is to identify, mature, and test key concepts and technologies based on their potential benefit towards increasing system efficiency. To accomplish this goal, the following technical objectives will be satisfied:

- Define operational issues, factors, and concerns that must be considered in conducting system analysis;
- Assess collective impact of mature technologies using fast-time modeling and simulation and feed back results into the baseline program to enhance and validate research concepts;
- Examine the feasibility of the integrated concepts and technologies using human performance models and human-in-the-loop simulations;
- Demonstrate the impact of the integrated concepts and technologies using field trials;
- Assess alternate fleet implications on trajectory-based operations;
- Collaborate with industry and Government partners to transition technologies that enable increases in capacity and efficiency, while maintaining safety and environmental conditions; and
- Integrate technologies from the current portfolio to further advance greater utilization of Automatic Dependent Surveillance-Broadcast (ADS-B) application technologies, thus providing optimization of airport surface movements with precise scheduling to reduce surface and en-route traffic delays and enhance safety.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Airspace Systems

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
In 2013, develop conflict alert capability for terminal operations to increase throughput and safety.	Airspace Systems	No change
In 2015, define allocation of air traffic control functions between air- and ground-based on human-in-the-loop (HITL) simulation studies involving nominal and off-nominal scenarios.	Airspace Systems	No change
In 2017, complete integrated testing involving ground-based scheduling and flight deck merging and spacing.	Airspace Systems	No change

Program Management

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD and NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Airspace Systems	Program Director	ARC, LARC	FAA, JPDO, DOT, Air Force Research Lab (AFRL)

Acquisition Strategy

ASP spans research and technology from foundational research to integrated system capabilities. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NRA is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. ASP awards grants, contracts, and cooperative agreements, primarily with industry, academia, and non-profit institutions. These awards also help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions. The program also utilizes partnerships with cost sharing and in-kind contributions to gain access to system-level research and integration opportunities.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2010	The 12-month review is a formal independent peer review. Experts from other Government agencies report on their assessment of technical and programmatic risk and/or program weaknesses. In the FY 2010 review, the independent review panel rated ASP as "Excellent/Very Good" overall.	11/2011

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Fundamental Aeronautics

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**199.0**	**-**	**97.2**	**95.9**	**93.6**	**90.9**	**88.2**
Fundamental Aeronautics	199.0	-	97.2	95.9	93.6	90.9	88.2

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

FAP develops new aircraft that will fly faster, cleaner, and quieter, and use fuel far more efficiently as the Nation transitions to a more modernized air transportation system. FAP research affects all flight regimes, addressing:

- Public concern over noise and emissions;
- The sustainability of affordable air travel given the fluctuating cost and availability of jet fuel; and
- Requirements for increasing mobility even as the NAS grows more crowded.

FAP conducts research in four specific flight regimes.

- The two subsonic regimes address advanced fixed wing and subsonic rotary wing (SRW) aircraft.

Subsonic fixed wing (SFW) research focuses on new aircraft configurations, advanced propulsion systems, and enabling technologies to dramatically reduce noise, emissions, and fuel burn. Subsonic rotary wing research targets speed and range increases, payload capacity, noise reduction, and propulsive efficiency. Envisioned future rotorcraft will enable further increases in moving people and goods through the national airspace system. In both cases, subsonic and rotorcraft vehicles will be dramatically quieter and will fly very efficiently, burning far less fuel.

- A third flight regime is supersonics. Technologies to meet the environmental challenges specifically associated with faster-than-sound flight, such as sonic boom and emissions, are addressed by FAP's supersonics research. Elimination of such barriers would enable routine overland commercial supersonic flight.

In addition, FAP is creating and maturing technology approaches to 21st century supersonic commercial airplanes. Their introduction into service could one day reduce domestic and international flight times dramatically, with environmental impacts on par with other aircraft.

- A fourth flight regime is hypersonics. Hypersonics research focuses on long-range, fundamental research to enable very high speed air-breathing vehicles. New hypersonics approaches could ultimately enable rapid transoceanic and transcontinental flight, with improved reliability for lower-cost and more routine access to space, and result in new technologies that enable high-mass entry into atmospheres.

FAP research also includes the creation and maturation of tools and technologies to enable hypersonic vehicles. Their development may one day make air-breathing access to space possible, while simultaneously enabling entry and descent into a variety of planetary atmospheres.

Ultimately, FAP research enables a future in which a variety of advanced vehicles improve the flexibility, efficiency, and environmental impacts of the air transportation system. The program is dedicated to developing the tools, technologies, and scientific knowledge needed to design novel air vehicles that do not exist today.

For more information, please see http://www.aeronautics.nasa.gov/fap.

Plans For FY 2012

Plans for the study of the four fundamental aeronautics flight regimes include:

- SFW research will focus on multidisciplinary analysis of technologies and toolsets needed to achieve reductions in noise and emissions along with significant improvements in efficiency. Essential to this research will be improvements in prediction tools and new experimental methods that provide fundamental physics data/properties and establish validation data and identification of key driving technologies (including advanced materials and aerodynamics predictions). SFW research will characterize gaseous and particulate emissions of alternatives to current jet fuel that will aid reducing the carbon dioxide contribution from air transportation, including preparations for future flight tests with alternative fuels. SFW research will also demonstrate the application of a system-level, multi-fidelity, multidisciplinary analysis/optimization framework for conventional and unconventional subsonic transport vehicles, which is important for creating a design capability for truly revolutionary configurations.

- SRW research will result in demonstrating new technologies to enable high-speed, efficient rotorcraft. Capitalizing on new facilities and hardware investments, SRW will demonstrate concepts for variable speed transmissions on small- to mid-scale test articles. These concepts will enable efficient operation over a wide speed range for the engine and transmission system, as variable rotor speed has been identified as a critical technology for high-speed rotorcraft configurations. In addition, the project will prepare the tiltrotor test rig for use in advance research in large, advanced tiltrotor configurations. The goals of advancing technologies leading to high-speed rotorcraft will be accomplished through improvement of design and analysis tools and validation of those tools with unique data obtained in NASA and partner facilities. In FY 2012, an area of focus will be to improve the understanding of drag reduction benefits of active flow control technologies, which can make a variety of rotorcraft vehicles more efficient.

- Supersonics research will complete data analysis and reporting for a large-scale wind tunnel test of a propulsion system inlet design that incorporates low boom design features and employs flow control devices to improve performance and efficiency. The analysis will include comparisons of experimental data with computational fluid dynamics (CFD) data. These data, and the technology concepts embodied in the test model, will enable the design of future supersonic propulsion systems that are an essential part of a highly integrated aircraft that meets the efficiency and environmental goals for a new generation of civil supersonic transports. The project will also complete the first phases of experimental computational code validations and technologies for designing the eternal shape of aircraft concepts that produce very low sonic boom noise and high cruise efficiency. The experimental and analytical assessments will involve wind tunnel to CFD comparisons for full configuration geometries. The project will also conduct research on advanced high temperature materials that enable better performance in future supersonic and subsonic aircraft.

- Hypersonics research will enable more accurate CFD predictions of ramjet-to-scramjet mode transition and will validate these predictions by comparisons with wind tunnel and/or flight data. The ability to accurately predict scramjet performance under mode-transition fueling levels is a key enabler for the design of efficient hypersonic air-breathing propulsion systems. This CFD assessment activity will validate and verify the accuracy of propulsion CFD codes. Additionally, the first generation multidisciplinary integrated design and engineering analysis tool suite will achieve operational status, and will be validated on the NASA air-breathing two-stage-to-orbit reference vehicle.

Project Descriptions and Explanation of Changes

Subsonic Fixed Wing (SFW)

SFW research enables advances to future generations of fixed wing vehicles, with primary focus on "N+3" vehicles (i.e., three generations beyond current state-of-the-art aircraft), which will require mature technology by FY 2030. Because enhanced N+3 performance requires significantly improved energy efficiency to reduce fuel burn and improve operational technologies, progress in this area holds the promise of emissions reduction not just in the long term, but within the coming decade.

SFW provides technologies, novel test methods, and validated prediction tools to improve system trades for advanced concepts capable of meeting longer-term noise, emissions and performance targets. For example: FAP's SFW alternative-fuels research is focusing on characterization of synthetic fuels and biofuels in order to understand their impact on engine combustor design, performance, and emissions.

SFW continues to pursue the following goals:

- Improve prediction tools and new experimental methods to understand fundamental properties and establish validation data;

- Develop noise-prediction and noise-reduction technologies for airframe and propulsion systems that will enable up to -71 decibel (dB) cumulative, below Stage 4, which is a limit imposed by the International Civil Aviation Organization on the maximum allowable noise levels for current aircraft;

- Devise emissions-reduction technologies and prediction tools to achieve a 70+ percent reduction in landing and take-off nitrogen oxide levels-- below the "sixth state" of regulation recommended by the Committee on Aviation Environmental Protection;

- Improve vehicle performance through design and development of lightweight, multifunctional and durable structural components, low-drag aerodynamic components, advanced aircraft configurations, and higher bypass ratio engines with efficient power plants in order to enable a fuel burn reduction of more than 70 percent as compared to today's state-of-the-art commercial subsonic transport; and

- Create multidisciplinary design and analysis tools and processes to enable design of advanced aircraft configurations with a greater degree of confidence.

Subsonic Rotary Wing (SRW)

Each of the two broad classes of rotary wing vehicles has factors that limit their respective cruise speeds. The primary limiting factor for the cruise speed of helicopter configurations has been the dynamic stall encountered on the retreating side of the rotor as the forward speed is increased. The limiting factor for the cruise speed of tiltrotors has been prop-rotor efficiency, as designs typically trade cruise efficiency for hover performance, with a prop-rotor speed reduction of nominally 15 percent from hover to cruise in current vehicles.

SRW research will enable improved prediction methods and technologies for increasing cruise speed, range, and payload while decreasing noise and emissions of rotary wing aircraft. FAP has set aggressive goals to develop technologies that enable high-speed, efficient rotorcraft of various sizes and configurations to be viable commercial vehicles operating in the national airspace.

SRW research includes the following goals:

- Make rotorcraft competitive with fixed wing aircraft for short- and medium-range missions by enabling variable-speed rotor concepts that incorporate the ability to change rotor rotational speed by 50 percent, while retaining propulsion efficiency to enable optimum rotor aerodynamic performance in both hover and higher forward flight speeds;

- Contain external noise within the landing area, reduce internal noise to less than 77 dB, and develop scenarios for low-noise rotorcraft flight operations;

- Assess multiple active rotorcraft concepts for effectiveness in simultaneously increasing aerodynamic efficiency, controlling dynamic stall control for high-speed conditions, reducing vibration, and reducing noise. The goal for high speed is to increase the state-of-the-art cruise speed for any rotary wing configuration by 100 knots while maintaining low-vibration and low-noise characteristics;

- Advance technologies such as crashworthiness, safe operations in icing conditions, and condition-based maintenance methodologies to ensure that rotary wing vehicles remain viable commercial transport concepts; and

- Develop the next generation of rotorcraft analysis and design tools based on first-principles modeling rather than empirical methods. The objective is to ensure design tools are accurate for any configuration, that they can be used on any hardware platform, and that they are scalable to the future of parallel computing developments. This will reduce design cycle cost while increasing confidence in new-design performance.

Supersonics

The Supersonics project will develop improved prediction methods and technologies to enable the elimination of barriers that today prevent practical, commercial supersonic flight. NASA's supersonics research is organized along the following major technical challenges:

- Efficiency: Supersonic cruise, light weight, and durability at high temperature;

- Environment: Airport noise, sonic boom and high-altitude emissions;

- Performance: Aero-propulso-servo-elastic analysis and design, and cruise lift/drag ratio; and

- Multidisciplinary design, analysis and optimization.

The project's focus is to mature the technologies necessary to enable overland supersonic cruise for civilian applications with minimal environmental impact from sonic boom, airport noise, and high-altitude emissions. NASA's supersonics research should result in:

- Airframe and propulsion-system cruise-efficiency improvements that will increase the range factor (miles/lb of fuel consumed) to 30 percent higher than "best achieved" in low-sonic-boom designs made during NASA's High-Speed Research Program;

- Reductions of propulsion-system noise to a level of 10 to 15 dB effective perceived noise, below that of aircraft certified to Federal Aviation Regulations Part 36 Stage 3 noise standards;

- A reduction of loudness to a level of 65-70 dB perceived loudness for small supersonic aircraft; and

- Minimization of impact from high-altitude emissions.

Hypersonics

The scope of the hypersonics research project has been reduced and will focus on foundational hypersonic research areas where NASA supports unique core competencies and technologies. The revised portfolio is directly responsive to the National Aeronautics Research and Development Plan goal for demonstrating sustained, controlled hypersonic flight. NASA will retain key elements of the portfolio for expanding the foundational knowledge of air breathing propulsion systems and re-entry system technologies that are enabling for future NASA and commercial systems. NASA's hypersonics research is motivated by the reality that all access to Earth or planetary orbit, and all entry from orbit into any atmosphere, requires sustained, controlled flight through the hypersonic regime. NASA's Hypersonics project is addressing the technical challenges for two high-payoff technology areas: Hypersonic Air-breathing Vehicle Technologies (HAVT) and Entry, Descent and Landing Technologies (EDLT). Cutting-edge hypersonics research on HAVT will enable sustained, air-breathing, powered hypersonic flight through the atmosphere for space access or other applications. HAVT research will enable new air-breathing launch vehicles such as two-stage-to-orbit systems to eventually provide more routine low-cost access to space. The research focused on EDLT will result in the development of foundational tools and knowledge that enable significant improvements in performance of future re-entry systems.

The FAP will focus its hypersonics research on addressing that speed regime's most difficult technological challenges, including:

- The development of accurate predictive tools and models for high-speed compressible flow including turbulence, heating, ablation, combustion, and their interactions in order to reduce the uncertainty in predictions of aerodynamic heat loads during the design of hypersonic vehicles. This improved knowledge and predictive capability will result in lower vehicle weight due to reduced design margins for thermal structures and thermal protection systems;

- Knowledge and tools to enable air-breathing propulsion systems that operate efficiently over a very wide speed range and that can be scaled up from the current state of the art; and

- The development of materials and structures for applications that can withstand the severe temperatures encountered in hypersonic flight for extended periods of time.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
In 2017, integrate higher fidelity hypersonic discipline design tools to reduce design time and increase design space.	Fundamental Aeronautics	Updated to reflect restructured hypersonics research
In 2018, validate advanced cabin noise-reducing concepts for large, advanced rotorcraft.	Fundamental Aeronautics	No change
In 2018, demonstrate tools and technologies to reduce sonic boom to levels that allow supersonic flight over land and accurately assess the impact of sonic boom on community populations.	Fundamental Aeronautics	No change
In 2020, demonstrate through analysis and component testing technologies that enable a 50 percent fuel burn reduction and 50 percent CO2 emissions reduction for fixed wing aircraft.	Fundamental Aeronautics	No change

Program Management

The ARMD Associate Administrator has oversight responsibility for the FAP. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD or NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Fundamental Aeronautics	Program Director	ARC, DFRC, GRC, and LaRC	Air Force Research Lab (AFRL), Boeing, Pratt & Whitney, Northrop Grumman, General Electric Aviation, Gulfstream Aerospace, United Technologies Corporation, Office of the Secretary of Defense, U.S. Army, U.S. Air Force, Center for Rotorcraft Innovation (CRI), Bell Helicopter, Sikorsky, Boeing, DARPA, FAA, ONERA, JAXA, DLR, Lockheed martin, Aerion Corporation, U.S. Air Force Office of Scientific Research (AFOSR), and U.S. Navy.

Acquisition Strategy

Acquisitions within FAP provide the basic elements for fundamental research, tools and methods development, enabling technologies, and validation and verification of research results. This broad spectrum necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NRA is used as the primary means to solicit innovative proposals in key research areas that compliment NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. FAP awards grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards also help to strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions. The program also utilizes partnerships with cost sharing and in-kind contributions to gain access to system-level research and integration opportunities.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Expert Review	11/2010	The 12-month review is a formal independent peer review of the program. Experts from other Government agencies will report on their assessment of technical and programmatic risk and/or program weaknesses. Their recommendations will be received in a timely fashion and a response will be developed no later than six months after the review.	11/2011

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**65.6**	**-**	**50.7**	**50.0**	**48.8**	**47.4**	**46.0**
Aeronautics Test	65.6	-	50.7	50.0	48.8	47.4	46.0

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test

Program Overview

U.S. leadership in aerospace depends on ready access to technologically advanced, efficient, and affordable aeronautics test capabilities. These capabilities include major wind tunnels, propulsion test facilities and flight test assets. The Federal Government owns the majority of these critical test capabilities in the United States, primarily through NASA and DOD. However, changes in the aerospace landscape (primarily the decrease in demand for testing over the last two decades) required an overarching strategy for the management of these national assets. In response, NASA established ATP as a two-pronged strategic initiative to: retain and invest in NASA aeronautics test capabilities considered strategically important to the Agency and the Nation, and establish a strong, high-level partnership to expand cooperation between NASA and DOD, facilitating the establishment of an integrated national strategy for the management their respective facilities. The national view or coordinated approach is becoming more important, specifically in addressing the challenges NASA and the Nation are facing, in terms of managing and evolving this large critical set of capabilities in a changing and increasingly demanding environment.

ATP facilities that comprise this set of critical capabilities are geographically dispersed across the United States. They are located at the Ames Research Center (northern California), Dryden Flight Research Center (southern California), Glenn Research Center (Ohio), and Langley Research Center (Virginia). These ATP facilities cover the flight envelope from subsonic through hypersonic and include unique capabilities ranging from simulating icing environments to modeling extreme dynamic situations. ATP offers Government agencies, the U.S. aerospace industry, and academic institutions unmatched research and experimental opportunities that reflect four generations of accumulated aerospace skill and experience. These capabilities encompass every aspect of aerospace ground and flight testing and all associated engineering.

ATP addresses opportunities and challenges, particularly with respect to the program's aging facilities, long-range forecasting of wind tunnel test demand, and determining the best approach to investing in new capabilities across the portfolio. A major FY 2012 focus for ATP is expanding the management structure upon which ATP was established in 2006. This includes a national view, reaching across agency boundaries (primarily DOD and NASA). It defines capabilities and joint technology efforts to address future requirements for NASA and the Nation. The National Partnership for Aeronautics Testing (NPAT) includes DOD and NASA and is the primary vehicle for addressing this national approach. These cross-agency partnerships are increasingly important as usage of NASA's and DOD's aeronautical test facilities continues to decrease despite increasing customer demand for improved test techniques and instrumentation. Broadening the scope of NASA's aeronautics testing program to include DOD provides additional value in ensuring the right capabilities are available to NASA and the Nation.

Looking to the future, ATP continues to implement its strategic plan. The plan was finalized in October 2009 and focuses in the following four areas:
- Providing management guidance and recommendations to the NASA ARMD Associate Administrator and Center Directors with respect to NASA aeronautics ground and flight test capabilities;
- Representing the strategic interest of NASA and the Nation with respect to stewardship of NASA ground and flight test capabilities;
- Providing direction to NASA test capability managers; and
- Ensuring that the right capabilities are available at the right time to meet the needs of NASA and the Nation.

For more information, see http://www.aeronautics.nasa.gov/atp.

Plans For FY 2012

In FY 2011, ATP acquired one Gulfstream III through GSA auction and three F15D aircraft from the U.S. Air Force. The Gulfstream III will address the increasing requirement to provide a test bed environment for subsonic regimes. Particular flight experiments in the Gulfstream III range from the addition of synthetic aperture radar to support Earth science experiments, to the addition of a glove to support aeronautics research into the practical benefits of laminar flow. The three F15D aircraft are to replace the aging F15 and F18 aircraft, while providing increased capability and maintainability of the support and test bed aircraft fleet. Basic modifications to the Gulfstream III and F15D aircraft are scheduled for completion by the end of FY 2012.

In FY 2012, ATP will implement the recommendations of the Capability Reliance Framework (CRF). The CRF is a top-level view of the suite of capabilities that ATP oversees and supports. It also includes similar capabilities within DOD and is an initiative executed under NPAT. The NASA and DOD partnership improves coordination and moves toward a national management structure that crosses agency boundaries. The resultant CRF framework will inform decision makers about capability needs, and how those needs would best be served by facilities and resources operated by NASA, DOD, and other entities. The primary outcome of CRF is the identification of gaps in capabilities, redundancies, and, most importantly, potential opportunities for consolidation. The current aerospace testing environment is one of decreasing customer usage across ATP and DOD testing facilities and increasing demands by customers for new capabilities. Consolidation would potentially allow scarce resources to be redirected to address capabilities needed for the future.

One of ATP's primary activities is ensuring the reliability and availability of its testing capabilities. The majority of ATP's FY 2012 budget will support day-to-day operations and facilities maintenance, including addressing breakdowns and necessary repairs.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Test

Project Descriptions and Explanation of Changes

Flight Operations and Test Infrastructure

The flight operations and test infrastructure consists of an integrated set of elements, including the Western Aeronautical Test Range, which support aircraft maintenance and operations and the test bed aircraft that provide the resources required for research flight and mission support projects. ATP provides up to 100 percent of the facility fixed costs for these flight facilities to ensure facility and staff availability.

The activity also includes the simulation and flight loads laboratories, a suite of ground-based laboratories that support research flight and mission operations. ATP provides up to 20 percent of the fixed costs for laboratories, ensuring facility and staff availability.

Aero Ground Test Facilities

The aeronautics ground test facilities are different classes of facilities including low speed, transonic, supersonic, and hypersonic wind tunnels. Three primary efforts support the long-term viability of the facilities and to continually improve on the efficiency and effectiveness of safe, reliable, and productive operations:

- Facility operations support, which provides a portion of the fixed costs for ground test facilities to ensure facility and staff availability and user price stability;

- Facility maintenance and upgrades, which provides for maintenance and the upgrades that correct known deficiencies in facility safety, reliability, and productivity and enables the facilities to meet near -term and future testing requirements. These activities result in improved facility productivity and reduced operational cost; and

- Facility test technology, which develops and implements new technologies that increase test capability, improve productivity and efficiency, and improve data quality.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Deliver at least 86 percent of on-time availability for operations and research facilities.	Aeronautics Test	No change

Program Management

The ARMD Associate Administrator has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD or NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Aeronautics Test	Program Director	ARC, DFRC, GRC, and LaRC	DoD

Acquisition Strategy

Acquisitions supporting ATP activity are performed at each of the test sites consistent with the FAR and the NASA FAR Supplement. Each Center is responsible for coordinating major acquisitions supporting ATP activities through the ATP Office as required by the ATP Director. Acquisitions that support the ATP facilities are usually less than $0.5 million and are initiated as early as possible in the fiscal year.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Expert Panel	06/2010	Periodic reviews are carried out by the NAC and the U.S. users of ATP facilities. The last ATP review was carried out by the Aeronautics Committee of the NAC in July 2009; no major findings were reported. The last major community outreach meeting was held in April 2010 with NASA, DOD, and U.S. aerospace industry users at the Arnold Engineering Development Center. The next meeting is planned for September 2011.	07/2011
Performance	Expert Panel	11/2010	Periodic reviews are carried out by the NAC and the U.S. users of ATP facilities. The last ATP review was carried out by the Aeronautics Committee of the NAC in July 2009; no major findings were reported. The last major community outreach meeting was held in April 2010 with NASA, DOD, and U.S. aerospace industry users at the Arnold Engineering Development Center. The next meeting is planned for September 2011.	11/2011

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Integrated Systems Research

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**56.9**	**-**	**81.7**	**80.6**	**78.6**	**76.4**	**74.1**
Environmentally Responsible Aviation	56.9	-	58.4	57.0	55.1	53.1	50.1
UAS Integration in the NAS	0.0	-	23.3	23.6	23.6	23.3	24.0

Note:
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Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Integrated Systems Research

Program Overview

ISRP conducts integrated system-level research on promising concepts and technologies to explore, assess, or demonstrate their benefits. ISRP evaluates these technologies through system-level experimentation and focuses specifically on maturing and integrating technologies into major vehicle and operations systems/subsystems for accelerated transition to practical application. The research in this program is coordinated with on-going, long-term, fundamental research within the other three research programs, as well as efforts of other Government agencies.

As air transportation demand grows and system capacity is enhanced, there is the potential for adverse environmental effects. Concerns over community noise and emissions may limit the capacity at some airports. NextGen is addressing these potential impacts through enhancements to airspace system operations and the vehicles that will operate in the NAS. Addressing these vehicle related environmental concerns is the driving impetus behind NASA's Environmentally Responsible Aviation (ERA) project. With a focus on advanced vehicles, ERA is conducting system-level research and experiments of promising vehicle concepts and technologies that simultaneously reduce fuel burn, noise, and emissions.

Through the ERA project, NASA focuses its research and development efforts to understand how advanced environmental technologies can best work in an integrated vehicle/aviation operations system. NASA engages the external research community by including traditional and non-traditional research partners. NASA initiates activities to expand its role in aviation alternate and biofuels research, ensuring parallel research in advanced engine combustor technologies keeps pace with advances in advanced fuels. In addition, NASA performs activities to determine if and how advances in air traffic management technologies can be exploited to mitigate adverse aviation effects on the environment.

NASA focuses on technologies to enable routine operations for UAS of all sizes and capabilities in the NAS. Specifically, NASA is addressing technology development in several areas to reduce the technical barriers related to the safety and operational challenges. The technical barriers include:

- Robust separation assurance algorithms;

- Command and control, and air traffic control communication systems;

- Consistent standards to assess UAS ground control stations; and

- Airworthiness requirements for the full range of UAS classes.

These technical barriers are formidable obstacles to meeting NASA's goals. NASA will validate data and technology through a series of high-fidelity HITL simulations (i.e., where a human is part of the simulation and influences the outcome) and flight tests conducted in a relevant environment. The project deliverables will help key decision makers in Government and industry make informed decisions, leading towards routine UAS access.

For more information, please see http://www.aeronautics.nasa.gov/programs_isrp.htm.

Plans For FY 2012

ERA has established goals and targets to simultaneously achieve significant reductions in community noise, fuel efficiency, and nitrous oxide emissions for commercial airliners. In support of these goals, NASA will conduct tests to validate low-noise characteristics of an energy-efficient unconventional aircraft concept, and demonstrate a low-weight, damage-tolerant, stitched-composite structural concept on large-scale structure in the NASA Combined Loads Test System facility. The project will also complete low speed flight controls research on X-48C and conduct discrete roughness elements glove flight tests on a Gulfstream G-III. In addition, Phase 1 of both the low nitrous oxide fuel flexible combustor study and the geared turbofan study will be completed. Finally, preliminary design of up to two advanced concept subscale test bed vehicles will be completed and down-selection to five to six integrated system-level demonstrations for Phase 2 of the project (FY 2013-FY 2015) will be made.

UAS integration in the NAS project will leverage UAS Executive Committee efforts, and work in collaboration with JPDO to develop a global civil UAS access roadmap. This roadmap is crucial to ensure efficient interagency cooperation, minimize unnecessary duplication of work, and maximize the opportunity to leverage research and development activities among Government and commercial industry. NASA's contributions include the development of a NextGen concept of operations, an analysis of the current state of the art for UAS, and a gap analysis between the two. FY 2012 deliverables also include a comparative analysis of certification methodologies and detailed descriptions and test plans for HITL simulations and integrated flight tests to be conducted in FY 2013 through FY 2015.

Project Descriptions and Explanation of Changes

Environmentally Responsible Aviation (ERA)

Research in environmentally responsible aviation explores and assesses new vehicle concepts and enabling technologies through system-level experimentation that simultaneously reduces fuel burn, noise, and emissions and thus reduces the impact of aviation on the environment. ISRP matures concepts and technologies, evaluates their performance at the system and sub-system level in a relevant environment, and identifies and assesses issues relative to safety. Through system-level analysis, promising advanced mid-term vehicle and propulsion concepts and technologies can be down-selected based on their potential benefit towards the stated national goals. Among the technologies to be explored are the following:

- Non-conventional aircraft architectures that enable reduced drag and shielding of propulsion system noise;

- Drag reduction through laminar flow;

- Advanced composite structural concepts for weight reduction;

- Low nitrous oxide combustors; and

- Propulsion/airframe integration for noise reduction and fuel burn improvements.

ISRP expands the well-informed design trade space for these types of technologies and transfers knowledge outward to the aeronautics community so that aircraft and propulsion system manufacturers can confidently transition these technologies into new products. The program also has the potential to transfer knowledge back to FAP so that concepts and technologies that do not yield predicted performance benefits can be further investigated and developed at a foundational level. This would occur only after an evaluation of such concepts and technologies indicates that further fundamental research is warranted.

UAS Integration in the NAS

There is an increasing need to fly UAS in the NAS to perform missions of vital importance to national security and defense, emergency management, science, and to enable commercial applications. One example is the use of a Predator UAS by the Department of Homeland Security to fly over the Nation's borders.

Current Federal aviation regulations are built upon the condition of a pilot being in the aircraft. There exist few regulations specifically addressing UAS, and the primary user of UAS to date has been the military. Because of this, the technologies and procedures to enable seamless operation and integration of UAS in the NAS need to be developed, validated, and employed by FAA through rule making and policy development.

The goal of the UAS integration in NAS research is to contribute capabilities that reduce technical barriers related to the safety and operational challenges of enabling routine UAS access to the NAS. This goal will be accomplished through a two-phased approach based on development of system-level integration of key concepts, technologies, and/or procedures, and demonstrations of integrated capabilities in an operationally relevant environment. The project will conduct integrated test and evaluation focusing on four technical challenges: separation assurance, communications, human systems integration, and certification.

The Phase 1 technical objectives include: developing a gap analysis between the current state of the art and the NextGen concept of operations; validating the key technical elements identified by the project requirements; initial modeling, simulation, and flight testing; and completion of sub-project Phase 1 deliverables (e.g., spectrum requirements, and comparative analysis of certification methodologies) and continuation of Phase 2 preparation (e.g., infrastructure and tools).

The Phase 2 technical objectives include: providing regulators with a methodology for developing airworthiness requirements for UAS, and data to support development of certifications standards and regulatory guidance; and providing systems-level, integrated testing of concepts and/or capabilities that address barriers to routine access to the NAS. Through simulation and flight testing, ISRP addresses issues including separation assurance, communications requirements, and human systems integration in operationally relevant environments.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
In 2014, complete community noise assessment of advanced hybrid wing body vehicle concepts from synthesis of experimental databases and noise prediction results.	Integrated Systems Research	No change
In 2015, develop and downselect vehicle concepts with the appropriate technology suite to simultaneously meet the N+2 fuel burn, community noise, and LTO NOx subsonic transport goals.	Integrated Systems Research	No change
In 2015, develop, validate and deliver robust simulation and flight test data for integrated technologies including separation assurance, communications, and human systems interfaces.	Integrated Systems Research	No change

Program Management

The ARMD Associate Administrator (AA) has oversight responsibility for the program. The program director oversees program portfolio formulation, implementation, evaluation, and integration of results with other ARMD or NASA programs.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Integrated Systems Research	Program Director	ARC, DFRC, GRC, and LaRC	Boeing, General Electric, Pratt & Whitney, Air Force Research Laboratory, FAA, Gulfstream, Goodrich, and Exa Corporation.

Acquisition Strategy

ISRP develops and further matures promising technologies to the integrated system-level. This necessitates the use of a wide array of acquisition tools relevant to the appropriate work awarded externally through full and open competition. Teaming among large companies, small businesses, and universities is highly encouraged for all procurement actions.

A full and open NRA is used as the means to solicit innovative proposals in key research areas that complement NASA expertise. One of the main objectives of the NRA investment is to stimulate close collaboration among NASA researchers and NRA award recipients to ensure effective knowledge transfer. ISRP awards grants, contracts, and cooperative agreements, primarily with industry, academia and non-profit institutions. These awards help strengthen the research capabilities that are of interest to NASA within the recipient organizations and institutions. The program also utilizes partnerships with cost sharing and in-kind contributions to gain access to system-level research and integration opportunities.

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Integrated Systems Research

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Subject Matter Experts	08/2010	The National Research Council held a meeting of experts to review NASA's UAS integration in the NAS research. The meeting brought together experts in government, industry, and academia. Findings included strong community support for NASA's new UAS project and a recommendation to have strong coordination with other government agencies and industry to ensure safety of the NAS and proper integration of UAS into NextGen. NASA has considered the comments and observations the refined the plans accordingly.	N/A
Relevance	Expert Review	10/2010	A formulation review was held for the UAS integration in the NAS project. This review was an independent peer review and experts from other government agencies gave a recommendation to the ARMD AA on whether or not the technical plans address relevant challenges and can achieve the stated objectives and schedule within the allocated resources. The independent review panel recommended that the project proceed to implementation and the AA concurred.	N/A
Performance	Review Panel	10/2010	The 12-month review is a formal independent peer review. Experts from other government agencies report on their assessment of technical and programmatic risk and/or program weaknesses. In the FY 2010 review, the independent review panel rated ISRP and the ERA project overall as "excellent" on relevance and quality and "very good" on performance in their first year of execution.	11/2011

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	Aeronautics Strategy and Management

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**22.6**	**-**	**24.3**	**24.0**	**23.4**	**22.8**	**22.1**
Aeronautics Strategy and Management	22.6	-	24.3	24.0	23.4	22.8	22.1

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The ASM Program will be formed in FY 2012 to provide a more efficient management structure for the directorate. This new program's content and budget is from the transfer of the cross program activities from FAP and innovative concepts for aviation activities from ISRP. Therefore, no additional funding or change in content to the directorate results from this transfer.

ASM conducts research and provides programmatic support that does not fit well into the current five programs. ASM will be managed by headquarters and is organized into three main areas: Innovative Concepts for Aviation (ICA), Cross Program Support, and Education and Outreach. ICA supports early stage high risk research and technology demonstrations.

The cross program support area includes coordination and institutional expenses such as information technology, studies, and other administrative functions. Education and outreach activities support NASA's educational goals and communicate the results from Mission Directorate research.

Plans For FY 2012

ICA research is scheduled to begin in FY 2011. In FY 2012, the best ideas and concepts from the first year of research into new concepts and processes for aviation will be evaluated and considered for further study or incorporation into the existing research programs. Also in FY 2012, ICA technology demonstrations will be conducted.

Project Descriptions and Explanation of Changes

Aeronautics Strategy and Management

Aeronautics Strategy and Management is organized into three functional areas described below.

Innovative Concepts for Aviation explores novel concepts and new processes with the potential to create new capabilities in aeronautics research. ICA's goal is to mature the new concepts and incorporate them into the existing research programs or launch new avenues of aeronautics research. To meet this goal, both internal and external aeronautics communities will be targeted through solicitations, challenges, and prizes.

Cross Program Support funds institutional expenses such as information technology, studies, and other administrative functions. Also, coordination with JPDO is covered by cross program support funding.

Education and Outreach targets key constituencies in different age brackets and its activities are well integrated into the overall NASA portfolios, including providing subject matter experts and aeronautics-related materials that are complementary to the Agency portfolio. Students and teachers at all levels of learning are engaged through research grants, scholarship programs, internships, design competitions, exhibits and hands-on activities. Outreach through various media forums informs the general public and technical communities of the outcomes of ARMD research and supports the transition of knowledge to the aeronautics community.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Not applicable	Not applicable	Not applicable

Program Management

The ARMD Associate Administrator has oversight responsibility for the program.

Acquisition Strategy

The research conducted through ICA activities will use a wide array of acquisition tools relevant to the research objectives including external solicitations through full and open competitions.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	Not applicable	N/A	Not applicable	N/A

Mission Directorate:	Aeronautics Research
Theme:	Aeronautics
Program:	ARMD Civil Service Labor and Expenses

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**196.7**	**201.7**	**210.6**	**220.7**	**231.3**
ARMD Civil Service Labor and Expenses	0.0	-	196.7	201.7	210.6	220.7	231.3

Program Overview

This program contains labor funding, both salary and benefits, for civil service employees at NASA's Centers who are assigned to work on projects in ARMD. These funds support the critical skills and capabilities required to provide the technology development, as outlined in the other programs, within this mission area.

Overview

Space Technology is the central NASA contribution to the President's revitalized research, technology, and innovation agenda for the Nation. These investments will stimulate the economy and build the Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs. A technology-driven NASA positions the Nation's aerospace community as a global technological leader and serves as an inspiration for young people to pursue science, technology, engineering, and mathematics (STEM) education and career paths. Space Technology focuses not only on the technological advances required for NASA's future missions in science and exploration, but also on providing space technologies that can improve the capabilities and lower the cost of other government and commercial space activities.

NASA technology development activities under Space Technology transform the Nation's capabilities for exploring and utilizing space. Through Space Technology, NASA advances crosscutting and exploration-specific technology, performs technology transfer and technology commercialization activities, develops technology partnerships with other Government agencies, and coordinates the Agency's overall technology investment portfolio. The Office of the Chief Technologist (OCT) manages Space Technology.

The NASA Authorization Act of 2010 endorses Space Technology, stating, "It is critical to maintain an Agency space technology base that helps align mission directorate investments and supports long term needs to complement mission-directorate funded research and support, where appropriate, multiple users, building upon its Innovative Partnerships Program and other partnering approaches." In addition, the Act supports "development of technologies and in-space capabilities for beyond near-Earth space missions."

Consistent with the NASA Authorization Act of 2010, NASA recently developed a draft set of 14 space technology roadmaps (available at http://www.nasa.gov/offices/oct/home/roadmaps), which define pathways to advance the Nation's capabilities in space and establish a mechanism for prioritization of NASA's technology investments. The National Academies is reviewing these roadmaps to provide independent guidance and recommended prioritization for NASA's future technology investments. NASA uses these space technology roadmaps and the Space Technology Grand Challenges, a set of technically challenging, long-term space-related goals, to guide NASA's technology portfolio and prioritize future technology investments.

In managing Space Technology NASA employs a portfolio approach that spans technology readiness levels from concept study to flight demonstration. These technology development activities include early stage conceptual studies, ground-based and laboratory testing aimed at demonstrating technical feasibility, relevant environment flight demonstrations, and technology test beds, which include the International Space Station (ISS). The activities funded in Space Technology provide a balance between long-range, mission-focused technology investments and transformational technology investments that enable revolutionary capabilities. To achieve its Space Technology goals, NASA sponsors relevant activities at its Centers, in academia and industry, and in partnership with other Government agencies. The acquisition approach includes both competed and strategically guided activities. Integrated technology transfer efforts ensure NASA technologies are infused into commercial applications, promoting the creation of new jobs and maturing new products and services that benefit the Nation and the world.

For more information about Space Technology, please visit http://www.nasa.gov/offices/oct.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**275.2**	**327.2**	**512.0**	**1,024.2**	**1,024.2**	**1,024.2**	**1,024.2**	**1,024.2**
Space Technology	275.2	-	-	1,024.2	1,024.2	1,024.2	1,024.2	1,024.2

Note: FY 2010 and FY 2011 figures have been adjusted to show comparable Exploration technology content from the Exploration account, and the movement of the Innovative Partnerships Program from the Cross Agency Support account, within the Space Technology account consistent with the FY 2012 Budget.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267). For the Space Technology account the amount shown represents the $350 million authorized for Space Technology and a portion of the $250 million authorized for the Exploration Technology Development activities that have been transferred to this account in the FY 2012 Budget. For FY 2012, the NASA Authorization Act of 2010 included approximately $800 million for Space Technology and the transferred Exploration Technology Development activities.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Space Technology

Space Technology

New Initiatives:

None

Major Changes:

In the FY 2011 budget request, Space Technology funding was included under the Aeronautics and Space Research and Technology appropriations account. For the FY 2012 request, NASA has established Space Technology as a unique appropriations account.

In FY 2012, a significant portion of the FY 2010 Exploration Technology Development Program, as well as new exploration technology activities in planning for FY 2011, will move from the Exploration Systems Mission Directorate (ESMD) to Space Technology. For traceability, the transferred activities have been consolidated in a specific budgetary element within Space Technology: Exploration Technology Development (ETD). Some elements of exploration technology efforts, such as life support, extravehicular activity, and habitation development, will remain in Exploration Systems due to their engineering development nature and strong coupling to exploration crew vehicle systems. NASA plans to capitalize on technical and management synergies in integrating and managing this technology portfolio.

Major Highlights for FY 2012

Space Technology will focus on developing breakthrough space capabilities and applications. Supporting national efforts in innovation, NASA is developing a robust pipeline of technology developments that enable new approaches to scientific and human exploration of the solar system.

In FY 2012, NASA will receive two reports from the National Academies on NASA's space technology roadmaps containing independent guidance and prioritization for NASA's future technology investments. NASA will use this input to guide Space Technology solicitations that develop and demonstrate advanced space systems concepts and technologies, and enable new, currently unfeasible, approaches to achieving NASA's current missions and future missions. The National Academies' response to the NASA roadmaps supports NASA's contribution to the National Space Technology Policy called for in the NASA Authorization Act of 2010 (P.L. 111-267).

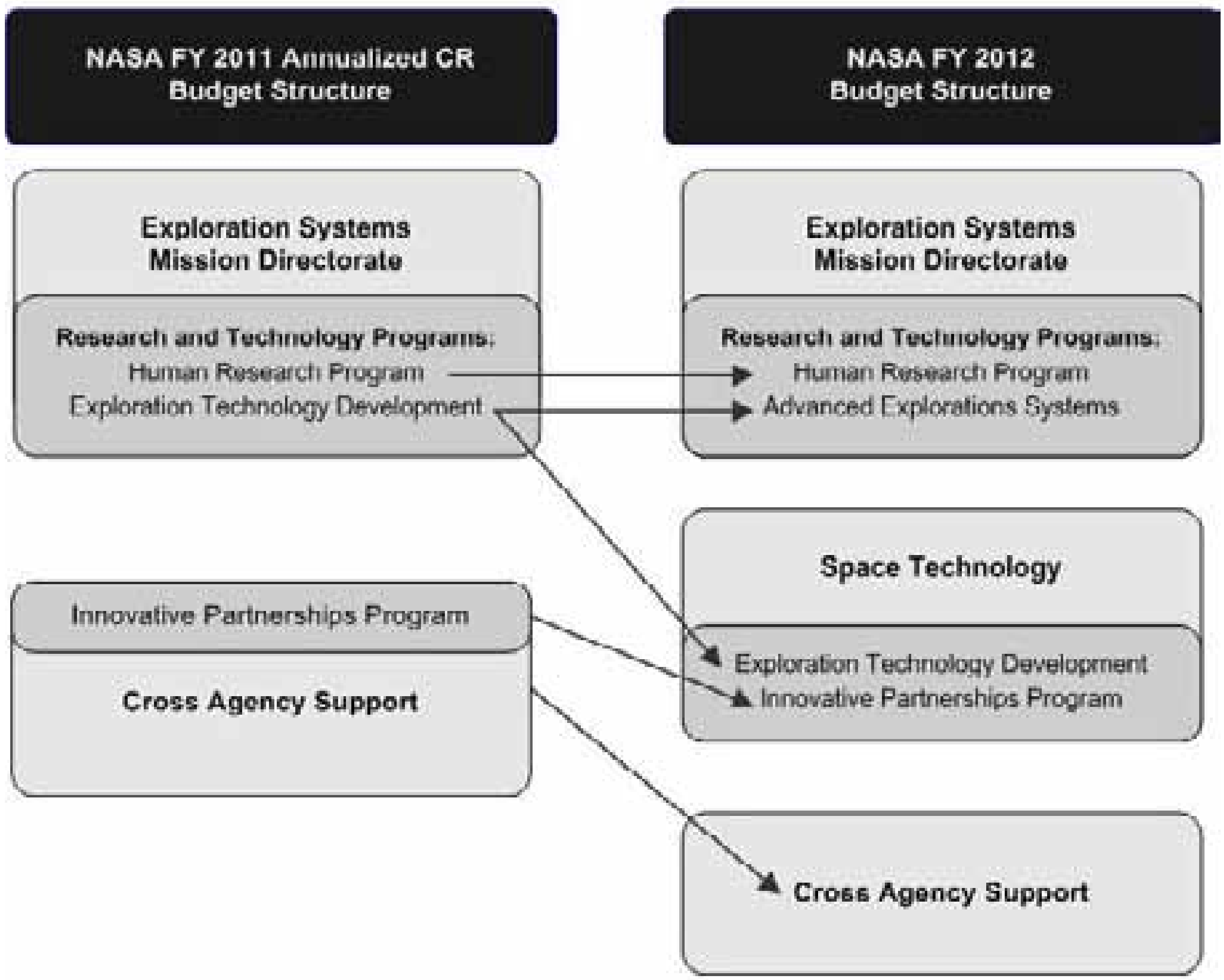
NASA aligns Small Business Innovative Research (SBIR) and Small Business Technology Transfer (STTR) topics and subtopics with NASA's technology roadmaps. Chief Technologists from NASA Centers and the Jet Propulsion Laboratory will coordinate between Center SBIR and STTR projects and mission needs on topic development, selection, project administration, infusion activities, and reporting processes. A Mission Directorate steering council will maximize alignment and infusion of the SBIR and STTR products into future missions and systems. This approach more fully integrates and couples the SBIR and STTR programs as critical components of the Agency's technology development activities, providing the small business researchers with more efficient infusion paths for viable products.

In Crosscutting Space Technology Development (CSTD), NASA funds NASA Innovative Advanced Concepts (NIAC) Phase I and Phase II studies, develops a cadre of space technology graduate fellows, conducts Centennial Challenges competitions, awards new grants for foundational space technology research, invests in innovative research activities at NASA Centers, implements Game Changing Development (GCD) activities that lead to revolutionary technologies, sponsors new Franklin Small Satellite Subsystem Technology projects, procures suborbital flight services from commercial reusable suborbital and parabolic platform providers, and initiates in-space Technology Demonstration Missions and Edison Small Satellite Demonstration Missions. NASA's Mission Directorates, other Government agencies, and industry are the ultimate customers for CSTD products.

Exploration Technology Development (ETD) manages both strategically-guided and competed project elements focused on critical technology advances necessary for humans to explore beyond low Earth orbit. ETD leverages the existing technical strength of the NASA Centers and known needs for the future human exploration activities. Competed ETD projects augment and complement the guided efforts, providing the opportunity to develop the best ideas, innovations, approaches, and processes for the future human space exploration efforts. ESMD is the primary customer for ETD products.

Maintaining two robust space technology development programs allows the Exploration Technology Development and Crosscutting Space Technology Development budgetary elements to focus on different sets of customers and goals, operate with a different balance of competed and guided project elements, and use different cost-share requirements.

Mission Directorate Budget Structure Adjustments



Mission Directorate:	Space Technology
Theme:	Space Technology

Theme Overview

Space Technology consists of four budgetary elements: Partnership Development and Strategic Integration, SBIR/STTR, CSTD, and ETD.

The Partnership Development and Strategic Integration element includes technology transfer and commercialization, interagency technology coordination, intellectual property management, and technology partnership opportunities with other Government agencies and commercial industry. Consistent with the NASA Authorization Act of 2010, this budgetary element also has the responsibility to align NASA's technology investments, ensuring that Space Technology investments, as well as technology investments from other agencies, and future mission plans.

NASA tracks the maturity of technologies funded by Space Technology through use of Technology Readiness Levels (TRLs). Tracking TRLs provides insight into the progress of each technology, and over time, the performance of commercialization and infusion processes. For more about TRLs, please see http://www.hq.nasa.gov/office/codeq/trl/trl.pdf.

SBIR and STTR continue to support early-stage research and development performed by small businesses through competitively awarded contracts. These programs produce innovations for both Government and commercial applications. SBIR and STTR provide the high-technology small business sector with an opportunity to develop technology for NASA, and commercialize that technology to spur economic growth. Technologies funded by SBIR and STTR have contributed to numerous NASA programs and projects and also have resulted in commercial successes of benefit to society. SBIR and STTR awards are selected as an integrated component of the Agency's technology strategy. This facilitates an increase in the number of NASA-funded SBIR and STTR technologies used in NASA's missions, and provide small business researchers with more efficient infusion paths for viable products.

NASA's CSTD activities span from early-stage conceptual studies to flight demonstration. CSTD uses competitive and strategically guided processes to engage a broad array of participants, including the NASA Centers, other Government agencies, academia, and industry. CSTD activities enable quantum leaps in broadly applicable technological capability for NASA's future science and exploration missions, while being of relevance to other national needs. CSTD is grouped by TRL into three technology investment areas: Early Stage Innovation (TRL 1-3), Game Changing Technology (TRL 4-5), and Crosscutting Capability Demonstrations (TRL 6-7). NASA recognizes that each step in maturing space technologies from idea and concept inception through demonstration in a relevant environment is a significant challenge. CSTD was developed to address these concerns and create a steady pipeline of technologies for NASA's future missions.

NASA's ETD activities (TRL 4-7), now managed under Space Technology, advance the new technologies required to conduct future human missions beyond low Earth orbit. Using Center expertise and fulfilling requirements set by ESMD, these activities develop long-range, critical technologies that provide the basis for a broad set of future human exploration capabilities. Prototype systems and key capabilities are demonstrated in ground-based and laboratory testing, relevant environment flight demonstrations, and technology test beds, including the ISS. After successful demonstration of technologies, human space flight program managers can identify and baseline proven technologies as part of future deep space systems and as part of NASA's overall human exploration architecture.

Integrating ETD within Space Technology creates one robust space technology budget line, consolidates the management of NASA's space technology programs within an organization focused on technology development and mission infusion, and eliminates the potential for overlap had NASA's space technology investments been split among two accounts.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**275.2**	**-**	**1,024.2**	**1,024.2**	**1,024.2**	**1,024.2**	**1,024.2**
SBIR and STTR	96.0	-	177.3	176.8	175.6	174.3	172.8
Partnership Development and Strategic Integration	20.3	-	19.5	19.4	19.3	19.1	19.0
Crosscutting Space Technology Development	7.5	-	433.3	432.1	429.2	425.8	422.4
Exploration Technology Development	151.4	-	261.3	259.3	257.5	255.5	253.4
ST Civil Service Labor and Expenses	0.0	-	132.9	136.6	142.6	149.5	156.6

Note: FY 2010 and FY 2011 figures have been adjusted to show comparable Exploration technology content from the Exploration account, and the movement of the Innovative Partnerships Program from the Cross Agency Support account, within the Space Technology account consistent with the FY 2012 Budget. The FY 2010 level shown does not include the $51.7 million transferred to the Science and Exploration accounts, to be made available to the SBIR/STTR programs in FY 2011.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

In the 2011 State of the Union address, the President set a goal to "spark the creativity and imagination of our people" through increased investments in research and development, reminding the Nation that, "maintaining our leadership in research and technology is crucial to America's success." In remarks on Innovation delivered at Pennsylvania State University, the President stated, "We need you to seek breakthroughs and new technologies that we can't even imagine yet."

The economic competitiveness and high standard of living in the United States are based on decades of investment in technology and innovation. Space Technology is the central NASA contribution to a revitalized research, technology, and innovation agenda for the Nation. As a research and development agency, NASA plays a vital role in American innovation, thus, its future economic prosperity and security. Space Technology investments will stimulate the economy and build the Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs.

NASA's focus on technology and innovation leverages the skills and expertise of NASA's Centers, industry, academia and other Government partners. It provides knowledge and capabilities required to for future missions in science and exploration, and addresses significant national needs. By investing in space technology, NASA affects and improves life on Earth every day. It creates energy management systems on spacecraft, monitoring the health of astronauts as they explore, and observing the weather on other planets.

An enhanced technology and innovation focus at NASA responds to the recommendations of multiple stakeholders, including Congress and the National Academies. In 2010, the President released the U.S. Space Policy, affirming the importance of space technology investments. In the NASA Authorization Act of 2010, Congress directed development of a National Space Technology Policy to guide the space technology development programs for the United States. This policy will further guide NASA's technology portfolio through an integrated national approach.

Relevance to the NASA Mission and Strategic Goals:

NASA's transformative technology development activities funded through Space Technology advance the Agency and industry capabilities for exploring space. NASA leads strategic planning, integration, and coordination of civilian aerospace technology investments for the Nation.

Space Technology specifically addresses the national policies and needs encompassed by NASA's Strategic Goal 3, to "Create the innovative new space technologies for our exploration, science, and economic future."

With a strong focus on technology development, the intellectual capital at NASA's Centers will be utilized to deliver solutions to some of the Nation's technological challenges. Through its space technology efforts, NASA will improve the Nation's leadership in key technology areas, enable far-term capabilities and spurring advanced technology development that will ultimately make the exploration and utilization of space more affordable and sustainable.

Relevance to education and public benefits:

Space Technology will inspire a new generation of students, and launching career interests resulting in young engineers, scientists, technologists, and mathematicians that are able to address future national needs. Space Technology activities leverage expertise and resources with partners, drive new sources and methods of innovation, and maximize benefits to taxpayers. For example, Space Technology graduate fellowships support graduate and doctoral student researchers enrolled in a U.S. university. Students with promising initial graduate research may apply to have their work sponsored and integrated into Space Technology activities. Selected candidates will perform research on campus, and visit NASA Centers, not-for-profit research and/or development laboratories. A NASA researcher will act as the student's professional advisor. In 2012, this program element will reach its goal of actively engaging 500 graduate students per year.

These Space Technology education activities are integrated in the Agency's overall education plan through participation in the NASA Education Coordinating Council. NASA seeks activities such as these as integral to the Administration's strategy of creating a world-class workforce to develop the leading ideas and innovations of the 21st century.

Investments in Space Technology will stimulate the economy and build our Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs. A technology-driven NASA positions our Nation's aerospace community as a global technological leader and serves as an inspiration for young people to pursue science, technology, engineering, and mathematics (STEM) education and career paths. As demonstrated over many years, advanced technologies needed for space exploration stimulate the development of new products and services that improve our Nation's economic competitiveness and standard of living. Knowledge provided by weather and navigational spacecraft flying overhead; efficiency improvements in ground and air transportation; biomedical applications including blood-flow monitoring devices, pacemakers, Lasik eye surgery; and the protective armor that keeps our military, firefighters and police safe. Our Nation's investments in aerospace technology made these possible. By investing in Space Technology, NASA improves the quality of life on Earth.

Mission Directorate:	Space Technology
Theme:	Space Technology

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**	
Outcome 3.1	**Sponsor early-stage innovation in space technologies in order to improve the future capabilities of NASA, other government agencies, and the aerospace industry.**	
Objective 3.1.1	**Create a pipeline of new low Technology Readiness Levels (TRL) innovative concepts and technologies for future NASA missions and national needs.**	
Performance Goal 3.1.1.1	***Explore revolutionary aerospace concepts, with an initial research phase for preliminary assessment of a broad range of ideas, and a second phase for further development of the most promising concepts.***	
APG 3.1.1.1: ST-12-1	Initiate Phase II studies to further develop two of the most promising prior (FY 2011 and predecessor NASA Institute for Advanced Concepts (NIAC)) Phase I concepts.	Crosscutting Space Technology Development
Performance Goal 3.1.1.2	***Provide cash prize incentives to non-traditional sources for innovations of interest and value to NASA and the Nation.***	
APG 3.1.1.2: ST-12-2	Conduct at least three Centennial Challenges competitions.	Crosscutting Space Technology Development
Performance Goal 3.1.1.3	***Establish and maintain a culture of innovation at each of the 10 NASA Centers through the development of new Center ideas and technologies.***	
APG 3.1.1.3: ST-12-3	Twenty innovative projects will be initiated across the NASA Centers.	Crosscutting Space Technology Development
Performance Goal 3.1.1.4	***Increase the proportion of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies successfully infused into NASA programs/projects.***	
APG 3.1.1.4: ST-12-4	At least 25 percent of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase II technology projects awarded between 2007-2011 will be infused into NASA programs and projects.	SBIR and STTR
Performance Goal 3.1.1.5	***Increase the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase III contracts initiated or expanded.***	
APG 3.1.1.5: ST-12-5	At least 40 of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies will be advanced to Phase III (received non-SBIR/STTR funding).	SBIR and STTR
Performance Goal 3.1.1.6	***Accelerate the development of push technologies to support the future space, science and exploration needs of NASA, other government agencies, and the commercial space sector.***	
APG 3.1.1.6: ST-12-6	Complete 100 research plans.	Crosscutting Space Technology Development

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Outcome 3.2	**Infuse game changing and crosscutting technologies throughout the Nation's space enterprise to transform the Nation's space mission capabilities.**	
Objective 3.2.1	**Prove the technical feasibility of potentially disruptive new space technologies for future missions.**	
Performance Goal 3.2.1.1	***Transition developed game changing technologies to the technology demonstration programs or directly to Mission Directorates for mission insertion.***	
APG 3.2.1.1: ST-12-7	Initiate five game changing technology projects.	Crosscutting Space Technology Development
Objective 3.2.2	**Spur the development of routine, low-cost access to space through small payloads and satellites.**	
Performance Goal 3.2.2.1	***Mature technologies that enable small satellites to provide game changing capabilities for the government and commercial space sectors.***	
APG 3.2.2.1: ST-12-8	Initiate development of at least two new technologies with game changing potential for small satellites.	Crosscutting Space Technology Development
Objective 3.2.3	**Demonstrate new space technologies and infuse them into future science and exploration small satellite missions and/or commercial use.**	
Performance Goal 3.2.3.1	***Demonstrate small satellite capabilities with game changing and crosscutting potential for the government and commercial space sectors.***	
APG 3.2.3.1: ST-12-9	Initiate at least one new small satellite mission that will demonstrate game changing or crosscutting technologies in space.	Crosscutting Space Technology Development
Objective 3.2.4	**Demonstrate new space technologies and infuse them into missions.**	
Performance Goal 3.2.4.1	***Infuse game changing and crosscutting technologies into future NASA missions through flight or relevant environment demonstrations.***	
APG 3.2.4.1: ST-12-10	Complete preliminary design of at least two system-level technologies for flight or relevant environment demonstration.	Crosscutting Space Technology Development
Objective 3.2.5	**Provide flight opportunities and relevant environments to demonstrate new space technologies.**	
Performance Goal 3.2.5.1	***Perform sub-orbital, simulated zero-gravity and other space analog flight opportunities to develop and demonstrate emerging ideas and technologies.***	
APG 3.2.5.1: ST-12-11	Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least three commercial reusable suborbital and parabolic platform providers.	Crosscutting Space Technology Development

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Outcome 3.3	**Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.**	
Objective 3.3.1	**Demonstrate in-space operations of robotic assistants working with crew.**	
Performance Goal 3.3.1.1	***Demonstrate robotic technologies that support in-space operations, scientific discovery, and work as assistants with the crew.***	
APG 3.3.1.1: ERD-12-8	Demonstrate Robonaut 2 assisting the crew to perform tasks inside the ISS.	Exploration Technology Development
Objective 3.3.2	**Develop and demonstrate critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.**	
Performance Goal 3.3.2.2	***Develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer making exploration and science missions more affordable and capable.***	
APG 3.3.2.1: ST-12-12	Test automated fluid couplings for cryogenic propellant transfer to support Cryogenic Propellant Storage And Transfer (CRYOSTAT) systems requirements.	Exploration Technology Development
Outcome 3.4	**Facilitate the transfer of NASA technology and engage in partnerships with other government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.**	
Objective 3.4.1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and national interests.**	
Performance Goal 3.4.1.1	***Establish 12 technology-related significant partnerships that create value for programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g., reduced volume or mass, improved safety) per year.***	
APG 3.4.1.1: ST-12-13	Establish at least 12 technology-related significant partnerships during FY 2012.	Partnership Development and Strategic Integration
Performance Goal 3.4.1.2	***Complete 30 technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements per year.***	
APG 3.4.1.2: ST-12-14	Complete at least 30 technology transfer agreements during FY 2012.	Partnership Development and Strategic Integration

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Performance Goal 3.4.1.3	***Successful application of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies into commercial products or services.***	
APG 3.4.1.3: ST-12-15	Greater than 35 percent of the Phase II Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technology projects awarded between 2007-2011 will be transferred into commercial products or services.	SBIR and STTR
Performance Goal 3.4.1.4	***Document 40-50 of the most notable examples of successful transfer and commercialization of NASA-derived technology per year and publish in Spinoff annually.***	
APG 3.4.1.4: ST-12-16	Document at least 40 notable technology transfer successes in NASA's Spinoff publication.	Partnership Development and Strategic Integration
Performance Goal 3.4.1.5	***Document, coordinate, and prioritize Agency-level technology strategic investments to ensure NASA has a balanced portfolio of both near-term NASA mission (pull) technologies and longer-term transformational (push) technologies that benefit both Agency programs and national needs.***	
APG 3.4.1.5: ST-12-17	Ensure that 75 percent of all NASA technology projects are recorded in the portfolio database and are analyzed against the prioritizations in the space technology roadmaps.	Partnership Development and Strategic Integration

Uniform and Efficiency Measures:

Measure #	Description
Space Technology Theme	
APG EFF 3.4.1.5: ST-12-17	Ensure that 75 percent of all NASA technology projects are recorded in the portfolio database and are analyzed against the prioritizations in the space technology roadmaps.

Performance Achievement Highlights:

NASA conducted low-level planning activities, including issuing requests for information for budgeted elements of the FY 2011 Space Technology Theme, and received approximately 1,400 responses.

NASA hosted a Space Technology Industry Forum with over 300 external participants and announced three new Centennial Challenges. Competitive solicitations, including NASA research announcements research announcements (NRA) and broad Agency announcements (BAAs), have been prepared for all CSTD projects.

The Space Technology Graduate Fellowship solicitation was released, allowing graduate students from across the Nation, whose research interests are aligned with the 14 space technology roadmap areas, to participate in NASA Space Technology activities. NASA expects to announce the Space Technology fellows in August 2011.

In FY 2010, Innovative Partnerships Program (IPP) was integrated into Space Technology. IPP successes include more than 1,400 new invention disclosures on NASA-funded technology that could lead to patents and technology transfer, and broad dissemination of about 600 of those through NASA's TechBriefs magazine. NASA civil servant innovators were recognized by the Wall Street Journal, R&D Magazine, the Federal Laboratory Consortium and others.

As part of intellectual property management activities, eighty patent applications were filed and awarded in FY 2010. NASA has continued its initiative to generate licenses for NASA technologies through an auctioning intermediary at no cost to NASA.

NASA entered into over 300 Space Act Agreements with private and other external entities for development of dual-use technologies that have applications that meet NASA's technology needs.

In FY 2010, at least 68 technologies were infused into various NASA programs from IPP. Infused technologies fly on NASA missions during the year, are adopted for use in future systems, or are chosen by the Mission Directorates for further development.

Forty-one Innovation Fund projects were selected to encourage NASA civil servant innovators to create breakthrough technologies. NASA funding for select projects was matched by $800,000 in external partner contributions.

Commercial parabolic flight services were provided for 17 projects involving external and internal entities that could take advantage of limited exposure to reduced gravity to mature NASA mission-relevant technologies.

ETD developed manufacturing concepts for 10 meter diameter heavy-lift launch vehicle composite structures, flight testing of laser and optical sensors for autonomous precision landing and hazard avoidance, ISS demonstration of precision free flying remote manipulators, in-situ resource utilization field tests, and the evaluation of operational scenarios for future surface exploration missions.

Robonaut 2, or R2, is ready for launch to the ISS on Space Shuttle Discovery as part of the STS-133 mission. R2 will become the first dexterous humanoid robot in space and the first U.S.-built robot at the ISS.

The Mars Science Laboratory Entry, Descent, and Landing Instrument (MEDLI) is currently undergoing final testing, calibration, and integration into the Mars Science Laboratory in preparation for launch in late 2011.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	National Academies	01/2011	NASA's 14 space technology roadmaps consider a wide range of pathways to advance the Nation's current capabilities. NASA developed the set of draft roadmaps for use by the National Academies as an initial point of departure for mapping the Agency's future investments in technology. This independent review by the National Academies will facilitate development of the National Space Technology Policy called for in the NASA Authorization Act of 2010.	03/2012

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	SBIR and STTR

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**96.0**	**-**	**177.3**	**176.8**	**175.6**	**174.3**	**172.8**
SBIR and STTR	96.0	-	177.3	176.8	175.6	174.3	172.8

Note: Included in this total request ($177.3 million) for SBIR and STTR are both the estimated total award values ($173.3 million) and funding ($4 million) necessary for the program operations and support. The FY 2010 level shown does not include the $51.7 million transferred to the Science and Exploration accounts, to be made available to the SBIR/STTR programs in FY 2011.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

NASA's SBIR and STTR programs continue to support early-stage research and development by small businesses through competitively awarded contracts. These programs continue to produce innovations for both government and commercial applications.

SBIR and STTR programs are implemented under the Space Technology Theme, with the dual objectives of providing the high technology small business sector with an opportunity to develop technology for NASA and commercializing that technology to spur economic growth. These technologies have extended their reach beyond NASA's missions, contributing to commercial successes that ultimately result in marketable products and societal benefits.

Research and technologies funded by SBIR and STTR have made important contributions to numerous NASA programs and projects, and the Agency is actively working to increase the number of NASA-funded SBIR and STTR technologies used in NASA's missions and projects. Some of NASA's high-profile programs directly benefiting from SBIR technologies include the Space Shuttle, ISS, Mars Exploration Rovers, and the Phoenix lander.

SBIR and STTR awards, and support to cover the cost of managing the program, are included in this budget. Each year, 28 to 30 percent of applicants represent firms new to NASA's SBIR and STTR Program. New participants make up 20 to 35 percent of the total number of proposals in any given year.

For more information about SBIR and STTR, please visit http://sbir.gsfc.nasa.gov/SBIR/SBIR.html.

Plans For FY 2012

For prior years, the maximum value and period of performance for Phase I contracts for SBIR was $100,000 over six months and for STTR was $100,000 over 12 months. For Phase II, the maximum for SBIR awards was $750,000 over 24 months and for STTR was $750,000 over 24 months.

Small Business Administration policy changes made in 2011 allow for larger maximum award sizes. Starting with the FY 2011 SBIR solicitations, Phase I awards can reach $150,000, and Phase II can reach up to $1 million. Awards for solicitations allowing this new range will be made in early to mid FY 2012.

For the FY 2012 solicitation, NASA will align SBIR and STTR topics with the space technology roadmaps and the National Aeronautics Research and Development Plan. NASA's Center Chief Technologists will coordinate between Center SBIR and STTR projects and mission needs on topic development, selection, project administration, infusion activities, and reporting processes. A Mission Directorate steering council will maximize alignment and infusion of the SBIR and STTR products into NASA's future missions and systems. This approach integrates and couples the SBIR and STTR programs as a critical component of the Agency's technology development activities, providing the small business researchers with more efficient infusion paths for viable products.

Project Descriptions and Explanation of Changes

The Small Business Innovation Research (SBIR) Program

SBIR was established by Congress in 1982 to increase research and development opportunities for small businesses with 500 or fewer employees, increase employment, and improve U.S. competitiveness. The program's specific objectives are to stimulate U.S. technological innovation, employ small businesses to meet Federal research and development needs, increase private sector commercialization of innovations derived from Federal research and development, and encourage and facilitate participation by socially disadvantaged businesses. NASA, as a mission driven agency, seeks small, high-technology companies to participate in Government-sponsored research and development efforts in technology areas critical to NASA's missions. Current authorization provides for SBIR funding at 2.5 percent of NASA's extramural research and development budget.

The Small Business Technology Transfer Research (STTR) Program

STTR awards contracts to small business concerns for cooperative research and development with a non-profit research institution, such as a university. NASA's STTR program has the primary objective of facilitating the transfer of technology developed by a research institution through the entrepreneurship of a small business, resulting in technology to meet NASA's needs. The small business and its partnering institution are required to sign an intellectual property agreement. Modeled after the SBIR program, STTR is a separately funded activity. STTR is smaller than SBIR, with funding set at 0.3 percent of the NASA extramural research and development budget.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	SBIR and STTR

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
At least 25 percent of the SBIR/STTR Phase II technology projects awarded between 2007 and 2011 will be infused into NASA programs and projects.	SBIR/STTR Program	None
At least 40 of the SBIR/STTR technologies will be advanced to Phase III (received non-SBIR/STTR funding).	SBIR/STTR Program	None
Greater than 35 percent of the Phase II SBIR/STTR technology projects awarded between 2007-2011 will be transferred into commercial products or services.	SBIR/STTR Program	None

Program Management

The SBIR and STTR Program is led by OCT Program Executives at NASA Headquarters. They oversee the Level II Program Office at ARC.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Small Business Innovation Research (SBIR) and Small Business Technology Transfer Research (STTR)	NASA Headquarters Program Executives. Level 2 Program Office at ARC.	All Centers	

Acquisition Strategy

The OCT Program Executives, the Level 2 Program Office, the Mission Directorates, and the Center Chief Technologists contribute to the acquisition process, from topic development, selection, project administration, and infusion activities to final reporting processes. In addition, a Mission Directorate steering council is employed to maximize alignment and infusion of the SBIR and STTR products into NASA's future missions and systems. NASA issues annual program solicitations that set forth a substantial number of topics and subtopic areas consistent with stated Agency needs or missions. Both the list of topics and the description of the topics and subtopics are sufficiently comprehensive to provide a wide range of opportunity for small business concerns to participate in NASA research or development programs. Topics and subtopics emphasize the need for proposals that meet specific Agency needs.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	National Academies	09/2009	Assessment of the SBIR program: Review is currently in Phase II of a two-phase study. Phase II results are planned for completion in early FY 2012. Phase I results have been published.	10/2011

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Partnership Development and Strategic Integration

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	20.3	-	19.5	19.4	19.3	19.1	19.0
Partnership Development and Strategic Integration	20.3	-	19.5	19.4	19.3	19.1	19.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

Partnership Development and Strategic Integration includes the activities of the Partnerships, Innovation and Commercial Space (PICS) and the Strategic Integration (SI) offices.

The PICS office is responsible for technology transfer and commercialization, interagency coordination and joint activities, intellectual property management, and partnership opportunities with other Government agencies and commercial industry. The office represents OCT in deliberations involving innovation-related policies, pilots, and processes for NASA to ensure these policies and processes stimulate greater commercial space activities within NASA and in the United States. The Executive Secretary for the Commercial Space Subcommittee of the NASA Advisory Council (NAC) resides within PICS.

The SI office works with the Mission Directorates and NASA Centers to develop an Agency technology portfolio and coordinate Agency technology investments. Consistent with the NASA Authorization Act of 2010, SI focuses on aligning NASA's technology investments to ensure that Space Technology complements Mission Directorate investments. SI is responsible for Agency technology strategic planning activities including technology roadmapping and serves as the primary point of collaboration for Mission Directorates, Mission Support Offices, and Center Chief Technologists. The Executive Secretary for the NAC Technology and Innovation Committee, NASA Technology Executive Council (NTEC), and Chief Technologist Council (CTC) reside within SI and support OCT representation to various Agency leadership panels.

Plans For FY 2012

PICS continues to support partnership opportunities with industry, academia, other Government agencies, and international entities. These activities include managing NASA's intellectual property from identifying new inventions to documenting and facilitating the patent process, to seeking partners to license the technology. NASA also seeks other opportunities for technology transfer through partnership agreements and release of software for public use. Partnership development activities continue to identify and demonstrate strategic areas of innovation with potential benefit to NASA.

To further energize new commercial space capabilities and industries, NASA will analyze, coordinate, and facilitate emerging commercial space efforts across the Agency and provide a NASA "front door" to new entrepreneurial space firms with a new Level 2 office at Ames Research Center (ARC).

In FY 2012, SI continues to carry out strategic technology planning, conduct technology studies, and coordinate Agency-level technology investments. SI will implement a system to capture and track NASA's technology portfolio, identify synergies and gaps, and ensure that the technology portfolio aligns with the technology investments and priorities documented in the NASA space technology roadmaps. SI continues development of the space technology roadmaps in cooperation with the National Academies; disseminates quarterly and annual technology reports; identifies and updates the Space Technology Grand Challenges; and guides prioritization for future technology development.

Project Descriptions and Explanation of Changes

Partnerships Innovation & Commercial Space (PICS)

PICS funds technology partnership activities at all NASA Centers. These Center offices carry out program support functions to facilitate Center-based technology transfer, innovative partnerships and commercialization activities.

Partnership activities focus on stimulating economic growth through technology transfer and access to NASA expertise, leveraging the technology investments of other Government agencies, connecting with industry technologists to permit utilization of NASA facilities, and expanding relationships with state, local, and regional technology-based economic development agencies.

Innovation activities identify strategic areas with potential benefit to NASA. In particular, NASA addresses gaps identified through technology roadmapping activities and seeks to increase the exchange of ideas with the most innovative segments of the private sector and Government. This is accomplished in several ways: piloting projects to explore how new methods and practices in innovation may be of benefit to NASA; appointing Innovation Ambassadors (i.e., NASA employees placed at external innovative organizations for up to 12 months); conducting one to two-day "Innovation Scouts" workshops that enable the exchange of information on innovation; bringing proven start-up entrepreneurs to NASA Centers to help develop business cases for promising NASA technologies; and engaging from leading experts in innovation.

Commercial space activities analyze, coordinate, and facilitate emerging commercial space capabilities and industries in support of NASA's missions, promoting economic growth, and improving national security. This is done by working with entrepreneurs across the aerospace industry to enable new commercial space capabilities similar to the way NASA's predecessor, the National Advisory Committee on Aeronautics (NACA), aided the early aeronautics industry, while leveraging ongoing NASA activities such as ISS utilization and the Commercial Orbital Transportation Services (COTS) and Commercial Crew Development (CCDEV) Programs. NASA will promote new business practices and collaboration models within NASA to lower cost and provide value to the American taxpayer while assessing, leveraging and facilitating the expansion of commercial capabilities into new areas, including commercial in-space servicing.

Strategic Integration (SI)

Strategic Integration works with the Mission Directorates and NASA Centers to document the Agency's technology portfolio, identify gaps, identify potential areas of synergy, collect information, and conduct decision-making studies that guide future technology investments. SI develops two sets of strategic guidance documents that assist in Agency technology prioritization. First, NASA uses the independent guidance provided by the STR, an integrated set of roadmaps from 14 space technology areas that includes near-term mission-focused technology and longer-term transformational technology. Second, NASA uses the Space Technology Grand Challenges, a set of technically challenging, strategic, space-related goals that push the Nation's technology boundaries and provide a guide to a stronger and more vibrant future for the Nation in space.

SI conducts focused studies, working group meetings, and development activities with NASA Mission Directorates, Centers, Agency partners, academia, and industry. SI disseminates information and coordinates technology development and infusion activities that are closely aligned with NASA missions and support national needs. SI organizes and coordinates the NTEC meetings, and the CTC, both chaired by the NASA Chief Technologist.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Establish at least 12 technology-related significant partnerships during FY 2012.	Partnership Development and Strategic Integration/PICS	None
Complete at least 30 technology transfer agreements during FY 2012.	Partnership Development and Strategic Integration/PICS	None
Document at least 40 notable technology transfer successes in NASA's Spinoff publication.	Partnership Development and Strategic Integration/PICS	None
Ensure that 75 percent of all NASA technology projects are recorded in the portfolio database and are analyzed against the prioritizations in the space technology roadmaps.	Partnership Development and Strategic Integration/SI	None

Program Management

The PICS and Strategic Integration offices are based at NASA Headquarters. Both programs work with technology partnership offices and the chief technologists at each NASA Center.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
PICS	Partnerships, Innovation and Commercial Space Director, NASA Headquarters	Technology Partnership Offices at all NASA Centers	N/A
Emerging Commercial Space Opportunities	NASA HQ program executive. ARC Level 2 Program Office facilitates emerging commercial space efforts.	All NASA Centers	N/A
Strategic Integration	Strategic Integration Director, NASA Headquarters	Center Chief Technologist Offices at all NASA Centers	N/A

Acquisition Strategy

A majority of the Partnership Development procurement activities are distributed to the NASA Centers for competitively selected contract support to their technology partnership offices. NASA uses novel approaches to facilitate technology transfer, as ensuring technologies are infused into commercial applications will promote the creation of new jobs and advance new products and services that will benefit the Nation.

Strategic Integration activities are accomplished by NASA Headquarters and the NASA Centers. Guidance is provided by the NASA Mission Directorates through the NTEC, and from the NASA Centers through the CTC. There are minimal procurement activities associated with this Agency technology coordination and strategic planning function.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Crosscutting Space Technology Development

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**7.5**	**-**	**433.3**	**432.1**	**429.2**	**425.8**	**422.4**
Crosscutting Space Tech Development	7.5	-	433.3	432.1	429.2	425.8	422.4

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Crosscutting Space Technology Development

Program Overview

CSTD invests in a diversified technology development portfolio that spans the TRL spectrum from concept study to flight demonstration, enabling revolutionary space capabilities. These activities focus on broadly applicable technologies, designed to enable quantum leaps in technological capability. NASA's Mission Directorates, other Government agencies, and industry are the ultimate customers for CSTD products. Within this program, there are three investment areas: Early Stage Innovation, Game Changing Technology, and Crosscutting Capability Demonstrations.

Within Early Stage Innovation, NASA sponsors a wide range of advanced aerospace system concept and foundational technology development (TRL 1-3) efforts. This includes the following four projects: Space Technology Research Grants that provide both foundational research in space technology and fellowships for graduate student research in space technology, NASA Innovative Advanced Concepts (NIAC), which engages innovators within and external to the Agency on aerospace system concept studies, a Center Innovation Fund to stimulate aerospace creativity and innovation at the NASA Centers, and Centennial Challenges Prizes that address key technology needs through new sources of innovation outside the traditional aerospace community.

Within Game Changing Technology, NASA focuses on maturing potentially transformational technology across the critical mid-TRL (3-5) gap between Early Stage Innovation and flight demonstration of a new technology. These fixed duration, principal investigator-led project elements are managed within two projects: Game Changing Development, which seeks disruptive technologies for future science and exploration missions, and Franklin Small Satellite Subsystem Technologies, which seeks innovation in subsystems for small satellites. Within Game Changing Technology, success is not expected with each investment; however, on the whole and over time, dramatic advances in space technology enabling entirely new NASA missions and solutions for a wide variety of society's grand technological challenges are expected and will be measured.

Within Crosscutting Capability Demonstrations, NASA demonstrates technologies that benefit multiple NASA missions, other Government agencies, or the space industry. This investment area matures new technology to flight readiness status (TRL 6-7) via three projects: Technology Demonstration Missions that demonstrate crosscutting technologies in the space environment, Edison Small Satellite Demonstration Missions that develop and operate a series of small satellite demonstration missions, and Flight Opportunities, which matures technologies by providing access to the space environment while also facilitating the development of the commercial reusable suborbital transportation industry.

Plans For FY 2012

Within Early Stage Innovation, NASA will initiate Phase II NIAC studies to further develop at least three of the most promising NIAC Phase I concepts from FY 2011 and predecessor NIAC efforts. An additional round of NIAC Phase I studies will be awarded resulting in at least 12 new NIAC efforts. In FY 2012, NASA will reach its goal of supporting 500 Space Technology Graduate Fellows from the Nation's universities. In addition, NASA will conduct at least three new Centennial Challenges competitions and initiate a wide range of innovative projects across the NASA Centers through the Center Innovation Fund. NASA also plans to release NRAs and make awards for approximately 40 new foundational space technology research activities. All Early Stage Innovation activities are competitively selected.

Within Game Changing Technology, the Game Changing Development project consists of both strategically guided and competed project elements. In FY 2012, the following four guided project elements are initiated: Nanotechnology, Deep Space Navigation and Communication, Space Synthetic Biology, and Manufacturing Innovation. Additionally, NASA expects to competitively award at least five Game Changing Development activities that augment the four project elements listed above or begin new crosscutting space technology development project elements. NASA will also competitively select at least three new project elements through the Franklin Small Satellite Subsystem Technology project.

Within Crosscutting Capability Demonstrations, the Technology Demonstration Missions and Edison Small Satellite Demonstration Missions projects consist of both strategically guided and competed project elements. In FY 2012, NASA will continue development of the Low Density Supersonic Decelerator Technology Demonstration Mission project element, transitioning this project element from formulation to implementation contingent on the results of the FY 2011 Mission Concept Review. In FY 2012, NASA plans to complete preliminary design of two competitively selected Technology Demonstration Mission project elements of system-level technologies for relevant environment flight demonstration. In FY 2012, at least three new small satellite missions will be initiated within Edison Small Satellite Demonstration Missions, with at least one of these missions being led by ARC. In Flight Opportunities, NASA will select and fly technology payloads from NASA Centers, other Government agencies, industry, and academia using flight services procured from at least three commercial reusable suborbital and parabolic platform providers. In this project element, in-space flight demonstrations are pursued not only as standalone missions, but also using planned NASA missions, the ISS, and commercial and international partner space platforms (e.g., hosted payloads or missions of opportunity).

Project Descriptions and Explanation of Changes

Game Changing Development project elements

Nanotechnology- Led by Glenn Research Center (GRC), this project element will include advancing nanotechnology research and applications for space technology, including nanomanufacturing, nanoelectronics, and nanoenhanced solar energy conversion. It also includes continued development of the Nano Energetics Propulsion effort led by the Marshall Space Flight Center (MSFC).

Deep Space Navigation and Communication- High bandwidth communications and advanced navigation capabilities will enable future deep space exploration of the solar system and pinpoint navigation in near-Earth space. This project element includes research in optical, X-ray, and other approaches to achieve high bandwidth communications and navigation activities. This project element is led by Space Communications and Navigation (SCaN) at NASA Headquarters and will involve both the Goddard Space Flight Center (GSFC) and the Jet Propulsion Laboratory (JPL).

Space Synthetic Biology- Biology readily demonstrates that life is an efficient user of resources around it, turning those resources into habitats, materials and forms that perform a wide range of functions efficiently. This project element, which will be led by the Ames Research Center (ARC), researches a range of genomics and synthetic biology approaches for the design of organisms to perform reliable functions for future human and robotic exploration activities.

Manufacturing Innovation- This project element, led by GRC, includes innovation in rapid prototyping for low-cost manufacturing, including algorithm and software development for modeling and simulation to streamline the design to manufacturing pipeline.

Through release of a BAA open to industry, academia, and the NASA Centers, NASA expects to competitively award at least five additional Game Changing Development activities that either augment the four project elements listed above or begin new project elements of a crosscutting space technology development nature.

Technology Demonstration Missions project elements

Low Density Supersonic Decelerator Technology Demonstration Mission- To safely land high-mass payloads on planetary surfaces, particularly for higher surface elevation landing sites, advances in supersonic decelerator technology are required. This project element (led by JPL) designs, develops and tests a range of supersonic decelerator technologies at high altitude on Earth (i.e., Mars relevant environment conditions). This project element will transition from formulation to implementation in FY 2012, contingent on the results of a Mission Concept Review in FY 2011. In FY 2012, NASA plans to complete preliminary design of at least one competitively selected Technology Demonstration Mission project of system-level technologies for relevant environment flight demonstration and initiate development of at least two additional Technology Demonstration Missions. These Technology Demonstration Mission activities will be undertaken to begin new project elements of a crosscutting space technology development nature.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Initiate Phase II studies to further develop two of the most promising prior (FY 2011 and predecessor NASA Institute for Advanced Concepts (NIAC)) Phase I concepts.	NASA Innovative Advanced Concepts Program (NIAC)	None
Conduct at least three Centennial Challenges competitions.	Centennial Challenges (CC)	None
Initiate at least five game changing technology projects.	Game Changing Development (GCD)	None
Complete preliminary design of at least two system-level technologies for flight or relevant environment demonstration.	Technology Demonstration Missions	None
Select and fly technology payloads from NASA, other government agencies, industry and academia using flight services procured from at least three commercial reusable suborbital and parabolic platform providers.	Flight Opportunities	None
Initiate at least 20 innovative projects across the NASA Centers.	Center Innovation Fund (CIF)	None
Initiate at least one new small satellite mission that will demonstrate game changing or crosscutting technologies in space	Edison Small Satellite Demonstration Missions	None
Initiate development of at least two new technology with game changing potential for small satellites.	Franklin Small Satellite Subsystem Technologies	None
Complete 100 research plans.	Space Technology Research Grants (STRG)	None

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Crosscutting Space Technology Development

Program Management

Management responsibility for project elements from CSTD and ETD are performed in an integrated manner.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Center Innovation Fund	NASA HQ program executive. Center Chief Technologists will competitively select projects.	All Centers	
Centennial Challenges	NASA HQ program executive. MSFC Level 2 Program Office implements innovative prize program.	N/A	
NASA Innovative Advanced Concepts (NIAC)	NASA HQ program executive will manage conduct of visionary, long-term concept studies.	All Centers	
Space Technology Research Grants	NASA HQ program executive. GRC Level 2 Program Office manages foundational research.	All Centers	
Franklin Small Satellite Subsystem Technologies	NASA HQ program executive. ARC Level 2 Program Office manages subsystem technology efforts.	All Centers	
Game Changing Development	NASA HQ program executive. LaRC Level 2 Program Office fosters revolutionary technology.	All Centers	
Technology Demonstration Missions	NASA HQ program executive. MSFC Level 2 Program Office manages crosscutting technology flight test.	All Centers	
Edison Small Satellite Demonstrations	NASA HQ program executive. ARC Level 2 Program Office manages demonstration missions.	All Centers	
Flight Opportunities	NASA HQ program executive. DFRC Level 2 Program Office manages flight platforms.	All Centers	

Acquisition Strategy

To achieve the Agency's technology goals, the Crosscutting Space Technology Development (CSTD) program is implemented predominantly through a technical peer review, open competition acquisition approach, with solicitations open to the broad aerospace community to ensure engagement with the best sources of new and innovative technology. As such, CSTD will be performed by the Nation's highly skilled workforce in industry, academia, across all NASA Centers, and in collaboration with other Government agencies. Awards will be made based on technical merit, cost, and impact to the Nation's future space activities. NASA's Mission Directorates, other Government agencies, and industry are the ultimate customers for Crosscutting Space Technology Development products.

To increase competition within CSTD solicitations, NASA plans to engage potential partners using industry forums, requests for information, and bidder's conferences. NASA uses acquisition mechanisms such as BAAs, NRAs, and prize competitions.

All selections in Early Stage Innovation and 70 percent of Game Changing Development and Crosscutting Capabilities Demonstrations are competitively awarded. NASA has partnered with Defense Advanced Research Projects Agency (DARPA) to share lessons learned. In FY 2012, additional Government agency partners are likely. CSTD Technology Demonstration Missions require proposers to partner with entities (external to CSTD) to cost share a minimum of 25 percent of the proposed development effort in demonstrating a credible infusion path. Flight Opportunities solicitations will be focused on facilitating the development of the commercial reusable suborbital transportation industry. This is an important step in the longer-term path that envisions suborbital reusable launch vehicles evolving to provide the Nation with low-cost, frequent, reliable access to orbital space.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Exploration Technology Development

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**151.4**	**-**	**261.3**	**259.3**	**257.5**	**255.5**	**253.4**
Exploration Technology Development	151.4	-	261.3	259.3	257.5	255.5	253.4

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

In FY 2012, NASA has moved a significant portion of the FY 2010 ETD, as well as the planned FY 2011 exploration technology activities, from ESMD to Space Technology in order to capitalize on the synergy between these activities and those in the Crosscutting Space Technology Development. For traceability, the transferred activities have been consolidated in a specific budgetary element within Space Technology: ETD. ETD activities provide the long-range, critical technologies required to conduct future human exploration missions beyond low Earth orbit with reduced risk and life cycle cost. Through ETD, exploration-specific prototype systems and key capabilities are demonstrated in ground-based and laboratory testing, relevant environment flight demonstrations, and technology test beds, including the ISS. ETD focuses on the highest priority technology needs identified in NASA's recent human exploration mission architecture studies. ESMD is the primary customer for ETD advances. By moving a majority of the Agency's exploration-specific technology development activities from ESMD to Space Technology, NASA better integrates its space technology portfolio, gains management and technical synergies, and places the management of these activities within an organization focused upon technology development and infusion.

NASA will continue to manage ETD through both strategically guided and competed project elements. The guided project elements will focus upon key Agency technology priorities identified in recent human exploration mission architecture studies, leveraging the existing technical strength of the NASA Centers. The competed project elements will focus on enabling exploration technologies that either augment the guided project elements or begin new project elements with an exploration-specific technology demonstration focus.

ETD consists of two projects: Exploration-specific Game Changing Development and Exploration-specific Technology Demonstration Missions. ETD seeks disruptive technologies for future human exploration missions to multiple destinations, including the Moon, Lagrange points, near Earth asteroids, and Mars and its moons. After successful maturation of these critical technologies, program managers can identify and baseline proven technologies for future ESMD human space flight systems.

Plans For FY 2012

ETD will continue most of the investments from the FY 2010 Exploration Technology Development Program and includes new exploration technology activities in planning in FY 2011. The transferred activities have been consolidated within two projects in ETD: Exploration-specific Game Changing Development and Exploration-specific Technology Demonstration Missions. Capitalizing on technical and management synergies, NASA plans to manage ETD and CSTD in an integrated manner. Customer focus, the balance between competed/guided project elements, and cost-share requirements are the differentiating characteristics of ETD and CSTD. In FY 2012, 70 percent of the funds within ETD will be applied to guided activities.

Within ETD, FY 2010 Exploration Technology Development Program activities and FY 2011 plans have been organized into the following nine FY 2012 Exploration-specific Game Changing Development project elements: In-Space Propulsion, Space Power Generation and Storage, Nuclear Systems, Lightweight Materials and Structures, Human-Robotic Systems, Autonomous Systems, Next-Generation Life Support, Adaptive Entry Systems, and In-Situ Resource Utilization. In addition, in FY 2012, NASA will release a BAA open to industry, academia, and the NASA Centers for additional exploration-specific Game Changing Development activities. NASA expects to competitively award at least seven activities that either augment the nine project elements listed above or begin new project elements with an exploration-specific technology development focus.

In FY 2012, NASA will continue development of the following FY 2010 Exploration Technology Development Program activities and FY 2011 plans through five Exploration-specific Technology Demonstration Mission project elements: Human Exploration Telerobotics, Mars Science Laboratory Entry, Descent, and Landing Instrumentation (MEDLI), Autonomous Landing and Hazard Avoidance Technology (ALHAT), Cryogenic Propellant Transfer and Storage, and Solar Electric Propulsion. The Cryogenic Propellant Transfer and Storage and Solar Electric Propulsion project elements will complete Phase A concept studies in FY 2011. Based on the results of these concept study efforts, these two Exploration-specific Technology Demonstration Missions will transition from formulation to implementation in either FY 2012 or FY 2013.

Project Descriptions and Explanation of Changes

Exploration-specific Game Changing Development project elements:

In-Space Propulsion: This project element, led by GRC, will focus on the component low-thrust and high-thrust propulsion technology advances necessary for efficient transfer into deep space.

Space Power Generation and Storage: This project element, led by GRC, will develop technologies to provide low-cost, abundant power for deep-space missions (and dual-use terrestrial applications), including high-efficiency solar cells, advanced batteries and regenerative fuel cells.

Nuclear Systems: This project element, led by GRC, will test power conversion and thermal management technologies for in-space nuclear power and propulsion systems. Non-nuclear testing will validate the performance of integrated systems. NASA will partner with DOE in this development.

Lightweight Materials and Structures: This project element, led by LaRC, will develop advanced materials and structures technology to enable lightweight systems to reduce mission cost. As part of this element, a composite cryogenic propellant tank activity applicable to heavy lift launch vehicles, propellant depots, and future lander systems will be led by MSFC.

Human-Robotic Systems: This project element, led by JSC, will develop advanced robotics technology to amplify human productivity and reduce mission risk by improving the effectiveness of human-robot teams. Key technologies include human-robot interaction, robotic assistance, and surface mobility systems.

Autonomous Systems: This project element, led by ARC, will develop and demonstrate integrated autonomous systems (including automated planning, Integrated Systems Health Management [ISHM], and radiation hardened electronics) capable of managing complex operations in space to reduce crew workload and dependence on Earth.

Next-Generation Life Support: This project element, led by JSC, will develop next-generation life support systems technologies (including atmospheric revitalization, water recovery, thermal control, active radiation protection, food production, and next-generation spacesuit technologies) needed for humans to live and work productively in space.

Adaptive Entry Systems: This project element, led by LaRC, will design, analyze, and test options for development of a large aeroshell, including the use of hypersonic inflatable aerodynamic decelerators, deployable systems, and those constructed through on-orbit assembly. As part of this element, deployable systems and flexible ablative thermal protection system (TPS) activities will be led by ARC.

In-Situ Resource Utilization (ISRU): This project element will enable sustainable human exploration through use of local resources. Concepts to produce fuel, oxygen, and water from the soil and atmosphere of celestial bodies will be explored. Led by KSC.

NASA will also release a BAA open to industry, academia, and the NASA Centers through which at least seven activities that either augment the nine project elements listed above or begin new project elements with an Exploration-specific technology development focus are expected to be awarded.

Exploration-specific Technology Demonstration Missions project elements:

Human Exploration Telerobotics: This project element, led by ARC, will demonstrate safe and cooperative interactions between humans and robots. The Robonaut 2 humanoid robot and Synchronized Position Hold, Engage, Reorient, Experimental Satellites (SPHERES) experiments on ISS will be teleoperated from the ground to assist the crew in performing hazardous or routine tasks. A standard robot control interface will be tested that allows different robots from NASA and international partners to work together.

MEDLI: The MEDLI suite is a set of engineering sensors designed to measure the atmospheric conditions and performance of the MSL heat shield during entry and descent at Mars. While not part of the core MSL scientific payload, it will provide important information for the design of entry systems for future planetary missions. This project element, led by LaRC, will be completed in 2012.

ALHAT: This project element, led by JSC, is developing technologies that will allow planetary landers to automatically identify and navigate to the location of a safe landing site while detecting landing hazards during the final descent to the surface. Technologies being testing include flash lidar for three-dimensional mapping, advanced speed measurements and algorithms. This project element will be completed in 2012.

Cryogenic Propellant Transfer and Storage: Minimizing boil-off of cryogenic propellants on long-duration missions is a critical capability needed to enable high-energy cryogenic propulsion stages, a key component of future human spaceflight architectures. This Exploration-specific Technology Demonstration Mission will, for the first time, demonstrate the capability of storing liquid oxygen and liquid hydrogen in-space for at least six months. The flight system consists of a representative cryogenic propulsion stage launched into low Earth orbit. Testing of fluid transfer between tanks is under consideration. Ongoing technology developments will include active cooling of propellant tanks, advanced thermal insulation, measurement of propellant mass, liquid acquisition devices, and automated fluid couplings for propellant transfer between vehicles. This activity, led by GRC, will transition from formulation to implementation in either FY 2012 or FY 2013, based on the results of concept study efforts conducted in FY 2011.

Solar Electric Propulsion: This near-Earth technology maturation effort, led by GRC, will demonstrate a solar electric propulsion system of sufficient power to serve as a stepping-stone to that required for the future human exploration missions. This activity will transition from formulation to implementation in either FY 2012 or FY 2013, based on the results of concept study efforts conducted in FY 2011. NASA will partner with Air Force Research Laboratory (AFRL) in this development.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Demonstrate Robonaut 2 assisting the crew to perform tasks inside the ISS.	Exploration Technology Development	
Test automated fluid couplings for cryogenic propellant transfer to support Cryogenic Propellant Storage And Transfer (CRYOSTAT) systems requirements.	Exploration Technology Development	

Program Management

ETD and CSTD project elements are managed in an integrated manner as listed below.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Exploration-specific Game Changing Development	NASA HQ program executive. LaRC Level 2 Program Office fosters revolutionary technology.	All Centers	
Exploration-specific Technology Demonstration Missions	NASA HQ program executive. MSFC Level 2 Program Office manages crosscutting technology flight test.	All Centers	DoE, General Motors, Air Force Research Laboratory

Acquisition Strategy

A lead Center will manage each of the guided ETD project elements as a finite duration effort that will include a number of competitive procurements. For example, starting in FY 2012, NASA Centers will initiate a series of Exploration-specific Technology Demonstration Missions that will issue competitive contracts for mission development and flight demonstration support. The first two Exploration-specific missions in this line will be the CRYOSTAT and the Solar Electric Propulsion Technology Demonstration Missions, each led by GRC.

In FY 2012, 30 percent of the funds within ETD will used for competitive awards, drawing proposals from industry, academia, and the NASA Centers. Exploration-specific Game Changing Development BAA proposers will be expected to either augment the identified ETD project elements or propose high-value complementary or gap areas of ETD. Exploration-specific Technology Demonstration Missions proposers are strongly encouraged to partner and cost share with entities (external to Space Technology). However, unlike CSTD, a minimum of 25 percent cost share is not required.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	ST Civil Service Labor and Expenses

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**132.9**	**136.6**	**142.6**	**149.5**	**156.6**
ST Civil Service Labor and Expenses	0.0	-	132.9	136.6	142.6	149.5	156.6

Program Overview

This program contains labor funding, both salary and benefits, for civil service employees at NASA Centers who are assigned to work on projects in the Space Technology programs. These funds support the critical skills and capabilities required to provide technology development, as outlined in the other programs, within this mission area.

Mission Directorate: Exploration

Overview

The Exploration Systems Mission Directorate (ESMD) develops the systems and capabilities required for human exploration of space beyond low Earth orbit (LEO) and for U.S. crew access to the International Space Station (ISS) after retirement of the Space Shuttle. These systems and capabilities developed by ESMD include launch and crew vehicles for missions beyond LEO, affordable commercial crew access to the ISS, technologies and countermeasures to keep astronauts healthy and functional during deep space missions, and technologies to reduce launch mass and cost of deep space missions. NASA's goals are consistent with the NASA Authorization Act of 2010, which calls for expanding permanent human presence beyond LEO to destinations such as the surface of the Moon, near-earth asteroids, and Mars, while maintaining uninterrupted U.S. human space flight capability in LEO and beyond.

- The Human Exploration Capability (HEC) Theme will develop the launch and space flight vehicles that will provide the initial capability for crewed exploration missions beyond LEO. In particular, HEC's Space Launch System (SLS) Program will develop the heavy lift vehicle (HLV) that will launch the crew vehicle, other modules, and cargo for these missions. The Multi-Purpose Crew Vehicle (MPCV) Program is developing the vehicle that will carry the crew to orbit, providing emergency abort capability, sustaining the crew while in space, and providing safe re-entry from deep space return velocities.

- The Exploration Research and Development (ERD) Theme comprises the Human Research Program (HRP) and the Advanced Exploration Systems (AES) Program, which provides the knowledge and advanced human spaceflight capabilities required to implement the U.S. Space Exploration Policy. HRP will provide technologies, countermeasures, diagnostics, and design tools to keep crews safe and productive on long-duration space missions. The Theme's technology development efforts can contribute toward advances in U.S. high technology products and services.

- Exploration's Commercial Spaceflight Theme creates incentives for commercial providers to develop and operate safe, reliable, and affordable commercial systems to transport crew and cargo to and from the ISS and LEO. This approach will provide assured access to the ISS, strengthen America's space industry, and provide a catalyst for future business ventures to capitalize on affordable access to space. A vibrant commercial space industry will add well-paying, high-tech jobs to the U.S. economy and will reduce America's sole reliance on foreign systems.

One of the greatest challenges for NASA is to reduce the development and operating costs for human space flight missions. NASA will not be able to sustain a long-term U.S. human spaceflight program without such reductions. NASA must plan and implement an exploration enterprise with costs that are credible, sustainable, and affordable for the long term under constrained budget environments. Longer-duration crewed exploration missions to destinations such as near-Earth asteroids, Lagrange points, the Moon, and Mars require additional vehicles and capabilities beyond the crew and launch vehicles. To extend human presence to these destinations, the development and operation costs of the crew and launch vehicles must be affordable enough to allow for the development and operation of the additional vehicles and capabilities.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,625.8**	**3,594.3**	**3,706.0**	**3,948.7**	**3,948.7**	**3,948.7**	**3,948.7**	**3,948.7**
Human Exploration Capabilities	3,287.5	-	-	2,605.8	2,591.2	2,581.4	2,570.4	2,560.2
Commercial Spaceflight	39.1	-	-	792.8	795.0	792.5	789.7	785.5
Exploration Research and Development	299.2	-	-	211.4	214.3	211.2	207.5	203.7
ESMD Civil Service Labor and Expenses	0.0	-	-	338.7	348.2	363.6	381.1	399.4

Note: For comparability, previous similar program content is shown in the FY2010 column, in the new program structure.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267). The amount shown for the Exploration account, reflects a reduction of $162M from the $250M that was authorized for Exploration Technology Development activities, which were transferred to the Space Technology account.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Exploration

Human Exploration Capabilities

New Initiatives:

The HEC Theme is the successor to the Constellation Systems Theme in the FY 2010 appropriation. The HEC programs were authorized by the NASA Authorization Act of 2010.

Major Changes:

The HEC Theme will focus on two general initial capabilities for human exploration beyond LEO. The former Constellation Theme, which the HEC Theme replaced, focused on ISS crew access, followed later by missions to the surface of the Moon.

Major Highlights for FY 2012

In FY 2012, the SLS and MPCV Programs will build upon the acquisition strategies, program management, and the NASA workforce and institution choices made in FY 2011 in order to maximize value to the American taxpayers and enable groundbreaking human exploration beyond LEO.

Commercial Spaceflight

Major Changes:

The Commercial Spaceflight Theme will transition from completing commercial cargo capability milestones to expanding NASA's efforts to develop commercial crew capability to LEO and the ISS.

Major Highlights for FY 2012

Under the Commercial Spaceflight Theme, NASA's commercial partners will be completing milestones associated with their Commercial Crew Development (CCDev) Round 2 awards. In spring FY 2012, the CCDev Round 2 awards will be completed and NASA plans to further expand commercial crew systems under CCDev Round 3 awards. Round 3 awards will support development, testing, and demonstrations of multiple commercial crew systems for U.S. crew access to LEO and the ISS.

Major Changes:

In FY 2012, the Exploration Technology Development (ETD) Program, which was an element of the ERD Theme in FY 2011, will be transferred to the Office of the Chief Technologist.

Major Highlights for FY 2012

HRP will conduct biomedical flight experiments on the ISS, including the delivery of a biomedical ultrasound device to the ISS and a training program to use the device for diagnosing bone fractures. HRP will also deliver a design tool to assess radiation shielding on space vehicles and update the acute radiation risk model.

While the ETD Program will be transferred to the Office of Chief Technologist, an Advanced Exploration Systems (AES) Program will be established to contain a few critical efforts that do not fit with the other efforts of that Office. Life support, habitation, and extra-vehicular activity elements of ETD will remain in the AES Program, because these capabilities are critical to crew safety and the success of future vehicle production and human spaceflight missions. It is important that these areas be managed in concert with associated vehicle development and closely overseen by human spaceflight personnel.

AES will develop and demonstrate prototype systems for life support, habitation, and extravehicular activity (EVA), which will enable NASA to conduct future human missions beyond LEO while reducing risk and lifecycle cost. AES demonstrates these systems using ground test beds, Earth-based field and underwater tests, and ISS flight experiments.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities

Theme Overview

The HEC Theme develops the vehicles and supporting elements to extend human presence beyond LEO and enables missions to locations such as near-Earth asteroids, Lagrange points, the surface of the Moon, or Mars. The initial capabilities developed by the HEC Theme are the MPCV and SLS. MPCV Program development efforts include a crew capsule, service module, and launch abort system. SLS Program development focuses on a heavy lift vehicle that can carry the large payloads required for human exploration missions, including MPCV. HEC's programs also provide essential supporting elements, including mission operations, ground operations and processing, ground test facilities, and crew equipment. While HEC's primary purpose is human exploration beyond LEO, the MPCV and SLS could be combined to provide backup crew and cargo services for the ISS.

NASA is developing plans for implementing the MPCV and SLS Programs, including transition of relevant design and developmental activities of the Constellation Program. A major element of the transition involves shifting design and developmental efforts away from a closely coupled system (Ares I and Orion) to a more general launch vehicle (i.e., SLS) and crew vehicle (i.e., MPCV).

Safety and affordability are central to NASA's HEC planning efforts. MPCV and SLS development and operations costs must be sufficiently low to allow development and operation of the vehicles and capabilities required for longer-duration exploration missions beyond LEO. These missions require innovative development of propulsion, crew habitat, and life support, and missions to other planetary surfaces will require additional exploration vehicles.

NASA plans to approach affordability comprehensively in pursuit of exploration beyond LEO to increase the probability that key elements are developed and missions can occur within a realistic budget profile. For all development activities, NASA will emphasize innovative acquisition and program management approaches, including risk management, to reduce recurring and operations costs. In doing so, plans for bringing the MPCV and SLS vehicles online with lower costs will be as credible and realistic as possible, and significant efforts made to ensure cost risks will be well understood. Overall, NASA's designs and acquisition strategies for the MPCV and SLS Programs will not be solidified until all of the pertinent knowledge on cost and safety is obtained to ensure an affordable and executable solution.

NASA is aligning its HEC efforts with the goals and requirements of the NASA Authorization Act of 2010 (P.L. 111-267) in a long-term, affordable, safe, and sustainable manner. Lowering costs will enable ambitious missions and help create a more exciting future for humanity in space.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,287.5**	**-**	**2,605.8**	**2,591.2**	**2,581.4**	**2,570.4**	**2,560.2**
Space Launch System		-	1,689.5				
Multi-Purpose Crew Vehicle		-	916.3				

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Multi-Purpose Crew Vehicle

NASA is developing plans for implementing the MPCV and SLS Programs, including efforts to transition the design and developmental activities of the Constellation Program. These efforts involve concurrent evaluation of MPCV and SLS Reference Vehicle Designs (RVDs) and alternative designs. NASA has developed a process to make progress on them while determining whether the designs are sufficiently affordable, sustainable, and realistic, and at the same time, studying other options to solicit innovative ideas. To achieve human exploration beyond LEO, NASA must determine an affordable and credible development plan for MPCV and SLS.

In addition to improving acquisition and program management approaches, NASA will drive down development and operations costs through innovation, improved practices, right-sized infrastructure, and reducing other fixed costs. These efforts will help NASA achieve the earliest possible date for initial operational capability. During FY 2012, the MPCV and SLS Programs will build upon these choices to maximize the value to the American taxpayers and enable groundbreaking human exploration beyond LEO.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

HEC efforts reflect alignment to the goals and requirements of the NASA Authorization Act of 2010 in a long-term, affordable, safe, and sustainable manner for participation and leadership in the exploration and utilization of space, and expanding a permanent human presence beyond LEO to destinations such as near-Earth asteroids, the Moon, and Mars.

Relevance to the NASA Mission and Strategic Goals:

HEC develops the vehicles that will meet NASA Strategic Outcome 1.4, to "Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit." Capabilities for delivering crew and cargo beyond low Earth orbit enable Goal 1, to "Extend and sustain human activities across the solar system." The HEC Theme will draw upon previously demonstrated capabilities and operational experience from human spaceflight programs in establishing exciting new programs that can take astronauts to many possible destinations within the inner solar system.

Relevance to education and public benefits:

As it has throughout NASA's history, human presence in space will continue to serve as a public symbol of the Nation's leadership. NASA's efforts to exceed the capability, affordability and safety of the Space Shuttle and develop systems leading to human exploration beyond LEO will demonstrate technologies with many possible applications to future prosperity and national security. These activities also provide a training ground for the next generation of scientists and engineers. NASA's exploration initiatives continue to nurture elements of the aerospace industry and workforce and are likely to inspire the Nation's youth to pursue careers in science, technology, engineering, and mathematics (STEM) fields.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.3	**Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.**	
Objective 1.3.1	**Execute development of an integrated architecture to conduct human space exploration missions beyond low Earth orbit.**	
Performance Goal 1.3.1.1	***Complete design reviews for Space Launch System (SLS).***	
APG 1.3.1.1: HEC-12-1	Successfully complete Space Launch System's (SLS) Systems Requirements Review (SRR).	Space Launch System
Performance Goal 1.3.1.2	***Complete design reviews for Multi-Purpose Crew Vehicle (MPCV).***	
APG 1.3.1.2: HEC-12-2	Complete testing of Multi-Purpose Crew Vehicle (MPCV) Ground Test Article (GTA).	Multi-Purpose Crew Vehicle

Performance Achievement Highlights:

The HEC Theme begins NASA's transition from the Constellation Program in FY 2011 consistent with constraints in NASA's appropriations and authorizations. The Theme shifts focus toward development of capabilities permitting flexible missions to multiple destinations beyond LEO. These efforts involve replanning for vehicle capabilities, realigning schedules, and shifting the management approach from a closely coupled system (Ares I and Orion) to a more general launch vehicle and crew vehicle.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Space Launch System

Program Overview

SLS is a new program to develop a heavy-lift vehicle (HLV) as one of the components to extend human presence in space beyond LEO and to enable ambitious missions with destinations such as near-Earth asteroids, the Moon, and Mars. The SLS Program would provide the capability to lift the MPCV and other vehicles and cargo necessary for exploration missions, as well as large science spacecraft.

To be successful both as an individual program and as a component of an affordable exploration architecture, the SLS program must greatly reduce development and operations costs from NASA's experience in past programs. Affordability, and crew and public safety, are primary objectives for heavy-lift, NASA, with support from industry partners, will investigate alternative vehicle designs and architectures to validate, support, or challenge design plans, ensuring an affordable design that meets NASA's requirements.

To help inform decisions on the final detailed design concept and acquisition details for the SLS, NASA has initiated several industry study contracts regarding heavy-lift and propulsion. These study contracts will provide a "fresh look" at innovative launch vehicle concepts, propulsion technologies, and processes that can be infused into the development of the new human exploration missions. This information that will be used to help inform the overall selection and development of the final SLS vehicle detailed design.

In FY 2012, NASA will continue to define a sufficiently affordable, sustainable and realistic SLS development plan. Human Exploration Capabilities will perform technical assessments to determine the best path forward for SLS. Consistent with direction in the NASA Authorization Act of 2010, NASA will leverage existing designs and hardware which includes NASA's selection of an SLS RVD RVD that is derived from Ares and Shuttle hardware. Informed by the NASA analyses, the current RVD is a 27.5-foot diameter core liquid oxygen/liquid hydrogen (LOX/LH2) vehicle with five Space Shuttle Main Engine (SSME)-derived core stage engines, (designated RS-25E), a LOX/LH2 upper stage with a J-2X engine, and two Ares-derived five-segment solid rocket boosters. The RVD would provide a combined lift capability of approximately 100-130 metric tons to LEO.

Program Relevance

SLS directly supports NASA Strategic Goal 1, to "Extend and sustain human activities across the solar system," and Outcome 1.4, to "Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit." SLS develops the affordable, safe, and capable HLV that is essential to launch the crew and cargo elements for exploration missions beyond LEO.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Space Launch System

Plans For FY 2012

NASA has established three principles for development of future systems for exploration: these systems must be affordable, sustainable, and realistic. NASA commits to identify a heavy-lift architecture that would meet these goals within the available SLS budget.

NASA recognizes that in order to be sustainable, future launch systems, their infrastructure, and corresponding missions must be affordable and timely. The costs for design, development, test, and evaluation (DDT&E) for new propulsion systems must be within the projected NASA budgets. Similarly, the recurring costs of producing and operating these systems in future space exploration missions must be significantly reduced to enable development of additional needed exploration flight elements, and a sustainable flight rate for future NASA missions.

In FY 2012, NASA will continue to define a sufficiently affordable, sustainable and realistic SLS development plan. FY 2012 efforts will build upon the multiple parallel activities of the SLS FY 2011 formulation phase that are planned to find the most efficient and effective development and recurring annual operating costs for the SLS. NASA will transition relevant work from the Space Shuttle Program and Ares project to the new SLS Program and continue to define the requirements for the SLS. Included in this approach is the performance of technical assessments to determine the best path forward for SLS. Consistent with direction in the NASA Authorization Act of 2010, NASA will leverage existing designs and hardware, which includes NASA's selection of an SLS RVD that is derived from Ares and Shuttle hardware. The RVD will continue to be refined as NASA completes its studies and evaluations. Informed by NASA's analyses to-date, the current RVD is a 27.5-foot diameter core LOX/LH2 vehicle with five SSME-derived core stage engines, a LOX/LH2 upper stage with a J-2X engine, and two Ares-derived five-segment solid rocket boosters. The RVD would provide a combined lift capability of approximately 100 to 130 metric tons to LEO.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Successfully complete Space Launch System's (SLS) Systems Requirements Review (SRR).	Space Launch System (SLS)	New

Program Management

The SLS Program will be managed at the Marshall Space Flight Center (MSFC), with supporting input from the Glenn Research Center (GRC) and the Kennedy Space Flight Center (KSC).

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Space Launch System

Acquisition Strategy

NASA is developing a full acquisition strategy for the SLS. Given that the current RVD would utilize heritage systems from the Shuttle and Ares, NASA is evaluating existing Ares and Shuttle contracts and potential money saving improvements and modifications to them. This process will determine whether those contracts could be used for development work on the SLS and whether doing so would be the most affordable and efficient option for developing the SLS. As NASA seeks to maintain existing capabilities during this planning effort, HEC continues work on the elements of the Ares I project that are most likely to feed forward into the SLS.

On November 8, 2010, NASA announced the results of the heavy lift and propulsion study contracts that were awarded as part of a Broad Agency Announcement (BAA) issued in May 2010. As part of this competitive solicitation, NASA selected 13 companies to conduct six-month studies examining the trade space of potential heavy-lift launch and space transfer vehicle concepts. The BAA is focused on achieving affordability, operability, reliability and commonality at the system and subsystem levels with multiple users, including other Government, commercial, science and international partners. These trade studies will provide a "fresh look" at innovative launch vehicle concepts, propulsion technologies, and processes that can be infused into the development of the new human exploration missions information that will be used to help inform the overall selection and development of the final SLS vehicle detailed design.

Reducing recurring costs and the cost of operations will be one of the greatest challenges for the SLS team. For all SLS acquisitions and development activities, NASA will employ improved acquisition approaches such as design-to-cost and lifecycle cost analyses that use industry best practices, consider incentives for contractor reductions in fixed costs, and address cultural changes within the Agency to focus more on affordability rather than just performance factors.

NASA hopes to finalize its acquisition decisions as early as the spring of 2011. Details will be included in a follow-on report to Congress.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Multi-Purpose Crew Vehicle

Program Overview

MPCV is a new program to develop a spacecraft that will carry humans beyond LEO. MPCV will be capable of conducting in-space operations with other payloads and vehicles in low Earth orbit and beyond. NASA's initial assessments show high applicability of the Orion spacecraft development to the MPCV requirements. To the extent possible NASA will utilize the progress made by the Orion project. NASA will continue the advanced development of the human safety features, designs, and systems already identified.

The current RVD for MPCV consists of a crew module capsule, service module, and launch abort system. The combined crew and service modules provide power, life support, crew systems and habitability, communications, and propulsion for operations beyond LEO. The RVD lands safely on water, with land as a contingency option. The MPCV Program includes the supporting functions of mission operations and suits for launch/entry/landing and EVA.

The MPCV development and operations cost must be affordable enough to allow development and operation of the vehicle and capabilities required for longer duration exploration inherent in missions beyond LEO. Controlling and reducing costs requires implementing affordability measures such as streamlining NASA's insight/oversight of contractor activities, implementing a streamlined test and verification strategy consistent with other aerospace practices, phasing work to meet spending rate targets, adopting incremental development methods to achieve capabilities consistent with the Agency strategy, realizing efficiencies in the implementation of internal NASA governance and program management processes and practices, and optimizing Agency facilities and infrastructure costs. Flexibility to develop optimal technical solutions and a schedule that best benefits the Agency's long-term exploration needs are essential to the development of a robust and affordable MPCV.

Program Relevance

MPCV is a direct element of NASA Strategic Goal 1, to "Extend and sustain human activities across the solar system," and Outcome 1.4, to "Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit." The plan for MPCV is to develop an affordable and safe, crew vehicle that will facilitate exploration missions beyond LEO.

Plans For FY 2012

In FY 2012, the MPCV Program will focus on maturing designs from the Orion Crew Exploration Vehicle's Preliminary Design Review toward an MPCV Critical Design Review level of maturity. Integrated and component ground testing will continue, including evaluation of the Ground Test Article and the parachute system. Facilities construction and outfitting will continue where needed to enable testing, assembly, and processing of test flights.

An MPCV master program schedule, including all major milestones from inception to achieving operational capability, will be developed as part of program initiation. NASA will achieve an early operational readiness date within the available budget and in a manner that leads to affordable operations over the long term.

Mission Directorate:	Exploration
Theme:	Human Exploration Capabilities
Program:	Multi-Purpose Crew Vehicle

Program Commitments

Commitment/Output **FY 2012**	**Program/Project**	**Changes from FY 2011 PB Request**
Complete testing of Multi-Purpose Crew Vehicle (MPCV) Ground Test Article (GTA).	Multi-Purpose Crew Vehicle (MPCV)	New

Program Management

The MPCV Program will be managed at the Johnson Space Center (JSC), with support from the four research Centers--Ames, Dryden, Glenn, and Langley--and MSFC and KSC.

Acquisition Strategy

NASA is adhering to guidance set forth in the 2010 Authorization Act, which states that the Administrator shall "to the extent practicable extend or modify existing vehicle development and associated contracts necessary" to develop to MPCV. Existing Constellation Program contracts pertaining to the Orion project and supporting functions continue to be executed while the final MPCV implementation plan is being developed. This approach provides the least impact on jobs in the near term, while providing maximum leverage to the Agency as it plans development of the earliest affordable MPCV.

Final plans for leveraging existing contracts, civil service, and contract workforce will be updated when the final FY 2011 appropriation is provided. Initial planning is focusing on using the existing Orion project contracts, organization, and workforce to the maximum extent possible.

Mission Directorate:	**Exploration**
Theme:	**Commercial Spaceflight**

Theme Overview

NASA's vision of commercial space flight to LEO is a robust, vibrant, profitable enterprise with many providers and a wide range of private and public customers. NASA is embracing this vision with the newly established Commercial Spaceflight Theme.

Activities within this Theme aim to incentivize and encourage commercial providers to build and operate safe, reliable, and cost-effective commercial crew and cargo transportation systems for flight to and from LEO and the ISS. During the development phase, NASA plans to partner with U.S. industry, providing technical and financial assistance as they develop commercial launch and transportation capabilities. During the operations phase, NASA plans to be a customer for these transportation services. NASA anticipates that these activities will stimulate the development of new commercial services available to many customers, not just the U.S. Government.

NASA expanded its commercial spaceflight efforts in 2006 with the formation of Space Act Agreements for the development of ISS cargo resupply systems under the Commercial Orbital Transportation Services (COTS) Program. Space Act Agreements are written to maximize the flexibility and innovation of private development efforts by ensuring Government specifications are kept to a minimum. As part of these Agreements, companies partnering with NASA were required to contribute their own funding to the activity thereby leveraging NASA dollars and ensuring a larger net investment in commercial cargo capability development. The COTS Program made significant progress in FY 2010, culminating in the successful first demonstration flight of the Falcon 9 launch vehicle and Dragon spacecraft. This flight attested to the viability of Government and private sector partnerships in the development of commercial cargo space flight services.

In FY 2010, NASA further expanded its commercial spaceflight efforts to encompass crew transportation systems in addition to the cargo transportation systems. NASA made Commercial Crew Development (CCDev) awards in order to stimulate efforts within the private sector, encouraging them to develop and demonstrate human spaceflight capabilities. Crew transportation efforts will be further expanded via CCDev Round 2 awards in early 2011.

In FY 2012, NASA proposes to take the accomplishments and lessons learned from the successes of CCDev and CCDev2, and incorporate them into a new initiative called CCDev Round 3. This initiative will facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS. CCDev Round 3 will result in vehicles that could become the Nation's primary means for ISS crew transportation reducing American reliance on foreign systems and allowing NASA to focus on deep space exploration missions.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**39.1**	**-**	**792.8**	**795.0**	**792.5**	**789.7**	**785.5**
Commercial Crew	0.0	-	792.8	795.0	792.5	789.7	785.5
Commercial Cargo	39.1	-	0.0	0.0	0.0	0.0	0.0

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Commercial Crew

The two primary activities planned for FY 2012 are: the continued execution and completion of CCDev Round 2 Space Act Agreements, which will be awarded in the spring of 2011, and the formation of long-term agreements with industry for CCDev Round 3, planned for late spring 2012.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA's Commercial Spaceflight Theme is stimulating the development of a commercial space industry in the United States by encouraging the growth of a new competitive market that will help decrease launch costs, reduce NASA's reliance on foreign systems, enable exploration beyond LEO, and transform spaceflight for future generations. By pushing the boundaries of private enterprise and commerce into LEO, NASA has initiated the first truly sustainable activity for expansion into space.

Relevance to the NASA Mission and Strategic Goals:

The Commercial Spaceflight Theme supports two of NASA's strategic goals. Goal 1, to "Extend and sustain human activities across the solar system," directly applies by developing competitive opportunities for the commercial community to provide best value products and services to LEO (Sub-goal 1.2). Goal 3, to "Create the innovative new space technologies for our exploration, science, and economic future" is being applied by facilitating the transfer of NASA technology and engage in partnerships with other Government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits (Sub-goal 3.4).

Relevance to education and public benefits:

As it has throughout NASA's history, human presence in space will continue to serve as a public symbol of the Nation's leadership in space exploration. The Agency's renewed efforts to leave LEO and to explore the Moon and other destinations will accelerate the development of technologies critical to the economy and national security. These efforts will also provide a training ground for the next generation of scientists and engineers. By enabling emerging enterprises to achieve commercial viability, U.S. technology sectors will expand, providing opportunities that are likely to inspire the Nation's youth to pursue careers in STEM disciplines.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.2	**Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.**	
Objective 1.2.1	**Enable the commercial sector to provide cargo and crew services to the International Space Station (ISS).**	
Performance Goal 1.2.1.1	***Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.***	
APG 1.2.1.1: CS-12-1	Conclude the commercial crew transportation systems (CCDev2) agreements and make initial selections for the design, development, and demonstration of commercial crew transportation systems.	Commercial Crew
Performance Goal 1.2.1.2	***Develop and document evaluation and certification processes for an integrated commercial crew transportation system.***	
APG 1.2.1.2: CS-12-2	Begin evaluation and certification of integrated commercial crew transportation system.	Commercial Crew

Performance Achievement Highlights:

COTS and CCDev have made significant progress over the past year. Within the COTS effort, Space Exploration Technologies (SpaceX) and Orbital Sciences Corporation (Orbital Sciences) steadily achieved impressive results in their respective cargo transportation development efforts, with NASA's financial and technical assistance.

SpaceX completed many challenging, funded milestones during FY 2010, culminating in the first successful COTS demonstration mission in December 2010. SpaceX launched the Falcon 9 vehicle, which demonstrated separation of the Dragon spacecraft and completion of two full orbits, orbital maneuvering and control, Dragon reentry, parachute decent, and Dragon spacecraft recovery after splashdown in the Pacific Ocean.

Orbital Sciences also completed several funded milestones over the past year. These included:

- A Critical Design Review, which determined that the system design maturity was appropriate to support proceeding with full scale fabrication, assembly, integration, and test;
- Completion of the spacecraft service module structural core;
- A service module test readiness review; and
- A successful cargo integration demonstration using a sample manifest of cargo simulators for physical stowage and demonstration of cargo handling procedures. NASA astronauts participated in this demonstration.

Under the CCDev program, $50 million in America Recovery and Reinvestment Act (ARRA) funds were competitively awarded to five companies to encourage significant progress on developing long-lead capabilities, technologies, and commercial crew risk mitigation tasks that will ultimately accelerate their commercial crew transportation concepts. The accomplishments of these five companies included the following:

- Sierra Nevada Corporation successfully completed several development milestones, including space vehicle propulsion hybrid motor testing and the Dream Chaser spacecraft composite test article and structural testing.

- Blue Origin successfully met milestones for multiple pusher launch abort motor tests to verify operation of new jet tab thrust vector control and the manufacture, assembly, and structural testing of their crew composite pressure vessel.

- Paragon Space Development Corporation manufactured and tested an air revitalization system engineering development unit and successfully moved their concept through a Preliminary Design Review.

- Boeing matured their commercial crew system architecture and design through a Systems Definition Review. They also demonstrated key technologies and capabilities including crew module mockup, base heat shield fabrication, avionics systems testing, landing attenuation system demonstration, demonstration of air bags in water and on land, life support system demonstration, and crew module pressure shell fabrication.

- United Launch Alliance developed and demonstrated a prototype emergency detection system that can be used with launch vehicles, providing real time launch vehicle health monitoring and providing the earliest warning of impending catastrophic launch vehicle failures. System warnings are essential for commanding crew launch escape and improving crew launch safety.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight
Program:	Commercial Crew

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	0.0	-	792.8	795.0	792.5	789.7	785.5
Commercial Crew	0.0	-	792.8	795.0	792.5	789.7	785.5

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight
Program:	Commercial Crew

Program Overview

In 2009, NASA began commercial crew activity with the initial round of five CCDev awards to stimulate efforts within the private sector to develop and demonstrate human space flight capabilities that could ultimately lead to the availability of commercial human space flight services. In October 2010, NASA solicited proposals from U.S. space industry participants for a second round of CCDev initiatives (CCDev 2) to further advance commercial crew transportation system concepts and mature the design and development of elements of the system such as launch vehicles and spacecraft. The agreements are expected to result in significant maturation of commercial crew transportation system capabilities, with consideration given to NASA's draft human certification requirements and standards or industry equivalent to those requirements and standards.

The results of these efforts will feed into CCDev Round 3. The primary objective of CCDev Round 3 will be to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS. Once the capability is matured and available to customers, NASA plans to purchase transportation services to meet its ISS crew rotation and emergency return obligations.

CCDev Round 3 will follow an alternative business method that allows U.S. private companies more design ownership of their space systems and requires those companies to invest private capital to complement government funds. This approach is similar to that in use with the development, demonstration, and eventual purchase of cargo transportation services pioneered under the COTS and ISS Commercial Resupply Services (CRS) Programs.

For CCDev Round 3, NASA plans to award competitive, pre-negotiated, milestone-based agreements that support the development, testing, and demonstration of multiple commercial crew systems. CCDev Round 3 will feature an acquisition strategy based on pay-for-performance milestones, a fixed Government investment, the use of negotiated service goals instead of detailed design requirements, and a requirement for private capital. CCDev Round 3 will also use a Government insight/oversight model featuring a core team of sustaining engineering and discipline experts who closely follow the development of the vehicles. Additionally, CCDev Round 3 will use tailored human rating requirements, standards, and processes, with NASA providing the final crew transportation system certification.

Plans For FY 2012

Throughout most of FY 2012, the CCDev Round 2 commercial partners will be executing milestones associated with their Space Act Agreements. In spring 2012, NASA plans to make awards for CCDev Round 3. Partnering with industry in this innovative way potentially accelerates the availability of U.S. human access to LEO and reduces the risk of relying solely on foreign crew transports to the ISS for years to come. It will strengthen the U.S. commercial space launch industry, encourage competition, act as a catalyst for the development of additional space markets, provide new high-technology jobs, and reduce the cost of human access to space.

Mission Directorate:	Exploration
Theme:	Commercial Spaceflight
Program:	Commercial Crew

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Conclude the commercial crew transportation systems (CCDev2) agreements and make initial selections for the design, development, and demonstration of commercial crew transportation systems.	Commercial Crew	None
Begin evaluation and certification of integrated commercial crew transportation system.	Commercial Crew	None

Program Management

The Commercial Crew Program Manager, located at Kennedy Space Center, reports to NASA Headquarters. The Deputy Program Manager resides at Johnson Space Center.

Acquisition Strategy

NASA is still developing the specific acquisition strategy for CCDev Round 3. Based on industry input and the lessons learned from COTS, CCDev, and CCDev Round 2, NASA is planning an acquisition approach that provides the following features:

- Pre-negotiated, pay-for-performance milestones to shift risk during the development phase to the private sector, encouraging innovation and efficiency in vehicle design;

- A fixed government investment that will permit NASA to seed the development of a risk-balanced portfolio of multiple concepts and systems;

- A tailored approach to government oversight of programmatic activities during development, including eliminating the need to validate contractor costs, reducing reporting requirements, and cutting down on significant paperwork, thereby decreasing costs and schedules;

- Identification of less prescriptive goals and objectives during the development phase that enables the companies the flexibility to provide innovative design solutions that effectively meet the needs of the commercial market and NASA while ensuring crew safety;

- Minimal Government retention of intellectual property to provide companies with confidence that they will retain the benefit of their investment; and

- A requirement for industry investment to leverage NASA dollars and ensure a larger net investment in commercial crew capability development.

NASA's objective is to remain primarily goal-based in the development phase, establishing a set of top-level performance requirements to encourage innovation and cost effectiveness.

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Failure of a Commercial Partner	Commercial partners may not be able to complete the demonstration phase and thus NASA's investment would not result in available commercial services.	Commercial partners are incentivized to work through difficulties in order to avoid losing future funding and NASA technical assistance. Also, in order to insulate the agency in the unlikely event of a single commercial partner not completing their agreed-to milestones, NASA plans to execute agreements with multiple commercial providers.
Uncertainty Regarding Emerging Commercial Market Demand	With a minimum of only two flights per year from NASA and an uncertain non-NASA market, potential providers may be wary of the commercial business potential.	Given the decision to extend the life of the ISS, NASA will be an ongoing, long-term customer for commercial crew services, providing a strong base market for commercial providers. In addition, NASA plans to have extensive interaction with industry via requests for information, industry days, and draft announcements that will allow NASA to optimize the strategy of the program prior to awards.
Requirements Unique to NASA	NASA-unique requirements will increase the cost to provide services such that the commercial providers may not be able to capture non-NASA markets.	NASA has explicitly acknowledged that there are two objectives for the Commercial Crew program. One is the safe transportation of astronauts to and from the ISS, and the other is to enable the development of non-NASA commercial markets for human transportation services to and from LEO. NASA will seek a balance to achieve both objectives, not achieving one objective at the expense of the other.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development

Theme Overview

The ERD Theme expands fundamental knowledge that is key to human space exploration, and develops advanced exploration systems that will enable humans to explore space in a more sustainable and affordable way.

The ERD Theme is comprised of HRP and the AES Program, and provides knowledge and the advanced human space flight capabilities required to implement NASA's new exploration program. In FY 2012, the ETD Program, which was an element of the ERD Theme in FY 2011, will be transferred to the Office of the Chief Technologist.

The life support, habitation, and extra-vehicular Activity elements of ETD will remain in the AES program because these capabilities are critical to crew safety and the success of future vehicle production and human spaceflight missions. It is important that these areas be managed in concert with the associated vehicle development, and closely overseen by human spaceflight personnel. Undersea and field analogs as well as ISS flight tests that simulate human exploration missions will also remain in AES because they have strong ties to future exploration success validating operational concepts for exploring the Moon, near Earth asteroids, and Mars.

HRP investigates and mitigates the highest risks to astronaut health and performance to support NASA human exploration missions. Through its projects, HRP conducts fundamental and applied research on the human system to provide countermeasures, knowledge, technologies, and tools to enable safe, reliable, and productive human space exploration. As astronauts journey beyond LEO, they will be exposed to microgravity, radiation, and isolation for long periods of time. Keeping crews healthy and productive during long missions will require new technologies and capabilities. To accomplish this, NASA studies how the space environment, close quarters, heavy workloads, and prolonged time away from home contribute to stress, and then develops technologies that can prevent or mitigate these effects. In addition, the Agency is developing innovative exploration systems to provide basic needs such as oxygen, water, food, and shelter that can operate dependably for at least a year.

AES develops and demonstrates prototype systems for life support, habitation, and EVA that will enable NASA to conduct future human missions beyond LEO, while reducing risk and lifecycle cost. AES demonstrates these systems in ground test beds, Earth-based field and underwater tests, and ISS flight experiments.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**299.2**	**-**	**211.4**	**214.3**	**211.2**	**207.5**	**203.7**
Human Research Program	146.3	-	143.3	143.8	143.0	142.0	140.9
Advanced Explorations Systems	152.9	-	68.1	70.5	68.2	65.5	62.8

Note:

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Human Research Program

During FY 2012, HRP will support approximately 15 to 20 biomedical flight experiments on the ISS and deliver the next-generation space biomedical ultrasound device to enhance the ISS' human research facility capability. Other activities include development of a training program for ultrasound diagnosis of fractures and evaluation of blood analysis technology for astronaut health monitoring. In addition, the program will provide a preliminary recommendation regarding the use of bisphosphonates in conjunction with a routine in-flight exercise program to reduce bone loss. HRP projects will deliver an enhanced design tool for vehicle radiation shielding assessments and release the second version of an acute radiation risk model. In the area of behavioral health and performance, researchers will complete a sleep-wake actigraphy report on the ISS crew. In order to support its research requirements, HRP will release two NASA research announcements addressing space radiation health risks and human physiological changes associated with space flight.

Advanced Explorations Systems

In FY 2012, AES will use a ground test bed to demonstrate the reliability of life support system components, and a portable life support system for an advanced space suit will be tested in a vacuum chamber. Ground-based analog field tests and underwater tests will validate a prototype Space Exploration Vehicle and Deep Space Habitat, and demonstrate operational concepts for exploring the surfaces of near-Earth asteroids with humans and robots.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.1	**Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.**	
Objective 1.1.2	**Advance engineering, technology, and research capabilities on the ISS.**	
Performance Goal 1.1.2.2	***Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.***	
APG 1.1.2.2: ERD-12-1	Conduct flight definition review for at least five flight experiments in fundamental space biology that were selected through the 2010 International Space Life Sciences Research Announcement.	Advanced Explorations Systems
APG 1.1.2.2: ERD-12-2	Deliver at least four physical sciences payloads for launch to the ISS.	Advanced Explorations Systems
APG 1.1.2.2: ERD-12-3	Conduct at least six experiments in combustion, fluids, or materials sciences on the ISS.	Advanced Explorations Systems
Outcome 1.3	**Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.**	
Objective 1.3.2	**Develop a robust biomedical research portfolio to mitigate space human health risks.**	
Performance Goal 1.3.2.1	***Develop technologies that enable biomedical research and mitigate space human health risks associated with human space exploration missions.***	
APG 1.3.2.1: ERD-12-4	Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Human Research
Performance Goal 1.3.2.2	***Perform research to ensure that future human crews are protected from the deleterious effects of space radiation.***	
APG 1.3.2.2: ERD-12-5	Release Acute Radiation Risk Model Version 2 to assess effects of solar particle events during exploration missions.	Human Research
Performance Goal 1.3.2.3	***Develop exploration medical capabilities for long-duration space missions.***	
APG 1.3.2.3: ERD-12-6	Deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.	Human Research

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Objective 1.3.3	**Identify hazards, opportunities, and potential destinations, to support future safe and successful human space exploration missions.**	
Performance Goal 1.3.3.1	***Prioritize the knowledge of hazards, opportunities, and potential destinations for human space exploration that will be of use to future operations of an integrated architecture for human space exploration.***	
APG 1.3.3.1: ERD-12-7	In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions.	Advanced Explorations Systems
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**	
Outcome 3.3	**Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.**	
Objective 3.3.2	**Develop and demonstrate critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.**	
Performance Goal 3.3.2.1	***Develop advanced spacesuits to improve the ability of astronauts to conduct Extra-Vehicular Activity (EVA) operations in space including assembly and service of in-space systems and exploration of surfaces of the Moon, Mars, near-Earth objects (NEOs), and other small bodies.***	
APG 3.3.2.1: ERD-12-9	Initiate tests of Extra-Vehicular Activity (EVA) Portable Life Support System (PLSS) technologies in a vacuum chamber environment.	Advanced Explorations Systems

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**146.3**	**-**	**143.3**	**143.8**	**143.0**	**142.0**	**140.9**
Human Research Program	146.3	-	143.3	143.8	143.0	142.0	140.9

Note: The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

Program Overview

HRP is focused on investigating and mitigating the highest risks to human health and performance in order to enable safe, reliable, and productive human space exploration. The HRP budget enables NASA to resolve health risks in order for humans to safely live and work on missions in the inner solar system. HRP conducts research, develops countermeasures, and undertakes technology development to address human health risks in space and ensure compliance with NASA's health, medical, human performance, and environmental standards. The risks examined by HRP include health concerns from space radiation exposure, behavioral health, and team cohesion challenges associated with confinement and isolation, ensuring vehicle functions are properly designed for efficient human interface in space, and providing for emergency medical care in space. HRP also studies the effects of microgravity on the human body including rapid muscle atrophy, bone loss, neurovestibular system changes that produce motion sickness, significant fluid shifts that affect intracranial pressure, visual changes, cardiovascular function, blood volume, and orthostatic intolerance.

HRP activities are designed to:

- Develop human health capabilities, countermeasures, and technologies in support of human space exploration;

- Enable the definition and improvement of human spaceflight medical, environmental and human factors standards;

- Develop technologies to reduce medical and environmental risks within spacecraft and mission resource limitations;

- Ensure maintenance of Agency core human health competencies that are necessary to enable risk reduction in the areas of space medicine;

- Leverage resources to apply space technology to practical applications on the ground; and

- Develop national and international collaborations that support NASA goals with organizations such as the National Space Biomedical Research Institute (NSBRI), National Institute of Health (NIH), Department of Education, Department of Defense (DoD), European Space Agency (ESA), Japan Aerospace Exploration Agency (JAXA), Centre National d'Etudes Spatiales (CNES), German Aerospace Center (DLR), Canadian Space Agency (CSA), Italian Space Agency (ASI), and potentially others.

Plans For FY 2012

The ISS Medical project (ISSMP) will maximize the opportunity provided by the ISS for human health and performance evaluations during long duration missions. ISSMP will use the ISS to understand the significant effects of long duration space flight on the human body. In FY 2012, this project will support approximately 15 to 20 biomedical flight experiments per each ISS six month mission and will deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.

The Space Radiation projects will continue using the NASA Space Radiation Laboratory at Brookhaven National Laboratory to evaluate the increased risk of cancer as a function of age, age at exposure, radiation quality, latency, and gender. These efforts will enable more accurate predictions of risks and facilitate longer stays in space. In FY 2012, space radiation research will shift emphasis and begin evaluating central nervous system and degenerative tissue risks, deliver an enhanced design tool for vehicle radiation shielding assessments, and release the second version of the acute radiation risk model.

The HRP Exploration Medical Capability project will strive to meet the level of care standards for space exploration missions by testing the next generation of medical care and crew health maintenance technologies. HRP will develop a training program for ultrasound diagnosis of fractures, evaluate blood analysis technology for astronaut health monitoring, and ensure human health and performance data is captured, maintained, and usable.

The Human Health and Countermeasure (HHC) project will perform research studies to reduce crew health risks during missions and long-term health risks after missions, including cardiac structure and function and bone demineralization monitoring and mitigation techniques. This project will provide a preliminary recommendation on the use of bisphosphonates in conjunction with a routine inflight exercise program in order to reduce bone loss. The HHC project will also provide a final report on the effects of microgravity on shuttle crew task performance.

The Space Human Factor and Habitability project will research nutrition requirements for long-duration missions, provide a final report of spinal elongation flight studies, recommend permissible lunar dust exposure limit standards, and design and test a software tool to support the crew's ability to optimally function during space missions. This project will also continue studying the exercise regimes necessary to maintain the astronauts' physical health in space, EVA system standards to maintain the astronaut's health outside of the space vehicles, and the pharmacological and nutritional health requirements for human space missions.

The Behavioral Health and Performance project will use ground-based analog and ISS flight-based studies to evaluate contributing factors to health or performance degradation, errors, or failures during critical mission operations. These studies will evaluate sleep loss and circadian rhythms, medication side effects, fatigue, team cohesion, and training protocols. In FY 2012, behavioral health and performance researchers will complete a sleep-wake actigraphy report on crew members.

To support its research requirements in FY 2012, the program will release two NASA research announcements: one addressing space radiation health risks, and the other a joint NASA/ NSBRI research solicitation focused on human physiological changes associated with spaceflight.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

Project Descriptions and Explanation of Changes

Exploration Medical Capability

The Exploration Medical Capability (ExMC) project is responsible for identifying and testing next generation medical care and crew health maintenance technologies during exploration missions. The ExMC project is also responsible for the evolution of exploration health care options based on past experience, anticipated needs, and input from flight surgeons and crew offices.

The major deliverables from this project are identifying the requirements for medical equipment and clinical care capabilities, developing remote medical technologies, and assessing the medical requirements for each mission.

Human Health Countermeasures

The Human Health Countermeasures (HHC) project provides the biomedical expertise for the development and assessment of medical standards, vehicle and spacesuit standards dictated by human physiological needs, and develops biomedical countermeasures that ensure the maintenance of crew health.

The major deliverables for the HHC project are input for the refinement of health and medical standards, validated human health prescriptions, validated exercise system requirements, EVA injury and decompression sickness prevention standards, integrated physiological countermeasures, and criteria for the Agency fitness for duty and crew selection/retention standards. The project also supports biomedical core laboratories that provide the expertise to enable the development of medical standards, the assessment of the risks to crew health and performance, and the validation of countermeasures.

Behavioral Health and Performance

The Behavioral Health and Performance (BHP) project identifies and characterizes the behavior and performance risks associated with training, living, and working in space, and returning to Earth. The major deliverables for the BHP project consists of: recommendations for NASA medical standards; development of operational tools and technology to prevent performance degradation, human errors or failures during critical operations resulting from sleep loss, circadian de-synchronization, fatigue or work overload; deterioration of morale and motivation; interpersonal conflicts or lack of team cohesion, coordination, and communication; team and individual decision-making; performance readiness factors (fatigue, cognition, and emotional readiness); behavioral health disorders; and individual selection and crew assignments.

Space Human Factors and Habitability

The Space Human Factors and Habitability project consists of three main areas:

- Space Human Factors Engineering validates models for predicting the effects of interface designs on human performance, methods for measuring human and human-system performance, and design concepts for, and evaluations of, advanced crew interfaces and habitability systems.

- Advanced Environmental Health research assesses the acute and long-term health impacts of targeted pollutants in the environment including lunar dust, microorganisms, and atmospheric contaminants.

- Advanced Food Technology provides a safe, nutritious, and acceptable food system to maintain crew health and performance. Technology development addresses nutritional, psychological, safety, and acceptability requirements while minimizing mass, volume, waste, power, and trace gas emissions.

Space Radiation Health

The Space Radiation Health project performs investigations to assure that crews can safely live and work in a space radiation environment without exceeding the acceptable exposure limits during and after missions. The major deliverables for the Space Radiation project include inputs to standards for radiation health, habitability, and environments, requirements for radiation protection, early technology development for monitoring equipment, caution, and warning models, and tools to assess and predict risks due to space radiation exposure, and strategies to mitigate exposure effects.

ISS Medical Project

ISSMP provides planning, integration, and implementation services for HRP research tasks and evaluates activities requiring access to space or related flight resources on the ISS, Shuttle, Soyuz, Progress, or other spaceflight vehicles and platforms. This includes support to related pre-flight and post-flight activities.

ISSMP services include operations and sustaining engineering for HRP flight hardware, experiment integration and operation including individual research tasks and on-orbit validation of next generation on-orbit equipment, medical operations, procedures and crew training concepts, and operation and sustaining engineering for the Telescience Support Center, which provides real-time operations and data services to all HRP flight experiments. This project integrates HRP-approved flight activities and interfaces with external implementing organizations, such as the ISS Payloads Office and international partners to accomplish the HRP's objectives.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Human Research Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Human Research	None
Release Acute Radiation Risk Model Version 2 to assess effects of solar particle events during exploration missions.	Human Research	
Deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.	Human Research	

Program Management

HRP is managed by the Human Research Program Office, located at the Johnson Space Center (JSC) with support from Ames Research Center, Glenn Research Center, Langley Research Center and Kennedy Space Center.

Acquisition Strategy

In FY 2012, two NASA Research Announcements (NRAs) will be used to further efforts in human research. The Space Radiation NRA will focus on better understanding and reducing risks that crews could face from space radiation on exploration missions. The Joint NASA/NSBRI NRA to support crew health and performance in space exploration missions will focus on: bone loss; cardiovascular alterations; human performance factors, sleep, and chronobiology; muscle alterations and atrophy; neurobehavioral and psychosocial factors; nutrition, physical fitness, and rehabilitation; sensorimotor adaptation; smart medical systems; biomedical technology development; and analog bed rest investigations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Peer Panel Reviews	02/2010	Peer review of NASA Research Announcements	02/2011
Quality	External Independent Reviews	12/2010	Review of Research Projects Gaps and Tasks	12/2011
Quality	External Independent Reviews	02/2009	Program Implementation Review	08/2012
Quality	National Academies	06/2008	The Institute of Medicine will review the "NASA Research on Human Health Risks"	06/2013

Mission Directorate:	**Exploration**
Theme:	**Exploration Research and Development**
Program:	**Advanced Explorations Systems**

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**152.9**	**-**	**68.1**	**70.5**	**68.2**	**65.5**	**62.8**
Advanced Explorations Systems	152.9	-	68.1	70.5	68.2	65.5	62.8

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Advanced Explorations Systems

Program Overview

AES develops and demonstrates prototype systems for life support, habitation, and EVA that will enable NASA to conduct future human missions beyond LEO, while reducing risk and lifecycle cost. AES focuses on advanced development of flight system concepts. This includes a Deep Space Habitat where the crew would live during transit on long missions and a Space Exploration Vehicle that would allow the crew to closely approach an asteroid, explore its surface, and conduct EVAs. AES demonstrates these systems in ground test beds, Earth-based field and underwater tests, and on-board ISS flight experiments.

AES uses innovative approaches for the rapid development of system concepts, such as small, focused teams of NASA engineers and technologists working with industry partners to gain hands-on experience. AES will pilot these processes to improve the affordability of future exploration programs.

Plans For FY 2012

In FY 2012, AES will use a ground test bed to demonstrate the reliability of life support system components. A portable life support system for an advanced space suit will be tested in a vacuum chamber. Ground-based analog field tests and underwater tests will be used to validate a prototype Space Exploration Vehicle and Deep Space Habitat, and to demonstrate operational concepts for exploring the surfaces of near-Earth asteroids with humans and robots.

Project Descriptions and Explanation of Changes

Advanced Life Support Ground Test Bed

This project will integrate advanced life support system components in a ground test bed to demonstrate their reliability for life support systems that recycle air, water, and waste in order to minimize consumables, which are critical capabilities for long-duration missions.

EVA Flight Demonstration

Building on current EVA technology projects, NASA will work with industry and academia to develop advanced space suits to improve the ability of astronauts to assemble and service in-space systems, and to explore the surfaces of the Moon, Mars, and small bodies. An advanced technology space suit and a suit port designed to enable rapid ingress and egress from habitats will be demonstrated on the ISS.

Advanced Exploration Systems Development

This project will use innovative approaches to develop prototype systems for a Deep Space Habitat where the crew will live during transit on long missions, and a Space Exploration Vehicle that will allow the crew to closely approach an asteroid, explore the surface, and conduct EVA. The operation of these systems will be demonstrated in desert field tests and underwater tests to simulate the low-gravity environment of an asteroid.

Joint Robotics Program

ERD in ESMD, working closely with the Planetary Science Division of the Science Mission Directorate (SMD), will develop instruments for SMD and international missions to destinations relevant to human exploration beyond LEO. These precursor activities will strive to characterize the engineering boundary conditions of representative exploration environments, identify hazards, and assess resources. These activities will provide knowledge to inform the selection of future destinations, support the development of exploration systems, and reduce the risk associated with human exploration. ESMD will also fund a small Research and Analysis effort with the goal of turning the data gathered by these instruments, as well as the data of other SMD instruments and missions, into strategic knowledge in support of human spaceflight planning and systems development. Many of these research and analyses activities will be jointly conducted with SMD to maximize the mutual benefit to both science and exploration objectives, as was done with the highly successful Lunar Reconnaissance Orbiter mission. ESMD will also maintain a small study effort to plan for future precursor activities to further enable and reduce the risk associated with human exploration.

Mission Directorate:	Exploration
Theme:	Exploration Research and Development
Program:	Advanced Explorations Systems

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Conduct flight definition review for at least five flight experiments in fundamental space biology that were selected through the 2010 International Space Life Sciences Research Announcement.	Advanced Explorations Systems	
Deliver at least four physical sciences payloads for launch to the ISS.	Advanced Explorations Systems	
Conduct at least six experiments in combustion, fluids, or materials sciences on the ISS.	Advanced Explorations Systems	
In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions.	Advanced Explorations Systems	

Program Management

The program management for this program has not been assigned.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Advanced Life Support Ground Test Bed	JSC	JSC, MSFC, ARC	
EVA Flight Demonstration	JSC	JSC	
Advanced Exploration Systems Development	JSC	JSC, KSC, LaRC, GRC	

Acquisition Strategy

All projects are managed at NASA Centers, which issue competitive contracts for research and development support. Advanced life support component technologies and subsystems will be competitively selected for integration with an in-house ground test bed.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	National Academies	10/2007	Assessment of program effectiveness and technical quality	TBD

Program Risk Management

Title	Risk Statement	Risk Management Approach and Plan
System Requirements	Prototype systems may not meet requirements for human exploration missions.	Conduct architectural studies to identify the probable capabilities required to meet the requirements for human exploration missions. Flight system designers who will use the prototype systems must endorse technical performance goals.
Development Progress	Project delays preventing on time delivery of prototype systems to support the development of flight systems.	Progress towards technical milestones will be the key decision criterion for project continuation.
Transition into Flight Programs	Lack of commitment from flight system designers to incorporate completed prototype systems into their missions.	Develop a transition plan with agreement from flight programs to incorporate prototype systems into mission designs.

Mission Directorate:	Exploration
Theme:	ESMD Civil Service Labor and Expenses

Theme Overview

This Theme contains labor funding, both salary and benefits, for civil service employees at NASA's field centers who are assigned to work on projects in the Exploration Systems Mission Directorate. These funds support the critical skills and capabilities required to provide the technology development and space flight missions, as outlined in the other themes, within this mission area.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**338.7**	**348.2**	**363.6**	**381.1**	**399.4**
ESMD Civil Service Labor and Expenses	0.0	-	338.7	348.2	363.6	381.1	399.4

Overview

NASA's Space Operations Mission Directorate (SOMD) provides space exploration services to NASA customers and other partners in the U.S. and throughout the world. SOMD manages the safe flyout of the Space Shuttle Program (SSP); oversees the operation of the system and payloads on the International Space Station (ISS); provides safe and reliable access to space through the Launch Services Program (LSP); develops and implements future space launch complex upgrades through the 21st Century Space Launch Complex (21st CSLC) Program; manages rocket testing capabilities through the Rocket Propulsion Test (RPT) Program; maintains secure and dependable communications to ground stations and between platforms across the solar system through the Space Communication and Navigation (SCaN) Program; and provides the necessary training and supports the health and safety of our Nation's astronauts through Human Space Flight Operations (HSFO).

The Space Shuttle will be retired before FY 2012 so that NASA can focus on the new challenges facing a 21st century space agency. As a result, the FY 2012 budget for the Space Shuttle Program continues to support the planning, cost-effective utilization, and responsive disposition of processes, personnel, resources, and real and personal property. The majority of requested FY 2012 funds for the Space Shuttle Program are to cover the pension liability for the Space Shuttle Program's prime contractor. The estimated liability is approximately $550 million as of January 2011 and will continue to fluctuate until formal pension plan termination. If funding remains after the pension plan termination, it will be used to defray Space Shuttle closeout costs that would otherwise require FY 2013 funding; however, if there is a shortfall, it will reduce available Space Shuttle funds for closeout.

The ISS is a unique, international orbital outpost for learning how to live and work in space, and how to perform the scientific and engineering research needed for prolonged stays in low Earth orbit, on the Moon, Mars, or on other bodies. After Shuttle retirement NASA will use commercial and international transportation capabilities to embark on extended and enhanced ISS utilization, focusing on basic scientific research and technology demonstration that will prepare the Agency for future exploration and benefit life on Earth. The Agency will also invest in the Space Station facility itself by initiating new activities to increase functionality. To enhance return on investment, NASA is transferring management of research that is not directly related to the NASA's exploration mission to an independent non-profit organization and has secured partnerships with other U.S. Government agencies and private firms to utilize a portion of the ISS as a National Laboratory.

In addition to these high-profile programs, SOMD ensures that the critical infrastructure to access and use space is available to meet the needs of NASA's internal and external customers. The Space and Flight Support (SFS) budget is comprised of multiple programs providing Agency-level enabling capabilities that play a critical role in the success of NASA missions and goals.

- The SCaN Program operates NASA's extensive network of terrestrial and orbiting communications nodes and the associated hardware and software needed to pull down the terabytes of data generated by NASA's fleet of crewed vehicles and robotic spacecraft.

- LSP facilitates access to space by providing leadership, expertise and cost-effective Expendable Launch Vehicle (ELV) services for NASA's missions.

- The RPT Program maintains NASA's wide variety of test facilities for use by NASA, other agencies, and commercial partners.

- The HSFO Program ensures that NASA's astronauts are fully prepared for current and future missions.

- NASA is also planning to continue 21st century space launch complex modernization program at the

Kennedy Space Center (KSC), which will benefit current and future NASA and commercial space launch activities and other complex users.

- Mission Operations Sustainment provides support for essential human spaceflight activities by addressing space operations requirements and risks for which precise costs cannot be known until after formal technical requirements, risk management approaches, and cost estimates are prepared.

With the upcoming retirement of the Space Shuttle, planning is underway which will lead to SOMD and the Exploration Systems Mission Directorate (ESMD) merging to create a new directorate. The resulting organization will implement the human spaceflight program content, in alignment with the goals of the NASA Authorization Act of 2010. The new organization will manage the ISS, Commercial Crew and Cargo, Space Launch System and Multi-Purpose Crew Vehicle, and Exploration Research and Development.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	6,141.8	6,146.8	5,508.5	4,346.9	4,346.9	4,346.9	4,346.9	4,346.9
Space Shuttle	3,101.4	-	-	636.8	65.8	0.0	0.0	0.0
International Space Station	2,312.7	-	-	2,667.0	2,775.8	2,818.0	2,847.3	2,883.8
Space and Flight Support (SFS)	727.7	-	-	699.8	1,156.8	1,168.7	1,122.2	1,067.5
SOMD Civil Service Labor and Expenses	0.0	-	-	343.4	348.5	360.2	377.5	395.6

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Space Operations

Space Shuttle

New Initiatives:

None

Major Changes:

The FY 2012 budget represents a decrease from FY 2011 due to the completion of the Space Shuttle manifest. Only transition and retirement activities remain funded in FY 2012. The majority of requested FY 2012 funds for SSP are to cover the pension liability for SSP's prime contractor. The estimated liability of approximately $550 million as of January 2011 will continue to fluctuate until formal pension plan termination. If funding remains after the pension plan termination, it will be used to defray Space Shuttle closeout costs that would otherwise require FY 2013 funding; however, if there is a shortfall, it will reduce available Space Shuttle funds for closeout and some activity could move later than planned.

Major Highlights for FY 2012

The Space Shuttle is scheduled to fly the last mission in FY 2011. Disposition of property and capabilities no longer needed for safe mission execution has been underway for some time and culminates with the disposition of most Space Shuttle assets by the end of FY 2013.

International Space Station

New Initiatives:

None

Major Changes:

None

Major Highlights for FY 2012

ISS will serve as a fully functional and continuously crewed research laboratory, orbital observatory, and technology test bed providing a critical stepping stone for exploration and future international cooperation.

To increase the return on investment and further U.S. research productivity, NASA is awarding a cooperative agreement to an independent organization with the responsibility to further develop national uses of ISS through partnerships with NASA researchers, other U.S. Government agencies, private firms, and non-profit institutions.

Space and Flight Support (SFS)

New Initiatives:

Beginning in FY 2013, a new Mission Operations Sustainment line provides support for essential human space flight activities, by addressing space operations requirements and risks for which precise costs cannot be known until after formal technical requirements, risk management approaches, and cost estimates are prepared.

Major Changes:

None

Major Highlights for FY 2012

SCaN's major milestone in FY 2012 will be to complete the delivery of the Tracking and Data Relay Satellite (TDRS) K spacecraft as part of the TDRS Replenishment project. The project is responsible for the acquisition of two new tracking and data relay satellites, TDRS-K and TDRS-L, to replenish the aging fleet of communications spacecraft in the Space Network. The TDRS Replenishment project office at the Goddard Space Flight Center (GSFC) is managing the procurement, which includes on-orbit delivery, and acceptance of the two spacecraft: TDRS-K to be launched in December 2012 (or as early as April 2012), followed by launch of TDRS-L in December 2013.

LSP provides a reliable service that gets the satellites into orbit. It has five such planned NASA launches in FY 2012.

RPT facilities are part of the critical path for the development of future propulsion technologies required to support developing vehicle architectures. RPT will continue to utilize available resources to improve aging infrastructure in preparation of future propulsion test requirements.

HSFO is comprised of Space Flight Crew Operations (SFCO) and Crew Health and Safety (CHS). For FY 2012, SFCO will provide crew expertise for future vehicle development and four ISS long-duration crew rotation missions by providing and maintaining an adequate number of astronauts with appropriate skills and experience to conduct planned research and maintenance activities. NASA has enlisted the National Academies in FY 2011 to conduct an independent study of the activities funded within NASA's HSFO Program after the Space Shuttle is retired.

The 21st CSLC Program will continue to develop and establish necessary partnerships, to gain an understanding of evolving requirements from the users of the Florida launch and range complex at KSC. In 2012, CSLC expects to begin work on several projects to improve the launch and range complex. Areas under consideration include modernization activities to support safer and more efficient launch operations, enhancing payload processing capabilities, relocating the KSC perimeter to facilitate certain private sector activities and operations; environmental remediation, and supporting the modernization of the launch range capabilities. The 21st CSLC Program will also develop a cost-effective ground infrastructure plan that considers the Space Launch System and potential ground investment activities with the NASA Centers.

Mission Directorate:	Space Operations
Theme:	Space Shuttle

Theme Overview

Thirty-eight years ago, NASA was charged with developing the world's first reusable space transportation system, a powerful vehicle with the versatility to revolutionize how people access and operate in near-Earth space. Since 1981, the Space Shuttle has carried more people (over 350) and more cargo (almost four million pounds) on more (and different types of) missions than any other launch system in history. For the past 13 years, the full capabilities of the Space Shuttle have been applied to the mission for which the system was originally conceived and uniquely designed: assembly of a large, advanced research station in low Earth orbit (LEO), one which can serve as a critical international research technology test bed to help NASA and its partners learn how humans can live in space and to prepare for further missions out to the Moon, to Mars, and beyond. In FY 2011, the Space Shuttle will retire, marking the end of its chapter in the history of space exploration. As NASA continues Space Shuttle Transition and Retirement (T&R) activities in FY 2012, the Agency is transitioning key workforce, technology, facilities, and operational experience to a new generation of human space flight exploration activities. However, the recent delay in the completion of the manifest until later in FY 2011 than originally planned has required the program to reevaluate the final completion date, with some disposition activities moving into FY 2013. The majority of requested FY 2012 funds for SSP are to cover the pension liability for the program's prime contractor. The estimated liability of approximately $550 million as of January 2011 will continue to fluctuate until formal pension plan termination. If funding remains after the pension plan termination, it will be used to defray Space Shuttle closeout costs that would otherwise require FY 2013 funding; however, if there is a shortfall, it will reduce available Space Shuttle funds for closeout and some activity could move later than planned.

For more information, please visit http://www.nasa.gov/shuttle.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,101.4**	**-**	**636.8**	**65.8**	**0.0**	**0.0**	**0.0**
Space Shuttle Program	3,101.4	-	636.8	65.8	0.0	0.0	0.0

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Space Shuttle Program

The Space Shuttle is scheduled to fly its last mission in FY 2011. Disposition of property and capabilities no longer needed for safe mission execution has been underway for some time. With the launch of STS-134 moved to no earlier than April 2011 and the potential of launching the authorized, yet-to-be funded STS-135 in June 2011, some Shuttle property disposition activity may continue into FY 2013. The majority of requested FY 2012 funds for the SSP are to cover the pension liability for SSP's prime contractor. The estimated liability of approximately $550 million as of January 2011 will continue to fluctuate until formal pension plan termination. If funding remains after the pension plan termination, it will be used to defray Space Shuttle closeout costs that would otherwise require FY 2013 funding; however, if there is a shortfall, it will reduce available Space Shuttle funds for closeout and some activity could move later than planned.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

With the completion of ISS assembly and the retirement of the Space Shuttle, NASA is transferring key program assets to programs and operations that will support the next generation of human space exploration activities. This transfer will safeguard the long-term viability of key and enabling technical capabilities, while capabilities that are no longer needed or are obsolete will be retired or transitioned to other users.

Relevance to the NASA Mission and Strategic Goals:

SSP supports the Agency Strategic Goal 1 to "Extend and sustain human activities across the solar system," by transitioning needed assets and capabilities for use in future NASA programs or other organizations.

Relevance to education and public benefits:

Space Shuttle assets and capabilities are being assessed for use in future NASA programs. Where those capabilities have a future use, they are being transferred to the relevant NASA programs. For those capabilities without a future use, NASA is partnering with the General Services Administration and other organizations to ensure assets are dispositioned in accordance with all relevant Federal regulations and statutes. Through the authority of the Stevenson-Wydler Act, NASA is making special accommodations so that schools and accredited museums have first priority in acquiring Space Shuttle property for educational purposes.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.1	**Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.**	
Objective 1.1.1	**Maintain resources (on orbit and on the ground) to operate and utilize the ISS.**	
Performance Goal 1.1.1.2	***HPPG: Safely fly out the Space Shuttle manifest and retire the fleet.***	
APG 1.1.1.2: SSP-12-1	Ensure the Space Shuttle Endeavour is ready for transport to its final display location.	Space Shuttle Program

Performance Achievement Highlights:

The Space Shuttle safely and successfully completed every mission objective for all four flights in FY 2010. With construction of ISS nearly complete, the focus of the Space Shuttle flights to ISS in FY 2010 shifted predominately to provisioning ISS to support operations and utilization through the next 10 years and beyond.

- STS-129, launched on November 16, 2009, focused on staging spare components on the outside of ISS, including gyroscopes, nitrogen and ammonia tank assemblies, pump modules, and end effectors for the ISS robotic arm.

- STS-130, launched on February 8, 2010, saw the delivery and installation of the Tranquility (formerly Node 3) module and the Cupola. The name for the Tranquility module was suggested through a NASA public outreach effort, tying together the installation of the last planned U.S. pressurized module with history of space exploration and the landing of Apollo 11 at Tranquility Base on the Moon in July 1969.

- STS-131, launched on April 5, 2010, carried the Italian-built Multi-Purpose Logistics Module, Leonardo, loaded with eight tons of science equipment and cargo. Leonardo will return to the ISS one last time on STS-133 when it is permanently installed to the ISS.

- STS-132, launched on May 14, 2010, was the final mission of FY 2010. It carried the final scientific module destined for ISS, the Russian Rassvet Mini Research Module, as well as over 5,300 pounds of external supplies on an Integrated Cargo Carrier Vertical Light Deployable pallet in the Space Shuttle cargo bay.

- Also the last set of Reusable Solid Rocket Motors (RSRM-114) and the last production External Tank (ET-138) were delivered to KSC in FY 2010.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Council	10/2010	Provides independent guidance for the NASA Administrator. No recommendations were provided to SSP at this time.	02/2011
Other	Aerospace Safety Advisory Panel (ASAP)	10/2010	Provides independent assessments of safety to the NASA Administrator. In their 2008 Annual Report, ASAP stated that they "strongly endorse the NASA position on not extending Shuttle operations beyond successful execution of the December 2008 manifest, completing the ISS." NASA will fly the Space Shuttle to complete the ISS and then retire the Shuttle. ASAP did, however, endorse the NASA position that it is acceptable to undertake the STS-135 mission.	02/2011
Other	NASA Engineering and Safety Center	09/2010	The NASA Engineering and Safety Center conducted a review independent of SSP of the relative safety of proceeding with the STS-135 mission without a typical, Shuttle-based rescue mission. They stated that using a smaller crew and a Soyuz-based rescue approach is no riskier than a Shuttle-based rescue.	

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,101.4**	**-**	**636.8**	**65.8**	**0.0**	**0.0**	**0.0**
SPOC Pension Liability	0.0	-	547.9	0.0	0.0	0.0	0.0
Program Integration	627.2	-	24.8	21.3	0.0	0.0	0.0
Flight and Ground Operations	1,115.4	-	27.9	17.0	0.0	0.0	0.0
Flight Hardware	1,358.8	-	36.1	27.6	0.0	0.0	0.0

Note:
NASA will work with the Administration and Congress to determine the highest priority use of the FY 2011 funds if they are not required to fly the Shuttle in the first quarter of FY 2011.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Descriptions and Explanation of Changes

Program Integration

The FY 2012 SSP Integration budget supports Space Shuttle retirement and the efficient and cost-effective transition of assets to other uses once they are no longer needed for safe Shuttle mission execution. Program Integration ensures the overall safety and efficiency of Space Shuttle T&R activities, including software support, systems engineering, and business management. Program Integration T&R funding also covers severance and retention costs associated with managing the drawdown of the Space Shuttle workforce.

Flight and Ground Operations

The FY 2012 Flight and Ground Operations budget ensures the availability of resources needed to identify, process, safe, and transfer flight and ground processing assets once they are no longer needed for safe SSP mission execution. The T&R budget includes funds needed to prepare assets (e.g., Mission Control Center, the launch pads, the Vehicle Assembly Building, and the Launch Control Center) for modification, transfer to other users, or disposal. The Mobile Launch Platforms, the Orbiter Processing Facilities, and landing site hardware no longer needed by NASA will be made safe of hazardous materials and prepared for transfer to other Federal Government users or other disposition.

Flight Hardware

The FY 2012 Flight Hardware T&R budget provides resources needed to identify, process, safe, and transfer flight hardware assets once they are no longer needed for safe Shuttle mission execution. For orbiters, these costs include safing the vehicles of hazardous materials. For the main engines, these costs also include safing and transportation preparation of current and older engine components that are being made available for alternate use or public display. The Flight Hardware T&R budget also covers the costs of dispositioning orbiter, Space Shuttle main engine, external tank, and reusable solid rocket motor production tooling capabilities that the Agency will no longer need.

Space Program Operations Contract (SPOC) Pension Liability

The FY 2012 Pension Liability budget provides funding under the SPOC as a contractually reimbursable cost of their defined benefit pension plans. United Space Alliance, LLC (USA), the NASA incumbent contractor for SPOC under SSP, after negotiation with the Agency, agreed to freeze the plans as of December 31, 2010, and delay formal pension plan termination until after the completion of the Space Shuttle manifest. USA does not expect to have sufficient funding available to irrevocably settle all benefit obligations of the plans. Per Federal Cost Accounting Standards (which govern the allowability of contract costs) 413-50(c)(12)(vi), the Government's share on an adjustment "may be recognized by modifying a single contract, several but not all contracts, or all contracts, or by use of any other suitable technique."

Due to the overwhelming majority of USA underfunded pension liability being attributed to the SPOC, all allowable costs associated with the termination of the qualified plans will be recognized on the SPOC, and the responsibility of the Government. The estimated liability of approximately $550 million as of January 2011 will continue to fluctuate until formal pension plan termination. If funding remains after the pension plan termination, it will be used to defray Space Shuttle closeout costs that would otherwise require FY 2013 funding; however, if there is a shortfall, it will reduce available Space Shuttle funds for closeout and some activity could move later than planned.

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Space Shuttle Orbiters Discovery, Atlantis, and Endeavour ready for transport to final display locations.	Space Shuttle Program	SSP manifest through April 2011 to complete currently funded-flights, with the potential additional authorized flight STS-135 in June 2011, and to fund SPOC contract for USA contract pension liability

Implementation Schedule

Project	Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24	Phase Dates	Beg	End
Program Integration		Tech		
		Form		
		Dev		
		Ops	Dec-04	Jun-11
		Res		
Flight and Ground Operations		Tech		
		Form		
		Dev		
		Ops	Dec-04	Jun-11
		Res		
Flight Hardware		Tech		
		Form		
		Dev		
		Ops	Dec-04	Jun-11
		Res		
Transition and Retirement		Tech		
		Form	Jan-06	Jan-08
		Dev		
		Ops	Jun-08	Sep-13
		Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Space Operations
Theme:	Space Shuttle
Program:	Space Shuttle Program

Program Management

The SSP Manager reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Program Integration	Johnson Space Center	Johnson Space Center	N/A
Flight and Ground Operations	Kennedy Space Center	Kennedy Space Center and Johnson Space Center	N/A
Flight Hardware	Johnson Space Center	Johnson Space Center and Marshall Space Flight Center	N/A

Acquisition Strategy

The SPOC prime contractor is USA. Other prime contractors are ATK Thiokol (reusable solid rocket motors), Lockheed Martin (external tanks), and Pratt & Whitney-Rocketdyne (Space Shuttle main engines).

Mission Directorate:	**Space Operations**
Theme:	**International Space Station**

Theme Overview

The ISS orbits the Earth 16 times a day at a speed of 17,500 miles per hour and an altitude that ranges from 230 to 286 miles. The ISS is a research and development test bed that is in itself, an experiment in the design, development, and assembly of an orbital space facility. The ISS serves as a habitat for its crew, a command post for orbital operations, and a port for the rendezvous and berthing of smaller orbiting vehicles. It functions as an orbital microgravity and life sciences laboratory, a test bed for new technologies (e.g., life support and robotics), a platform for astronomical and Earth observations, and a market and destination for the burgeoning commercial crew and cargo transportation industry. The ISS has been continuously crewed since November 2000. Through calendar year (CY) 2010, there were 106 U.S. and international partner flights to ISS, including missions for assembly, crew rotation, and logistical support. At the time of the Space Shuttle retirement, ISS assembly will be complete and the ISS will be composed of approximately 1,000,000 pounds of hardware brought to orbit over the course of more than a decade. ISS is the largest human-made object ever to orbit Earth.

The ISS Program is among the largest international cooperative endeavors in the history of science and technology. The ISS international partnership is composed of NASA, the Canadian Space Agency, the European Space Agency, the Japanese Aerospace Exploration Agency, and the Russian Federal Space Agency. International participation in the program has significantly enhanced the capabilities of the ISS.

In accordance with the NASA Authorization Act of 2010, the ISS will continue through 2020 or beyond. The orbiting facility will support basic and applied research, exploration technology development, and demonstrations, and will be a market and destination to spur the development of a robust commercial crew and cargo transportation services. ISS functionality will be increased--an investment in the facility itself--and will also be utilized to develop and demonstrate in-space human and robotic servicing and repair capabilities which could ultimately be used to support on-orbit servicing and repair of future observatory-class scientific spacecraft.

NASA is in the process of creating an independent, non-profit organization (NPO) to manage and oversee ISS National Laboratory research by U.S. organizations other than NASA. This entity will be responsible for maximizing the value of ISS to the Nation by developing and managing a diversified research and development portfolio based on U.S. national needs for basic and applied research, with the goal of increasing the return on the U.S. investment in the ISS.

NASA has already secured partnerships with other U.S. Government agencies and private firms to use a portion of the ISS as a National Laboratory (per the NASA Authorization Act of 2005). NASA's plan for the ISS National Laboratory, "National Lab Report," was submitted to Congress in May 2007. Approximately 50 percent of planned U.S. resources and accommodations on ISS could be available for use by organizations other than NASA. Firm interest in ISS use has been expressed by organizations representing education, human health, plant and animal biotechnologies, aerospace technologies, and defense sciences research. NASA has signed Memoranda of Understanding (MOUs) for use of the ISS with the National Institutes of Health (NIH) and the Department of Agriculture (USDA), and has pre-existing agreements with the Department of Energy (DOE), DoD, and the National Science Foundation (NSF). In addition, NASA re-issued an announcement of "Opportunity for Use of the ISS by Non-Government Entities for Research and Development and Industrial Processing Purposes," in August 2009. To date, NASA has entered into Space Act Agreements (SAA) with seven private firms and two universities. Additional MOUs and SAAs are in various stages of discussion.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**2,312.7**	**-**	**2,667.0**	**2,775.8**	**2,818.0**	**2,847.3**	**2,883.8**
International Space Station Program	2,312.7	-	2,667.0	2,775.8	2,818.0	2,847.3	2,883.8

Note:
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Plans for FY 2012

International Space Station Program

NASA will focus on increasing research, continuing safe operations, and utilizing the ISS to its full capacity as a test bed for exploration technology demonstrations and development. These efforts are intended to revitalize, enhance, and augment the ISS Program and are discussed below.

Section 503 of the NASA Authorization Act of 2010 states: "The Administrator shall take all actions necessary to ensure the safe and effective operation, maintenance and maximum utilization of the United States segment of the ISS through at least September 30, 2020."

NASA will also invest in the ISS facility itself by initiating new activities to revitalize ISS and increase functionality. The activities are intended to support ISS upgrade efforts while proving new space technologies, reducing costs, and increasing functionality. Potential objectives include lowering costs or increasing the efficiency of ISS operations in space or on the ground, reducing demands on crew time, improving ISS safety, and supporting activities benefiting future exploration programs or capabilities. ISS is a major asset for demonstrating technologies and capabilities that are funded and operated by NASA and other sponsors. ISS will enhance the Nation's ability to operate future human space flight activities and make space exploration more affordable and effective. The ISS Program will facilitate National Laboratory research and engineering activities consistent with Agency objectives.

The ISS will be utilized to conduct multidisciplinary science, technology, and applications development and operate as an outpost for human exploration. In FY 2011, NASA will begin operations on new external unpressurized payloads, including the Alpha Magnetic Spectrometer (AMS) particle physics detector, a communications navigation and networking demonstration, and an advanced materials technology test bed.

Additionally, internal pressurized payloads scheduled for FY 2012 will include ongoing studies to support NASA's human research program for exploration. NASA will continue National Laboratory collaborations with: the NIH, DoD, DOE, NSF; private industry collaborations including Astrogenetix, Inc., and Ad Astra Rocket Company; academic institutions such as University of Colorado-Bioserve; and other agencies supporting science, technology, engineering, and mathematics (STEM) education.

The independent non-profit organization will be operational in FY 2012. It will identify the unique capabilities of the ISS that provide breakthrough opportunities for non-NASA uses in science and applications, technology development, and STEM education, including but not limited to human health, biological sciences, biotechnology, biological research, energy and biofuels, physical and materials science and development, engineering research and technology development, and Earth and space imaging and observations. They will also formulate a comprehensive portfolio of activities to maximize the value of the ISS as a venue for STEM education.

Space Operations provides for crew and cargo transportation services to and from the ISS. The Commercial Resupply Services (CRS) contracts awarded to SpaceX and Orbital Sciences are scheduled to provide commercial resupply flights beginning in CY 2011. Cargo transportation to the ISS will also be supplemented by the Japanese HII Transfer Vehicle (HTV) and European Automated Transfer Vehicle (ATV). Crew transportation and rescue will be provided by the Russian Soyuz vehicle until domestic transportation providers are available by 2016. The Exploration Systems Mission Directorate (ESMD) budget includes funding to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

NASA leads scientific and technological advances in aeronautics and space for a Nation on the frontier of discovery. ISS is essential in addressing critical health, safety, performance, and cost issues confronting the future of human space flight beyond LEO. ISS supports scientific research and the development of new technologies and capabilities that enable human space exploration and other activities that put humans in space. Research aboard ISS is critical in understanding the effects of space environments on the human body and developing mitigation techniques. Research on ISS will lead to strategies that minimize the logistical burden of supporting humans far from Earth, address remote medical emergencies, and demonstrate enabling technologies for human exploration. NASA and its international partners are applying the information learned to plan for future human and robotic missions. Techniques demonstrated in robotics, assembly, and maintainability on the ISS are guiding development of next-generation space vehicles that will fly farther, faster, and for longer duration.

U.S. Government agencies, private firms, and universities will conduct research on the ISS in its capacity as a National Laboratory. Research will yield important data that address challenges in human health, energy and the environment. The ISS also promotes the commercial space transportation industry by providing a market for crew and cargo transportation. The ISS partnership provides a successful example of peaceful and constructive international cooperation, one that provides tangible benefits here on Earth.

Relevance to the NASA Mission and Strategic Goals:

ISS supports NASA's Strategic Goal 1 to "Extend and sustain human activities across the solar system." The ISS National Laboratory will enable research for scientific, technological, diplomatic, and educational purposes, support future objectives in human space exploration, allow competitive opportunities for the commercial community to provide best value products and services to LEO and beyond, and lay the groundwork for an integrated architecture and capabilities for safe crew and cargo missions beyond LEO.

ISS also supports NASA's Strategic Goal 5 to "Enable program and institutional capabilities to conduct NASA's aeronautics and space activities," by establishing partnerships with commercial, international, and other government entities in order to maximize mission success.

Relevance to education and public benefits:

Research conducted on the ISS offers benefits that cross all areas of American life, including public health, energy, environment, education, and promoting international cooperation. Specific examples include new uses of ultrasound technology, embedded Web technology to allow remote monitoring and control of devices through a Web browser, and scientific discoveries that are helping the medical community understand and mitigate muscle, balance, and bone health issues.

Research performed on the ISS will contribute to a broader understanding of injury and disease with both space and Earth-based medical applications. For example, potential new vaccines for bacteria-induced infectious diseases have been identified through ISS research and scientists will be applying to the Food and Drug Administration for an investigational new drug classification. Ongoing investigations are focused on developing vaccines for salmonella-induced food poisoning and Methicillin resistant Staphylococcus aureus (commonly known as MRSA), which has been responsible for over 19,000 U.S. deaths per year, according to the Centers for Disease Control.

The ISS will be used to develop and demonstrate new technologies including closed loop life support systems and remote medical care capabilities, both of which benefit people here on Earth. NASA's water recycling technology is being used to provide potable water to places devastated by natural disasters. NASA will also use the ISS to demonstrate technologies necessary for future space systems such as thermal control, environmental control, and power generation. The onboard crew also utilizes the ISS as a low-cost platform to monitor and record natural and human-driven changes and events on Earth.

Over 10,000 students have participated in ISS-based educational activities. These have ranged from student-developed experiments to interactive classroom video sessions with crewmembers. The ISS has made a consistent contribution to advancing national STEM education objectives.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 1	**Extend and sustain human activities across the solar system.**	
Outcome 1.1	**Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.**	
Objective 1.1.1	**Maintain resources (on orbit and on the ground) to operate and utilize the ISS.**	
Performance Goal 1.1.1.1	***Maintain capability for six on-orbit crew members.***	
APG 1.1.1.1: ISS-12-1	In concert with the International Partners, maintain a continuous crew presence on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station Program
Performance Goal 1.1.1.3	***Provide cargo and crew transportation to support on-orbit crew members and utilization.***	
APG 1.1.1.3: ISS-12-2	Fly the ISS spares, logistics, and utilization hardware as agreed to by the International Partners in the ISS transportation plan.	International Space Station Program
APG 1.1.1.3: ISS-12-3	Complete at least two flights to the ISS by U.S. developed cargo delivery systems.	International Space Station Program
Performance Goal 1.1.1.4	***Maintain and operate a safe and functional ISS.***	
APG 1.1.1.4: ISS-12-4	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.	International Space Station Program
APG 1.1.1.4: ISS-12-5	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps.	International Space Station Program
Objective 1.1.2	**Advance engineering, technology, and research capabilities on the ISS.**	
Performance Goal 1.1.2.1	***Advance knowledge of long-duration human space flight by establishing agreements with organizations to enable full utilization of the ISS.***	
APG 1.1.2.1: ISS-12-6	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2012.	International Space Station Program

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**	
Outcome 5.5	**Establish partnerships, including innovative arrangements, with commercial, international, and other government entities to maximize mission success.**	
Objective 5.5.1	**Facilitate the use of the ISS as a National Laboratory for cooperative research, technology development, and education.**	
Performance Goal 5.5.1.1	***HPPG: Establish an independent non-profit (NPO) organization to enhance the utilization of the ISS as a National Laboratory.***	
APG 5.5.1.1: ISS-12-7	Facilitate non-profit organization (NPO) implementation of its initial grants solicitation process.	International Space Station Program

Uniform and Efficiency Measures:

Measure #	Description
International Space Station Theme	
APG EFF 1.1.1.4: ISS-12-3	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.
APG EFF 1.1.2.1: ISS-12-6	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2012.

Mission Directorate:	**Space Operations**
Theme:	**International Space Station**

Performance Achievement Highlights:

FY 2010 marked completion of the tenth year of continuous human presence in space on the ISS.

During FY 2010, the pace of vehicles visiting the ISS increased:
- Four Space Shuttle flights delivered hardware to and provided logistics support.

- Japan's first HTV successfully completed its mission to unberth from Node 2 and deorbit on October 30, 2009.

- In November 2009, two ExPRESS Logistics Carriers (ELC) were delivered to the ISS and crew members robotically attached them to the ISS truss. The ELCs also carried critical external spares. Also, the Russian Mini-Research Module 2 was launched and docked to the Service Module zenith port to function as a fourth Russian docking port.

- In February 2010, the Tranquility module and Cupola were delivered. The Cupola's multi-directional view allows the crew to control and monitor robotics, spacewalking, and docking operations, and a unique view of Earth and celestial objects. Also, with the arrival of Progress 36P there were four Russian vehicles docked at ISS for the first time. During this period, ISS crews were supported by re-supply and crew rotation using the Space Shuttle, HTV, Russian Progress, and Soyuz vehicles.

- In April and May 2010, vital system spares and research outfitting equipment was delivered. The April mission marked the first time four women and two astronauts from Japan were in space at the same time.

- Research was conducted in biological sciences, human research, technology development, physical sciences, education, and Earth observation. The number of science of technology experiments increased 250, supporting the work of more than 400 researchers worldwide. With delivery of the final 5 research facilities, the full complement of 29 is in place.

- Investigations of the effects of long-duration spaceflight on overall crew health and their re-adaptation to Earth gravity conditions included, analysis of nutritional requirements and food systems, microbes and pathogens, radiation exposure inside ISS modules, and plant growth in microgravity.

- Investigations included high performance nano-materials, physical properties of materials, and materials exposure to the external environment, among them, Hamilton-Sundstrand's successful demonstration of a Sabatier reaction to generate water on-orbit by using waste carbon dioxide and hydrogen from ISS systems.

- Educational experiments and activities provided supplementary K-12 educational opportunities.

- Example pathfinder investigators for the National Lab as included: Astrogenetix, Inc., a company pursuing a series of commercial vaccine experiments on bacterially-induced infectious diseases, including MRSA; a University of Florida and Zero Gravity, Inc. collaborative study of microgravity effects on the Jatropha curcas plant and its application as a biofuel; the Naval Research Laboratory's operation of a visible and near-infrared maritime hyperspectral imager for coastal oceans, and a remote atmospheric and ionospheric detector that will conduct the most comprehensive multi-spectral survey of the upper atmosphere in 20 years; and the Defense Department's study of space wound healing, tissue regeneration, and engine exhaust plumes in the upper atmosphere.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	ISS Advisory Committee	07/2010	Assess ISS operational readiness to support new crew, assess Russian flight team preparedness to accommodate the Expedition missions, and assess health and flight readiness of Expedition crew members.	Ongoing
Other	NAC	09/2010	Provides independent guidance for the NASA Administrator. The NAC was briefed by the JSC Safety and Mission Assurance Office on NASA lessons learned. The Space Operations committee made two recommendations on NASA utilization of lessons learned, including expanding the teaching aspect.	02/2011
Other	ASAP	10/2010	Provides independent assessments of safety to the NASA Administrator. No recommendations issued relating to ISS.	02/2011
Other	Program Implementation Review	08/2008	Provides an independent review of ongoing ISS and SSP operations. The report cited concerns on budget resources, which have been addressed in this budget and in cargo transportation availability post Shuttle retirement.	2011

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	2,312.7	-	2,667.0	2,775.8	2,818.0	2,847.3	2,883.8
ISS Systems Operations and Maintenance	1,555.2	-	1,291.4	1,425.3	1,385.1	1,449.6	1,526.3
ISS Research	129.5	-	189.8	176.9	178.8	186.1	189.1
ISS Crew and Cargo Transportation	628.0	-	1,185.7	1,173.6	1,254.1	1,211.6	1,168.5

Note:

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In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Descriptions and Explanation of Changes

ISS Systems Operations and Maintenance

The FY 2012 budget extends ISS operations and supports full utilization through at least 2020. This includes: recertification of ISS structures, purchase of additional spares and consumables, extending baseline operational services, enabling services and facilitating National Laboratory partnerships and commitments, and initiating activities that increase ISS upgrade efforts, improve new space technologies, reduce costs, and increase research capacity. Operating the ISS is often more complicated than other space flight endeavors because of its many international partner components. Each ISS partner has the primary authority for managing and operating the hardware it provides, but the various elements provided by the partners are inter-dependent. Oversight by NASA is required to ensure the elements all operate as an integrated system.

ISS Operations Program plans, controls, and executes the ISS program. ISS includes systems engineering, analysis, and integration function entails optimization of the system architecture, integrated system performance and verification analyses, tracking of vehicle configuration, interface requirements, and mission design. The spacecraft function maintains the ISS on orbit in a fully crewed and mission-ready mode. Safety and mission assurance functions implements safety, reliability, maintainability, and quality assurance requirements to ensure that significant risks are reviewed, tracked, and mitigated. Other key operational activities include medical support, and launch site processing of the hardware.

NASA will also invest in the ISS facility itself by initiating new activities to revitalize the ISS and increase functionality. The activities will support ISS upgrade efforts while proving new space technologies, and reducing costs. Potential objectives include increasing the ISS operational efficiency in space or on the ground, reducing demands on crew time, improving safety, and supporting activities to benefit future exploration efforts. Examples include: a common S-band communication system; a common radio frequency/attached audio/video/command/telemetry system; EVA shock hazard improvements and solar array modifications to decrease sensitivities to visiting vehicles flight attitudes and longeron shadowing; mission integration tool enhancements and throughput increases; research results tracking, increased payload integration and verification support; and biotech sample analysis instruments.

Functionality increases will also include development of a docking mechanism to provide compatibility to all visiting vehicles in compliance with the International Docking System Standards. To ensure that the docking system is highly focused on keeping costs low for commercial providers who will use it for their visiting vehicles:

- Design process will be well-coordinated with industry, solicit regular, detailed input, and have a mechanism to resolve industry concerns;and to the degree feasible, the design will be standards-based and not lock the commercial providers into using particular vendors;

- Design will adhere to standard aerospace practices and processes within reach of commercial providers; and

- Necessary and effective cost controls are in place in FY 2012 and the outyears.

ISS Research

Having launched the U.S. and international partner elements and established six-person crew capability, the ISS Program focus is now primarily on utilization.

During FY 2011, NASA will be awarding a cooperative agreement to an independent non-profit organization with responsibility to further develop national uses of the ISS. This organization will:

- Act as a single entry point for non-NASA users to interface efficiently with the ISS;

- Assist researchers in developing experiments, meeting safety and integration rules, and acting as an ombudsman on behalf of researchers;

- Perform outreach to researchers and disseminate the results of ISS research activities; and

- Provide easily accessed communication materials with details about laboratory facilities, available research hardware, resource constraints, and more.

The NPO will oversee all research involving organizations other than NASA and transfer current NASA biological and physical research to the NPO in future years.

- SOMD oversight of existing research projects will be phased out and the NPO will co-select/manage new peer-reviewed projects.

- As on-going work within the NASA research project offices is completed in future years, extension/renewal decisions should be made exclusively by the NPO.

Through the management partnership, research opportunities will be expanded to conduct research in life sciences, material sciences, biotechnologies, condensed matter physics, and thermal sciences (e.g., fluid mechanics, thermodynamics, heat transfer, and combustion). NASA will continue to support research to meet NASA requirements for exploration including astronaut health and serve as a test bed for the development and demonstration of technology for future space exploration missions.

The ISS Program multi-user systems support function is responsible for all payload physical, analytical and operations integration activities and for projecting available utilization resources and accommodations, tactical planning, and execution of the day-to-day ISS integrated research plan for all payloads, including NASA, international partners, and non-NASA users.

ISS Crew and Cargo Transportation

Cargo and Crew Transportation provides services to and from the ISS, including services provided by international partners and commercial purchases. NASA has contracted with Roscosmos to purchase crew transportation through CY 2013. The ISS Program plans to purchase crew transportation services from Russia, as needed, until a domestic capability is available by 2016.

NASA has also contracted with domestic companies to provide cargo supply and return services beginning in CY 2011 via the Commercial Resupply Services (CRS) contract. The FY 2012 budget provides for the acquisition of cargo transportation through CY 2020, including cargo transportation for National Laboratory research payloads. SpaceX currently has four missions on its manifest and Orbital Sciences has three missions on its manifest. Both SpaceX and Orbital Sciences are making progress on their missions which are planned to begin in FY 2012.

In addition, proposed Exploration funding would develop U.S. commercial crew transportation that will ultimately be utilized by the ISS. The FY 2012 ISS budget does not include any specific funding to purchase commercial crew transportation services, but NASA has developed a funding strategy to accommodate purchase of commercial crew seats as the development activities progress and better estimates for those services become available. A new Mission Operations Sustainment line within SFS provides support for essential human spaceflight activities, including purchase of commercial seats and communications infrastructure capability, by addressing space operations requirements and risks for which precise costs cannot be known until after formal technical requirements, risk management approaches, and cost estimates are prepared.

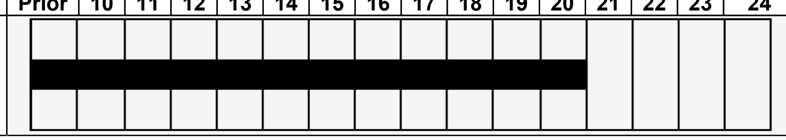
Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
ISS construction complete.	International Space Station (ISS)	same
In concert with the International Partners, maintain a continuous crew presence on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station	N/A
Fly the ISS spares, logistics, and utilization hardware as agreed to by the International Partners in the ISS transportation plan.	International Space Station	N/A
Complete at least two flights to the ISS by U.S. developed cargo delivery systems.	International Space Station	N/A
Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.	International Space Station	N/A
Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps.	International Space Station	N/A
Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2012.	International Space Station	N/A
Facilitate non-profit organization (NPO) implementation of its initial grants solicitation process.	International Space Station	N/A

Implementation Schedule

Project: ISS

Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24



Phase Dates	Beg	End
Tech		
Form		
Dev	Oct-93	Sep-07
Ops	Oct-07	Sep-20
Res	Oct-11	Sep-20

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Mission Directorate:	Space Operations
Theme:	International Space Station
Program:	International Space Station Program

Program Management

The ISS Program Manager reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
On-orbit assembly and operations	NASA Johnson Space Center	NASA Johnson Space Center	Russian Federal Space Agency, European Space Agency, Japan Aerospace Exploration Agency, Canadian Space Agency, and Italian Space Agency.

Acquisition Strategy

NASA extended the Boeing U.S. On-Orbit Segment contract until September 30, 2015. NASA has competed and awarded the ISS Mission Integration Contract (MIC) to Barrios Technology. MIC, with options, will be extended through 2017. NASA has competed and awarded the follow-on Cargo Mission Contract (CMC) to Lockheed Martin. The CMC basic period extends through March 31, 2014 with four one-year extension options. The Program Integration Contract has been in place since October 2009, continuing for up to five years.

NASA awarded commercial cargo transportation services to SpaceX and OSC through the CRS contracts on December 23, 2008. Initial activities have begun for cargo services beginning as early as CY 2011, with services available until early 2016. NASA has also extended its contract with Roscosmos to purchase crew launches through CY 2013 and crew rescue and return through mid 2014. NASA plans to continue to purchase Russian crew transportation services until a domestic capability is available. ESMD has funding to facilitate the development of a U.S. commercial crew space transportation capability with the goal of achieving safe, reliable, and cost effective access to and from LEO and the ISS.

Mission Directorate:	**Space Operations**
Theme:	**Space and Flight Support (SFS)**

Theme Overview

As explorers, pioneers and innovators, NASA expands frontiers to inspire and serve America and to benefit the quality of life on Earth. Space and Flight Support (SFS) provides Agency-level capabilities that enable exploration and science. SFS programs are authorized as "Space and Flight Services" under the NASA Authorization Act of 2010.

The 21st Century Space Launch Complex Program (21st CSLC) at the Kennedy Space Center (KSC) is working to modernize KSC's launch facilities, and the Florida range, to play a key role in future space exploration for a wide range of users. This includes NASA test flights, commercial flights in support of ISS, and expendable launch vehicles in support of NASA payloads and robotic precursor missions. Based on understanding of the evolving requirements from the users at KSC, the program is developing a comprehensive ground infrastructure plan and potential ground investment activities to improve KSC launch operations for future and current non-NASA users of the range.

The Space Communications and Navigation (SCaN) Program provides the support structure to conduct exploration and science. SCaN manages multiple space communication networks including the Deep Space Network, the Space Network, and the Near Earth Network. SCaN provides the support to regulate, maintain, and grow NASA's space communications and navigation capabilities that support NASA's space missions. Whether NASA missions are providing data about Earth, focusing science instruments on cosmic phenomena, or exploring far regions in space, reliable communication with Earth-based control centers is key to mission success. As new spacecraft with different objectives and advanced technology are launched, communications needs change. SCaN modifies and evolves its space communications capabilities to ensure current and new mission requirements are met.

Human Space Flight Operations (HSFO) is comprised of Space Flight Crew Operations (SFCO) and Crew Health and Safety (CHS). SFCO provides trained crew for NASA human space flight endeavors and is responsible for Johnson Space Center (JSC) aircraft operations and aircrew training. CHS enables healthy and productive crew during all phases of space flight missions; provides comprehensive health care program for astronauts; prevents and mitigates negative long-term health consequences of space flight. With the last flights of Shuttle in FY 2011, HSFO is focused on post-Shuttle retirement requirements. NASA has enlisted the National Academies to conduct an independent study of the activities.

Mission Operations Sustainment supports future essential human spaceflight activities by addressing space operations requirements and risks whose costs will not be precisely known after formal technical requirements, risk management approaches, and cost estimates are prepared. In FY 2013 and beyond, Mission Operations sustainment will fund future commercial transportation services to the ISS and such other potential needs as potential future requirements for space communications and Space Shuttle transition and retirement. Space Operation's future functional requirements and risks will be addressed as programmatic requirements and prioritized through analysis and planning that will become specific budget requirements in the FY 2013 Budget request.

The Launch Services Program (LSP) is responsible for understanding the full range of civil space launch needs. LSP works with other Government agencies and the launch industry to ensure that safe, reliable, on-time and cost-effective launch opportunities are available on a range of launch systems.

The Rocket Propulsion Test (RPT) Program reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernization and refurbishments, integration for multi-site test activities, identification and protection of core capabilities, and the advancement and development of test technologies.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	727.7	-	699.8	1,156.8	1,168.7	1,122.2	1,067.5
21st Century Space Launch Complex	0.0	-	128.0	139.1	130.2	31.0	42.9
Space Communications and Navigation	482.3	-	404.8	450.2	460.9	460.8	460.8
Human Space Flight Operations	104.0	-	84.1	85.5	85.0	87.3	87.4
Mission Operations Sustainment	0.0	-	0.0	400.4	409.4	459.1	391.4
Launch Services	89.4	-	46.0	43.1	44.1	44.6	45.7
Rocket Propulsion Test	43.3	-	36.8	38.4	39.0	39.4	39.4
Crew Health & Safety	8.8	-	0.0	0.0	0.0	0.0	0.0

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

21st Century Space Launch Complex

Efforts for the 21st CSLC Program are intended to benefit NASA's current and future operations at KSC, but also to enhance the capabilities for non NASA users of the range. This new initiative focuses on upgrades to the Florida launch range, expanding capabilities to support commercial launch providers, and transforming KSC into a modern facility that is well positioned to support the next century of space exploration. Areas under consideration include modernization activities to support safer and more efficient launch operations, enhancing payload processing capabilities, relocating the KSC perimeter to facilitate certain private sector activities and operations, environmental remediation, and supporting the modernization of the launch range capabilities.

Space Communications and Navigation

In FY 2012, the SCaN Program will continue to successfully provide space communications and navigation capabilities to all missions and continue to define future communications requirements. SCaN will also continue to advance cross support opportunities with foreign space agencies through the definition and adoption of common standards and protocols, as well as proceed with the implementation of infrastructure upgrades and continue the development of enabling capabilities and technologies. Milestones to be completed in FY 2012 include: completion of the TDRS K and L spacecrafts, in preparation for launch of Tracking and Data Relay Satellite (TDRS) K in December 2012 (or possibly as early as April 2012) and TDRS L in December 2013; infrastructure upgrades, including the Space Network Ground Segment and the Deep Space Network (DSN) Canberra Deep Space Communications Complex 34-meter Beam Wave Guide; and continued development of enabling capabilities and technology, including early 2012 launch of the Communications, Navigation, and Networking reConfigurable Testbed (CoNNeCT), and integration and testing for the Lunar Laser Communication Demonstration (LLCD) for a FY 2013 launch, hosted by Lunar Atmosphere and Dust Environment Explorer (LADEE).

Human Space Flight Operations

HSFO is comprised of SFCO and CHS. For FY 2012, SFCO will provide crew expertise for future vehicle development as well as four ISS long-duration crew rotation missions by providing and maintaining an adequate number of astronauts with appropriate skills and experience. This will be accomplished by maintaining safe and effective aircraft operation, supporting human space flight program activities such as boards, and technical evaluations that require operational input and expertise, and representing NASA to the public directly and through media.

Launch Services

LSP has five planned NASA launches in FY 2012 including: the National Polar-orbiting Operational Satellite System (NPOESS) Preparatory Project (NPP), the last NASA mission to be launched on a Delta II; the Mars Science Laboratory (MSL) on an Atlas V; the Nuclear Spectroscopic Telescope Array (NuSTAR) on a Pegasus XL; TDRS-K on an Atlas V; and the Radiation Belt Storm Probes (RBSP) mission on an Atlas V. In addition to processing, mission analysis, spacecraft integration and launch services of these missions, LSP will continue to provide support for the development and certification of emerging launch providers critical to supporting future NASA programs.

Rocket Propulsion Test

RPT will continue to provide test facility management, and provide maintenance, sustaining engineering, operations, and facility modernization projects necessary to keep the test-related facilities in the appropriate state of operational readiness. RPT continues to use the established testing requirements from all of the RPT customers to identify excess and "at-risk" test facilities and will support decisions relative to test asset consolidation initiatives.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

SFS provides the enabling capabilities required to advance space exploration and expand scientific knowledge of Earth and the universe.

The 21st CSLC Program enables a more efficient and affordable future access to space for an evolving multi-user community by modernizing and transforming the Florida launch and range complex at KSC.

SCaN provides able and dependable space communications and navigation capabilities vital to successfully conduct human and robotic space missions.

SFCO provides trained crew members for all NASA human space flight endeavors, brings expertise to resolve operational or development issues and plays a major role in the public advocacy of human space flight. CHS provides enhancements to the health care provision environment both in space and on the ground for the astronaut corps. CHS contributes to the medical and health certification of astronauts before flight and the provision of care throughout their careers.

LSP enables access to space for NASA and other select Government missions. LSP provides safe, reliable, cost-effective, and on-time commercial launch services for NASA and NASA-sponsored payloads using ELVs.

RPT capabilities continue to support safe operation of the Space Shuttle through retirement, and provides test facilities for use by Department of Defense (DoD) and commercial programs. RPT facilities are part of the critical path for the development of future propulsion technologies required to support developing vehicle architectures.

Relevance to the NASA Mission and Strategic Goals:

21st CSLC supports NASA's Strategic Goal 5, to "Enable program and institutional capabilities to conduct NASA's aeronautics and space activities," by transforming the Florida Launch and Range Complex to provide a robust launch complex for NASA and future users.

HSFO supports NASA's Strategic Goal 1, to "Extend and sustain human activities across the solar system," by providing adequate numbers of healthy, productive, and assignable crew members during all phases of space flight missions.

RPT and LSP also relate to NASA's Strategic Goal 5, to "Enable program and institutional capabilities to conduct NASA's aeronautics and space activities."

Relevance to education and public benefits:

The benefits of SFS to education and the public include the return of scientific and educational data from space to Earth, the safe launching of expendable launch vehicles necessary for research, the assurance that rocket systems have been adequately tested, and the testing and implementation of various human health and illness prevention measures.

SFCO assigns astronauts for requested appearances and supplying the accompanying presentation materials. Astronauts support numerous public appearances sharing information about current and future space missions with the general public.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**	
Outcome 5.3	**Ensure the availability to the Nation of NASA-owned, strategically important test capabilities.**	
Objective 5.3.1	**Work with the National Rocket Propulsion Test Alliance to identify NASA, Department of Defense and commercial capabilities and requirements.**	
Performance Goal 5.3.1.1	***Develop and execute the Rocket Propulsion Test (RPT) Master Plan.***	
APG 5.3.1.1: SFS-12-1	Meet Rocket Propulsion Test (RPT) Master Plan requirements for year one.	Rocket Propulsion Test
Outcome 5.4	**Implement and provide space communications and launch capabilities responsive to existing and future science and space exploration missions.**	
Objective 5.4.1	**Ensure reliable and cost-effective access to space for missions critical to achieving the National Space Policy of the United States of America.**	
Performance Goal 5.4.1.1	***Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.***	
APG 5.4.1.1: SFS-12-2	Sustain 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.	Launch Services
Performance Goal 5.4.1.2	***Continue utilizing existing contract mechanisms and agreements with emerging launch vehicle providers to gain information for future Launch Service orders and to provide technical exchanges to enhance early launch success.***	
APG 5.4.1.2: SFS-12-3	Incorporate information sharing processes into programmatic policies and incorporate into crew demonstration activities and future crew transportation service contracts.	Launch Services
Objective 5.4.2	**Transform the Florida launch and range complex to provide a robust launch and range infrastructure for future users.**	
Performance Goal 5.4.2.1	***By FY 2014, enable future government and commercial launching and testing from the Florida launch and range complex.***	
APG 5.4.2.1: SFS-12-4	Implement FY 2012 milestones within the 21st Century Space Launch Complex (21st CSLC) plan.	21st Century Space Launch Complex

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Objective 5.4.3	**Build and maintain a scalable, integrated, mission support infrastructure that can readily evolve to accommodate new and changing technologies, while providing integrated, comprehensive, robust, and cost-effective space communications services at order-of-magnitude higher data rates to enable NASA's science and exploration missions.**	
Performance Goal 5.4.3.1	***By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) spacecraft in geosynchronous orbits to replenish the Tracking and Data Relay Satellite System (TDRSS) constellation.***	
APG 5.4.3.1: SFS-12-5	Complete Tracking and Data Relay Satellite (TDRS) K Pre-ship review.	Space Communications and Navigation
Performance Goal 5.4.3.2	***By FY 2016, replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).***	
APG 5.4.3.2: SFS-12-6	Complete the Space Network Ground Segment Sustainment (SGSS) Preliminary Design Review (PDR).	Space Communications and Navigation
Performance Goal 5.4.3.3	***By FY 2018, replace aging and obsolete Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).***	
APG 5.4.3.3: SFS-12-7	Complete Deep Space Station-35 (DSS-35) antenna fabrication at vendor.	Space Communications and Navigation

Performance Achievement Highlights:

During FY 2010, SCaN continued to develop a unified space communication and navigation network capable of meeting both robotic and human exploration needs. During FY 2010:

- CoNNeCT and LLCD technology projects successfully completed Critical Design Reviews;

- The Space Network (SN) supported missions at or above 99.9 percent proficiency, exceeding official requirements. Supported missions included the Space Shuttle, ISS, Hubble Space Telescope, and Terra Earth science;

- A contract award was made for SN Ground Segment Sustainment to provide major Ground Segment modernization upgrades and provide a framework for further SCaN networks integration towards a single network;

- DSN supported missions at or above 95 percent proficiency for both telemetry and command, exceeding requirements. Supported missions included the Cassini, Kepler, Mars Reconnaissance Orbiter, and the Mars Exploration Rovers. (A contract for the 70 meter antenna replacement project was awarded in the first quarter of FY 2011.);

- The Near Earth Network supported missions at or above 99.1 percent proficiency, above requirements. Supported missions included the Lunar Reconnaissance Orbiter, Solar-B, and the Aqua and Aura Earth science missions. The Space Communications Network Services contract was awarded to support the operation, maintenance, and sustainment of the Space and Near Earth Networks;

- LSP successfully launched the Solar Dynamics Observatory and served in an advisory role for the Geostationary Operational Environmental Satellite mission. LSP awarded the NASA Launch Services II Contract, which brought several new launch vehicles on board, enabling additional competition in the small to small/medium class range of launch services. Successful technical interchange meetings were held with SpaceX and Orbital Science Corp;

- The RPT Program maintained its ability to safely test rocket propulsion systems by evaluating requirements and focusing resources to complete those requirements, including assuring the accuracy of requirements through close coordination with the DoD;

- HSFO, through SFCO, provided trained crew members to successfully complete four Space Shuttle and three long duration ISS crew rotation missions, supported over 460 public outreach appearances on NASA's behalf. CHS further enhanced the Longitudinal Study of Astronaut Health and implemented a system that allows flight surgeons easy access to analysis of medical requirements. CHS identified and leveraged the development of clinical care capabilities, such as ultrasound units, and is developing new technologies for hazardous and/or extreme environments ranging from the battlefield to space exploration use; and

The 21st CSLC Program acquired input through formal Requests For Information from the broader space community providing information on near-and long-term needs that the Florida Launch Range complex, and Space Florida as a means to broaden the Agency's information acquisition activity. NASA evaluated the needs of the community as a whole and folded those potential requirements into the planning process. With the passage of the NASA Authorization Act of 2010, this project has broadened its focus to consider SLS processing and launch infrastructure.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	21st Century Space Launch Complex

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**128.0**	**139.1**	**130.2**	**31.0**	**42.9**
21st Century Space Launch Complex	0.0	-	128.0	139.1	130.2	31.0	42.9

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The 21st CSLC Program's primary objective is to modernize and transform the Florida launch and range complex at KSC to benefit current and future NASA programs along with other emerging users. Described as the "launch support and infrastructure modernization program" in the NASA Authorization Act of 2010, the 21st CSLC Program will develop and implement shared infrastructure and process improvements to provide more flexible, affordable, and responsive capabilities to a multi-user community. The 21st CSLC Program will focus on the life cycle of a launch complex as an integrated system (from development, activation, operations, maintenance of capabilities to manufacture, assemble, test, checkout, and launch) to enable more efficient operations and simplify access to space for NASA and non-NASA users.

Plans For FY 2012

The 21st CSLC Program will continue to develop and establish necessary partnerships in order to gain an understanding of evolving requirements from the users of the launch and range complex. The 21st CSLC Program will develop a cost-effective ground infrastructure plan that considers the space launch system and potential ground investment activities with the NASA Centers. In addition, NASA will pursue opportunities to partner or leverage investments planned by other mutually benefitting parties within the space user community. Based on available resources, areas under consideration for future cooperative efforts include modernization activities to support safer and more efficient launch operations, enhancing payload processing capabilities, relocating the KSC perimeter to facilitate certain private sector activities, operations environmental remediation, and supporting the modernization of the launch range capabilities.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	21st Century Space Launch Complex

Project Descriptions and Explanation of Changes

Mission Focused Modernization

Modernization of systems necessary for vehicle integration and launch, horizontal takeoff and landing, vertical takeoff, and landing

Range Interface and Control Services

Modernization of range systems including command and control, communications, telemetry and tracking, and weather

Environmental Remediation and Technologies

Performance of environmental planning and compliance, energy reduction, sustainability, material replacement, remediation, and green or energy saving projects

Offline Manufacturing, Processing and Recovery Systems

Modernization of systems necessary for off-line payload processing, launch vehicle processing, laboratory testing, hazardous operations and servicing, and recovery

Florida Infrastructure Modernization

Modernization of systems or infrastructure necessary to support missions including power and utilities, transportation, safety and security, information technology, propellants, gases, and life support

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Continue implementation of a focused investments plan enabling future government and commercial launching and testing from the Florida Launch and Range Complex beginning no earlier than FY 2014.	21st Century Space Launch Complex	
Implement FY 2012 milestones within the 21st Century Space Launch Complex (21st CSLC) plan.	21st Century Space Launch Complex	N/A

Program Management

The 21st CSLC Program Manger reports to the Associate Administrator for Space Operations at NASA Headquarters.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	21st Century Space Launch Complex

Acquisition Strategy

The 21st CSLC Program will encompass projects with varying content and sizes. Many of the projects are consistent with the type of architecture and engineering, construction, and programmatic support available within the scope of existing Center and program support contracts.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Council	07/2010	Provides independent guidance for the NASA Administrator. No formal recommendations were provided.	TBD

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	482.3	-	404.8	450.2	460.9	460.8	460.8
Space Communications Networks	363.3	-	348.7	382.5	401.8	408.9	408.3
Space Communications Support	93.5	-	55.1	56.3	59.1	51.9	52.4
TDRS Replenishment	25.4	-	1.0	11.4	0.0	0.0	0.0

Note:
The FY 2011 President's Budget request numbers in the FY 2010 column reflects the Initial Operating Plan budget numbers to be submitted to Congress.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Program Overview

Today's spacecraft are increasingly powerful, complex, and capable of acquiring and processing ever increasing amounts of mission data. They can even employ artificial intelligence systems, enabling autonomous decision making. However complex and sophisticated these machines have become, two key functions have not changed: the needs to communicate with Earth and navigate in space. A failure of space communications and navigation on the spacecraft or on Earth could result in a complete loss of a mission. Hence, space communications and navigation is a fundamental capability of missions that depends on a high quality of hardware and software on both the spacecraft and the ground facilities. NASA's space communications and navigation capabilities rely on ground- and space-based assets that enable near Earth and deep space missions, as well as those of the other U.S. agencies and international partners. These national assets are managed as dedicated projects within SCaN. SCaN manages these assets for the Agency and strives for a cost efficient approach to effectively meet all missions' needs throughout all stages of their life.

SCaN is responsible for all Spectrum Management and Data Standards policy, oversight, and management for the Agency. It represents NASA before all domestic and international regulatory or technical bodies dealing with Spectrum and/or Data Standards, thus providing NASA with an integrated approach to promoting and safeguarding its SCaN equities and interests. Additionally, SCaN leads all NASA activities associated with present and future navigation technology and capabilities such as supporting spacecraft tracking and position determination.

These seemingly disparate functions, sustainment of existing assets, technology development, spectrum management, and international standards, are integrated through a robust System Engineering and Integration (SE&I) activity. This assures uninterrupted SCaN capabilities and prevents adverse impacts or data losses to science or exploration missions. In addition, SE&I conducts long-range planning based on projected mission needs and identifies technical performance targets for new technologies such as Disruption Tolerant Networking (DTN), Optical Communications, and Software Defined Radio.

By planning, developing, operating, and maintaining space and ground networks of tracking and data systems, SCaN services the Nation's space missions, both crewed and robotic, from LEO to the fringes of the solar system. For more information, please see https://www.spacecomm.nasa.gov/spacecomm/.

Plans For FY 2012

In FY 2012, SCaN will continue to provide space communications and navigation capabilities to all missions and continue to define and coordinate future communications requirements for NASA and other users. SCaN will also continue to advance cross-support opportunities with foreign space agencies through the definition and adoption of common standards and protocols. SCaN will proceed with the implementation of infrastructure upgrades and continue the development of enabling capabilities and technologies. Milestones to be completed in FY 2012 include: completion of the TDRS K and L spacecraft, in preparation for launch of TDRS K in December 2012 (and possibly as early as April 2012) and of TDRS L in December 2013; infrastructure upgrades including the SNGS and the DSN Canberra Deep Space Communications Complex 34-meter Beam Wave Guide; continued development of enabling capabilities and technology, including early 2012 launch of CoNNeCT, and integration and testing for LLCD for a FY 2013 launch, hosted by LADEE.

Project Descriptions and Explanation of Changes

Space Communications Networks

The DSN consists of three facilities spaced approximately 120 degrees apart on the globe enabling continuous communications to spacecraft as the Earth rotates. The facilities are located in Spain, Australia, and California. DSN stations are NASA-owned assets managed by the DSN Project Office at the Jet Propulsion Laboratory (JPL). To maintain facility assets, SCaN utilizes funds appropriated for Construction of Facilities (CoF) to provide minor revitalization of the three DSN facilities. A list of the total CoF projects is included in the Construction and Environmental Compliance and Restoration section of this document.

Near Earth Network (NEN) consists of globally distributed tracking stations that are strategically located to maximize the communications service coverage provided to flight missions. The stations are located in Norway and Alaska, with additional antennas located at Wallops Island, Virginia, and Merritt Island, Florida. The NEN Project Office at GSFC manages the network, which includes both commercially owned assets and NASA facilities. NEN provides communications services to a variety of missions in certain orbital and suborbital locations, including LEO, Geosynchronous Earth Orbit (GEO), lunar, and highly elliptical orbits. SCaN is evaluating implementing higher data rate capability in the Ka-band to meet the evolving needs of future NASA missions and to reduce the mission load on the X-band that is limited in capacity.

The Space Network (SN) is a combination of TDRS System (TDRSS) and a set of supporting Space-to-Ground Link Terminals (SGLT) located at White Sands, New Mexico, and the Guam Remote Ground Terminal (GRGT). The ground terminals transmit signals to and from the TDRSS, which in turn relays those signals to and from flight missions. The SN predominantly supports LEO missions with global coverage, but it can also support launch vehicles and provide communications services to researchers in remote locations on Earth, such as the South Pole. The SN has proven to be an effective national asset meeting critical NASA and U.S. needs.

SN Ground Segment Sustainment (SGSS) is responsible for replacing outdated equipment and standardizing systems at all SN ground locations. The ground locations are White Sands and Guam. After replacement, the SGLT equipment at each SN ground station will be capable of supporting any spacecraft in the TDRSS fleet. A key objective of SGSS is to establish the capabilities required to support future space exploration vehicles.

The NASA Integrated Services Network (NISN) has a commercial service framework that provides point-to-point terrestrial signal transport services and routing network services. The Chief Information Officer has management responsibility for this project.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Space Communications Support

Space Communications Support manages crosscutting communication functions, responsible for defining and protecting the integrity of the overall SCaN architecture, including identifying, assessing, and establishing policy or response to external policies. These functions include Spectrum Management, Systems Planning, and advanced concept enabling technology such as Optical Communications and DTN.

- Spectrum Management ensures the availability and allocation of radio frequency spectrum for all Agency programs, supporting the operation of navigation systems, space and ground based radio transmission, and mission active and passive remote sensing requirements.

- Systems Planning develops the communications and navigation architecture to support Agency Exploration and Science programs through FY 2030. This includes: Space Data Standards, which pursues the implementation of national and international space data standards with the aim of improved interoperability; Technology, which aims to predict the needs of future communications missions in a manner that will yield initiatives with performance enhancements with reduced costs; and Systems Engineering, which coordinates all SCaN systems engineering activities and manages the requirements that enable NASA to fulfill its space communications and navigation needs for future missions.

- An important part of the SCaN Technology Program is optical communications technology development and demonstration. The first NASA demonstration of this technology will be during the LADEE mission, which is scheduled to launch in May 2013. The optical communication capability would provide NASA with a high rate communication technique for deep space mission data with an objective of at least a 10-fold data rate increase over that achievable with RF technology. This revolutionary technology will provide higher data rates for less space, weight, and power burden compared to RF technology. Higher data rates will allow more science spacecraft to share the same Earth-based optical receivers, and enable greater science return over spacecraft life.

- Another SCaN Technology program effort currently in the demonstration phase is DTN. Two DTN nodes have been installed on ISS and initial demonstration results indicate significant productivity gains through automation of data transfers in the ISS's disruptive communications environment. DTN has also been demonstrated in a deep space environment during FY 2009 aboard the EPOXI spacecraft. A more rigorous second demonstration is planned for FY 2011 and is expected to show that data transport efficiency can be improved 100 percent. International standardization of DTN protocols will be moved forward by the SCaN Standards program along with other communication data standards that provide a sound base for interoperability of NASA missions with other International space agencies.

In addition, SCaN provides subject matter expertise to the NASA Deputy Administrator for the Deputy Secretary-level Positioning, Navigation, and Timing (PNT) Executive Committee that manages the U.S. Global Positioning System (GPS). GPS is a critical infrastructure component for NASA human spaceflight and science, and enables greater autonomous navigation of spacecraft while reducing the operational and cost burdens of traditional two-way ranging and tracking.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Tracking and Data Relay Satellite (TDRS) Replenishment

The TDRS Replenishment project is responsible for the acquisition of TDRS-K and TDRS-L to replenish the aging fleet of communications spacecraft in the SN. The TDRS-K and TDRS-L Project Office at GSFC is managing the procurement, which includes on-orbit acceptance of two spacecraft. TDRS-K and TDRS-L. TDRS-K currently is set to be launched in December 2012, although NASA is evaluating the possibility of launching the satellite in April 2012. TDRS-L is scheduled to launch in December 2013. Modifications of the SGLT equipment at the White Sands Complex are included. In July 2009, the TDRS Replenishment project completed Key Decision Point (KDP)-C, and the development documentation was approved. SN meets critical NASA and U.S. needs that cannot be supported by commercial providers or any other U.S. assets. NASA is presently using the TDRS reliability model in consultation with TDRS users to assess future requirements for the TDRS constellation and assess future options.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Achieve less than three percent of lost operating time on NISN available services.	NASA Integrated Services Network, NISN	Same
Achieve at least 98 percent Network proficiency for delivery of Space Communications services.	Space Network, Deep Space Network, and Near Earth Network	Same
Complete Tracking and Data Relay Satellite (TDRS) K Payload and Bus Integration and test.	TDRS K	N/A
Complete the Space Network Ground Support Sustainment (SGSS) Integrated Baseline Review (IBR) and Systems Requirements Review (SRR).	Space Communications and Navigation	N/A
Complete Deep Space Station-35 (DSS-35) Pedestal Excavation and Azimuth track at Canberra Deep Space Communications Complex (CDSCC).	Space Communications and Navigation	N/A
Complete Tracking and Data Relay Satellite (TDRS) K Pre-ship review.	TDRS K	N/A
Complete the Space Network Ground Segment Sustainment (SGSS) Preliminary Design Review (PDR).	Space Communications and Navigation	N/A
Complete Deep Space Station-35 (DSS-35) antenna fabrication at vendor.	Space Communications and Navigation	N/A

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation

Implementation Schedule

Schedule by Fiscal Year: Prior, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24

Project	Phase	Beg	End
Space Communications and Navigation Operations	Tech		
	Form		
	Dev		
	Ops	Oct-05	Oct-20
	Res		
TDRS Replenishment - TDRS K	Tech		
	Form	Oct-07	Jul-09
	Dev	Jul-09	Jul-12
	Ops	Aug-12	Aug-27
	Res		
TDRS Replenishment - TDRS L	Tech		
	Form	Oct-07	Jul-09
	Dev	Jul-09	May-13
	Ops	Jun-13	Jun-28
	Res		

Tech & Adv Concepts (Tech)
Formulation (Form)
Development (Dev)
Operations (Ops)
Research (Res)
Represents a period of no activity for the Project

Program Management

The Deputy Associate Administrator for SCaN reports to the Associate Administrator for SOMD at NASA Headquarters. SCaN projects are managed from NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Deep Space Network	Space Communications and Navigation Program Office - NASA Headquarters	Jet Propulsion Laboratory	N/A
Near Earth Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	N/A
SN Ground Segment Sustainment	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	U.S. Government Agencies
Network Integration and Engineering	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Glenn Research Center, Jet Propulsion Laboratory	N/A
Space Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center	U.S. Government Agencies
Space Communications Support	Space Communications Program Office - NASA Headquarters	Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center	N/A
Optical Communications	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Jet Propulsion Laboratory	U.S. Government Agencies
NASA Integrated Services Network	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Marshall Space Flight Center	N/A
TDRS Replenishment	Space Communications and Navigation Program Office - NASA Headquarters	Goddard Space Flight Center, Kennedy Space Center	U.S. Government Agencies

Acquisition Strategy

NASA owns a large, established base of space communications assets located nationally, internationally, and in orbit near Earth and Mars. SCaN conducts acquisition planning with the objective of preserving the Government's past investments, and altering capability or capacity in response to mission needs and NASA SCaN architecture goals.

NASA conducts major SCaN acquisitions on a competitive basis. To meet mission support objectives and achieve the best value for the Government, mission suitability and cost criteria are appropriately weighted and evaluated for competitively awarded acquisitions. When feasible, NASA pursues commercially available space communications services and products in preference to developing NASA-owned systems. NASA may also consider unique technical capabilities and maintenance of core competency in the NASA work force during the "make versus buy" decision process. To further achieve best value for NASA and the U.S. Government, the Agency may place task orders on Government Wide Acquisition Contracts (GWAC).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Other	NASA Advisory Committee (NAC)	09/2009	SCaN was reviewed by the NAC in 2009. The NAC recommended that an independent study of space communications needs for science, exploration, and space operations be conducted. Initial studies have been performed and results are being incorporated in SCaN strategic planning.	10/2011

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Development:	TDRS Replenishment

FY 2012 Budget Request

Budget Authority ($ millions)	Prior	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**369.0**	**25.4**	**-**	**1.0**	**11.4**	**0.0**	**0.0**	**0.0**

Note:
For the FY 2012 Budget Request, project life cycle estimates, required to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613), have been consolidated in the Management and Performance Section of this document. This consolidation provides for a comparative analysis across projects, and the inclusion of corrective action plans for the projects that have exceeded their original baseline estimates by greater than fifteen percent.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Purpose

The existing TDRSS fleet supports tracking, data, voice, and video services to the ISS, space and Earth science missions, as well as other Government agency users. The total mission load is predicted to increase, which will require additional satellites to be added to the fleet. The existing fleet is aging and reliability analyses predict a shortage of flight assets to support NASA missions and the user community by FY 2011. To meet this requirement, in FY 2007, NASA began the acquisition of two additional spacecraft, TDRS-K and TDRS-L. TDRS-K is scheduled to be launched in December 2012, although NASA is evaluating the possibility of launching as early as April 2012. TDRS-L is scheduled for launch in December 2013. By adding these two spacecraft to the TDRSS fleet, continuity of service will be insured for NASA and other Government agency user missions through at least FY 2016. The TDRS Replenishment project supports future Agency requirements and technology initiatives consistent with the approved baseline of the SCaN architecture.

Project Parameters

TDRSS consists of in-orbit telecommunications satellites stationed at a geosynchronous altitude with associated ground stations located at White Sands and Guam. This system of satellites and ground stations is SN providing services for near-Earth user satellites and orbiting resources. SN supports spacecraft that depend on it for reliable services to continue their missions. The TDRSS constellation includes first and the second generation satellites.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Development:	TDRS Replenishment

Project Commitments

The TDRS-K and TDRS-L spacecraft will be fully compatible and capable of functioning as a part of the existing TDRSS. Contract requirements are design, development, fabrication, integration, test, on-orbit acceptance, and launch vehicle and services. Launch dates for TDRS-K and TDRS-L are in December 2012 (or possibly as early as April 2012) and December 2013, respectively. The spacecraft are required to have an operational life of 11 years. The basic requirement will also include modification of the White Sands SGLT to provide compatibility with the new spacecraft.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
TDRS Replenishment	NASA	Aging hardware replacement	Same	Same

Schedule Commitments

The TDRS Replenishment project was approved for entry into Phase C, development, in July 2009. The launch vehicle and payload will be delivered to KSC for processing to meet the TDRS-K and TDRS-L launch dates.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
TDRS System Critical Design Review (CDR)	January 2010	N/A	Same
TDRS Systems Integration Review (SIR)	January 2011	N/A	Same
TDRS Flight Readiness Review (FRR)	November 2012	N/A	Same
TDRS K Launch Readiness Date (LRD)	December 2012	N/A	Same
TDRS L Launch Readiness Date (LRD)	December 2013	N/A	Same

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Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
Project In Development:	TDRS Replenishment

Project Management

The Deputy Associate Administrator for SCaN reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
TDRS Replenishment	Space Communications and Navigation (SCAN) Program Office - NASA Headquarters	Goddard Space Flight Center, Kennedy Space Center	US Government Agencies

Acquisition Strategy

The TDRS K and L project is providing follow-on and replacement spacecraft necessary to maintain and expand the Space network. The contract to build two additional TDRS spacecraft was awarded to Boeing Satellite Systems in December 2007. In addition to building the TDRS K and L spacecraft, the contract also includes the modifications to the White Sands Complex ground system required to support these new spacecraft. The contract also provides fixed price options to procure two additional satellites, and NASA is using the TDRS reliability model, in consultation with TDRS users, to assess future requirements for the TDRS constellation and determine whether the Government needs to exercise the options.

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
TDRS-K and TDRS-L Obsolescence Risk Management	Aging spacecraft requires replacement hardware by FY 2013. The mission load is predicted to exceed current capacity and will need additional spacecraft to provide enough capacity.	The project has awarded a firm fixed price with incentive fee contract as of December 2007 to Boeing Satellite Systems, Inc. Spacecraft will launch in December 2012 and December 2013, respectively.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Human Space Flight Operations

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**104.0**	**-**	**84.1**	**85.5**	**85.0**	**87.3**	**87.4**
Human Space Flight Operations	104.0	-	84.1	85.5	85.0	87.3	87.4

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Program Overview

In FY 2012, HSFO will include the ongoing SFCO and CHS efforts. HSFO will provide capabilities required for continued support of International Space Station and future support of human space exploration activities, including a number of unique human space flight capabilities and facilities that NASA needs to preserve after ISS construction is completed. Assessment of crew input will continue to be important for defining and guiding HSFO activities.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Human Space Flight Operations

Plans For FY 2012

SFCO provides trained astronauts for all of NASA human space flight endeavors. For FY 2012, the SFCO will support ISS long-duration crew rotation missions, which will include support of the first commercial delivery of cargo to the ISS under the Space Exploration Technologies contract. During FY 2012, SFCO will provide support and training for astronauts preparing for future flights to the ISS, as well as provide technical and safety panel support to development of future human space systems. To help NASA determine the role and size of the human space flight office after Space Shuttle retirement and ISS construction completion, NASA enlisted the National Academies to conduct an independent study of the office's activities. In particular, the study will look at the requirements for crew-related training facilities in addition to the currently required aircraft and training, and a cost-effective means of meeting of achieving requirements. Results are expected in time to inform the FY 2013 budget process.

Crew Health and Safety will continue to enable healthy and productive crew during all phases of space flight missions, implementation of a comprehensive health care program for astronauts, and the prevention and mitigation of negative long-term health consequences of spaceflight. CHS will continue to collect, maintain, and mine health data related to the long-term effects of space flight in order to enable the mitigation of those effects. This data will be useful to ongoing operations and assist human space exploration activities in defining requirements for assuring safe human space operations for future systems. CHS will also work to implement technologies for monitoring health status before, during, and after flight and assure that medical personnel and crew members are trained to best use those technologies.

Project Descriptions and Explanation of Changes

Human Space Flight Operations

In FY 2012, SFCO and CHS will be funded under the HSFO Program.

- SFCO provides trained astronauts for all of NASA human space flight endeavors and brings astronaut expertise to help resolve operations or development issues within the human space flight programs. SFCO is responsible for all JSC aircraft operations including aircrew training.

- CHS will continue to help develop and refine a standardized battery of clinical and physiological tests for all crew members. CHS will focus on developing and refining medical standards that are critical to meet the needs that will facilitate human space exploration activities. Similarly, real-time mission evaluation will continue to help define and deliver medical operations hardware for current programs and meet the needs of known architectures.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
SFCO will provide trained astronauts for all U.S. human space flight endeavors and bring experienced astronauts expertise to help resolve operations or development issues.	HSFO/SFCO	same
CHS will provide the full suite of medical capabilities necessary for the health and safety of the astronauts, and to assure they are mission ready from a health perspective.	HSFO/CHS	same

Program Management

The SFCO and CHS managers report to the Associate Administrator for SOMD at NASA Headquarters.

Acquisition Strategy

The contracts supporting SFCO are the Aircraft Maintenance and Modification Program provided by the Computer Services Corporation and the Aircraft Simulation Provider contract with Lockheed Martin. The contract supporting CHS bioastronautics is provided by Wyle Labs.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Human Space Flight Operations

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	NAC	10/2010	Provides independent guidance for the NASA Administrator. No recommendations were provided to SFCO at this time.	02/2011
Performance	National Academies	01/2011	Providing independent assessment of activities funded within the NASA Human Space Flight Operations program for the Associate Administrator for SOMD. Recommendations will inform FY 2013 budget decisions.	TBD
Performance	Aerospace Safety Advisory Panel	10/2010	Provides independent assessments of safety to the NASA Administrator. In their 2008 Annual Report, ASAP stated that they "strongly endorse the NASA position on not extending Shuttle operations beyond successful execution of the December 2008 manifest, completing the ISS." NASA will fly the Space Shuttle to complete the ISS and then retire the Shuttle.	02/2011
Performance	Institute of Medicine	03/2007	At the request of NASA, the Institute of Medicine established a committee and issued this report. The committee was charged with examining the process by which NASA establishes space flight health standards for human performance. It assured the transparency of the current process, as well as considering its validity and integrity, particularly related to ensuring worker safety and integrating stakeholder input.	TBD
Performance	Institute of Medicine	04/2009	This report examines NASA's plans to assemble the available evidence on human health risks of space flight and to move forward in identifying and addressing gaps in research. The committee provided recommendations to strengthen the content, composition, and dissemination of the evidence books.	TBD

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Mission Operations Sustainment

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	0.0	-	0.0	400.4	409.4	459.1	391.4
Mission Operations Sustainment	0.0	-	0.0	400.4	409.4	459.1	391.4

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Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Mission Operations Sustainment

Program Overview

Mission Operations Sustainment addresses future Space Operations functions that are essential to the NASA human spaceflight mission. These crucial functions cannot be separately budgeted for at this time because specifications and requirements have yet to be defined, cost estimates must mature, and technical and/or cost risks factors and uncertainties have not been sufficiently evaluated. In all cases, the needs are real, but it will not be until the FY 2013 budget process that accurate assessments of the scope and relative priority of the need will be understood well enough to justify specific allocation of resources. For example:

- The NASA Exploration Systems budget provides funds to facilitate development of U.S. commercial crew transportation capability to ISS, but neither Exploration nor Space Operations budgets specifically provide funds to purchase those services once developed. Even though NASA will purchase cost-effective commercial crew transportation services once they become available, NASA cannot allocate specific levels of resources for the services until development activities progress and better cost estimates become available; and

- NASA has identified a potential future gap between ongoing communication infrastructure capability and future demand. The NASA SN comprises a constellation of eight communications satellites and associated ground facilities providing global communications coverage to Earth orbiting spacecraft. Key components of the SN infrastructure have exceeded their useful design life and are deteriorating. Although the time of a failure is largely unpredictable, in some cases system components are already operating beyond their expected design life. In addition, future demand is not well known dependent on the needs and capabilities of other users. In order to ensure that future NASA mission communications requirements are met, the Mission Operations Sustainment Budget line may potentially be utilized to fund this performance gap, if it arises in FY 2013 or later, to mitigate impact on NASA and other users.

Overall, NASA's human spaceflight mission cannot be sustained without resources provided by Missions Operations Sustainment. Given the tight fiscal environment, development of the Mission Operations Sustainment line is the responsible way to position Space Operations as it faces several important outyear requirements and threats. This approach is similar to that proposed in prior FY 2011 Continuing Resolution bills. NASA has already begun and will continually perform the requisite technical, program analysis, and planning to separately budget the resources for presentation in the FY 2013 Budget request.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**89.4**	**-**	**46.0**	**43.1**	**44.1**	**44.6**	**45.7**
Launch Services	89.4	-	46.0	43.1	44.1	44.6	45.7

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Program Overview

Assuring reliable and cost-effective access to space for missions is critical to achieving NASA's goals. NASA has assigned responsibility for understanding the full range of civil space launch needs to the Space Operations' Launch Services Program (LSP). LSP works closely with other U.S. Government agencies and the launch industry to ensure that the most safe, reliable, on-time, cost-effective commercial launch opportunities are available on a wide range of launch systems. The program works with customers from universities, industry, government, and international partners from the earliest phase of a mission.

A key challenge for LSP is matching the launch capabilities to the needs of the different customers. Through various scientific missions, these customers seek to understand: the origins, evolution, and destiny of the universe; the nature of life in the universe and what kinds of life may exist beyond Earth's orbit; the solar system, both scientifically and in preparation for human exploration; and the Sun and Earth and the consequences of the Earth-Sun relationship for life on Earth. The program purchases fixed-price launch services from domestic suppliers and provides oversight to ensure that these valuable, one-of-a-kind missions safely leave Earth to explore this planet and the universe beyond.

Within LSP, NASA maintains critical skills that provide technical management of launch services on the full fleet of existing and new launch systems. For more information, please see http://www.nasa.gov/centers/kennedy/launchingrockets/index.html.

LSP also supports integration activities for the Alpha Magnetic Spectrometer (AMS) particle physics and astrophysics experiment planned for the International Space Station. AMS will look for dark matter, anti-matter, and strange matter. This experiment is sponsored by the Department of Energy and funded largely by international partners. AMS is scheduled to launch aboard STS-134 in FY 2011.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Program Relevance

LSP has five planned NASA launches including NPP, the last NASA mission to be launched on a Delta II, MSL on an Atlas V, NuSTAR on a Pegasus XL, TDRS-K on an Atlas V, and RBSP on an Atlas V.

- NPP is a joint mission with National Oceanic and Atmospheric Administration that extends key measurements in support of long-term monitoring of climate trends and of global biological productivity.

- MSL, which is mostly comprised of the Curiosity long-duration rover, is part of NASA's Mars Exploration Program. MSL is scheduled to launch from Cape Canaveral, Florida, in late 2011, and will arrive at a scientifically intriguing region of Mars in August 2012. The goal of Curiosity is to assess whether Mars ever had an environment capable of supporting microbial life and conditions favorable for preserving clues about life, if it once existed.

- NuSTAR is an explorer mission that will allow astronomers to study the universe in high energy X-rays. Launching in 2012, NuSTAR is expected to greatly exceed the performance of the largest ground-based observatories that have observed this region of the electromagnetic spectrum. NuSTAR will also complement astrophysics missions that explore the cosmos in other regions of the spectrum.

- TDRSS supports tracking, data, voice, and video services to the ISS, space and Earth science missions, as well as other Government agency users. The requirements are predicted to increase and the existing fleet is aging. Reliability analyses predict a shortage of flight assets to support NASA missions and the user community by FY 2011. As a result, TDRS-K has a scheduled launch date of December 2012; however, NASA is evaluating the possibility of launching as early as April 2012.

- RBSP is being designed to help with understanding the Sun's influence on Earth and near-Earth space by studying Earth's radiation belts on various scales of space and time.

In addition to processing, mission analysis, spacecraft integration, and launch services of the above missions, LSP will continue to provide support for the development and certification of emerging launch providers that will be critical to supporting NASA programs, continue providing engineering analysis and integration support for approximately 35 NASA missions in various stages of planning and development, and provide and telemetry and communication support to several DoD launches.

Plans For FY 2012

The LSP program has five planned NASA launches including: 1) NPOESS Preparatory Project (NPP), the last NASA mission to be launched on a Delta II; 2) Mars Science Laboratory (MSL) on an Atlas V; 3) Nuclear Spectroscopic Telescope Array (NuSTAR) on a Pegasus XL; 4) Tracking and Data Relay Satellite (TDRS-K) on an Atlas V; and 5) the Radiation Belt Storm Probes (RBSP) mission on an Atlas V. In addition to processing, mission analysis, spacecraft integration, and launch services of the above missions, LSP will continue to provide support for the development and certification of emerging launch providers that will be critical to supporting NASA programs.

The NPP is a joint mission with National Oceanic and Atmospheric Administration that extends key measurements in support of long-term monitoring of climate trends and of global biological productivity. MSL, aka Curiosity, is part of NASA's Mars Exploration Program, a long-term suite of robotic exploration of the Red Planet. MSL is scheduled to launch from Cape Canaveral, FL in late 2011, and arrive at a scientifically intriguing region of Mars in August 2012. The goal of Curiosity, a rolling laboratory, is to assess whether Mars ever had an environment capable of supporting microbial life and conditions favorable for preserving clues about life, if it once existed. NUSTAR is an explorer mission that will allow astronomers to study the universe in high energy X-rays. Launching in 2012, the NuSTAR mission will allow astronomers to study the universe in high energy x-rays and is expected to greatly exceed the performance of the largest ground-based observatories that have observed this region of the electromagnetic spectrum. NuSTAR will also complement astrophysics missions that explore the cosmos in other regions of the spectrum. TDRSS supports tracking, data, voice, and video services to the ISS, Space and Earth science missions, as well as other government agency users. The requirements are predicted to increase and the existing fleet is aging. Reliability analyses predict a shortage of flight assets to support NASA missions and the user community by FY 2011. As a result, TDRS-K has a scheduled launch date of December 2012; however, NASA is evaluating the possibility of launching as early as April 2012. RBSP is being designed to help with understanding the Sun's influence on Earth and near-Earth space by studying the Earth's radiation belts on various scales of space and time.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Project Descriptions and Explanation of Changes

Launch Services Program

LSP provides the acquisition and program management of ELV missions using primarily domestic launch vehicles and associated standard services with mission unique options. These services are contracted through LSP at KSC. LSP assures that NASA retains the technical, management, and acquisition skills necessary to meet Agency and customer needs, and provides mission integration, technical, and launch management functions.

Manifesting and scheduling of payload launches are accomplished through the Flight Planning Board. LSP acquires launch services to meet the full range of requirements, ranging from finding space for small payloads as secondary payloads to the launch of dedicated payloads on a range of launch vehicles. LSP also provides technical management of the launch service, including planning, execution, and support for flight project customer requirements.

LSP provides engineering services and analysis for launch vehicle certification to maximize the mission success of commercially developed expendable launch services by employing a technical oversight approach that includes a combination of specified approvals and targeted insight. This element also provides for the coordination of mission-specific and fleet-wide launch vehicle analyses, hardware changes, and production oversight, assessments, and out-of-family anomaly resolution.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
LSP is planning for 15 missions by FY 2015 and is providing an advisory role for six additional missions.	SMD - 13 missions, and SOMD - two missions	NO CHANGE
Sustain 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.	Launch Services	N/A
Incorporate information sharing processes into programmatic policies and incorporate into crew demonstration activities and future crew transportation service contracts.	Launch Services	N/A

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Launch Services

Program Management

The Launch Services Program Manager reports to the Assistant Associate Administrator for Launch Services, SOMD at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Services Acquisition and Management	LSP, Kennedy Space Center	Kennedy Space Center	Air Force, National Reconnaissance Office
Engine Assembly and Test	LSP, Kennedy Space Center	Stennis Space Center	Air Force, National Reconnaissance Office
Mission Planning and Integration	LSP, Kennedy Space Center	Kennedy Space Center	Science Mission Directorate, Exploration Systems Mission Directorate, Space Operations Mission Directorate, Department of Defense/Missile Defense Agency, and the National Oceanic and Atmospheric Administration
Vehicle Production Insight	LSP, Kennedy Space Center	Marshall Space Flight Center	Air Force, National Reconnaissance Office

Acquisition Strategy

The NASA Launch Services (NLS) II contracts were awarded in September 2010 to Lockheed Martin Space Systems Company, Orbital Sciences, SpaceX, and United Launch Services, LLC. Under these contracts, the program will acquire services associated with launches of Athena, Pegasus, Taurus, Falcon, and Atlas launch vehicles. Services are provided on a multiple award indefinite delivery/indefinite quantity basis, spanning a ten-year period. Missions not presently under contract are competed among existing NLS II contractors through the use of a launch service task order mechanism. In addition to NLS II, Glory is the only active mission remaining under the Small Expendable Launch Vehicle Services contract with Orbital Sciences. Thirteen remaining missions will fly out under the terms of NLS I between FY 2011 and FY 2015.

The NLS II solicitation contains a provision that permits technology infusion or improvements. New offerors may seek an NLS II contract during open season that occurs each February and August. The NLS II contracts enable ordering of standard and non-standard services, as well as special studies and mission-unique modifications.

Integrated launch services are provided by the Analex Corporation through a hybrid fixed-price/cost contract that contains options to continue performance through September 2011. Payload processing for east coast missions is provided by Astrotech Space Operations. West coast payload processing is provided after a competitive selection by either Astrotech or Spaceport Systems International.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Independent Program Assessment Office (IPAO) Assessment	08/2009	This was a non-advocate review of LSP to present information to Agency decision-making councils. The NASA IPAO Review Team found that LSP is a highly successful program compliant with Agency direction, policy, and directives.	2012

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Test

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	43.3	-	36.8	38.4	39.0	39.4	39.4
Rocket Propulsion Testing	43.3	-	36.8	38.4	39.0	39.4	39.4

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

The RPT Program is the principal implementing authority for NASA's rocket propulsion testing. RPT reviews, approves, and provides direction on rocket propulsion test assignments, capital asset improvements, test facility modernizations and refurbishments. RPT provides integration for multi-site test activities, identification and protection of core capabilities, and the development of advanced test technologies.

RPT employs a collaborative approach to ensure rocket propulsion test activities are conducted in a manner that reduces cost, enhances safety, provides credible schedules, achieves technical objectives, and leverages the lessons learned. RPT reduces propulsion test costs through the safe and efficient utilization of rocket propulsion test facilities in support of NASA programs, commercial partners, and the DoD, while eliminating unwarranted duplication. RPT sustains and improves Agency-wide rocket propulsion test core capabilities (both infrastructure and critical skills) and ensures appropriate levels of capability and competency are maintained.

Additional information on the RPT program can be found at http://rockettest.nasa.gov/.

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Test

Plans For FY 2012

NASA will continue to conduct test facility management, maintenance, sustaining engineering, operations, and facility modernization projects required to keep the test-related facilities in the appropriate state of operational readiness. RPT will maximize program resources by completing, implementing, and keeping the RPT master plan current, merging current and future requirements, budget resources, and capabilities to assure the Agency maintains a proper propulsion test portfolio. Right-sizing of test infrastructure (both critical skills and facilities) will be implemented within existing budget guidelines to meet all technical, schedule, and cost requirements, both current and future, to include dispositioning facilities that are no longer required. Commercial testing and facility maintenance projects (e.g., commercial testing of the AJ-26 Liquid Oxygen and Kerosene Engine and the Stennis Space Center High Pressure Industrial Water project) will be implemented, as funding priorities permit, to improve safety and operational efficiencies.

The RPT program will continue to assist in the rocket propulsion testing requirements definition for low Earth orbit and in-space propulsion systems and related technologies.

Project Descriptions and Explanation of Changes

RPT

RPT represents the single point interface for NASA's rocket propulsion test facilities located at: Stennis Space Center (SSC), Marshall Space Flight Center (MSFC), JSC's White Sands Test Facility (WSTF), and GRC's Plum Brook Station (GRC-PBS). These facilities have a replacement value of greater than $2 billion. RPT sustains and improves Agency-wide rocket propulsion test core competencies (both infrastructure and critical skills), ensures appropriate levels of capability and competency are maintained, and eliminates unwarranted duplication. The program strategy is to fund and maintain core competencies of skilled test and engineering crews and test stand facilities, consolidate and streamline NASA's rocket test infrastructure, establish and maintain world-class test facilities, modernize test facility equipment; provide non-project specific equipment and supplies, and develop effective facility/infrastructure maintenance strategies and performance. The RPT budget does not include resources to support the marginal costs of testing (e.g., direct labor, propellants, materials, program-unique facility modifications, etc.) since these activities are funded by programs as a direct cost when they utilize the RPT test stands. When NASA, DoD, and commercial partners use the RPT-supported test stands, they are responsible for program-specific facility modifications in addition to the active testing of the program-specific test article.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Commercial testing of AJ-26 engine	Orbital Sciences Corporation	NO CHANGE
Testing of the J-2X Engine	Upper Stage Engine (USE)	NO CHANGE
Minuteman Decommissioning	U.S. Air Force	NO CHANGE
PCAD Component Testing	Propulsion Cryogenics Advanced Development (PCAD)	NO CHANGE
Commercial testing of RS-68 engine	Pratt Whitney Rocketdyne/Air Force	NO CHANGE
Meet Rocket Propulsion Test (RPT) Master Plan requirements for year one.	Rocket Propulsion Test	N/A

Mission Directorate:	Space Operations
Theme:	Space and Flight Support (SFS)
Program:	Rocket Propulsion Test

Program Management

The Rocket Propulsion Testing Program Manager reports to the Assistant Associate Administrator for Launch Services, SOMD at NASA Headquarters.

Project	Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Technical Services and Support	Stennis Space Center	Jacobs-Sverdrup, Mississippi Space Services	Rocket Propulsion Test Management Board Members: Stennis Space Center, Marshall Space Flight Center, Johnson Space Center, White Sands Test Facility, Glenn Research Center's Plum Brook Station, Kennedy Space Center (associate member), and Glenn Research Center (associate member). National Rocket Propulsion Test Management Board Department of Defense Members: Air Force Research Lab, Arnold Engineering Development Center, Redstone Technical Test Center, and Naval Air Warfare Center.

Acquisition Strategy

The Test Operations contract was extended for seven months (from August 2010 to March 31, 2011). A successful recompete was completed that included the consolidation of SSC Hardware Assurance and Test contract requirements to provide consolidation of test operations at SSC. Transition activities have begun with the new contractor and handover is expected on April 1, 2011.

Mission Directorate:	Space Operations
Theme:	SOMD Civil Service Labor and Expenses

Theme Overview

This Theme contains labor funding, both salary and benefits, for civil service employees at NASA's Centers who are assigned to work on projects in SOMD. These funds support the critical skills and capabilities required to provide the space flight missions operations and services, as outlined in the other themes, within this mission area.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**343.4**	**348.5**	**360.2**	**377.5**	**395.6**
SOMD Civil Service Labor and Expenses	0.0	-	343.4	348.5	360.2	377.5	395.6

Overview

NASA has engaged students and teachers in its engineering challenges and scientific discoveries since its inception. From school presentations to seeds flown in space, from filmstrips and posters to podcasts and virtual tours through the galaxies, NASA's education programs have fostered inquiry, built curiosity, and encouraged innovation. Generations of Americans have participated in NASA's science, technology, engineering, and mathematics (STEM) education programs, and thereby learned basic skills, discovered new career paths, and developed interests in emerging academic disciplines. The FY 2012 budget provides NASA with the resources necessary to continue this rich tradition in STEM education through support for the Nation's students and educators, the leveraging of cutting-edge education technologies, and partnerships with industry.

In 2010, NASA chartered an Education Design Team (EDT) to develop a strategy to improve NASA's education offerings, assist in establishing goals, structures, processes, and evaluative techniques to implement new sustainable and innovative STEM education programs. EDT has completed its task, and its recommendations are reflected in the FY 2012 education budget.

Meeting Stakeholder Needs: NASA works with professional organizations, academia, and state/local education providers to identify and address needs in STEM education. Quality professional development for STEM educators is a prevalent need. Through the education staff at NASA's Centers, NASA works cooperatively with states and school districts to identify content needs and opportunities, and with university partners to ensure that NASA investments will be effective in improving teaching practice. NASA also works through communities of practice to identify content areas and special events that supplement informal education programming offered by museums and science centers. NASA higher education efforts increasingly target community colleges, which generally serve a high proportion of minority students. NASA programs build student STEM ability, preparing students for study at a four-year institution. Competitive opportunities support initiatives like the President's "Race to the Top" and the Department of Education's "Star Project," which promote state-based education reform and identify replicable strategies for improving K-12 education.

Leveraging Relationships: NASA pursues strategic partnerships with intergovernmental, academic, industrial, entrepreneurial, and international communities. Partnerships and collaborations with NASA's education programs define specific benefits and outcomes, leverage the expertise of each organization, and share resources, including funding, distribution networks, and media representation. Presidential initiatives like "Educate to Innovate" and "Change the Equation" capitalize on the knowledge and expertise of the Nation's aerospace industry to support the development of a future STEM workforce. NASA investment in the National Space Grant College and Fellowship Program (Space Grant) takes this approach a step further, by supporting state-based consortia of academia, industry, and education organizations. In total, Space Grant actively engages more than 850 institutions in providing work and study experiences in the aeronautics, aerospace, and related sciences.

Inclusion of All Learners: The Administration has numerous initiatives to promote equal access to education opportunities. The White House Council on Women and Girls has established STEM education and careers as a priority area. Recent legislation promotes increased STEM engagement of Hispanic students. NASA's long-standing practice of ensuring inclusiveness of all, regardless of race, ethnicity, gender, disability, or other demographic, is in harmony with these priorities. Performance reports from higher education programs indicate that participation of racial/ethnic minorities and women exceed benchmarks for national enrollments (see Relevance section for reference).

Performance, Accountability, and Transparency: The Office of Education is committed to ensuring that its education opportunities, products, and services are high quality, effective, responsive to customer needs, and efficiently managed. In recent years, NASA's performance ratings in education have risen, as the Agency has invested more in the evaluation of its education programs and has built better tools to collect performance data (http://www.expectmore.gov). Additionally, NASA routinely seeks opportunities to eliminate redundancies and improve the reach of its programs. Federal working groups, such as the Federal Interagency Committee on Education and the National Science and Technology Council Subcommittee on Education, allow agencies to share successes and best practices, to identify common infrastructures and programs to reduce inter-agency competition, and to leverage resources for best return on taxpayer dollar. Results of studies, assessments, evaluations, and Federal performance ratings are all publicly available in accordance with the Administration's emphasis in sharing results with the public and honoring the public trust (http://www.nasa.gov/news/budget/index.html and http://www.nasa.gov/offices/education/performance/index.html).

The Agency is also increasing the transparency and interaction between Government and the public by soliciting public opinion on education planning decisions. Tools and strategies, like OpenGov and social networks, have allowed the Agency to "test drive" new ideas and possible activities assessing public reaction and comments in order to better align investments to the interests of students, teachers, and the public.

NASA is uniquely positioned to inspire students to be future scientists, engineers, explorers, and educators.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**180.1**	**182.5**	**145.8**	**138.4**	**138.4**	**138.4**	**138.4**	**138.4**
Education	180.1	-	-	138.4	138.4	138.4	138.4	138.4

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Education

Education

New Initiatives:

In FY 2012, NASA will implement the recommendations from EDT:

- Increase NASA's impact on STEM education by further focusing K-12 efforts on middle school pre- and in-service educator professional development;

- Increase emphasis on providing experiential opportunities for students, internships, and scholarships for high school and undergraduate students;

- Increase NASA's role in national and state STEM policy discussions;

- Emphasize evaluation and assessment, including external independent evaluation, to ensure that investments are providing desirable STEM impacts;

- Engage strategic partners with common objectives and complementary resources and approaches; and

- Use NASA's unique missions, discoveries, and assets (e.g., people, facilities, education infrastructures) to inspire student achievement and educator teaching ability in STEM fields.

Major Changes:

The President's budget reflects a $7.4 million decrease from previous request, consistent with the Administration's effort to reduce federal spending. NASA's Office of Education will focus its funds on existing commitments and grant renewals, continuation of scholarships, internships and fellowships, and activities that directly serve educators, students, and the general public. The decrease will be managed by reducing the number of new grant awards and seeking operational efficiencies (e.g., increased use of education technologies, reduction in printing/warehousing/shipping costs, reducing travel, coordinating solicitations).

Major Highlights for FY 2012

In FY 2012, NASA will pursue several education activities:

- Support national STEM improvement efforts championed by the Administration and led by the Department of Education. Focused, combined goals and solicitation opportunities will result in effective Federal agency contributions. Possible examples include, providing competitions and challenges for students, supporting clearinghouses of Federal STEM education resources, and providing high quality professional development to educators.

- Continue the Summer of Innovation (SoI) activity to inspire student achievement in STEM fields by partnering with internal and external stakeholders to leverage the excitement of NASA's missions. SoI will deepen and broaden the efforts of community and school-based organizations to engage students by providing high quality, inquiry-based content, customized support, and access to NASA people, facilities, and education technologies.

- Enable student launch initiatives, hands-on payload development, and engineering opportunities for NASA missions. Through partnerships with NASA Centers, universities, and industry, students will gain research experiences and hands-on engineering experience on a variety of real-world platforms that may include high-altitude balloons, sounding rockets, aircraft, space satellites, and the International Space Station (ISS).

- Improve STEM education coordination with other Federal agencies and seek opportunities to incorporate NASA content into the STEM education efforts of other Federal programs.

- Increase community college involvement in NASA research, and increase their ability to use NASA content to provide the education and training that will prepare students for jobs in the 21st century.

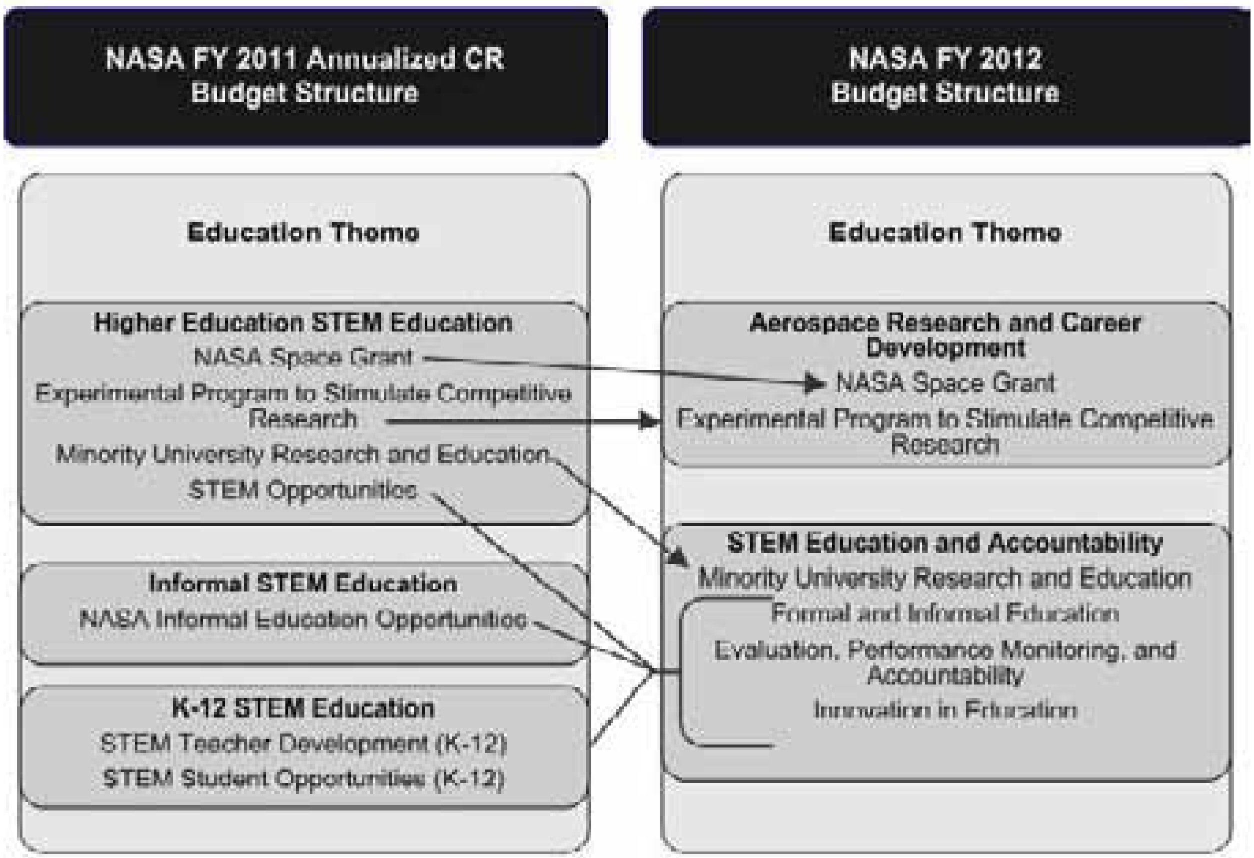
- Expand educator professional development and pre-service preparation that is based on education research and that reflects current and future NASA science and exploration missions.

- Immerse educators in current NASA science and technology by increasing use of education technologies (e-Education) and cyber-learning opportunities.

- Leverage the national, state, and local resources and networks of the Space Grant consortia in implementing these activities.

Mission Directorate Budget Structure Adjustments

In FY 2012, NASA is reorganizing its Education budget in order to provide better emphasis on achieving the Agency's goals. Rather than organizing investments around the type of client served (higher education, K-12 or informal education), NASA is focusing programs on the outcomes that the Agency seeks to achieve. This change will enhance the Agency's ability to leverage other resources. The new structure clusters activities that provide a progression of opportunities for students and/or educators into two program areas. Specifically, the structure of the programs from FY 2011 to FY 2012 is as shown in the figure below.



Mission Directorate:	Education
Theme:	Education

Theme Overview

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	180.1	-	138.4	138.4	138.4	138.4	138.4
Aerospace Research and Career Development	70.6	-	35.7	35.7	35.7	35.7	35.7
STEM Education and Accountability	0.0	-	94.4	94.2	93.8	93.4	92.9
Higher Ed. STEM Education	49.0	-	0.0	0.0	0.0	0.0	0.0
K-12 STEM Education	45.0	-	0.0	0.0	0.0	0.0	0.0
Informal STEM Education	15.5	-	0.0	0.0	0.0	0.0	0.0
ED Civil Service Labor And Expenses	0.0	-	8.3	8.5	8.9	9.3	9.8

Note:
For comparability purposes, the NASA Space Grant and Experimental Program to Stimulate Competitive Research (EPSCoR) FY 2010 funding is shown in the table above within the new Aerospace Research and Career Development Program line. All other past program content is reflected in the previous structure.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

A strong U.S. economy is founded on the abilities, interests, and innovations of its citizens. However, the performance of American students on international assessments of STEM ability is "middle of the pack."* To improve the state of U.S. STEM education, the Federal Government is calling upon its agencies to help improve the STEM performance of American students.

NASA is committed to providing equal access to its education activities by providing any student with the opportunity to contribute to the future STEM workforce. NASA is responding by focusing its education investments on areas of greatest national need and ensuring that the Agency's education programs support national STEM priorities. With its wealth of science and technology content and its expansive network of education professionals, NASA is well equipped to address national needs such as meeting state requirements for educator professional development.

NASA provides practical experience and skills development for those who will become the future workforce through internships, fellowships, and student research opportunities. NASA is uniquely qualified to attract students to pursue STEM study and careers. It also is able to engage these future workers through inspiring NASA missions, fostering collaborative relationships between students and the current workforce and offering students opportunities to work in "out of this world" facilities. Hands-on challenges with expert mentors generate increased interest in undergraduate STEM study, thereby increasing the number of students who seek employment in aerospace or related STEM fields.**

*Programme for International Student Assessment, 2009
**Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads, The National Academies Press, 2011

Relevance to the NASA Mission and Strategic Goals:

By building a strong future workforce for NASA and the Nation, NASA's investments in STEM education address Strategic Goal 5, to "Enable program and institutional capabilities to conduct NASA's aeronautics and space activities."

By providing mission based experiences and learning resources, Education addresses strategic goal 6, to "Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation and contribute to a strong national economy."

Relevance to education and public benefits:

In January 2011, President Barack Obama stated that, "over the next 10 years, nearly half of all new jobs will require education that goes beyond a high school education. And yet, as many as a quarter of our students aren't even finishing high school. The quality of our math and science education lags behind many other nations. America has fallen to ninth in the proportion of young people with a college degree. And so the question is whether all of us 'as citizens, and as parents' are willing to do what's necessary to give every child a chance to succeed." This speech echoes findings and calls-to-action by numerous committees, reports, professionals in education, and leaders in American industry. In response, the Department of Education has identified several strategies to improve STEM education and ways in which Federal agencies can contribute to the Nation's STEM improvement efforts. NASA is a strong contributor to the national plan.

NASA's education programs increase the number of students who are proficient in, choose to major in, and pursue careers in STEM fields. Improving STEM ability, increasing public scientific literacy, increasing the talent pool of future STEM workers, and developing the STEM skills of the future workforce are imperatives if the Nation is to remain globally competitive and sustain a strong economy. NASA actively works through mutually beneficial relationships with over 500 colleges and universities, hundreds of K-12 schools and districts, and over 400 museums and science centers to provide education experiences so that all students can learn deeply and think critically in STEM disciplines.

NASA supports cutting-edge undergraduate student research that contributes to NASA missions while training the next generation of scientists, engineers, and innovators. NASA targets recruitment and retention of underserved and underrepresented students, including women and girls, Hispanics, and students with disabilities.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**	
Outcome 5.1	**Identify, cultivate, and sustain a diverse workforce and inclusive work environment that is needed to conduct NASA missions.**	
Objective 5.1.2	**Provide opportunities and support systems that recruit, retain, and develop undergraduate and graduate students in STEM-related disciplines.**	
Performance Goal 5.1.2.1	***Assure that student participants in NASA higher education projects are representative of the diversity of the Nation.***	
APG 5.1.2.1: ED-12-1	Achieve 40 percent participation of underserved and underrepresented (in race and/or ethnicity) in NASA higher education projects.	STEM Education and Accountability
APG 5.1.2.1: ED-12-2	Achieve 45 percent participation of women in NASA higher education projects.	STEM Education and Accountability
Strategic Goal 6	**Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation and contribute to a strong national economy.**	
Outcome 6.1	**Improve retention of students in STEM disciplines by providing opportunities and activities along the full length of the education pipeline.**	
Objective 6.1.1	**Provide quality STEM curricular support resources and materials.**	
Performance Goal 6.1.1.1	***Provide educators nationwide with knowledge and tools with which to inspire students in STEM fields.***	
APG 6.1.1.1: ED-12-3	100,000 educators participate in NASA education programs.	STEM Education and Accountability
Objective 6.1.2	**Provide NASA experiences that inspire student interest and achievement in STEM disciplines.**	
Performance Goal 6.1.2.1	***Provide higher education students with authentic NASA mission-based opportunities that build knowledge and skills needed for STEM careers.***	
APG 6.1.2.1: ED-12-4	25,000 undergraduate and graduate students participate in NASA education opportunities.	STEM Education and Accountability
Performance Goal 6.1.2.2	***Provide elementary and secondary students with authentic NASA mission-based opportunities that build STEM knowledge, skills, and career awareness.***	
APG 6.1.2.2: ED-12-5	600,000 elementary and secondary students participate in NASA instructional and enrichment activities.	STEM Education and Accountability
APG 6.1.2.2: ED-12-6	85 percent of elementary and secondary students express interest in STEM careers following their involvement in NASA education programs.	STEM Education and Accountability

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Outcome 6.2	**Promote STEM literacy through strategic partnerships with formal and informal organizations.**	
Objective 6.2.1	**Develop NASA's leadership role in national STEM improvement efforts, as demonstrated by provision of meaningful educator professional development and student experiences, adoption of education technologies, and contributions to STEM education policies and strategies.**	
Performance Goal 6.2.1.1	***Provide educator professional development experiences and materials that align to needs and opportunities identified by districts, states, Department of Education, professional organizations, and other stakeholders.***	
APG 6.2.1.1: ED-12-7	5,000 educators use NASA resources in their curricula after participating in NASA professional development.	STEM Education and Accountability
Performance Goal 6.2.1.2	***Provide expertise in the development of STEM education policies and strategies.***	
APG 6.2.1.2: ED-12-8	Provide expertise to support the development of integrated science and engineering standards.	STEM Education and Accountability
Outcome 6.4	**Inform, engage, and inspire the public by sharing NASA's missions, challenges, and results.**	
Objective 6.4.1	**Use strategic partnerships with formal and informal educational organizations to provide NASA content to promote interest in STEM.**	
Performance Goal 6.4.1.1	***Leverage communities of practice to facilitate sharing of NASA successes and challenges with the public.***	
APG 6.4.1.1: ED-12-9	450 museums and science centers across the country actively engage the public in major NASA events.	STEM Education and Accountability

Performance Achievement Highlights:

In 2010, NASA chartered an EDT directed to develop a strategy for improving NASA's education offerings and to assist in establishing goals, structures processes, and evaluative techniques to implement new sustainable and innovative STEM education programs. The recommendations of the EDT are reflected in the FY 2012 education budget.

In FY 2010, nearly 21,000 Space Grant-supported undergraduate and graduate students participated in authentic hands-on research and engineering challenges, including developing and launching payloads on high altitude balloons, rockets, and other platforms.

In FY 2010, NASA piloted the SoI, engaging low-income and minority students in STEM disciplines through out-of-school learning activities. State education stakeholders, NASA Centers, and other education partners also offered STEM-related special events, educator professional development, and family activities.

During summer 2010, more than 150 events, led by NASA Centers and 130 participating partners from across the Nation, engaged over 150,000 students in NASA experiences. Of these, nearly 22,000 students received at least 40 hours of STEM engagement and instruction.

Of the 1,343 participants in NASA higher education activities, who self-reported post-employment data, 46.5 percent reported working for NASA, aerospace contractors, universities, or other educational institutions. Motivating Undergraduates in Science and Technology, or MUST, was a prototype for more closely mapping Office of Education investments to the NASA Early Career Hiring Initiative. This collaborative approach succeeded in placing 75.9 percent of MUST graduates with NASA.

In FY 2009 (reported in FY 2010), 6,743 higher education students self-reported being an underserved and underrepresented audience in terms of race/ethnicity. This represents 40.6 percent of the total number of higher education students served by NASA, an increase from 28 percent the previous year. Of all higher education students served by the Agency, 43 percent self-reported being women, a one-year increase from 41 percent. These figures are well above national averages for participation of minority students according to the National Science Foundation's report, "Women, Minorities, and Persons with Disabilities in Science and Engineering," released in April 2010.

In FY 2010, over 400 museums and science centers used NASA resources in their activities and exhibits. NASA selected some of these institutions to develop and implement public engagement activities to enhance education programs related to space exploration, aeronautics, space science, Earth science, and microgravity through the competitive program for science museums and planetariums.

NASA awarded 49 institutional research awards, worth more than $34.6 million, to targeted colleges and universities. This NASA-related research will better enable these institutions to compete for funding from sources other than NASA's Office of Education.

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Quality	Abt Associates, Cambridge, MA	FY 2008	External independent evaluation of Science, Engineering, Mathematics, and Aerospace Academy, or SEMAA, included randomized controlled trials (RCT), assessed effectiveness, and determined how intended goals were being implemented. Evaluation considered the overall effort, provided data on how differences in effectiveness were associated with site variations, and offered explanations for observed outcomes. Evaluation was used to consider options for SEMAA to promote sustainability.	FY 2015
Other	Abt Associates, Cambridge, MA	FY 2009	The external evaluation contractor conducted a planning phase by reviewing selected investments in Higher Education. An evaluation design that includes multiple higher education activities and examines where NASA higher education graduates are employed after graduation was developed.	FY 2012
Relevance	Abt Associates, Cambridge, MA	FY2010	Based on the results of the planning phase, Abt will conduct a survey of graduates that have received NASA funding to find out where graduates are employed, as well as potential barriers to NASA graduates being employed in STEM fields. This evaluation is exploratory in nature and will help NASA better understand which types of investments are best at producing graduates that go into STEM fields.	FY 2014
All	Abt Associates, Cambridge, MA	FY 2010	The external evaluator conducted a planning phase for Informal Education. This included examining Informal and K-12 investments. The exercise found that activities that could be considered informal education, were sometimes categorized under K-12, and that the line between informal education and outreach was blurred. The results of this evaluation helped to inform the NASA EDT redesign of NASA education.	FY 2012
All	Abt Associates, Cambridge, MA	FY 2010	The external evaluator conducted a case study of five informal education activities. The case study looked at resources available, sustainability, developing strategic partnerships, and achievement of intended outcomes. Also included in the evaluation report were considerations for conducting a more rigorous impact study of informal education investments.	FY 2012
Relevance	Booz-Allen Hamilton (BAH)	FY 2009	An external independent evaluation of the NASA Explorer Schools (NES) was conducted by BAH, per Congressional direction. The evaluation included review of previous assessments and the NES redesign model. BAH identified several structural elements for NES scalability to a level that would support significantly greater numbers of schools, students and educators.	FY 2011

Independent Reviews:

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Relevance	Abt Associates, Cambridge, MA	FY 2010	The external evaluator is working closely with the NES team to develop a comprehensive formative evaluation for NES over the next two years. At the end, the evaluation contractor will conduct an outcome study. If the outcome study looks promising, the evaluator will conduct a rigorous study of NES impact, either an RCT or a well-designed quasi-experimental evaluation.	FY 2012
All	Abt Associates, Cambridge, MA	FY 2010	Contractor was tasked with conducting a formative evaluation of the SoI pilot. The evaluation report was used to inform the design of the second year of SoI.	FY 2011
Relevance	Booz-Allen Hamilton	FY 2010	Contractor assessed the SoI model and conducted a benchmarking study to inform the second year planning.	FY 2011
Relevance	Abt Associates, Cambridge, MA	FY 2011	Contractor is designing a formative evaluation for the second year of SoI.	FY 2012

Mission Directorate:	Education
Theme:	Education
Program:	Aerospace Research and Career Development

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	70.6	-	35.7	35.7	35.7	35.7	35.7
NASA Space Grant	45.6	-	26.6	26.6	26.6	26.6	26.6
Experimental Program to Stimulate Competitive Research	25.0	-	9.1	9.1	9.1	9.1	9.1

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Education
Theme:	Education
Program:	Aerospace Research and Career Development

Program Overview

Aerospace Research and Career Development strengthens the research capabilities of the Nation's colleges and universities and provides opportunities that attract and prepare increasing numbers of students for NASA-related careers. This program includes NASA's Space Grant and Experimental Program to Stimulate Competitive Research (EPSCoR). The research conducted through these programs contribute to the research needs of NASA's Mission Directorates and furthers the Nation's scientific and technology innovation agendas. Student programs serve as a major link in the pipeline for addressing NASA's human capital strategies. The programs build, sustain, and effectively deploy the skilled, knowledgeable, diverse, and high-performing workforce needed to meet the current and emerging needs of NASA and the Nation.

In doing so, NASA uses several strategies.

Research Infrastructure Development and Increasing Competitiveness: NASA supports the development of research and engineering competitiveness at minority colleges and universities, community colleges, and at institutions in states underrepresented in STEM research. Support includes research funding, support for new partnerships, access to NASA's unique facilities, and mentoring/research collaborations with NASA's scientists and engineers. Through new STEM courses, highly qualified faculty, new laboratories and research centers, and successful competition for NASA research, institutions are better able to attract and educate the future STEM workforce.

Internships and Fellowships: NASA provides research and training experiences to high school, undergraduate, and graduate students. Participants conduct engineering, science, and/or STEM education research that contributes to NASA's missions. Interns and fellows work at universities and at NASA Centers and benefit from the guidance and mentoring provided NASA's scientists and engineers. Opportunities to develop leadership skills and foster peer-to-peer interactions are important features of NASA's internships and fellowships.

Inspiring Students: NASA uses its unique resources, such as its flight and research facilities, to inspire student achievement in STEM. NASA provides mission-focused engineering challenges, contests, simulations, and learning activities that engage students both in and out of school. Work is conducted by NASA and in partnership with partners from industry, academia, other Federal agencies, and international partners. Inspiring students and instilling in them a desire to pursue STEM study is a major aim of the Administration's STEM education initiatives.

Plans For FY 2012

In FY 2012, NASA will implement several activities through the Aerospace Research and Career Development Program:

- Prepare pre-college students for studies in STEM and increase the number of science and engineering graduates;

- Provide opportunities for student flight projects to access space. Through partnerships (e.g., NASA Centers, universities, and industry), students will gain research and hands-on engineering experiences on a variety of authentic flight platforms including high-altitude balloons, sounding rockets, aircraft, and space satellites;

- Strengthen STEM programs at the Nation's two-year community colleges--institutions that are critical to ensuring students are prepared for the workplace or to successfully transition to four-year institutions. Additionally, NASA will prepare graduating students from both two- and four-year institutions with skills, knowledge, and hands-on experiences in order to make them competitive when applying for employment with NASA, academia, or aerospace industries; and

- Engage in state and national level STEM education and employment-related policy discussions that improve and support national initiatives.

Project Descriptions and Explanation of Changes

National Space Grant College and Fellowship Program (Space Grant)

Space Grant is a national network that expands opportunities for students, educators, and faculty to understand and participate in NASA's aeronautics and space projects. Space Grant debuted in FY 1989, and it is now composed of 52 consortia in 50 states, the District of Columbia, and the Commonwealth of Puerto Rico. Space Grant leverages the resources of over 850 affiliates from universities, colleges, industry, museums, science centers, and state and local agencies. Space Grant supports and enhances science and engineering education and research efforts in higher education, K-12, and informal education. NASA establishes training grants with each consortium, aligning consortium work with the education priorities and the annual performance goals of the Agency.

Experimental Program to Stimulate Competitive Research (EPSCoR)

EPSCoR develops academic research enterprises that are long-term, self-sustaining, and nationally competitive by supporting states with modest research infrastructure so that they become more competitive in attracting non-EPSCoR funding. Funding is competitively awarded to lead academic institutions (in eligible states) to foster research and technology development opportunities for faculty and research teams. NASA actively seeks to integrate the research conducted by EPSCoR jurisdictions with the scientific and technical priorities being pursued by the Agency. These scientific and technical priorities are established and evaluated by the Agency's Office of the Chief Technologist and Mission Directorates. NASA's commitment to EPSCoR will be strengthened by closer alignment to the Agency's Space Technology Roadmaps.

Program Management

The Associate Administrator (AA) for Education is responsible to the NASA Administrator for NASA's education investments. The AA for Education reports to the Administrator, serves as NASA Education Officer, and manages all education responsibilities.

Acquisition Strategy

NASA solicits new and innovative education products, tools, and services from qualified external organizations. This occurs in response to changes in STEM education trends, identified gaps or opportunities in the education portfolio of investments, a response to demonstrated customer need or demand, or when the Administration or Congress identifies new priorities.

NASA awards education grants and contracts through full and open competition. Selections are based on peer reviews by external panels that evaluate educational merit and internal/external panels for content, merit, feasibility, and alignment to education goals.

While competition may sometimes be restricted by legislation to designated participants, such as defined EPSCoR states, grant awards and selection of participating institutions are still determined competitively. When designated participants are identified, all proposals are reviewed for merit, and each award must be justified and deemed worthy of funding.

NASA has initiated an omnibus solicitation, similar to the Science Mission Directorate ROSES. In these calls for proposals, the needs of several projects and programs are combined in an overarching solicitation issued before NASA education funds are appropriated. Final selections are made and funded only when NASA receives its final budget. This process is expected to provide a greater response time for proposers and reviewers, which increases the quality and relevance of awarded work. In FY 2011, MUREP issued a ROSES-type call, "Education Opportunities in NASA STEM (EONS) 2011," which included competitive elements for several MUREP activities.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**94.4**	**94.2**	**93.8**	**93.4**	**92.9**
Minority University Research Education Program	0.0	-	28.0	28.0	28.0	28.0	28.0
STEM Education and Accountability Projects	0.0	-	66.4	66.2	65.8	65.4	64.9

Note:
The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Mission Directorate:	Education
Theme:	Education
Program:	STEM Education and Accountability

Program Overview

NASA uses information about Earth and its climate, the Moon, Mars, and beyond to engage educators and learners of all ages in various venues. The Office of Education works to align the NASA education strategy with national STEM priorities in collaboration with other Federal agencies and state and local education leaders. The new STEM Education and Accountability Program provides lessons, materials, research opportunities, and hands-on activities that draw on NASA's unique missions. This program includes projects that serve Higher Education, K-12 STEM Education, and Informal Education. This program also includes the Evaluation, Performance Monitoring, and Accountability project that improves the management, effectiveness, and efficiency of all education investments. NASA will execute its education plan by taking a balanced approach to providing services and opportunities to students, educators, higher education students, and the public. By executing this plan, NASA will provide many types of services and products.

Internships and Fellowships: NASA provides research and training experiences to high school, undergraduate, and graduate students. Participants conduct engineering, science, and/or STEM education research that contributes to NASA's missions. Interns and fellows work at universities and at NASA Centers, and benefit from the guidance and mentoring provided NASA's scientists and engineers. Opportunities to develop leadership skills and foster peer-to-peer interactions are important features of NASA's internships and fellowships.

Educator Professional Development: NASA builds STEM content capability in teachers by providing them with professional development opportunities. To meet state and local teacher continuing education requirements, these experiences are often offered in partnership with credit-granting colleges and universities. To improve teaching effectiveness, NASA uses proven approaches and strategies, including working with state and local education agencies, enabling interactions with NASA scientists and engineers, providing leadership development programs, and fostering between-peer sharing of best practices.

Inspiring Students: NASA uses its unique resources, such as its flight and research facilities, to inspire student achievement in STEM. NASA provides mission-focused engineering challenges, contests, simulations, and learning activities that engage students both in and out of school. Work is conducted by NASA and in partnership with industry, academia, other Federal agencies, and international partners. Inspiring students and instilling in them a desire to pursue STEM study is a major aim of the Administration's STEM education initiatives.

Curricular Support Resources and Materials: NASA provides a wide-variety of topic areas on which NASA creates and provides resources and materials to educators. Lesson plans, hands-on activities, and lesson enrichment materials (e.g., career Web sites and podcasts) are based on national standards, which are presented in formats and media designed for easy integration into established curricula. Education technologies (e.g., online games and professional development) enable scaled up delivery of NASA's materials to educator audiences with differing backgrounds, abilities, and interests. Provision of quality STEM materials is recommended by Department of Education as a strategy to improve STEM education.

Leveraging Partnerships: To inspire lifelong learning, NASA leverages strategic partnerships with industry, state and local agencies, museums and science centers, universities, and other community-based organizations. NASA builds and fosters networks of user communities that share information broadly, translate NASA's technical successes into audience appropriate exhibits and educational materials, and connect with peers in addressing STEM challenges.

Plans For FY 2012

In FY 2012, NASA will implement several education activities.

1. Prepare pre-college students for studies in STEM and increase the number of science and engineering graduates.

2. Focus on educator in-service and pre-service professional development. Educators will use NASA's unique content to help prepare students for college study in STEM disciplines.

3. Provide opportunities for student flight projects to access space. Through partnerships (e.g., NASA Centers, universities, and industry), students will gain research and hands-on engineering experiences on a variety of authentic flight platforms, including high-altitude balloons, sounding rockets, aircraft, and space satellites.

4. Provide high school students with internship opportunities under mentorship of NASA scientists and engineers, and provide university students opportunities to participate in NASA space and aeronautics research missions. Fund institutions that make scholarships to students to support their studies and to help make college affordable. Some students will contribute to original research and support hardware designs that will fly on future NASA missions.

5. Enhance the capabilities of the formal and informal education community to inspire the next generation of explorers by providing access to NASA staff, research, technology, information, and/or facilities.

6. Immerse educators and students in current NASA science and technology by using social networks and Internet collaboration. NASA will make extensive use of e-education technologies, from Web-disseminated information and remote control of science instruments to learning in virtual worlds. Additionally, through NASA's digital infrastructure, the Agency will "beam" NASA scientists, engineers, and astronauts into classrooms, museums, and science centers across the Nation, providing real-time interactive discussion on topics related to NASA science and engineering.

7. Engage in state and national level STEM education policy discussions that improve and support education curricula development and/or support systemic reform initiatives.

Project Descriptions and Explanation of Changes

Innovation in Education

NASA has taken a prominent role in supporting the Administration's education initiatives, including "Educate to Innovate" and public-private collaborations like National Lab Day. Through competitive cooperative agreements and partnerships with state-based consortia, companies, and nonprofits, NASA will continue to use its substantial STEM assets, including the Agency's scientists and engineers, to support improvements in STEM teaching and learning.

NASA's Innovation in Education project focuses on innovative ways to reach educators and students, improving student retention in STEM disciplines and better engaging community colleges and minority-serving institutions. It enables NASA to seek out and support innovative, replicable, and scalable approaches to improve STEM learning and instruction and to provide opportunities for students and faculty to participate in NASA-related research and launch vehicle/payload development activities. In collaboration with the ISS Program Office, students and faculty will develop new ISS hardware, conduct experiments, and identify new strategies for utilizing ISS data in learning activities. NASA will provide competitive opportunities for NASA partners to engage students in authentic hands-on learning opportunities through design challenges, competitions, and the SoI. NASA will identify and validate practices that can increase impact on STEM education and then replicate those that have proven effective. Collaborations between government, academia, and industry, such as those employed in the SoI, are encouraged as a means of engaging students in stimulating mathematics and science-based education.

Evaluation, Performance Monitoring, and Accountability

NASA supports the Administration's commitment to the public trust through transparency in operations and accountability in programmatic, financial, procurement, and reporting practices. NASA will establish an Evaluation, Performance Monitoring, and Accountability project. This project will assist education managers in setting specific outcome-focused performance goals, measuring progress toward meeting the goals, and tracking completion of key milestones. The project will compare progress among peers to identify better practices and recommend adopting and implementing strategies based on analysis of performance and other relevant data. Education managers will use performance data to confirm achievement of intended outcomes, make quick adjustments to strategies when data indicates investments are not performing, and report to the public in useful and accessible formats.

NASA recognizes the need to have ambitious goals, achieve results, ensure projects are well managed, and continuously improve efficiency. NASA will continue to cooperate with the Office of Management and Budget and internal/external stakeholders, to develop and address short-term, intermediate, and longer-term data and public reporting requirements.

Minority University Research and Education Project (MUREP)

NASA will continue to assist minority institutions and faculty through existing multi-year research grants and to provide scholarships, internships, mentoring, and tutoring to underserved and underrepresented students. In FY 2012, MUREP will increase investments supporting undergraduate students. This focus will enable greater numbers of underserved and underrepresented students to participate in NASA programs and continue to support the entry of these students into the scientific and technical workforce.

Mission Directorate:	Education
Theme:	Education
Program:	STEM Education and Accountability

Formal and Informal Education

NASA's formal and informal education project supports educators and students in the classroom and in other education settings, like science centers, community-based organizations, or through an Internet presence. NASA partners with academic institutions, professional education associations, non-profits, industry, NASA visitor centers, and other Government agencies to provide teachers, faculty, and volunteers with the NASA experiences that they can use to spark students' interest in STEM fields. NASA invests in educator professional development, post-secondary STEM degrees, school-based resources, and multiple on-line learning activities. NASA resources and opportunities are available to all educators and students, and many investments have emphasis in attracting women, minorities, and persons with disabilities.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Achieve 40 percent participation of underserved and underrepresented (in race and/or ethnicity) in NASA higher education projects.	STEM Education and Accountability	N/A
Achieve 45 percent participation of women in NASA higher education projects.	STEM Education and Accountability	N/A
100,000 educators participate in NASA education programs.	STEM Education and Accountability	N/A
25,000 undergraduate and graduate students participate in NASA education opportunities.	STEM Education and Accountability	N/A
600,000 elementary and secondary students participate in NASA instructional and enrichment activities.	STEM Education and Accountability	N/A
85 percent of elementary and secondary students express interest in STEM careers following their involvement in NASA education programs.	STEM Education and Accountability	N/A
5,000 educators use NASA resources in their curricula after participating in NASA professional development.	STEM Education and Accountability	N/A
Provide expertise to support the development of integrated science and engineering standards.	STEM Education and Accountability	N/A
450 museums and science centers across the country actively engage the public in major NASA events.	STEM Education and Accountability	N/A

Program Management

The AA for Education is responsible to the NASA Administrator for NASA's education investments. The AA for Education reports to the Administrator, serves as NASA Education Officer, and manages all education responsibilities.

Mission Directorate:	Education
Theme:	Education
Program:	STEM Education and Accountability

Acquisition Strategy

NASA solicits new and innovative education products, tools, and services from qualified external organizations. This occurs in response to changes in STEM education trends, identified gaps or opportunities in the education portfolio of investments, a response to demonstrated customer need or demand, or when the Administration or Congress identifies new priorities.

NASA awards education grants and contracts through full and open competition. Selections are based on peer reviews by external panels that evaluate educational merit and internal/external panels for content, merit, feasibility, and alignment to education goals.

While competition may sometimes be restricted by legislation to designated participants, such as defined EPSCoR states, grant awards and selection of participating institutions are still determined competitively. When designated participants are identified, all proposals are reviewed for merit, and each award must be justified and deemed worthy of funding.

NASA has initiated an omnibus solicitation, similar to the Science Mission Directorate ROSES. In these calls for proposals, the needs of several projects and programs are combined in an overarching solicitation issued before NASA education funds are appropriated. Final selections are made and funded only when NASA receives its final budget. This process is expected to provide a greater response time for proposers and reviewers, which increases the quality and relevance of awarded work. In FY 2011, MUREP issued a ROSES-type call, "Education Opportunities in NASA STEM (EONS) 2011," which included competitive elements for several MUREP activities.

Mission Directorate:	Education
Theme:	Education
Program:	ED Civil Service Labor And Expenses

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**8.3**	**8.5**	**8.9**	**9.3**	**9.8**
ED Civil Service Labor and Expenses	0.0	-	8.3	8.5	8.9	9.3	9.8

Program Overview

This program contains labor funding, both salary and benefits, for civil service employees at NASA's Centers who are assigned to work on projects in the Education programs. These funds support the critical skills and capabilities required to support the education activities, as outlined in the other programs, within this Mission area.

Mission Directorate: Cross-Agency Support

Overview

Cross-Agency Support (CAS) provides critical mission support capabilities necessary to ensure the efficient and effective operation and administration of the Agency that cannot be directly aligned to specific program or project requirements. These functions align and sustain institutional and program capabilities for supporting NASA's mission portfolio by leveraging resources to meet mission needs, establishing Agency-wide capabilities, and providing institutional checks and balances. NASA's CAS includes two themes: Center Management and Operations (CMO) and Agency Management and Operations (AMO). CAS capabilities ensure core services are ready and available for performing NASA mission roles and responsibilities. CAS institutional capabilities ensure that Agency operations are effective and efficient and that activities are conducted in accordance with all statutory, regulatory, and fiduciary responsibilities. CAS program capabilities ensure that vital skills and assets are ready and available to meet technical milestones for programs and projects; that missions and research are technically and scientifically sound; and that Agency practices adhere to standards and processes that provide safety and reliability through proper management of risk.

CMO directly supports Agency programs and projects that reside at and are executed by NASA Centers. This theme provides for the care of institutional assets, for establishing and maintaining the staff and their competencies, and for the maintenance and operation of facilities required by current and future programs and projects at nine Centers. Center Institutional Capabilities provides resources, oversees the assignment of workforce and facilities, and manages Center operations. Center Program Capabilities sustains the technical facilities, workforce expertise and skills, equipment, tools, and other resources required to facilitate program and project execution.

AMO activities provide policy and oversight to assure compliance with external and internal requirements, assure safety and mission success, and sustain Agency-wide critical capabilities. These activities provide management of human capital, acquisitions, financial performance, information technology, and performance improvement. AMO provides for near and long-term alignment of its human capital policy and a corporate approach to managing its unique or highly specialized facilities. AMO maintains a core complement of civil service professionals to resolve the Agency's financial, acquisition, and business challenges.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**3,017.6**	**3,018.8**	**3,111.4**	**3,192.0**	**3,192.0**	**3,192.0**	**3,192.0**	**3,192.0**
Center Management and Operations	2,161.2	-	-	2,402.9	2,402.9	2,402.9	2,402.9	2,402.9
Agency Management and Operations	766.2	-	-	789.1	789.1	789.1	789.1	789.1
Institutional Investments	27.2	-	-	0.0	0.0	0.0	0.0	0.0
Congressionally Directed Items	63.0	-	-	0.0	0.0	0.0	0.0	0.0

Note:
In all budget tables, the Institutional Investments (II) budget has transferred to the new Construction and Environmental Compliance and Restoration (CECR) appropriation for FY 2010 and beyond. The remaining FY 2010 enacted funding includes labor and travel to support CECR activities. The II labor and travel budget transferred to Center Management and Operations in FY 2011. The Innovative Partnerships Program (IPP) has transferred to the new Aeronautics and Space Research and Technology appropriation in FY 2011.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Cross-Agency Support

Center Management and Operations

New Initiatives:

None

Major Changes:

The CMO FY 2012 budget request appears to differ significantly from the FY 2011 request because of the transfer of the civil service labor costs from CMO programs to CMO Civil Service Labor and Expenditures (CSLE). A total of $943.6 million was transferred from CMO programs to the CMO CSLE for labor, benefits, awards, and Center training.

Major Highlights for FY 2012

To support NASA missions, CMO provides continuing operations for nine Centers, including four major component facilities, in ten separate states. CMO ensures that Centers can provide the basic support required to meet internal and external requirements; effectively manage human capital, information technology, and facility assets; responsibly execute financial management and acquisition responsibilities; ensure independent technical oversight of NASA's programs and projects in support of safety and mission success; and provide a safe, secure, and environmentally sustainable workplace. These Center capabilities provide the services and products required by the programs and projects; enable technology innovation for NASA and the broader science and engineering communities; and serve as unique national capabilities to industry, academia, and government.

Agency Management and Operations

Major Changes:

The AMO FY 2012 budget request appears to differ significantly from the FY 2011 request because of the transfer of the civil service labor costs from the individual AMO programs to AMO CSLE. A total of $304.9 million was transferred from AMO programs to the AMO CSLE for labor, benefits, SES awards, Agency awards, and Agency training.

A zero-sum transfer was made within Safety and Mission Success to transfer $1.7 million to the Office of Safety and Mission Assurance for additional efforts toward the Micrometeoroid Orbital Debris program, in line with the NASA Authorization Act of 2010.

The FY 2012 funding request for Independent Verification and Validation (IV&V) is $20 million less that the FY 2012 request from the FY 2011 Budget Estimates book. The majority of this reduction ($15 million) is to restore IV&V funding to its FY 2008 funding level. The remainder of the $5 million difference represents the transfer of IV&V's civil service labor costs to AMO-Civil Service Labor and Expenditures.

Major Highlights for FY 2012

AMO provides for continuing operations of NASA Headquarters and management and oversight of Agency missions, functions, and Agency-wide mission support activities. AMO ensures that critical safety and mission success policies, procedures, and standards are in place for the safety and mission success of all NASA programs, projects and operations.

The Safety and Mission Success program will continue to administer and refine policies, procedural requirements, and technical standards. Safety and Mission Success program activities are a key component of the forums that provide advice to the Administrator, Mission Directorates, Center Directors, and program managers who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations. In FY 2012, AMO will support the NASA Engineering and Safety Center (NESC), NASA Safety Center (NSC), and IV&V Facility. The organizations will conduct independent research, audits, and assessments of NASA activities that have risk for loss or failure.

Strategic Capabilities Assets Program (SCAP) provides management and funding for identified critical facilities. The current portfolio consists of thermal vacuum chambers for the thermal testing of spacecraft, flight simulators that provide for simulation of air and space vehicle flight characteristics, and an arc jet facility for critical testing of re-entry materials.

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations

Theme Overview

NASA's Center Management and Operations (CMO) budget request funds the ongoing management, operations, and maintenance of nine NASA Centers, including four major component facilities, in 10 separate states. CMO provides Center Institutional and Program Capabilities to meet program requirements and schedules. The CMO budget enables the execution of NASA's mission at the Centers by providing the resources required to effectively oversee the assignment of workforce and facilities, and to manage Center operations to facilitate program and project execution while ensuring that statutory, regulatory, and fiduciary compliance requirements are met.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**2,161.2**	**-**	**2,402.9**	**2,402.9**	**2,402.9**	**2,402.9**	**2,402.9**
Center Management and Operations	2,161.2	-	1,319.6	1,305.7	1,257.6	1,204.3	1,148.5
CMO Civil Service Labor and Expenses	0.0	-	1,083.3	1,097.2	1,145.3	1,198.6	1,254.4

Note:
CMO Civil Service Labor and Expenses includes $35.1 million for Center-wide personnel costs for institutionally-funded training and permanent change of station.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Center Management and Operations

Activities funded within the CMO budget request include a wide variety of essential operations:

- Security, environmental management, and safety services to ensure that Centers meet basic workplace standards for the public and for the NASA workforce;

- Facility maintenance and operations, including utility funding, to support the Agency's infrastructure, including support to more than 4,800 buildings and structures with a current replacement value of over $27 billion;

- Information Technology services to provide video, voice, network, data center, and desktop computer support at the Centers;

- Program capability support required to ensure that the Agency's science, engineering, and technical authority staff have the resources, services, and laboratory support required to achieve the Agency's technical mission;

- Training, logistics, occupational health, and human resources services required to support the Agency's Center-based civil servants;

- Senior management, legal, equal employment opportunity, and public affairs support at the Centers; and

- Procurement and financial services supporting contract acquisition and financial management.

CMO Civil Service Labor and Expenses

This program contains labor funding (salary and benefits) for civil service employees at NASA's Centers who provide the above essential CMO services at the Center. In addition, it funds other Center civil service personnel costs such as institutionally funded training.

Relevance

Relevance to national priorities, relevant fields, and customer needs:

To accomplish its mission of space exploration, scientific discovery, and aeronautics research, NASA relies on its program and institutional capabilities. NASA develops energy and water conservation plans that enable execution of these capabilities in ways that enable progress towards the Nation's energy conservation goals.

Relevance to the NASA Mission and Strategic Goals:

CMO contributes to the Agency's strategic goals by enabling program and institutional capabilities to conduct NASA's aeronautics and space activities. These capabilities ensure that core services and resources are ready and available Agency wide for performing NASA's Mission roles and responsibilities; that Center operations are effective and efficient; and that activities are conducted in accordance with all statutory, regulatory, and fiduciary responsibilities.

Relevance to education and public benefits:

Strategic communications and education activities at the Centers keep stakeholders and the public informed in a way that helps them understand NASA policies, programs, and plans. These activities also fulfill the mandate of the National Aeronautics and Space Act of 1958 "[to] provide for the widest practicable and appropriate dissemination of information concerning its activities and results thereof."

Performance Achievement Highlights:

NASA Centers continue to provide high quality support for the execution of programs and projects. The budget supports NASA's ability to provide institutional support to the current programs, as well as new initiatives to reduce greenhouse gas emissions, while absorbing labor and utility cost increases.

To offset partially these increasing costs, NASA has implemented energy savings initiatives, consolidated activities, and reduced or deferred some CMO activities. As of the end of FY 2010, the Agency has decreased overall water usage by almost nine percent from 2007 baseline levels and has increased the use of renewable energy by six percent. NASA Centers, each of which has unique capabilities, developed master plans to guide a number of actions, such as consolidating and renewing needed capabilities, developing comprehensive energy and water conservation plans, and planning for repairs. These plans have been integrated at an Agency level, linking Center plans to program objectives and allowing for measurement of Agency-wide progress and trends.

NASA is working to meet energy intensity reduction goals of three percent per year and 30 percent by 2015, from the FY 2003 baseline. In an effort to assist Centers to administer their energy management programs, NASA Headquarters annually conducts Energy and Water Management Functional Reviews at a third of NASA Centers to help Centers improve their management systems and identify and implement energy conservation measures. NASA also initiated an Inter-Center Competition to reduce energy/water consumption. The competition encouraged Centers to implement low-cost and no-cost initiatives to reduce energy and water usage.

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations
Program:	Center Management and Operations

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	2,161.2	-	1,319.6	1,305.7	1,257.6	1,204.3	1,148.5
Center Institutional Capabilities	1,678.3	-	1,162.1	1,149.2	1,106.7	1,059.6	1,010.2
Center Programmatic Capabilities	482.9	-	157.5	156.5	151.0	144.8	138.3

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Project Descriptions and Explanation of Changes

Center Institutional Capability

NASA's Center Institutional Capability encompasses a diverse set of activities including financial and human capital management, acquisition services, facility maintenance, utilities, information technology, and safety and security. This capability manages and sustains the Center staff, facilities, and operations required for program and project execution. It also provides for the ongoing operations of nine NASA Centers, including four major component facilities, ensuring a safe, healthy, and environmentally responsible workplace. Center institutionally sustained services are the most efficient approach to providing services and products required by programs as they implement their assigned missions. The Agency's coordinated approach to institutional management is an essential element in preserving unique national capabilities relied upon by NASA, industry, academia, and government.

NASA's participation in the President's Accountable Government Initiative has resulted in significant savings in administrative costs. The reduction of $62 million from the FY 2011 request is partially reflective of these savings, as well as NASA's adjustment to the Nation's current fiscal situation. However, contractor labor, utility, and operations costs continue to grow at a higher rate than inflation. Accounting for these necessary belt-tightening measures, the FY 2012 request funds Center Institutional Capability almost to FY 2008 levels by implementing initiatives to reduce travel, printing, reproduction, and other administrative costs.

The request for FY 2012 reflects a transfer of $604 million for labor and expenses to Center Management and Operations CSLE.

Center Program Capability

NASA's Center Program Capability supports the scientific and engineering staff across the Agency tasked with providing engineering assessment and safety oversight pertaining to the technical readiness and execution of NASA programs and projects. It also sustains NASA's analysis, design, research, test services, and fabrication capabilities enabling efficient execution of the programs and projects hosted at the Centers. A key component of NASA's overall system of checks and balances is provided within Technical Capabilities through formally delegated Technical Authorities. The Technical Authorities at NASA's Centers provide independent oversight and review of programs and projects in support of safety and mission success. This is to assure that NASA's activities are safely implemented in accordance with accepted standards of professional practice and applicable NASA requirements.

The request for FY 2012 reflects a transfer of $339 million for labor and expenses to Center Management and Operations CSLE.

Mission Directorate:	Cross-Agency Support
Theme:	Center Management and Operations
Program:	CMO Civil Service Labor and Expenses

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**1,083.3**	**1,097.2**	**1,145.3**	**1,198.6**	**1,254.4**
Civil Service Labor and Expenses	0.0	-	1,083.3	1,097.2	1,145.3	1,198.6	1,254.4

Note: This program contains labor funding, both salary and benefits, for civil service employees at NASA's Centers who are assigned to work on projects in this mission support area. Also included is labor funding for 700 civil service FTE that have not yet been entirely planned against program content. It is expected that this currently undistributed workforce will be subsequently planned against Explorations Systems Mission Directorate, Space Operations Mission Directorate, and Space Technology programs once the work plans are complete. In addition, CMO Civil Service Labor and Expenses provides $35.1 million for Center-wide civil service personnel costs such as institutionally-funded training and permanent change of station. These funds support the critical skills and capabilities required to provide the institutional services that maintain Center Operations, as outlined in the other programs within this mission support area.

Program Overview

This program contains labor funding, both salary and benefits, for civil service employees at NASA's Centers who are assigned to work on projects in this mission support area. Also included is labor funding for workforce that has not yet been entirely planned against program content. It is expected that this currently undistributed workforce will be subsequently planned against Explorations Systems Mission Directorate, Space Operations Mission Directorate, and Space Technology programs once the work plans are complete. In addition, CMO Civil Service Labor and Expenses funds Center-wide civil service personnel costs such as institutionally-funded training. These funds support the critical skills and capabilities required to provide the institutional services that maintain Center Operations, as outlined in the other programs within this mission support area.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

Theme Overview

Agency Management and Operations (AMO) provides for the management and oversight of Agency missions, programs, functions and performance of NASA-wide mission support activities. AMO activities at NASA Headquarters ensure that: 1) core services are ready and available Agency-wide for performing mission roles and responsibilities; 2) Agency operations are effective and efficient; and 3) activities are conducted in accordance with all statutory, regulatory, and fiduciary requirements.

NASA Headquarters develops policy and guidance for the Centers and provides strategic planning and leadership on the issues concerning availability, readiness, and sustainability. Centers establish programs and initiatives to maximize individual and organizational capabilities. Headquarters establishes Agency-wide requirements and capabilities that improve collaboration, efficiency, and effectiveness. Agency management leverages resources and capabilities to meet mission needs, eliminate excess capacity, and scale assets accordingly.

AMO provides for policy-setting, executive management and direction for all essential corporate functions such as human capital, finance, information technology, infrastructure, procurement, chief counsel, protective services, occupational health and safety, equal opportunity and diversity, small business programs, external relations, and strategic communications. AMO also supports the operational costs of the Headquarters installation. The AMO Theme is divided into five programs: Agency Management, Safety and Mission Success (SMS), Agency Information Technology Services (AITS), Strategic Capabilities and Assets Program (SCAP), and AMO Civil Service Labor and Expenses (CSLE).

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**766.2**	**-**	**789.1**	**789.1**	**789.1**	**789.1**	**789.1**
Agency Management	395.5	-	182.9	179.7	170.4	159.9	148.9
Safety and Mission Success	196.0	-	144.5	143.7	141.3	138.5	135.6
Agency IT Services (AITS)	145.3	-	136.4	136.2	135.5	134.7	133.8
Strategic Capabilities Assets Program	29.4	-	20.4	20.2	19.8	19.3	18.7
AMO Civil Service Labor and Expenses	0.0	-	304.9	309.3	322.2	336.8	352.0

Note:
AMO CSLE includes $18.7 million for Headquarters and Agency-wide personnel costs for training and permanent change of station.

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the program amounts shown above. The allocation to each program is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Plans for FY 2012

Agency Management

The Agency Management Program will continue to deliver policies, controls, and oversight across a range of functional and administrative management service areas including procurement, finance, human capital, real property and infrastructure, protective services, diversity, equal opportunity, and small business. The Agency Management Program will continue to provide infrastructure support and facility operations for NASA Headquarters.

Safety and Mission Success

SMS will continue to administer and refine the pertinent policies, procedural requirements, and technical standards. SMS will participate in forums that provide advice to the Administrator, Mission Directorates, Center Directors, and program managers who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations. Plans for FY 2012 provide for an effective NESC, NSC, and IV&V. These activities represent established and recognized components of a comprehensive remedial response to lessons learned from NASA's greatest tragedies. These organizations form a basis for a disciplined execution of safety, reliability, quality, and system engineering expertise needed for the successful pursuit of NASA's missions.

Agency IT Services (AITS)

NASA will continue operations for essential AITS, such as the Agency business applications, the NASA Scientific and Technical Information (STI) program, NASA public Web portal, NASA Enterprise Architecture, and E-Government in FY 2012. The NASA Information Resources Management Strategic Plan focuses on four goals in this budget year associated with the AITS Program: 1) improve the management of information and information technology; 2) improve the security of NASA information and information technology; 3) improve information technology (IT) efficiency and collaboration capabilities; and 4) improve IT service delivery and visibility.

Strategic Capabilities Assets Program

SCAP will continue to provide management oversight and critical funding for NASA's assets. These assets include thermal vacuum chambers that provide capability for thermally testing spacecraft, flight simulators that test air and space vehicles flight characteristics, and arc jets that provides capability for critical testing of re-entry materials.

Relevance

Relevance to the NASA Mission and Strategic Goals:

AMO contributes to the Agency's strategic goals by enabling program and institutional capabilities to conduct NASA's aeronautics and space activities. AMO provides critical mission support activities that are necessary to ensure the efficient and effective operation and administration of the Agency but cannot be directly aligned to a specific program or project requirement. These functions align and sustain institutional and program capabilities essential for executing NASA's missions.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**	
Outcome 5.1	**Identify, cultivate, and sustain a diverse workforce and inclusive work environment that is needed to conduct NASA missions.**	
Objective 5.1.1	**Establish and maintain a workforce that possesses state-of-the-art technical and business management competencies.**	
Performance Goal 5.1.1.1	***Define and build the federal workforce skills and competencies needed for the Agency's future directions in technology development and deep space exploration.***	
APG 5.1.1.1: AMO-12-1	Ninety percent of Shuttle workforce is assigned to follow-on work by FY 2012 year-end.	Agency Management
APG 5.1.1.1: AMO-12-2	Twenty percent or more of annual recruitments will be through the early career hiring initiatives.	Agency Management
Performance Goal 5.1.1.2	***Build skills across all levels of the workforce through Leadership Development Opportunities.***	
APG 5.1.1.2: AMO-12-3	Install an Agency-wide mentoring program that includes an automated system for matching mentors and mentees.	Agency Management
APG 5.1.1.2: AMO-12-4	Eighty percent of the Agency's leadership training and development programs include "leading through transformation" content.	Agency Management
Performance Goal 5.1.1.3	***Achieve and sustain an effective labor-management dialogue.***	
APG 5.1.1.3: AMO-12-5	Identify and address at least three significant labor-management challenges identified during the year during periodic Agency-led Labor Management Forums.	Agency Management
Performance Goal 5.1.1.4	***Adopt and respond to innovative employee feedback mechanisms.***	
APG 5.1.1.4: AMO-12-6	Seventy-five percent of NASA's primary installations implement improvement initiatives derived from the Federal Employee Viewpoint Survey.	Agency Management
Performance Goal 5.1.1.5	***Establish and maintain a workplace environment free of illegal discrimination, harassing conduct, and retaliation for Equal Employment Opportunity (EEO) activity and that provides reasonable accommodations to individuals with disabilities.***	
APG 5.1.1.5: AMO-12-7	Complete all FY 2012 actions described in the NASA Model Equal Employment Opportunity (EEO) Agency Plan.	Agency Management
Performance Goal 5.1.1.6	***Implement an Agency-wide Diversity and Inclusion Framework to develop a more demographically diverse workforce and a more inclusive work environment.***	
APG 5.1.1.6: AMO-12-8	Adopt diversity improvement targets derived from the results of the Agency-wide diversity-inclusion survey and other relevant workforce and U.S. population data.	Agency Management

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Outcome 5.2	**Ensure vital assets are ready, available, and appropriately sized to conduct NASA's missions.**	
Objective 5.2.1	**Achieve mission success by factoring safety, quality, risk, reliability, and maintainability as integral features of programs, projects, technologies, operations, and facilities.**	
Performance Goal 5.2.1.1	***Through 2015, assure zero fatalities or permanent disabling injuries to the public.***	
APG 5.2.1.1: AMO-12-9	Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during the fiscal year.	Safety and Mission Success
Performance Goal 5.2.1.2	***By 2015, achieve a four percent reduction in the total case rate and lost time rate for the NASA civil service work force.***	
APG 5.2.1.2: AMO-12-10	Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	Safety and Mission Success
Performance Goal 5.2.1.3	***By 2015, reduce damage to NASA assets by eight percent from the 2010 baseline.***	
APG 5.2.1.3: AMO-12-11	Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.	Safety and Mission Success
Objective 5.2.2	**Provide information technology that advances NASA space and research program results and promotes open dissemination through efficient, innovative, reliable, and responsive services that are appropriately secure and valued by stakeholders and the public.**	
Performance Goal 5.2.2.1	***By 2014, consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, enterprise applications, enterprise data centers, and web services.***	
APG 5.2.2.1: AMO-12-12	Achieve Initial Operating Capability (IOC) for one Service Office (NASA Enterprise Data Center) and Full Operational Capacity (FOC) for the initial five Service Offices as part of the NASA Information Technology Infrastructure Integration Program (I3P).	Agency IT Services (AITS)
Performance Goal 5.2.2.2	***By 2015, implement a capability to identify and prevent unauthorized intrusions on the NASA institutional and mission networks.***	
APG 5.2.2.2: AMO-12-13	Implement intrusion detection sensors monitored by the NASA Security Operations Center (SOC) on 75 percent of NASA institutional network monitoring sites.	Agency IT Services (AITS)
Performance Goal 5.2.2.3	***By 2014, decommission the Agency Administrative mainframe computer.***	
APG 5.2.2.3: AMO-12-14	Migrate or retire all administrative systems from the Agency Administrative mainframe computer.	Agency IT Services (AITS)
Performance Goal 5.2.2.4	***By 2015, reduce data center energy consumption by 30 percent.***	
APG 5.2.2.4: AMO-12-15	Reduce the number of NASA data centers by 10 percent.	Agency IT Services (AITS)

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Performance Goal 5.2.2.5	***By 2015, establish at least four innovation laboratories that provide more effective, efficient, and responsive information technology (IT) across NASA in support of the Agency's Mission.***	
APG 5.2.2.5: AMO-12-16	Implement a Communications and Collaboration Lab that conducts five evaluations to assess new approaches for the dissemination of information, and real-time, multi-participant knowledge creation and management.	Agency IT Services (AITS)
Objective 5.2.3	**Develop and implement long-range infrastructure plans that address institutional capabilities and critical assets, directly link to mission needs, ensure the leveraging of external capabilities, and provide a framework for Agency infrastructure decision-making.**	
Performance Goal 5.2.3.1	***Consolidate functions and offices to reduce real property need, and use Agency Integrated Master Plan to identify and dispose of excess and aged facilities beyond useful life.***	
APG 5.2.3.1: AMO-12-17	Finalize remaining Center Master Plans into the Agency Integrated Master Plan.	Agency Management
Outcome 5.5	**Establish partnerships, including innovative arrangements, with commercial, international, and other government entities to maximize mission success.**	
Objective 5.5.2	**Enhance international and interagency partnerships through increased use of international and interagency coordination mechanisms.**	
Performance Goal 5.5.2.1	***Actively engage and provide leadership in international and interagency forums.***	
APG 5.5.2.1: AMO-12-18	Establish an internal Interagency Partnerships Working Group (IPWG) led by the Office of International and Interagency Relations (OIIR) to improve Agency-wide coordination of interagency partnerships and related interagency working groups.	Agency Management

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 6	**Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation and contribute to a strong national economy.**	
Outcome 6.1	**Improve retention of students in STEM disciplines by providing opportunities and activities along the full length of the education pipeline.**	
Objective 6.1.3	**Assess grant recipient institutions throughout the education pipeline to ensure that grant recipients demonstrate a consistent commitment to civil rights compliance.**	
Performance Goal 6.1.3.1	***Promote equal opportunity compliance and encourage promising practices among NASA grant recipient institutions through a fully-realized program of civil rights compliance reviews, policy guidance, and technical assistance.***	
APG 6.1.3.1: AMO-12-19	Equal opportunity (EO) assessment and technical assistance provided, or onsite compliance assessment performed, on-location at five STEM or STEM-related programs that receive NASA funding.	Agency Management
Outcome 6.3	**Engage the public in NASA's missions by providing new pathways for participation.**	
Objective 6.3.1	**Extend the reach of participatory engagement across NASA.**	
Performance Goal 6.3.1.1	***By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.***	
APG 6.3.1.1: AMO-12-20	Issue a competitive opportunity to engage the public in NASA's activities.	Agency Management
Outcome 6.4	**Inform, engage, and inspire the public by sharing NASA's missions, challenges, and results.**	
Objective 6.4.2	**Provide clear, accurate, timely, and consistent information that is readily available and suitable for a diverse audience.**	
Performance Goal 6.4.2.1	***Use current and emerging communications technologies to reach increasingly broad audiences.***	
APG 6.4.2.1: AMO-12-21	Evaluate communication tools for impact and establish Agency best practices.	Agency Management
Objective 6.4.3	**Provide the communications infrastructure to enable NASA's commitment to make government more open, transparent, and participatory.**	
Performance Goal 6.4.3.1	***Make available Agency records through the Freedom of Information (FOIA) and Privacy Act and Open Gov in accordance with federal laws and regulations.***	
APG 6.4.3.1: AMO-12-22	Finalize NASA Freedom of Information Act (FOIA) regulations.	Agency Management

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations

Uniform and Efficiency Measures:

Measure #	Description
Agency Management and Operations Theme	
APG EFF 5.2.1.2: AMO-12-10	Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.
APG EFF 5.2.1.3: AMO-12-11	Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.
APG EFF: AMO-12-20	Maintain system execution time during the year-end close process at FY 2010 baseline.

Performance Achievement Highlights:

In FY 2010, NASA did the following:

- Improved its financial integrity audit opinion from "disclaimed" to "qualified," with no material weaknesses. A real property management system was integrated into NASA's financial management system, eliminating many manual reconciliation processes improving financial reporting. This opinion is the best NASA rating since FY 2002.

- Began successful implementation of an Agency Safety Center in Cleveland, Ohio. Accomplishments include developing a technical qualification program for Agency safety and mission assurance (SMA) technical excellence, trending of root causes and communicating lessons learned from mishap investigations, and improving the Agency SMA review and audit program.

- Enhanced online communications features providing the public easier access to NASA information, streamlining business processes, implementing cost efficiencies and one-NASA messaging, and managing approximately 500,000 public inquiries annually. NASA Television completed transition to high-definition capability for productions, operations, and distribution of high quality video related to NASA's missions and activities.

- Implemented the e-Mail Threat Monitoring Capability, reducing e-mail-based cyber attacks. NASA completed phase one of the IT Security Enterprise Data Warehouse, which collects and correlates patch status data, vulnerability scanning results, and security configuration information, producing an Agency-wide security inventory of NASA computers.

- Completed the Wide-Area Network eXpansion project, increasing the corporate wide area network bandwidth, including all connections to Centers and facilities.

- Implemented Identity Framework 2.0 as part of its Identity, Credential, and Access Management program to improve the initial Identity Management system. This addresses Homeland Security Presidential Directive (HSPD-12) requirements. As part of the effort to consolidate and improve NASA's IT infrastructure, the Agency awarded the Enterprise Applications Service Technologies contract.

- Successfully completed the four-year project to consolidate NASA's distributed active directory infrastructure. This supports the Federal Data Center Consolidation Initiative by consolidating an application and reducing the amount of infrastructure required to support the service. This supports implementing HSPD-12 as the consolidated active directory and the NASA single authentication infrastructure.

- Created an Open Government Status Dashboard, which details the status of the Agency ongoing goals and 164 milestones. NASA's plan to meet the Open Government Initiative Directive was rated first out of 29 agency submissions by OpenTheGovernment.org.

- Implemented an Agency-wide Emergency Notification System, allowing emergency managers to notify all badged employees and contractors of emergency situations at any Center.

- Completed initial assessments of all of its data centers to document the power meters necessary to begin calculating energy consumption and energy efficiency of the Agency data centers. This supported the Federal Data Center Consolidation Initiative and the NASA Strategic Sustainability Performance Plan.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency Management

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**395.5**	**-**	**182.9**	**179.7**	**170.4**	**159.9**	**148.9**
Agency Management	395.5	-	182.9	179.7	170.4	159.9	148.9

Note:

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In FY 2012 through FY 2016, civil service labor and expenses (CSLE) funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project amounts shown above. The allocation to each project is reflected in the summary budget table included in the beginning of this budget request, which provides a full cost view. In FY 2010 and FY 2011, amounts are presented in full cost.

Program Overview

Agency Management provides governance and functional and administrative management oversight for the Agency and operational support for NASA Headquarters. This program function primarily supports ongoing operations. Agency Management support reflects the activities required for being in business in the Federal sector and provides the capability to respond to legislation and other mandated services that the Agency must provide. Agency Management also conducts independent assessments of Agency programs and delivers strategic planning services. Through Agency Management efforts, NASA program and mission performance are assessed and evaluated.

Agency Management provides policies, controls, and oversight across a range of functional and administrative management service areas. Agency Management governance and oversight activities include finance, protective services, general counsel, public affairs, external relations, legislative affairs, training, human capital, procurement, real property and infrastructure, budget management, systems support, internal controls, diversity, equal opportunity, independent program and cost evaluation, and small business programs.

Agency Management activities are performed at NASA Headquarters with critical support provided by the NASA Centers. Distributed Agency Management activities are also performed at the NASA Management Office at the Jet Propulsion Laboratory, Johns Hopkins University-Applied Physics Laboratory, and the NASA Shared Services Center at Stennis Space Center. The Agency Management program supports over 35 discrete operations and mission support projects with over 210 separate activity line items.

The Agency Management program supports operational activities of Headquarters as an installation. These activities include building lease costs, facility operations costs (such as physical security, maintenance, logistics, information technology hardware and software costs), and automated business systems implementation and operations costs including initiatives related to transparency and accountability in government.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency Management

Plans For FY 2012

Agency Management will deliver policies, controls, and oversight across a range of functional and administrative management service areas, and provide independent assessments and strategic planning services. Agency Management will also direct activities in procurement, finance, human capital, real property and infrastructure, protective services, diversity, equal opportunity, and small business.

Project Descriptions and Explanation of Changes

Agency Management

The Agency Management budget includes the operational costs of NASA Headquarters. Headquarters operations elements include the lease costs for the rent of the Headquarters office building, and leased space in New Jersey and California that supports the Inspector General. Other significant operations activities include:

- IT and communications infrastructure hardware and software acquisitions and maintenance, and contracted services for IT support;

- Facility operations support, including physical security, custodial, and maintenance services; equipment; expendable supplies; mail services; printing and graphics; motor pool operations; logistics services; and emergency preparedness; and

- Human resources staffing; employee payroll and benefits processing; retirement services; employee training; employee occupational health/fitness and medical services; and grants awards processing.

Headquarters operations costs also include support provided by the Goddard Space Flight Center for:

- Accounting and procurement operations; operations support; configuration maintenance; automated business and administrative systems; contract close-out services; and payments to the Office of Naval Research for grants management; and

- Human resources; equal opportunity alternate dispute resolution services; Equal Employment Opportunity complaint investigations; and the special emphasis diversity recognition program.

Agency Management also provides the Agency-wide management functions of finance, protective services, and independent program and cost evaluation. The Chief Financial Officer (CFO) is responsible for the financial leadership of NASA. A primary duty of the CFO is to uphold strong financial management and accountability practices while providing timely, accurate, and reliable financial information, and enhancing internal controls.

The Office of Protective Services provides: Agency protective services policy formulation; oversight, coordination and management of NASA protective services operations, including security, fire, emergency management, and emergency preparedness; support for Agency counterintelligence and counterterrorism activities; implementation of the Identity, Credentials and Access Management Systems and other security systems, including communications; continuity of operations; and national intelligence community services.

Independent Program and Cost Evaluation is an independent assessment organization that provides objective, transparent, and multidisciplinary analysis to support strategic decision making.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency Management

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Ninety percent of Shuttle workforce is assigned to follow-on work by fiscal year 2012 year-end.	Agency Management	N/A
Twenty percent or more of annual recruitments will be through the early career hiring initiatives.	Agency Management	N/A
Install an Agency-wide mentoring program that includes an automated system for matching mentors and mentees.	Agency Management	N/A
Eighty percent of the Agency's leadership training and development programs include 'leading through transformation' content.	Agency Management	N/A
Identify and address at least three significant labor-management challenges identified during the year during periodic Agency-led Labor Management Forums.	Agency Management	N/A
Seventy-five percent of NASA's primary installations implement improvement initiatives derived from the Federal Employee Viewpoint Survey.	Agency Management	N/A
Complete all FY 2012 actions described in the NASA Model Equal Employment Opportunity (EEO) Agency Plan.	Agency Management	N/A
Adopt diversity improvement targets derived from the results of the Agency-wide diversity-inclusion survey and other relevant workforce and U.S. population data.	Agency Management	N/A
Finalize remaining Center Master Plans into the Agency Integrated Master Plan.	Agency Management	N/A
Establish an internal Interagency Partnerships Working Group (IPWG) led by the Office of International and Interagency Relations (OIIR) to improve Agency-wide coordination of interagency partnerships and related interagency working groups.	Agency Management	N/A
Equal opportunity (EO) assessment and technical assistance provided, or onsite compliance assessment performed, on-location at five STEM or STEM-related programs that receive NASA funding.	Agency Management	
Issue a competitive opportunity to engage the public in NASA's activities.	Agency Management	
Evaluate communication tools for impact and establish Agency best practices.	Agency Management	
Finalize NASA Freedom of Information Act (FOIA) regulations.	Agency Management	

Mission Directorate:	**Cross-Agency Support**
Theme:	**Agency Management and Operations**
Program:	**Agency Management**

Headquarters FTE Assignments by Office

Headquarters	FY 2010 Total FTE	FY 2010 SES	FY 2010 Non-Career	FY 2010 Contract WYE	FY 2011 Total FTE	FY 2011 SES	FY 2011 Non-Career	FY 2011 Contract WYE	FY 2012 Total FTE	FY 2012 SES	FY 2012 Non-Career	FY 2012 Contract WYE
Mission Support	**336**	**25**	**0**	**321**	**320**	**26**	**0**	**353**	**320**	**27**	**0**	**340**
Agency Operations/JPL NASA Management Office	25	2		2	28	2		3	28	2		3
Human Capital Management	36	5		7	35	5		21	35	5		21
Headquarters Operations	108	4		295	102	4		315	102	4		303
Infrastructure	61	5		10	57	6		4	57	7		4
Internal Controls and Management Systems	10	1		3	10	1		1	10	1		1
Procurement	36	4			33	4			33	4		
Mission Support Directorate Front Office	10	2			9	2		1	9	2		0
Protective Services	49	2		4	46	2		9	46	2		8

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**196.0**	**-**	**144.5**	**143.7**	**141.3**	**138.5**	**135.6**
Safety and Mission Assurance	51.3	-	38.9	38.7	38.1	37.5	36.8
Chief Engineer	101.1	-	76.4	75.9	74.4	72.7	70.9
Chief Health and Medical Officer	3.6	-	4.1	4.1	4.1	4.1	4.1
Independent Verification and Validation	40.0	-	25.1	25.0	24.6	24.3	23.9

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Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Safety and Mission Success

Program Overview

Safety and Mission Success (SMS) includes the NASA Headquarters programs that address technical excellence, mission assurance, and technical authority. SMS includes the corporate work managed by the Office of the Safety and Mission Assurance (including the NSC and the IV&V), the Office of Chief Engineer (including the NESC), and the Office of the Chief Health and Medical Officer. The elements of SMS reflect the recommendations of many studies, boards, and panels including the direct recommendations from two major accident investigations resulting in the loss of 14 astronauts (Challenger in 1986 and Columbia in 2003). These programs directly support NASA's core values and serve to improve the likelihood for safety and mission success for NASA's programs, projects, and operations while protecting the health and safety of NASA's workforce. Aerospace technology advancement, because it is leading the edge of known capability, will always present a risk of catastrophe. SMS is the only resource that has the reduction of risk of failure as its exclusive focus.

SMS is responsible for developing policy and procedural requirements. SMS provides advice to the Administrator, Mission Directorates, Center Directors, and program managers who, due to their management responsibilities, are ultimately accountable for the safety and mission success of all NASA activities and the safety and health of the workforce. SMS resources provide the foundation for NASA's system of "checks and balances" enabling the effective application of the strategic management framework and the Technical Authorities defined in NASA's Strategic Management and Governance Handbook. SMS funding trains and maintains a competent technical workforce within the disciplines of system engineering (including system safety, reliability, and quality) and space medicine.

Resources provided by SMS are essential for judging the implications on safety and mission success, including the health and medical aspects of new requirements and departures from existing requirements. With this funding, discipline experts judge the criticality of the associated risk and evaluate the risk acceptability through an established process of independent review and assessment. The information and advice from these experts is critical data that is used by the technical authorities to develop authoritative decisions related to application of requirements on programs and projects.

Plans For FY 2012

In FY 2012, the individual plans for each element of SMS align with and directly support the objectives of the Agency's Mission Directorates by helping to improve the likelihood of safety and mission success for all NASA programs, projects, and operations. SMS managers will continue to administer and refine policies, procedural requirements, and technical standards. The managers will participate in forums that provide advice to the Administrator, Mission Directorates, Center Directors, and program managers who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations.

The plans for FY 2012 provide for an effective NESC, NSC, and IV&V as necessary elements in fulfilling the Agency's missions. This support assures that NASA civil service employees have, and continue to apply, the appropriate knowledge, skills, abilities, and tools for sound and well-informed decision making on matters critical to safety and mission success. The plans will include prioritized development, maintenance, and conduct of training and education necessary for assuring the existence of a competent technical workforce. The plans also include required support for independent research, audit, and assessment of NASA activities that have risk for loss or failure.

These organizations charter independent reviews that judge the safety and likelihood of success of NASA activities and the health of those individuals exposed to risks that are not commonplace. The ability to author effective requirements, evaluate precisely the departures from conformance with existing requirements, determine the criticality of the risk, and evaluate and advise on its acceptability are completely reliant on the proper investment in SMS. This established process of independent review supports informed decision-making through the execution of delegated technical authority applied to program and project decisions. Without a robust application of these resources, the Agency strategy to challenge the validity of complex engineering and operational plans and proposals is flawed and subject to incurring unnecessary risks.

Due to the tremendous energies possessed by space debris, the collision between a piece of debris only a half-inch in diameter and an operational spacecraft has the potential for catastrophic consequences. The intentional destruction of the Chinese Fengyun-1C weather satellite in January 2007 and the accidental collision of American and Russian spacecraft in February 2009 have increased the amount of cataloged debris by nearly 40 percent compared to debris levels from the first 50 years of the Space Age. In FY 2012, NASA, in connection with the U.S. Space Surveillance Network, will increase its effort in scientific studies to characterize the near-Earth space debris environment, to assess its potential hazards to current and future space operations, and to identify and implement methods for reducing the production of additional debris. Enhancements to this space situational awareness data program during FY 2012, especially close approach predictions, offer the greatest near-term and lowest-cost improvements to space safety. The National Academies' Aeronautics and Space Engineering Board (ASEB) is currently conducting a comprehensive review of NASA's Micrometeoroid and Orbital Debris (MMOD) program. NASA will take appropriate actions in response to the ASEB findings and recommendations.

Project Descriptions and Explanation of Changes

Safety and Mission Assurance (SMS)

SMS supports the Office of Safety and Mission Assurance (OSMA) by providing resources for independent evaluations of their approaches to improving mission success. OSMA is responsible for establishing and maintaining an acceptable level of technical excellence and competence in safety, reliability, maintainability, and quality engineering within the Agency. OSMA assures that the risk presented by either a lack of safety requirement or from lack of compliance with a safety requirement is analyzed, assessed, communicated, and used for proper decision making and risk acceptance by the appropriate organizational leader.

Fundamental to these two responsibilities is the definition and execution of a robust and well-understood methodology and process for the application of the disciplines of safety, reliability and quality (S, R and Q) in defining the level of risk. SMS conducts a schedule of review and assessments that focus on the life cycle decision milestones for crucial NASA programs and projects and S, R, and Q processes. Embodied in this program is a structured development of methodology and investigation into system attributes that improve the probability of mission success.

NSC assists OSMA in achieving its objectives in consolidating SMS efforts Agency-wide in four key areas: SMA technical excellence, knowledge management, audits and assessments, and mishap investigation support. Since being established in FY 2007, the NSC has:

1. Established a technical excellence initiative to improve and formalize training and qualification requirements for five SMA engineering disciplines (system safety, reliability and maintainability, quality, software assurance, and operational and aviation safety);

2. Undertaken streamlined processes to increase and sustain domain knowledge within the SMA community through the facilitation, storage, and retrieval of important documents and lessons learned by providing data analysis and trending of mishap-related data, by rapidly disseminating mishap-related Agency safety alerts, and by improving the Agency Incident Reporting Information System (a comprehensive, Agency-wide tool used for reporting mishaps and close calls);

3. Continued to evaluate and streamline the conduct of facilities, programmatic, and supplier audits; and

4. Assembled and deployed a trained team of mishap investigators to support mishap investigations boards. These activities promote the highest level of safety and reliability for NASA's programs and projects.

Chief Engineer

SMS supports the Office of Chief Engineer (OCE) by providing the resources for independent and senior engineering expertise to enhance mission success. OCE promulgates policy and requirements for program and project management, for the engineering excellence of the Agency, system engineering methodology, and for the Agency's system of engineering standards. The OCE manages the NESC, which is responsible for rapid, cross-Agency response to mission critical engineering issues and for improving the state of practice in critical engineering areas. OCE also sponsors the Academy of Program/Project and Engineering Leadership (APPEL) to develop program and project management and systems engineering skills.

APPEL delivers the necessary program/project management and engineering competence learning through the application of learning strategies, methods, models, and tools. APPEL provides professional development products and services for individual practitioners and program and project teams. This includes a formal training curriculum designed to address four career levels from recent college graduate to executive. APPEL provides direct support to project teams in the field through workshops, coaching, interactions technical experts, and through conferences, forums, and publications.

The NESC, established in FY 2003 in response to the Columbia accident, responds rapidly to cross-Agency mission-critical engineering issues and improves the state of the practice in critical engineering areas. The NESC performs value-added independent testing and analyses and technical assessments of NASA's projects and technical activities in order to enhance safety and mission success. The NESC works proactively to help NASA avoid problem recurrence and to prevent future problems. SMS funding provides for the core NESC organization of senior engineering experts from across the Agency, including the NASA Technical Fellows, and technical discipline teams composed of experts from NASA, industry, and academia.

Chief Health and Medical Officer

The Office of the Chief Health and Medical Officer (OCHMO) promulgates Agency health and medical policy, standards, and requirements, assuring the medical technical excellence of the Agency. OCHMO assures the physical and mental health and well-being of the NASA workforce, and assures the safe and ethical conduct of NASA-sponsored human and animal research. OCHMO exercises oversight of NASA medical and health related activities through audit processes. OCHMO monitors the implementation of health and medical related requirements and standards in all developmental human space flight programs through designated discipline experts at NASA Centers. OCHMO provides oversight of medical and health related activities in operational human space flight through Center-based discipline experts and clinical boards. Ongoing medical and health discipline professionalism and licensure are supported through annual certified continuing medical education activities and flight surgeon education and clinical currency is provided through OCHMO sponsored, university-based physician training programs. NASA's biomedical research programs in support of human space flight are guided by OCHMO-developed health and medical standards. Center-based review boards provide direct supervision of NASA-sponsored human and animal research safety and ethics, completing a comprehensive system of oversight to maintain robust health and medical support of NASA personnel at all levels.

Independent Verification and Validation

IV&V supports provides software expertise, services and resources to improve the likelihood for safety and mission success for NASA's programs, projects, and operations while protecting the health and safety of NASA's workforce. The NASA IV&V program performs independent software analysis activities on NASA's most critical software systems as a "checks and balances" to assure safety and mission success of those systems.

The IV&V program provides systems engineering activities that improve software S, R, & Q of NASA programs and projects through effective applications of systems and software IV&V methods, practices, techniques, and tools. The NASA IV&V program applies software engineering best practices to evaluate the correctness and quality of critical and complex software systems throughout the project's system development life cycle.

The IV&V program provides resources and expertise to other OSMA elements in support of independent evaluations of software related approaches and processes, developing software related policy/procedural requirements, and evaluating risks associated with new software requirements and departures from existing requirements. The IV&V program supports sustaining software technical excellence in the SMA community, sustaining software domain knowledge within the SMA organization, and in developing software development improvement recommendations to the Agency.

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during the fiscal year.	Safety and Mission Success	N/A
Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	Safety and Mission Success	N/A
Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.	Safety and Mission Success	N/A

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services (AITS)

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	145.3	-	136.4	136.2	135.5	134.7	133.8
IT Management	15.0	-	13.1	13.1	13.1	13.1	13.0
Applications	75.4	-	57.6	57.5	57.0	56.4	55.8
Infrastructure	54.9	-	65.7	65.6	65.4	65.2	65.0

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Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services (AITS)

Program Overview

The principles underlying the AITS Program are to enable NASA's missions through the integration of information and information technology in an efficient, effective, and secure, manner. Accordingly, the AITS Program provides for centrally managed, consolidated enterprise-level services benefitting the entire Agency. The three following projects constitute the AITS Program: IT Management; Applications; and IT Infrastructure, which includes IT security.

Within the IT Management project, NASA incorporates the necessary budget for the NASA Chief Information Officer (CIO) to ensure effective management of the Agency's IT resources in accordance with federal laws and regulations, Office of Management and Budget (OMB) guidance, and industry best practices. The IT Management project enables the Agency to meet requirements in areas such as privacy, records management, information collections, and information quality. It also supports value-add activities such as enterprise architecture, capital planning and investment control, and IT project management. Additionally, it incorporates payments to other Federal agencies for E-Government services.

Within the Applications project, NASA incorporates the development and sustaining support of Agency applications for mission support functions, such as financial management, supply management, procurement management, and human capital management. These services are provided by the NASA Enterprise Applications Competency Center in Huntsville, Alabama. The Applications project also includes enterprise licensing agreements and scientific and technical Information management on behalf of the Agency.

Within the IT Infrastructure project, NASA incorporates core IT and infrastructure services such as the NASA public Web portal, e-mail, calendaring, directory services, enterprise license management, identity and credential management. Due to the close relationship between IT infrastructure and IT security, NASA incorporates IT security-related initiatives within the IT Infrastructure project. These initiatives include the NASA Security Operations Center, Agency penetration testing, vulnerability scanning, patch management and reporting, and other proactive measures that mitigate security threats.

Plans For FY 2012

In FY 2012, the AITS program will largely provide sustaining operations for essential Agency information management and IT needs under the IT Management project, Applications project and the IT Infrastructure project, with some development, modernization, and enhancement (DME) planned.

The Infrastructure project is planning significant activity for FY 2012 including the Router Replacement project, which is to replace aging equipment on the network and to upgrade the bandwidth on the network to accommodate the needs of current and future missions. The investment will encompass significant upgrades, as they are required to continue to provide high-quality service to the Agency's mission customer base. The existing routers are antiquated, use an obsolete protocol, and are no longer supported by the vendor. The risk to ongoing missions due to the aging equipment in the network is significant (and growing) and will be mitigated by this investment.

The IT Infrastructure and Security project is planning significant DME activities including implementation of new contracts for end-user services, integrated communications services (local and wide area networks), consolidated data center services, and public Web services. In addition, the Agency plans to implement an Enterprise Service Desk and Ordering System for Agency IT services beginning in FY 2011. The implementation of these new contracts and services will pave the way towards consolidation of NASA's networks and network management in order to gain efficiencies, improve security, and enable the cross-Center data sharing required to execute effectively NASA missions. In addition, it provides the means to consolidate data center capabilities in order to gain efficiencies and reduce related infrastructure on NASA Centers. Under the Consolidated end-user Services contract, NASA expects improved standardization of desktop and laptop configurations, as well as increased effectiveness in applying patches. In addition, NASA will invest in renewal of network infrastructure where necessary to mitigate risks of prolonged network outages, most notably by replacing obsolete routers on the mission network and replacing outdated wiring and electronics within some Center networks. This infrastructure will include the IT Innovation Laboratory support structure and evaluation process for innovation and emerging communication and collaborative technologies from NASA personnel, industry, and academic partners building on NASA Virtual Institutes work. NASA will continue development of NEBULA (NASA's Cloud Computing Platform), allowing NASA Scientist and Engineers to focus on mission success without worrying about the stability and availability of computing infrastructure.

Project Descriptions and Explanation of Changes

IT Management

The IT Management project provides Agency level services for managing IT and meeting internal and external requirements relative to Agency CIO responsibilities. Included in this project are fees paid to E-Government managing partners for the various E-Government activities and Federal CIO Council Committees in which NASA participates. This project includes the budget for the NASA Office of the CIO to meet OMB guidance, Executive Orders, laws and regulations relative to E-Government, Paperwork Reduction and Information Collection, the Federal Information Security Management Act, Records Management, Mail Management, Forms Management, Privacy, Capital Planning and Investment Control, and IT Budget Formulation under Circular A-11.

Applications

The Applications project provides steady state operations of NASA's business and management systems developed under the Integrated Enterprise Management Program, such as, the Core Financial System (SAP), Integrated Asset Management System, the Human Capital Information Environment, and Aircraft Management Module. This project also provides scientific and technical information (STI) services for the Agency. It also supports the implementation of E-Government initiatives across the Agency, such as, E-Travel, Grants.gov, and E-Training.

Infrastructure

The IT Infrastructure project provides common core infrastructure services across the Agency, such as, the NASA public Web portal, enterprise licensing, and Personal Identification Verification card systems required for identity and credential management for logical access control. In addition, the IT Infrastructure project provides configuration control capabilities for networks, end-user services, and data centers. This project also provides IT security capabilities at the Agency level, such as the Security Operations Center (SOC), third party penetration testing, vulnerability scanning, and patch management. In FY 2012, an increase in funding will be applied to renew the aging IT network infrastructure, including the mission network. Additionally, NASA has begun realigning IT funds within the Agency to implement a common funding model for IT services beginning in FY 2011 and will complete the realignment in FY 2012. Under this model, e-mail, calendaring, directory services, software management and other core Agency infrastructure services will be provided by the Agency end user services contract and funded by the AITS IT Infrastructure project. In FY 2011 NASA realigned the Agency's IT Infrastructure funding to NEBULA (NASA's Cloud Computing) to enhance the cloud computing infrastructure. In FY 2012, NASA will enable automated provisioning capabilities to quickly scale up computing, storage, and bandwidth as demand rises, allowing NASA scientists and engineers to focus on mission success with stability and availability of computing infrastructure. NASA is also building the infrastructure and evaluation processes for innovation and emerging communication and collaborative technologies to support the IT Innovation Lab in FY 2012. Through this activity, NASA will evaluate new approaches to the dissemination of information with real-time, multi-participant work. NASA is collaborating with Science on the Open Government Initiative, social computing, telepresence, telerobotics, Web-based collaboration, secure collaborations, unified communications, virtual workspaces, broad access, and related technologies.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Agency IT Services (AITS)

Program Commitments

Commitment/Output FY 2012	Program/Project	Changes from FY 2011 PB Request
Achieve Initial Operating Capability (IOC) for one Service Office (NASA Enterprise Data Center) and FOC for the initial five Service Offices as part of the NASA Information Technology Infrastructure Integration Program (I3P).	AITS	N/A
Implement intrusion detection sensors monitored by the NASA Security Operations Center (SOC) on 75 percent of NASA institutional network monitoring sites.	AITS	N/A
Migrate or retire all administrative systems from the Agency Administrative mainframe computer.	AITS	N/A
Reduce the number of NASA data centers by 10 percent.	AITS	N/A
Implement a Communications and Collaboration Lab that conducts five evaluations to assess new approaches for the dissemination of information, and real-time, multi-participant knowledge creation and management.	AITS	N/A
Maintain system execution time during the year-end close process at FY 2010 baseline.	AITS	N/A

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	Strategic Capabilities Assets Program

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**29.4**	**-**	**20.4**	**20.2**	**19.8**	**19.3**	**18.7**
Strategic Capabilities Assets Program	29.4	-	20.4	20.2	19.8	19.3	18.7

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Program Overview

NASA's Strategic Capabilities Assets Program (SCAP) ensures that identified operational core assets and capabilities are available to support NASA's current and future missions. SCAP establishes an alliance between all Centers with like assets, makes decisions on disposition of capabilities no longer required, identifies re-investment/re-capitalization requirements within and among classes of assets, and implements changes. SCAP reviews the assets' capabilities each year to ensure the requirements continue to be valid.
SCAP ensures that essential test facilities are in a state of readiness. It maintains the skilled operational workforce and performs essential preventative maintenance to keep core facilities available to meet program requirements. Core capabilities supported within SCAP are thermal vacuum chambers, simulators, and the arc jet facility.

Plans For FY 2012

SCAP will sustain the strategic technical capabilities needed by NASA for successful missions. SCAP will institute consistency in reimbursable pricing policies, perform quarterly program performance reviews, continually reassess the strategy, and provide a forum for cooperation between all Centers within asset classes.

SCAP will ensure maximum benefit across the Government by broadening its alliances outside of the Agency for capabilities (e.g., thermal vacuum chambers). This has been accomplished by initiating a new collaborative working group, the Space Environment Test Alliance Group, which includes NASA, the Department of Defense (DoD), and other entities. SCAP has established a good relationship between DoD and NASA in the arc jet test area. SCAP will examine and scrutinize new proposals for additional capabilities that are submitted as part of the FY 2013 budget process.

SCAP is committed to continue developing and implementing disposition plans for assets that are no

Project Descriptions and Explanation of Changes

Strategic Capabilities Assets Program

SCAP sustains operations of simulators that are critical components of the success of NASA's Aeronautics Research in the areas of fundamental aeronautics and aviation safety. This capability includes an array of research and development crewed flight simulator assets at Ames Research Center (ARC) and Langley Research Center (LaRC) that are in the operations phase. Principal assets include the Vertical Motion Simulator, a large motion system, and its supporting cabs, laboratories, and equipment, that provide scientists and engineers with tools to explore, define, and resolve issues in both vehicle design and missions operations. The Cockpit Motion Facility and its supporting suite of simulators (the Differential Maneuvering Simulator and the Visual Motion Simulator) and other central support facilities at LaRC are designed to support aeronautics and space flight vehicle research studies in which motion cues are critical to the realism of the experiments being conducted.

SCAP sustains thermal-vacuum, vacuum, and acoustic chambers at NASA facilities (Glenn Research Center, Goddard Space Flight Center, Jet Propulsion Laboratory, Johnson Space Center (JSC), Kennedy Space Center, Marshall Space Flight Center, and Plum Brook Station) that simulate conditions during launch and in space environments. These assets are large enough to accommodate a spacecraft with adequate space surrounding the structure for safe, easy access while inside the chamber. Chambers with minimum outline dimensions of 10 by10 ft will generally meet this provision. These chambers have the capability of producing pressures of one by 10-2 torr or lower and thermal shrouds capable of liquid nitrogen temperatures or lower. Acoustic chambers are capable of generating approximately 150 decibels at frequencies in the range of 25 to 1000 Hertz. These chambers perform significant risk mitigation for most of NASA payloads launched into space as well as many in other government agencies such as National Oceanic and Atmospheric Administration, and DoD. Almost all spacecraft launched into space must first be tested in one of NASA's thermal vacuum chambers.

SCAP sustains arc jet complexes located at ARC and JSC. An arc jet provides simulated high temperature, high velocity environments that support the design, development, test, and evaluation activities of thermal protection materials, vehicle structures, aerothermodynamics, and hypersonics. A gas (typically air) is heated and accelerated to supersonic/hypersonic speeds by a continuous electrical arc. This high temperature gas passes over a test sample, producing an approximation of the surface temperature and pressure environments experienced by a vehicle on atmospheric entry. Arc jet testing has been critical in the safe return from orbit of space shuttles with tile damage. In addition, arc jet testing performed essential validation of materials for the Mars entry missions such as Mars Science Laboratory. The Dragon spacecraft, made by the commercial company Space Exploration Technologies and which recently completed an orbital test flight, completed heat shield development testing at NASA's arc jet facility. NASA maintains two of the four arc jets facilities in the U.S. providing a critical national capability.

Mission Directorate:	Cross-Agency Support
Theme:	Agency Management and Operations
Program:	AMO Civil Service Labor and Expenses

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**0.0**	**-**	**304.9**	**309.3**	**322.2**	**336.8**	**352.0**
AMO Civil Service Labor and Expenses	0.0	-	304.9	309.3	322.2	336.8	352.0

Note: This program contains labor funding, both salary and benefits, for civil service employees at NASA Headquarters. In addition, AMO Civil Service Labor and Expenses provides $18.7 million for civil service personnel costs such as institutionally-funded training and permanent change of station.

Program Overview

This program contains labor funding, both salary and benefits, for civil service employees at NASA Headquarters, as well as other Headquarters personnel costs such as institutionally funded training. It also contains labor funding for Agency-wide personnel costs such as Agency training, and funding for workforce from multiple Centers who provide the critical skills and capabilities required by the other Agency-wide programs outlined within this mission support area.

Overview

Construction and Environmental Compliance and Restoration (CECR) provides for design and execution of programmatic and non-programmatic discrete and minor revitalization construction of facilities projects, facility demolition projects, and environmental compliance and restoration activities.

The Construction of Facilities (CoF) Program ensures that the facilities critical to achieving NASA's science, space and aeronautics programs are the right size and type; that they are safe, secure, and environmentally sound; and that they are operated efficiently and effectively. An Agency-wide CoF program ensures that NASA installations conform to requirements and initiatives for the protection of the environment and human health. NASA facilities are essential to the Agency and facility revitalization is needed to maintain infrastructure that is safe and capable of supporting NASA's missions. The facilities being revitalized or constructed in this program are expected to remain active in the long term.

The purpose of NASA's Environmental Compliance and Restoration (ECR) program is to clean up pollutants released to the environment from past activities. Clean up activities are prioritized to ensure that the highest priority liabilities are addressed first, better protecting human health and the environment, and preserving natural resources.

NASA is seeking to amend its Enhanced Use Lease (EUL) authority to allow in-kind consideration for leases to develop renewable energy production facilities. This will create conditions attractive to industry and is necessary to support NASA's strategy to comply with statutory and Executive Order energy and greenhouse gas requirements.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**452.8**	**448.3**	**394.3**	**450.4**	**450.4**	**450.4**	**450.4**	**450.4**
Construction of Facilities	389.4	-	-	397.9	384.0	359.5	362.9	360.0
Environmental Compliance and Restoration	63.4	-	-	52.5	66.4	90.9	87.5	90.4

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

The "Auth. Act FY 2011" column represents FY 2011 authorized funding from the NASA Authorization Act of 2010 (P.L. 111-267).

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Construction and Environmental Compliance and Restoration

Construction of Facilities

Major Highlights for FY 2012

FY 2012 funding will continue essential infrastructure repair and revitalization activities. "Repair by replacement" projects are those that provide sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new, efficient, high-performance buildings. NASA will reduce infrastructure by disposing of unneeded facilities. NASA will continue its strategy to recapitalize essential infrastructure through projects that include the replacement of the potable water system at Stennis Space Center, constructing a consolidated services building at Langley Research Center, replacing the industrial water system in the Marshall Space Flight Center test area, and installing a new antenna at Canberra, Australia.

Environmental Compliance and Restoration

Major Highlights for FY 2012

FY 2012 funding supports cleanup of the Santa Susana Field Laboratory in preparation for dispositioning excess property.

Mission Directorate:	Construction and Environmental Compliance and Restoration

Theme Overview

CoF designs and executes all programmatic and non-programmatic facilities projects, including discrete minor revitalization and construction projects, and demolition of facilities. The Agency's CoF programs are managed by NASA's Capital Facility Investment program, which includes institutional and programmatic facility investments.

The construction planning process starts several years in advance, with design being funded two budget years prior to construction start. CoF requirements are developed through a process involving both internal and external stakeholders. Institutional CoF requirements from all the Centers are reviewed and prioritized annually, ensuring that only the highest-ranking priorities are funded. Programmatic facility requirements are identified as an integral part of each Mission Directorate's program development process, which ensures that only programmatic CoF projects that are necessary for mission success are funded.

No CoF requirements in support of Aeronautics or Exploration programs are requested for FY 2012.

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**389.4**	**-**	**397.9**	**384.0**	**359.5**	**362.9**	**360.0**
Institutional CoF	249.3	-	368.0	384.0	359.5	362.9	360.0
Science CoF	37.8	-	1.0	0.0	0.0	0.0	0.0
Space Operations CoF	26.9	-	28.9	0.0	0.0	0.0	0.0
Exploration CoF	72.6	-	0.0	0.0	0.0	0.0	0.0
Aeronautics CoF	2.8	-	0.0	0.0	0.0	0.0	0.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Plans for FY 2012

Institutional CoF

The Institutional CoF Program will make capital repairs to NASA's critical infrastructure to improve safety and security, protect NASA's infrastructure, and improve NASA's operating efficiency by reducing utility usage. The program will continue to "right size" the infrastructure by demolishing infrastructure that is no longer needed. Projects with initial cost estimates between $1 million and $10 million are included in the program as minor revitalization and construction projects, and projects with initial cost estimates of $10 million or greater are budgeted as discrete projects. Projects with initial cost estimates of $1 million or less are accomplished by routine day-to-day facility maintenance and repair activities provided for in program and Center operating budgets.

NASA will invest in projects that protect the Agency's critical assets, improve mission assurance, reduce mission risk, and maintain mission essential capabilities. Investment in projects, such as launch facility protection at Wallops Island, will protect NASA's critical assets in the case of natural disasters. Utility system repairs and replacements will improve reliability throughout NASA's infrastructure and reduce the risk of utility-caused mission failures. Installation of two photovoltaic plants will generate green energy for the Agency, supporting NASA's efforts to meet national initiatives to reduce fossil fuel consumption and green house gas emissions. NASA's repair by replacement program will provide sustainable and energy efficient infrastructure by replacing old, inefficient, deteriorated buildings with new efficient high performance buildings. In some cases, NASA will be able to refurbish existing facilities into sustainable buildings that will meet NASA's future technology needs while retaining only the structure and replacing the systems necessary for mission operations. When this approach is viable, the projects will save capital investment over wholesale replacement, but will still yield a good return on investment through reduced operating costs.

More than 80 percent of NASA's infrastructure is beyond its design life. As NASA's facilities age beyond their useful life, the facilities become unreliable and put NASA's programs and operations at risk. By investing in demolition, NASA will be able to reduce unneeded infrastructure and avoid future expenses for maintaining this infrastructure. The FY 2012 program will continue to demolish facilities that the Agency has identified as unnecessary after the Space Shuttle is retired. This will allow the Agency to shift some investment in Shuttle facilities to support new programs, such as the 21st Century Space Launch Complex. NASA will also demolish obsolete laboratory facilities that no longer support NASA missions. To mitigate the increasing risk to NASA's missions from infrastructure failure, NASA must maintain its investment in infrastructure repair and refurbishment. NASA's long-term strategy is to recapitalize its infrastructure to replace, refurbish, and consolidate critical facilities to support future NASA missions.

Science CoF

The Science CoF Program continues the modification of the thermal vacuum Chamber A at the Johnson Space Center (JSC). This facility provides required temperature and contamination control test conditions for hardware prior to flight. Renovation of the NASA Space Science Data Center at Goddard Space Flight Center will create a sustainable office facility in accordance with Federal energy mandates, and in compliance with applicable codes and standards.

Space Operations CoF

Space Operations CoF continues construction of the 34-Meter Beam Waveguide Antenna, DSS-35, at Canberra, Australia. It also provides for the revitalization of facilities utilized by the Launch Services Program and at Deep Space Network sites.

Mission Directorate:	Construction and Environmental Compliance and Restoration

Relevance

Relevance to national priorities, relevant fields, and customer needs:

CoF funding ensures that NASA's facilities and field installations meet the Agency's infrastructure needs in a safe, secure, and environmentally sound manner. Activities implement sustainable design practices and support compliance with state and national environmental laws and initiatives outlined under the Energy Policy Act of 2005.

Relevance to the NASA Mission and Strategic Goals:

CoF funding is vital to achieve the mission support Strategic Goal "enable program and institutional capabilities to conduct NASA's aeronautics and space activities." The CoF Program supports NASA's Space Flight, Science, and Aeronautics Research missions by ensuring that NASA's greatest mission risks related to infrastructure condition are mitigated; facilities that are critical to NASA missions are maintained, repaired, and refurbished; and facilities that cannot support current and emerging critical technologies are replaced with efficient suitable facilities that will support NASA's strategic goals for research and exploration. The CoF Program strives to reduce facilities operating costs, maintenance burdens, and utility costs to make more of NASA funding available for missions.

Performance

Performance Commitments:

Measure #	Description	Contributing Program (s)
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**	
Outcome 5.2	**Ensure vital assets are ready, available, and appropriately sized to conduct NASA's missions.**	
Objective 5.2.3	**Develop and implement long-range infrastructure plans that address institutional capabilities and critical assets, directly link to mission needs, ensure the leveraging of external capabilities, and provide a framework for Agency infrastructure decision-making.**	
Performance Goal 5.2.3.1	***Consolidate functions and offices to reduce real property need, and use Agency Integrated Master Plan to identify and dispose of excess and aged facilities beyond useful life.***	
APG 5.2.3.1: COF-12-1	Initiate facilities demolition process for five significant Agency facilities in addition to demolition processes initiated in FY 2011.	Institutional CoF

Mission Directorate:	Construction and Environmental Compliance and Restoration

Performance Achievement Highlights:

NASA continued essential infrastructure repair and revitalization activities, completing $387.9 million of construction. Eight facilities received Leadership in Energy and Environmental Design (LEED) certification in FY 2010 including the new office building at JSC, which was certified LEED Platinum. Six other facilities were certified LEED Gold and one was LEED Silver. Additionally, NASA continued reducing its infrastructure by initiating the demolition of 34 unneeded facilities or structures. Assertive recycling strategies and sustainable demolition practices resulted in low cost demolition projects, allowing the Agency to maximize the scope of its demolition program.

Project Descriptions and Explanations of Changes

Summary of FY 2012 Construction of Facilities (CoF) Projects

In Millions of Dollars	FY 2010 Actual	FY 2011 Ann. CR	FY 2012 Request
Science	37.8	40.5	1.0
Restore Building 26 (GSFC)	---	14.0	---
Modify Thermal Vacuum Chamber A (JSC)	21.6	26.5	1.0
Minor Revitalization of Facilities funded by Earth Science Research (Various Locations)	11.4	---	---
Minor Revitalization of Facilities funded by Heliophysics Research (Various Locations)	1.2	---	---
Facility Planning and Design (Various Locations)	3.6	---	---
Exploration	72.6	45.0	0.0
Modify Space Power Facility, Plum Brook Station (GRC)	23.9	1.2	---
Modify Multi-Payload Processing Facility (KSC)	1.0	---	---
Construct A-3 Propulsion Test Facility (SSC)	31.8	43.4	---
Minor Revitalization of Facilities funded by Constellation Systems (Various Locations)	12.4	---	---
Minor Revitalization of Facilities funded by Exploration Technology (Various Locations)	2.0	---	---
Facilities Planning and Design (Various Locations)	1.5	0.4	---
Space Operations	26.9	20.0	28.9
Construct 34-Meter Beam Waveguide Antennas, Canberra, Australia (JPL)	6.8	7.3	14.5
Revitalize High Pressure Industrial Water System (SSC)	---	6.0	10.0
Minor Revitalization funded by Space Flight Support (Various Locations)	16.6	6.7	4.4
Facility Planning and Design funded by Space Flight Support (Various Locations)	3.5	---	0.0
Aeronautics	2.8	---	---
Minor Revitalization funded by Integrated Systems Research Program (Various Locations)	2.8	---	---
Institutional CoF Projects	249.3	280.7	368.0
Re-skin Hangar 1 (ARC)	---	---	32.8
Construct Flight Project Center (GSFC)	---	---	36.9
Launch Facilities Protection, WFF (GSFC)	7.0	13.0	17.0
Construct West Arroyo Parking Structure (JPL)			22.0
Revitalize Water and Waste Water Systems, Various Locations (KSC)			30.0
Construct Integrated Services Building (LaRC)	---	30.4	20.0
Renovate East Test Area Industrial Water Distribution System (MSFC)			15.0
Replace Potable Water System (SSC)			10.0
Construct Replacement Facilities Support Center (DFRC)	---	12.5	---
Construct Replacement Engineering Office Building 4220 (MSFC)	---	40.0	---
Repair and Construct Consolidated Information Technology Center, (DFRC)	10.0	---	---
Repair Primary Electrical Distribution-Phase 6 (DFRC)	10.0	---	---
Construct Centralized Office Building (GRC)	25.3	---	---
Construct Shipping and Receiving Facility (GSFC)	12.8	---	---
Revitalize Building 25 Mission Support Building (JSC)	21.3	---	---
Renovation of Operations & Checkout Building (KSC)	15.5	---	---
Revitalize High and Medium Voltage Electrical Distribution Systems (KSC)	19.5	---	---

Replace Asbestos Siding and Provide Energy/Safety Upgrades, Bldg 4707 (MSFC)	5.0	---	---
Minor Revitalization of Facilities at Various Locations	84.9	137.2	119.3
Demolition of Facilities	15.0	19.9	25.0
Facility Planning and Design	23.0	27.7	40.0

Note: The amounts in the FY 2011 column identify the CoF projects NASA is able to fund within the annualized CR amount for the CECR account.

Discrete Projects

Science CoF

Project Title: Modify Thermal Vacuum Chamber A
Location: Johnson Space Center, Houston, Texas
Mission Directorate: Science
FY 2012 Estimate: $1.0 million

This project continues modifications to Chamber A to prepare for testing the James Webb Space Telescope (JWST) Optical Telescope Element and Integrated Science Instrument Module. Modifications include an upgrade of liquid nitrogen systems and an upgrade of high vacuum systems, which includes: installation of new gate valves and new cryogenic pumps; the installation of a helium system (both refrigeration system and shroud); and installation of a new clean air system in the chamber. These modifications to thermal vacuum Chamber A are necessary to achieve the required temperature and contamination control test conditions for flight hardware. This is the fifth increment for this project for a total project cost estimate of $73.9 million. Program replanning efforts, discussed in the Science section, may impact the schedule of this project.

Space Operations CoF

Project Title: Construct 34-Meter Beam Waveguide Antennas
Location: Canberra, Australia
Mission Directorate: Space Operations
FY 2012 Estimate: $14.5 million

This project includes fabrication and installation of the antenna structure, panels, gearboxes, bearings, electric drives, encoders, beam waveguide mirrors, subreflector and subreflector positioner for Deep Space Network antennas. This third increment completes Deep Space Station-35 (DSS-35) and initiates construction of Deep Space Station-36 (DSS-36), which will be funded in three increments. It also includes the design and construction of the antenna structure, foundations and pedestals, as well as facilities in and around the Canberra Deep Space Communication Complex, such as paved access roads, trenches, drainage, flood control devices, water main and distribution system, antenna apron, security fence, heating, ventilation, and air conditioning (HVAC), electrical power distribution, fire detection and suppression system, and surveillance system assembly. Multiple Beam Waveguide antennas are needed to add resilience in the southern hemisphere for the Deep Space Network. These antennas are needed to support additional mission loading from projects currently under development and scheduled for launch during or after 2015. The first antenna estimated construction cost is $24.0 million and the second antenna estimated construction cost is $25.2 million. Construction of the third antenna is anticipated to begin in FY 2014 with an estimated construction cost of $26.5 million. The total estimated construction cost for all three antennas is $75.7 million.

Project Title: Revitalize High Pressure Industrial Water System
Location: Stennis Space Center, Stennis Space Center, Mississippi
Mission Directorate: Space Operations
FY 2012 Estimate: $10.0 million

This project consists of construction of a new High Pressure Industrial Water (HPIW) Distribution Piping System. The HPIW directly supports testing rocket engines in the A and B Test Complexes at Stennis Space Center (SSC) by supplying water for test stand deflector coolant, fire protection (deluge system), and diffuser operation. It also furnishes water for fire protection of the Liquid Hydrogen and Liquid Oxygen barges located at the test stand docks. Replacement of the HPIW is necessary due to age-related poor condition (i.e., excessive leakage caused by corrosion). Continuous use of the facilities supported by this project is consistent with the SSC Master Plan and Agency goals to reduce deferred maintenance and upgrade basic institutional infrastructure. Total project cost is $40 million.

Institutional CoF

Project Title: Re-skin Hangar 1
Location: Ames Research Center, Moffett Field, CA
FY 2012 Estimate: $32.8 million

This project will install a new envelope on NASA Ames Research Center's Hangar One with new materials which will complement the historic structure's architecture. The Navy is currently remediating hazardous waste and environmental contamination. The Navy is removing the facility envelope as part of their remediation work. This project will install new exterior siding, roof and windows. The completed project will provide a weather tight structure. The scope of this project does not include upgrading building mechanical or electrical systems. This project will be executed as a design build project so NASA can explore competing concepts to best reflect the historic nature of this structure.

Project Title: Construct Flight Project Center
Location: Goddard Space Flight Center, Greenbelt, Maryland
FY 2012 Estimate: $36.9 million

This project designs and constructs a 95,000 GSF (gross square feet) office building for the Flight Projects Directorate (FPD). The new multi-story building will have maximal reconfigurable office space to house approximately 300 people. The building envelope will blend with its surroundings. The proposed site is south of the existing Building 16 Complex and east of existing Building 12. Following construction, the Building 16 complex will be demolished in accordance with Master Plan current replacement value reductions. The Building 16 Complex is comprised of Building 016 (two-story brick office building), Building 016W (warehouse/office structure), Building 016A (Gas Cylinder Storage), Building 016B (Ordnance), and Building 086 (Project Support Facility.) The total demolition will be 222,464 GSF.

Project Title: Launch Facilities Protection
Location: Wallops Flight Facility, Wallops Island, Virginia
FY 2012 Estimate: $17.0 million

This is the third and final increment for Wallops Island Launch Facilities Protection. The first increment extended the seawall south approximately 1,500 feet to protect existing assets and repair the failing seawall, as recommended after a detailed inspection. This increment will begin the sand fill portion of the project. The completed beach fill segment will provide a 70-foot wide dry beach in front of the seawall (about 3 million cubic yards) along its entire length (6,800 meters). Wallops Island has experienced erosion throughout the six decades of NASA occupation. Since the 1990s, part of the island has been protected with a stone rubble-mound seawall. Although the seawall has temporarily limited the shoreline's erosion, the structure is being undermined and is failing. This is occurring because there is little or no protective sand beach remaining and waves break directly on the sea wall. The south end of the island is currently unprotected and suffers continuous erosion. A 2006 Army Corps of Engineers study titled "Beach Erosion Mitigation and Sediment Management Alternatives at Wallops Island, VA" validates the need and outlines the requirements for protection. The Wallops Launch Range supports sounding rocket and NASA small satellites launches, Commercial Orbital Transportation Services (COTS) demonstration and re-supply to the International Space Station, launches for other Federal and commercial entities, and unmanned aerial vehicle (UAV) flights. The total project cost is $37.6 million. The project will provide a complete solution when this final increment is executed.

Project Title: Construct West Arroyo Parking Services
Location: Jet Propulsion Laboratory, Pasadena, California
FY 2012 Estimate: $22.0 million

This project constructs a multi-level parking garage to accommodate a minimum of 700 to 1,000 vehicles at the eastern boundary of the Jet Propulsion Laboratory (JPL) Oak Grove site, an area of approximately 1.6 acres currently used for surface parking. It will utilize a design and build project delivery methodology and building information modeling (BIM) in order to meet sustainable design objectives and net-zero energy usage. Underground utilities located within the footprint of the proposed garage will be relocated, including: an eight-inch sanitary sewer line; a 10-inch water main; storm drains; catch basins; and medium pressure gas lines. New work includes the garage superstructure, driving surfaces, water- and dampproofing, perimeter spandrel panels and cable barriers, stairs, elevators, lighting, and code-required fire alarm and protection systems. Roadway, hardscape, landscape, security, and parking control items related to changes in vehicle and pedestrian traffic flows will be addressed and mitigated.

In the summer of 2013, the city of Pasadena will construct ground water percolation ponds on the 11-acre East Arroyo site currently leased by JPL from the city and used for parking 1,100 employee vehicles. The city of Pasadena requires JPL to vacate the property in December 2012 to allow for restoration of the site in accordance with lease requirements. The loss of 1,100 parking spaces represents 24 percent of the 4,575 total parking spaces currently available for JPL employees. Of the total 4,575 available parking spaces, it is not uncommon for there to be fewer than 20 vacant parking spaces reported during weekly counts by JPL Protective Services. There is no "spare capacity," and JPL cannot absorb the loss of almost 25 percent of its parking spaces. In addition to the 1,100 space Pasadena lot, NASA JPL also leases a second 1,100 space parking lot from the Flintridge Riding Club, located on the western boundary of the site. At present, leased parking represents nearly one-half of the total parking supply. Construction of a 700 to 1,000 vehicle garage will help to provide sufficient parking and reduce dependence on leaseholders.

Project Title: Revitalize Water and Waste Water Systems, Various Locations
Location: Kennedy Space Center, Kennedy Space Center, Florida
FY 2012 Estimate: $30.0 million

This project will replace water lines throughout the Kennedy Space Center (KSC) water distribution system. Pipeline replacement is to include critical water mains, facility service lines, valves, and fire hydrants. Water meters will be installed at larger facilities to monitor water flow and progress of initiatives set to reduce water consumption. This project will rehabilitate lift stations through replacement of pumps, risers, controllers, valves, structure, and other aging lift station components. This project will also upgrade waste water system monitoring with an enhanced Supervisory Control and Data Acquisition (SCADA) system for lift station monitoring and energy optimization. Most of the components of the Center's water and waste water system are 45 years old and have exceeded their design life expectancy. This project continues an effort to improve KSC's water quality, replace aging system pipes and lift stations, reduce excessive water flushing, and eliminate drinking water notifications to the entire KSC workforce, which has resulted in drinking water lock outs arising from poor water quality. This is Phase four of five, with a total project cost of $53.0 million.

Project Title: Construct Integrated Services Building
Location: Langley Research Center, Hampton, Virginia
FY 2012 Estimate: $20.0 million

This project constructs a two-story integrated services building and provides related site improvements. The new 95,000 square foot building will house up to 125 administrative personnel and incorporate the media services center, main conference facilities, cafeteria, training classrooms, and many other services now scattered throughout Langley. The Integrated Services Building will be located very close to the center of the campus and will be energy efficient, designed to meet or exceed silver requirements of the U.S. Green Building Council Leadership in Energy and Environmental Design (LEED) certification. Site improvements include upgrades to the existing pedestrian walkway, addition of a civic mall in the center of the campus, and expansion of surrounding parking lots. The project also includes demolition of six older buildings directly impacted by this project, removing 98,000 square feet of floor space and eliminating $37.8 million in deferred maintenance.

The buildings to be replaced by the new Integrated Services Building are over 60 years old. The fire protection systems in these older facilities are very inadequate. Most do not have sprinkler systems and many of the fire alarms, smoke detection systems, and fire exits are not code compliant. The majority of these older facilities have antiquated HVAC systems, which frequently break down and disrupt operations. The existing media services are located in four separate locations, causing this service to be very inefficient. These buildings have potential problems with hazardous materials such as asbestos, polychlorinated biphenyls (PCBs) ballasts, mercury thermostats, and lead, chromium, and cadmium-based paints. Half of the buildings are not compliant with Americans with Disabilities Act regulations. All of these facilities are run down, inefficient, and inadequate to perform their intended functions. Renovation of the existing facilities is not cost effective and eliminating these facilities reduces the risk of accidental injury or death from fire or other system failures. This is the second of two increments with a total estimated construction cost of $50.4 million. The project will provide a complete and usable facility when this final increment is completed.

Project Title: Renovate East Test Area Industrial Water Distribution System
Location: Marshall Space Flight Center, Huntsville, Alabama
FY 2012 Estimate: $15.0 million

This project will replace 45 year old deteriorated industrial piping located in the East Test Area of the Marshall Space Flight Center (MSFC). In addition to the new piping, outdated diesel pumps will be replaced with new energy efficient electric pumps and centrally located controls. The installation of the new piping and pumps is necessary to boost pressures and flows to adequate levels in support of all facilities located in the test area. Continuous use of the facilities supported by this project is consistent with the MSFC Master Plan and Agency goals to reduce deferred maintenance and upgrade basic institutional infrastructure.

Project Title: Replace Potable Water System
Location: Stennis Space Center, Mississippi
FY 2012 Estimate: $10.0 million

This project will substantially replace the Stennis Space Center (SSC) system-wide potable water system. The project will replace existing main distribution piping constructed with more than 40-year old asbestos cement (transite), ductile cast iron, and steel materials. The project also replaces associated valves and hydrants directly connected to the main distribution system. Repair of the SSC potable water system is necessary due to its age-related poor condition (i.e., excessive leakage, corrosion, and potential human health hazard). Continuous use of the facilities supported by this project is consistent with the SSC Master Plan and Agency goals to reduce deferred maintenance and upgrade basic institutional infrastructure.

Minor Revitalization & Construction of Facilities (projects less than $10.0 million each)

This request includes facility revitalization and construction needs with initial cost estimate greater than $1.0 million but less than $10.0 million per project. Projects with initial cost estimates of $1.0 million or less are normally accomplished by routine day-to-day facility maintenance and repair activities provided for in direct program and Center operating budgets. Proposed FY 2012 institutional minor revitalization and construction projects total $119.3 million for components of the basic infrastructure and institutional facilities, and programmatic projects total $4.4 million. These resources provide for revitalization and construction of facilities at NASA facility installations and government-owned industrial plants supporting NASA activities. Revitalization and modernization projects provide for the repair, modernization, and/or upgrade of facilities and collateral equipment. Repair projects restore facilities and components to a condition substantially equivalent to the originally intended and designed capability. Repair and modernization work includes the substantially equivalent replacement of utility systems and collateral equipment necessitated by incipient or actual breakdown. It also includes major preventive measures that are normally accomplished on a cyclic schedule and those quickly needed out-of-cycle, based on adverse condition information revealed during predictive testing and inspection efforts. Modernization and upgrade projects include both restoration of current functional capability and enhancement of the condition of a facility so that it can more effectively accomplish its designated purpose, increase its functional capability, or so that it can meet new building, fire, and accessibility codes.

The minor revitalization and construction projects that comprise this request are of the highest priority, based on relative urgency, and expected return on investment. During the year, some rearrangement of priorities may be necessary, which may cause a change in some of the items to be accomplished.

Minor Revitalization Center Distribution

Space Operations

A. Jet Propulsion Laboratory, $2.8 million
   1. Modify Signal Processing Center Electrical Distribution, Madrid, Spain
   2. Replace Beam Waveguide Azimuth Tracks, 34M Subnet, Goldstone, CA

B. Kennedy Space Center, $1.6 million
   1. Repair and Renovate Building 836, Vandenberg, AFB, CA

Institutional

A. Dryden Flight Research Center, $20.8 million
   1. Repair by Replacement Fire Main Distribution System, Center-wide
   2. Repair Electrical Distribution, Phase 7 of 8
   3. Repair Flightline Access Roads & Aircraft Ramps, Phase 2 of 2
   4. Construct Photovoltaic Solar Power System

B. Glenn Research Center, $16.5 million
   1. Upgrade Campus Security Requirements
   2. Repair Cooling Tower Water Systems, Phase 2 of 3
   3. Repair Natural Gas System, Plum Brook Station

C. Goddard Space Flight Center, $2.3 million
   1. Upgrade Chiller/Boiler Plant Controls, Building 24

D. Jet Propulsion Laboratory, $4.7 million
   1. Replace LN2 Tanks, Phase 4 of 7
   2. Upgrade South Gate Security

E. Johnson Space Center, $21.9 million
   1. Upgrade and Replace Fire Alarm Network Nodes, Phase 1 of 2
   2. Upgrade and Repair Electrical Systems, Site-wide
   3. Upgrade Main Electrical Switchyard and Replace Site Poles, WSTF
   4. Upgrade Communications and Personnel Warning System, WSTF
   5. Construct 500kW Stationary Photovoltaic Solar Array System, WSTF

F. Kennedy Space Center, $3.0 million
   1. Replace Chilled Water Controls, Industrial Area

G. Langley Research Center, $18.0 million
   1. Rehabilitate Steam System and Plant
   2. Rehabilitate Electrical Systems
   3. Replace/Upgrade Fire Detection/Suppression Systems, Various Facilities (1148, 1232, 1235, 1250)

H. Marshall Space Flight Center, $21.0 million
1. Repair and Modify Critical Mechanical and Electrical Systems for Reliability, Building 4663
2. Upgrade Safety and Energy Systems, Buildings 4708,4619,4755
3. Upgrade/Repair Electrical Distribution System, North Campus

I. Stennis Space Center, $11.1 million
1. Repair B Test Stand and Dock
2. Repair Electrical Unit Substations
3. Repair Canal System Spillway
4. Upgrade Safety and Energy Systems, Building 1100

Demolition of Facilities

Cognizant Office: Office of Strategic Infrastructure
FY 2012 Estimate: $25.0 million

The funds requested will be used to eliminate inactive and obsolete facilities that are no longer required for NASA's Mission. Abandoned facilities present eyesores on the Centers and pose a potential safety and environmental liability. These abandoned facilities must still be maintained at minimal levels to prevent increasing safety and environmental hazards. These recurring maintenance costs impose a drain on the limited maintenance dollars needed at the Centers. Demolishing these abandoned facilities will allow the Agency to avoid non-productive operating costs required to keep abandoned facilities safe and secure. Furthermore, demolition is the most cost effective way to reduce the Agency deferred maintenance.

NASA identifies potential facilities for the demolition program through special studies to determine if the facility is required for a current of future missions. Facilities that are no longer needed are included in a five-year demolition plan that sets project schedules based on last need, annual costs avoided, potential liability, and project execution factors. Individual project schedules are sometimes adjusted in response to factors such as consultation with states on historic properties, changes in operational schedules, environmental remediation, funding profiles, local market forces, and cost of recycled materials. Proposed FY 2012 demolition projects will reduce annual facilities costs by an estimated $3.2 million.

Facility Planning and Design

Cognizant Office: Office of Strategic Infrastructure
FY 2012 Estimate: $$40.0 million

These funds are required for: advance planning and design activities; special engineering studies; facility engineering research; preliminary engineering efforts required to initiate design-build projects; preparation of final designs, construction plans, specifications, and associated cost estimates; and participation in facilities-related professional engineering associations and organizations. These resources provide for project planning and design activities associated with non-programmatic construction projects. Project planning and design activities for construction projects required to conduct specific programs or projects are included in the appropriate budget line item. Other activities funded include: master planning; value engineering studies; design and construction management studies; facility operation and maintenance studies; facilities utilization analyses; engineering support for facilities management systems; and capital leveraging research activities. The increase in facilities planning and design is crucial in implementation of the NASA Recapitalization Program. These recapitalization projects are necessary to make progress toward required sustainability, energy, and stewardship goals.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Construction of Facilities
Program:	Institutional CoF

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	249.3	-	368.0	384.0	359.5	362.9	360.0
Institutional CoF	249.3	-	368.0	384.0	359.5	362.9	360.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Construction of Facilities
Program:	Science CoF

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**37.8**	**-**	**1.0**	**0.0**	**0.0**	**0.0**	**0.0**
Science CoF	37.8	-	1.0	0.0	0.0	0.0	0.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Construction of Facilities
Program:	Exploration CoF

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**72.6**	**-**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Exploration CoF	72.6	-	0.0	0.0	0.0	0.0	0.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Construction of Facilities
Program:	Space Operations CoF

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	26.9	-	28.9	0.0	0.0	0.0	0.0
Space Operations CoF	26.9	-	28.9	0.0	0.0	0.0	0.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Construction of Facilities
Program:	Aeronautics CoF

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	2.8	-	0.0	0.0	0.0	0.0	0.0
Aeronautics CoF	2.8	-	0.0	0.0	0.0	0.0	0.0

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Environmental Compliance and Restoration
Program:	Environmental Compliance and Restoration

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**63.4**	**-**	**52.5**	**66.4**	**90.9**	**87.5**	**90.4**
Environmental Compliance and Restoration	63.4	-	52.5	66.4	90.9	87.5	90.4

Note:

The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended). Amounts in the "Ann. CR FY 2011" column reflect the annualized level provided by the Continuing Resolution.

In accordance with the President's proposal to implement a five-year non-security discretionary spending freeze, budget figures shown for years after FY 2012 are notional and do not represent policy. Funding decisions will be made on a year-by-year basis.

Program Overview

NASA's ECR program completes the cleanup of hazardous materials and wastes that have been released to the surface or groundwater at NASA installations, NASA-owned industrial plants supporting NASA activities, current or former sites where NASA operations have contributed to environmental problems, and other sites where the Agency is legally obligated to address hazardous pollutants. Nearly $1 billion worth of cleanup liabilities impact the NASA Centers. The cleanups are prioritized to ensure that the highest priority liabilities are addressed first, better protecting human health and the environment, and preserving natural resources. ECR program activities include projects, studies, assessments, investigations, plans, designs, related engineering, program support, sampling, monitoring, and regulatory agency oversight costs. Funding also covers and any land acquisitions necessary to ensure operation of remedial treatment processes and sites as part of the remediation and cleanup measures.

In response to recent Executive Orders to consider the increasing impacts of global climate change on NASA facilities and projects, the ECR program provides for strategic investment in environmental methods and practices that ensure NASA may continue to carry out its scientific and engineering missions. Included are investments in methodologies for sustainably reducing energy intensity and greenhouse gas emissions, and supporting operational activities by ensuring that advances in chemical risk management are incorporated early in mission design phases.

Additional information concerning NASA's ECR program can be found at http://www.nasa.gov/offices/emd/home/ecr.html.

Mission Directorate:	Construction and Environmental Compliance and Restoration
Theme:	Environmental Compliance and Restoration
Program:	Environmental Compliance and Restoration

Plans For FY 2012

The FY 2012 funding request represents a prioritized, risk-based approach for addressing a total of 136 cleanup projects remaining at all NASA Centers and is based upon the relative urgency and the potential health and safety hazards related to each individual cleanup. As studies, assessments, investigations, plans, regulatory approvals, and designs progress and as new discoveries or regulatory requirements change, it is expected that program priorities may change, requiring revisions to planned activities. Major activities and cleanups with the highest priority requirements planned for FY 2012 include:

1. Implementing thorough investigation and cleanup at Santa Susana Field Laboratory in accordance with a new Consent Order with the State of California, ensuring full public involvement throughout the process.

2. Continuing cleanup of ground water contamination and investigation of soil contamination at White Sands Test Facility, New Mexico; and

3. Operating and maintaining systems to address contaminated groundwater and drinking water emanating from the Jet Propulsion Laboratory, California.

NASA Office of Inspector General FY 2012 Budget Request Summary

Overview

For FY 2012, the NASA Office of Inspector General (OIG) requests $37.5 million. This request will support the work of 206 auditors, investigators, analysts, specialists, and support staff located at NASA Headquarters in Washington, D.C., and 12 other locations throughout the United States.

The OIG conducts audits, reviews, and investigations of NASA programs to prevent and detect fraud, waste, abuse, and mismanagement and to assist NASA management in promoting economy, efficiency, and effectiveness. The OIG's Office of Audits (OA) conducts independent and objective audits of NASA programs, projects, operations, and contractor activities. In addition, OA oversees the work of the independent public accounting firm that conducts the annual audit of NASA's financial statements. In its work, OA targets high-risk areas and management challenges, responds to NASA's changing needs and priorities, and provides measurable results that contribute to NASA's success in achieving its mission of pioneering the future of space exploration, scientific discovery, and aeronautics research.

Going forward, OA intends to focus its work in the areas identified by the OIG in November 2010 as the Agency's top management and performance challenges:

- Future of U.S. Space Flight
- Acquisition and Project Management
- Infrastructure and Facilities Management
- Human Capital
- Information Technology Security
- Financial Management

In this regard, ongoing audits are examining the status of NASA's safety and human rating efforts for the commercial space flight industry, whether NASA's grant funds are being used for intended purposes, NASA's tuition reimbursement program, and whether NASA is effectively managing its Mars Science Laboratory Project to accomplish its exploration objectives while meeting revised milestones and controlling costs.

The Office of Investigations (OI) investigates allegations of cybercrime, fraud, waste, abuse, and misconduct that may affect NASA programs, projects, operations, and resources. OI refers its findings to the Department of Justice for criminal prosecution and civil litigation or to NASA management for administrative action. Through its investigations, OI develops recommendations for NASA management to reduce the Agency's vulnerability to criminal activity.

Given the inherent risk associated with space operations and aeronautics and that NASA spends approximately 85 percent of its budget on contracts and grants, OI targets its resources to maintain the integrity of NASA's procurement process and on issues relating to the safety of NASA's missions and information systems. In the procurement area, OI's caseload includes investigations of allegations of false claims submitted by NASA contractors, conflict of interest cases involving NASA employees who place private gain before public service, and Procurement Integrity Act violations.

Finally, through its investiagations, the Office of Investigations seeks to prevent and deter misconduct at NASA through an aggressive "lessons learned" approach with NASA management. To this end, the OIG works with NASA officials to shore up vulnerabilities that may have allowed crimes or misconduct to occur within their programs and operations.

NASA Office of Inspector General FY 2012 Budget Request Summary

FY 2012 Budget Request

Budget Authority ($ millions)	FY 2010	Ann CR. FY 2011	Auth Act FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
FY 2012 President's Budget Request	**36.4**	**36.4**	**37.0**	**37.5**	**37.5**	**37.5**	**37.5**	**37.5**
Inspector General	36.4	-	-	37.5	37.5	37.5	37.5	37.5

NASA OIG submitted an original request of $40.8 million that included an over guide of $3.0 million.

In accordance with Public Law 110-409, Inspector General Reform Act of 2008, the Inspector General certifies that the $0.4 million for staff training in the budget request satisfies all known training requirements. We have no known funding requirement to support the Council of Inspectors General on Integrity and Efficiency for this budget request.

Plans for FY 2012

Inspector General

- Major Changes: None

Major Highlights for FY 2012

OIG's FY 2012 request is broken out as follows:

- $31.4 million (83.8 percent) of the proposed budget is dedicated to personnel and related costs. Salaries include the required additional 25 percent law enforcement availability pay for criminal investigators.
- $1.2 million (3.2 percent) of the proposed budget is dedicated to travel, per diem at current rates, and related expenses.
- $1.75 million (4.5 percent) of the proposed budget is dedicated to operational expenses and includes funding for training, government vehicles, special equipment for criminal investigators, employee transportation subsidies, and information technology equipment unique to the OIG.
- $3.2 million (8.5 percent) of the proposed budget funds the Agency's annual financial audit.

The Consolidated Appropriations Act, 2010 (P.L. 111-117) funded NASA OIG at the President's Budget level, but changed funding availability from two years to one year. In FY 2012, the OIG requests a return to two-year funding to more efficiently plan for, execute, and control its budget.

The FY 2012 budget estimate for the OIG totals $37.5 million:

- Personnel and related costs $31.4 million
- Travel $1.2 million
- Operations and Equipment $4.9 million

Performance Achievement Highlights

In 2010, OA issued 32 audit reports, including reports assessing how well NASA had managed its Tracking and Data Relay Satellite System Program to accomplish its technical objectives while meeting established milestones and controlling costs, NASA's implementation of recommendations to improve the medical and behavioral health care provided to the Astronaut Corps, and the performance of the private company NASA hired to provide reduced gravity flights for NASA research, engineering, and astronaut training. Other reports uncovered weaknesses in NASA's disposition of information technology equipment related to the Space Shuttle Program and in NASA's information technology security. In addition, after receiving disclaimers of opinion on its financial statements during the previous seven years, NASA received a qualified opinion on its FY 2010 financial statements. Over the past several years, NASA financial managers - working with the OIG and the independent accounting firm whose work the OIG oversees - made steady progress resolving previously identified weaknesses and their efforts resulted in the qualified opinion.

In 2010, OI investigated and issued reports on two high-profile matters involving senior NASA managers. In the first of these matters, the OI reviewed NASA's decision to remove the manager of NASA's Constellation Program. The OIG found that the reassignment was a management decision made by the Associate Administrator for Exploration Systems with the concurrence of the NASA Administrator, and was taken in response to actions by the manager that led senior NASA leadership to believe he could no longer effectively lead the Constellation Program during a period when the President was seeking to cancel the Program in the face of significant congressional opposition.

In the other matter, OI investigated allegations that NASA Administrator Charles F. Bolden, Jr. inappropriately consulted with Marathon Oil Corporation as he considered NASA's involvement in an alternative fuel project. Bolden had served on Marathon's Board of Directors for six years prior to becoming Administrator and held more than $500,000 in Marathon stock when he contacted the company seeking information about the project. The OIG concluded that Bolden's contact with Marathon did not violate federal laws or ethics regulations pertaining to conflicts of interest but was not consistent with the ethics pledge he signed upon taking office.

In the OIG's most recent semi-annual reporting period, OI investigations resulted in recoveries of more than $27.4 million through criminal, civil and administrative fines, restitution and other recoveries. Of this amount, $11.7 million was returned directly to NASA.

In the safety area, a recent OIG investigation resulted in the conviction of a Space Shuttle parts supplier who attempted to substitute non-conforming parts into Space Shuttle Discovery's payload bay. According to experts, an in-flight failure of this non-conforming part would have significantly endangered the crew. In addition, OI has pursued and successfully convicted in both domestic and foreign forums individuals who have illegally intruded ("hacked") into NASA's information systems. Many of these investigations are international in scope and involve suspects in Russia, China, Africa, Spain, Romania, Sweden, Portugal, and Italy. The schemes typically involve attempts to infiltrate NASA's systems to commit criminal acts, ranging from pure hacking to attempts to obtain NASA program data and technology.

SUPPORTING DATA TABLE OF CONTENTS

FUNDS DISTRIBUTION BY INSTALLATION

($ in Millions)	FY 2012
Ames Research Center	**$754.6**
Science	$193.5
Aeronautics Research	$134.1
Space Technology	$105.0
Exploration	$55.2
Space Operations	$11.4
Education	$4.8
Cross-Agency Support	$211.8
Construction & Envrmtl Compl Restoration	$38.7
Dryden Flight Research Center	**$283.8**
Science	$69.5
Aeronautics Research	$72.3
Space Technology	$29.7
Exploration	$3.3
Space Operations	$0.4
Education	$10.5
Cross-Agency Support	$76.0
Construction & Envrmtl Compl Restoration	$22.2
Glenn Research Center	**$809.2**
Science	$31.7
Aeronautics Research	$144.3
Space Technology	$215.8
Exploration	$99.7
Space Operations	$46.8
Education	$12.2
Cross-Agency Support	$229.6
Construction & Envrmtl Compl Restoration	$29.1
Goddard Space Flight Center	**$2,819.0**
Science	$2,100.9
Aeronautics Research	$0.0
Space Technology	$55.8
Exploration	$3.1
Space Operations	$128.2
Education	$2.4
Cross-Agency Support	$468.4
Construction & Envrmtl Compl Restoration	$60.1
Jet Propulsion Laboratory	**$1,194.6**
Science	$859.0
Aeronautics Research	$0.0
Space Technology	$93.4
Exploration	$4.3
Space Operations	$166.4
Education	$1.5
Cross-Agency Support	$17.2
Construction & Envrmtl Compl Restoration	$52.9

FUNDS DISTRIBUTION BY INSTALLATION (CONTINUED)

($ in Millions)	FY 2012
Johnson Space Center	**$4,987.5**
Science	$25.1
Aeronautics Research	$0.0
Space Technology	$53.6
Exploration	$1,119.1
Space Operations	$3,268.3
Education	$8.9
Cross-Agency Support	$471.8
Construction & Envrmtl Compl Restoration	$40.6
Kennedy Space Center	**$2,053.3**
Science	$280.6
Aeronautics Research	$0.0
Space Technology	$28.7
Exploration	$931.0
Space Operations	$352.0
Education	$4.0
Cross-Agency Support	$409.9
Construction & Envrmtl Compl Restoration	$47.1
Langley Research Center	**$927.3**
Science	$94.2
Aeronautics Research	$180.9
Space Technology	$242.1
Exploration	$39.1
Space Operations	$0.1
Education	$10.9
Cross-Agency Support	$319.1
Construction & Envrmtl Compl Restoration	$40.8
Marshall Space Flight Center	**$2,556.8**
Science	$130.6
Aeronautics Research	$0.0
Space Technology	$163.8
Exploration	$1,524.7
Space Operations	$199.5
Education	$5.2
Cross-Agency Support	$472.7
Construction & Envrmtl Compl Restoration	$60.3

FUNDS DISTRIBUTION BY INSTALLATION (CONTINUED)

($ in Millions)	FY 2012
NASA Headquarters and IG	**$2,112.1**
Science	$1,229.7
Aeronautics Research	$37.8
Space Technology	$25.8
Exploration	$80.9
Space Operations	$141.6
Education	$77.2
Cross-Agency Support	$456.5
Construction & Envrmtl Compl Restoration	$25.1
Inspector General	$37.5
Stennis Space Center	**$226.0**
Science	$2.1
Aeronautics Research	$0.0
Space Technology	$10.4
Exploration	$88.1
Space Operations	$32.2
Education	$0.7
Cross-Agency Support	$59.1
Construction & Envrmtl Compl Restoration	$33.5
Total	**$18,724.3**

Note: Totals may not add due to rounding

CIVIL SERVICE FULL TIME EQUIVALENT DISTRIBUTION BY CENTER

The workforce level proposed in the budget supports NASA's traditional investments in space exploration, aeronautics research, space technology development, science investigation, and sharing the results of Agency activities with the public and educators.

The Agency will apply its capabilities to the range of mission, research, and technology work while continuing to reshape and realign workforce skills to adjust to changing requirements. NASA anticipates offering buyouts in selected surplus skill areas, and is prepared to identify, recruit and retain employees who possess essential/critical skills and competencies. The workforce will continue to demonstrate the relevance if its work to society, apply itself to contemporary problems, lead or participate in emerging technology opportunities, and communicate the challenges and results of Agency programs and activities.

Average Agency full-time equivalent (FTE) levels are expected to decline by approximately 500 FTE over the period FY 2011 through FY 2016, stabilizing at just over 18,000 FTE. This ceiling decline addresses workforce at several Centers affected by changes in the human space flight portfolio, and it reflects the planned end of a temporary FTE increase in FY 2010 – FY 2011 that was granted to encourage early career hiring at Centers.

	Actuals[1]	FTE Estimates[2]					
	FY10	FY11	FY12	FY13	FY14	FY15	FY16
ARC	1,241	1,243	1,231	1,231	1,231	1,231	1,231
DFRC	552	559	555	551	551	551	551
GRC	1,629	1,662	1,652	1,642	1,634	1,634	1,634
GSFC	3,223	3,413	3,393	3,373	3,353	3,353	3,353
JSC	3,326	3,314	3,225	3,185	3,185	3,185	3,185
KSC	2,180	2,161	2,095	2,064	2,064	2,064	2,064
LaRC	1,921	1,946	1,927	1,927	1,927	1,927	1,927
MSFC	2,560	2,549	2,490	2,462	2,462	2,462	2,462
SSC	272	298	294	294	294	294	294
HQ	1,206	1,238	1,208	1,188	1,188	1,188	1,188
NSSC	130	146	146	146	146	146	146
TOTAL	18,240	18,529	18,216	18,063	18,035	18,035	18,035
OIG	194	213	213	213	213	213	213

[1] *Includes 307 student FTE*

[2] *Includes 285 student FTE each FY*

Supporting Data: Budget for FY 2012 by Object Class

BUDGET FOR FY 2012 BY OBJECT CLASS CODE

The following tables reflect projections of obligations for FY 2012 based on prior year actual object class obligation experience.

FY 2012 Total and Mission Directorate Estimates ($M)	NASA	SCIENCE	AERONAUTICS	SPACE TECHNOLOGY	EXPLORATION SYSTEMS	SPACE OPERATIONS	EDUCATION	CROSS AGENCY SUPPORT	CONSTRUCTION, ENVIRONMENTAL COMPLIANCE, and REMEDIATION
Personnel compensation									
Full-time permanent	$1,916	$216	141	$95	$242	$252	$6	$964	$0
Other than full-time permanent	$144	$24	$15	$9	$24	$18	$0	$54	$0
Other personnel compensation	$52	$1	$1	$1	$2	$2	$0	$45	$0
Special personal service payments	$1	$0	$0	$0	$0	$0	$0	$1	$0
Total Personnel compensation	**$2113**	**$241**	**$157**	**$105**	**$268**	**$272**	**$6**	**$1064**	$0
Civilian personnel benefits	$542	$63	$40	$28	$72	$71	$2	$266	$0
Benefits to former personnel	$3	$0	$0	$0	$0	$0	$0	$3	$0
Travel & transportation of persons	$77	$13	$6	$1	$15	$11	$0	$31	$0
Transportation of things	$1145	$2	$0	$0	$1	$1139	$0	$3	$0
Rental payments to GSA	$19	$0	$0	$0	$0	$0	$0	$19	$0
Rental payments to others	$10	$7	$0	$0	$0	$1	$0	$2	$0
Communications, utilities & misc charges	$90	$4	$2	$2	$8	$17	$0	$57	$0
Printing and reproduction	$7	$1	$0	$0	$0	$1	$0	$5	$0
Advisory and assistance services	$802	$143	$12	$65	$255	$82	$4	$184	$57
Other services	$783	$297	$22	$15	$58	$75	$4	$303	$9
Other purchases of goods & services from Gov accounts	$311	$118	$5	$15	$59	$49	$0	$59	$6
Operation and maintenance of facilities	$1627	$45	40	$49	$204	$925	$2	$273	$89
Research & development contracts	$8838	$3329	$201	$669	$2789	$1488	$7	$311	$44
Medical care	$5	$0	$0	$0	$0	$0	$0	$5	$0
Operation and maintenance of equipment	$750	$71	$11	$20	$79	$196	$3	$365	$5
Supplies and materials	$137	$22	$31	$5	$18	$27	$1	$26	$7
Equipment	$187	$72	$19	$5	$21	$11	$0	$59	$0
Land and structures	$349	$12	$3	$3	$10	$15	$0	$74	$232
Grants, subsidies, and contributions	$891	$566	$19	$22	$88	$3	$110	$83	$0
TOTAL DIRECT	**$18,686**	**$5006**	**$568**	**$1004**	**$3945**	**$4383**	**$139**	**$3192**	**$449**

Note: 90 percent of the FY 2012 Office of the Inspector General (OIG) Budget will be obligated in the personnel compensation object class

STATUS OF UNOBLIGATED FUNDS

The figures below represent actual unobligated balances within NASA's individual appropriation accounts as of September 30, 2010, and estimates for the disposition of those accounts at the future dates specified.

FY 2009 – FY 2012 Appropriations ($ in millions)	Unobligated Balances Sept. 30, 2010	Estimated Unobligated Balances Sept. 30, 2011	Estimated Unobligated Balances Sept. 30, 2012
Science	59	89	100
Aeronautics	34	10	12
Space Technology			21
Exploration	144	75	78
Space Operations	103	123	87
Education	6	4	3
Cross-Agency Support	15		
Construction and Environmental Compliance and Restoration	84	111	112
Science, Exploration, & Aeronautics*	5		
Inspector General	2	1	1
Total NASA	**452**	**413**	**414**

REIMBURSABLE ESTIMATES

Reimbursable agreements are agreements for which the NASA costs associated with the undertaking are borne by the non-NASA partner. NASA undertakes reimbursable agreements when it has equipment, facilities, and services that it can make available to others in a manner that does not interfere with NASA mission requirements. As most reimbursable requests to NASA do not occur until the year of execution, the FY 2011-2012 estimates are based on an annual survey of Centers' anticipated reimbursable agreements.

Budget Authority ($ in millions)	FY 2010	Ann. CR FY 2011[1]	FY 2012 Estimate
Cross Agency Support	**1,207.8**	**3,171.7**	**2,600.0**
Office of Inspector General	**0.8**	**1.3**	**1.3**
Total	**1,208.6**	**3,173.0**	**2,601.3**

Note:
[1]The FY 2011 appropriation for NASA was not enacted at the time the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111–242, as amended). The amounts included for FY 2011 reflect the annualized level provided by the Continuing Resolution.

ENHANCED USE LEASING

In 2003, NASA was authorized by Congress to demonstrate the feasibility of enhanced leasing authority (EUL) and collections at Ames Research Center (ARC) and Kennedy Space Center (KSC). In 2007 and in 2008, Congress amended the authority so that NASA may enter into EUL arrangements at all Centers after December 2008. After deducting the costs of administering the leases, Centers are then permitted to retain 65 percent of net receipt revenue, and the balance is made available for use Agency-wide. These funds are in addition to annual appropriations are no FTEs are funded from EUL income. To support full annual oversight and review, the 2010 Consolidated Appropriations Act (P.L. 111-117) contains a provision that requires NASA to submit in the annual budget justification an estimate of gross receipts, collections, and proposed use of all funds collected. The table below depicts the estimated FY 2012 EUL expenses and revenues. The amounts identified under Capital Asset Account Expenditures may be adjusted between projects listed, based on actual contract award.

FY2012 EUL Expenses and Revenues ($K)	ARC	KSC	Agency	Total
Base Rent	4,988.6	41.4		5,030.0
Institutional Support Income	1,832.9	15.0		1,847.9
Total Rent Income	**6,821.5**	**56.4**		**6,877.9**
Institutional Support Costs	(1,832.9)	$ (15.0)		(1,847.9)
Lease Management and Administration	(742.0)	-		(742.0)
Tenant Building Maintenance and Repair	(340.0)	-		(340.0)
Total Cost Associated with Leases	**(2,914.9)**	**(15.0)**		**(2,929.9)**
Net Revenue from Lease Activity	**3,906.6**	**41.4**		**3,948.0**
Beginning Balance, Capital Asset Account	**246.7**	**11.8**		**258.5**
Net Revenue from Lease Activity	**2,539.3**	**26.9**	**1,381.8**	**3,948.0**
- Planned Maintenance Various Buildings (ARC)	1,656.0			1,656.0
- Replace Roofs, Various Buildings (ARC)	883.3			883.3
- Install Fire Alarm Devices for Cafeteria Area, M7-0355 (KSC)		38.7		38.7
- Energy & Sustainability Upgrades, Various Buildings (Various Centers)			1,381.8	1,381.8
Center Capital Asset Account Expenditures	**2,539.3**	**38.7**	**1,381,8**	**3,959.8**
Capital Asset Account Ending Balance	**246.7**	**0.0**	**0.0**	**246.7**
Additional Reimbursable Demand Services Requested by Lessees (including overhead)	776.3			776.3
Cost to Fulfill Reimbursable Demand Services (including overhead)	(776.3)			(776.3)
Net activity due to Reimbursable Demand Services	**-**	**-**		**-**
In Kind	**425.0**	**-**		- **425.0**

Definitions:

Base Rent - Revenue collected from tenant for rent of land or buildings.
Institutional Support Costs - Cost for institutional shared services such as fire, security, first responder, communications, common grounds, road, and infrastructure maintenance, and routine administrative support and management oversight (i.e., environmental).
Total Rental Income - Total gross proceeds from EUL activities for expenses due to renting NASA property.

In-Kind - Consideration accepted in lieu of rent payment. (Only applies to selected leases signed prior to January 1, 2009).

Reimbursable Demand Services - Services such as janitorial, communications, and maintenance that solely benefit the tenant and provided for their convenience. There is no net income received by NASA, as these payments may only cover the costs of NASA and its vendors providing these services.

Overhead - General and administrative costs associated with management of the specified demand services.

BUDGET FOR INTERNATIONAL SPACE STATION RESEARCH

The Exploration Systems Mission Directorate (ESMD) and Space Operations Mission Directorate (SOMD) support research to take advantage of the unique environment of reduced gravity on International Space Station (ISS) in two broad categories – Exploration ISS Research and Non-Exploration ISS Research.

$ in millions	FY 2010	Ann. CR FY 2011[1]	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Exploration ISS Research	$183	$150	$151	$144	$143	$140	$143
Non- Exploration ISS Research	$83	$74	$69	$69	$72	$79	$79
Total	**$266**	**$224**	**$220**	**$213**	**$215**	**$219**	**$223**
% of Non-Exploration to Total	31%	33%	31%	32%	33%	36%	36%

Note:
[1]The FY 2011 appropriation for NASA was not enacted at the time the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111–242, as amended). The amounts included for FY 2011 reflect the annualized level provided by the Continuing Resolution.

Non-Profit Organization

Having launched the U.S. and international partner elements, and established six-person crew capability, the ISS program focus is now primarily on research. During FY 2011, NASA will be awarding a cooperative agreement to an independent non-profit organization (NPO) with responsibility to further develop national uses of the ISS. The NPO will oversee all research involving organizations other than NASA, and transfer current NASA biological and physical research to the NPO in future years. Space Operations oversight of existing research projects will be phased out and NPO will co-select/manage new peer-reviewed projects. As on-going work within the NASA research project offices is completed in future years, extension/renewal decisions should be made by the NPO.

Through the management partnership, research opportunities will be expanded to conduct research in life sciences, material sciences, biotechnologies, condensed matter physics and thermal sciences (e.g., fluid mechanics, thermodynamics, heat transfer and combustion). NASA will continue to support research to meet NASA requirements for exploration including astronaut health and serve as a test bed for the development and demonstration of technology for future space exploration missions.

Exploration ISS Research

Exploration ISS Research supports the Agency's need for improved knowledge about working and living in space to enable future long-duration human exploration missions.

The Human Research Program will provide research results that reduce risks to crew health and performance that stem from prolonged exposure to reduced gravity, space radiation, and isolation during exploration missions. Risk mitigation will be achieved by conducting ISS research in human health countermeasures, space human factors and habitability, behavioral health and performance, and exploration medicine, tools, and technologies.

ISS Research will investigate the underlying gravity-dependent phenomena in the following areas: fire prevention, detection, and suppression; boiling; multiphase flow of fluids; and capillary driven flow. These applied research investigations will provide needed data that is useful in the future design of the following space technology areas: life support systems; propellant storage; power generation; thermal control; and advanced environmental monitoring and control. Funding for the Multi-User System Support (MUSS), which supports Exploration ISS Research, is included in the table above. The MUSS function is responsible for all payload physical, analytical and operations integration activities; projecting available utilization resources and accommodations; tactical planning; and execution of the day-to-day ISS integrated research plan for all payloads, including NASA, international partners, and non-NASA users.

Non-Exploration ISS Research

NASA allocates at least 15 percent of the funds budgeted for ISS research to ground-based, free-flyer, and ISS life and physical science research that is not directly related to supporting the human space exploration program, in accordance with Section 204 of the NASA Authorization Act of 2005. The purpose is to ensure the capacity to support ground-based research leading to space-based basic and applied scientific research in a variety of disciplines with potential direct national benefits and applications that can be advanced significantly from the uniqueness of microgravity and the space environment. Additionally, this allocation allows basic ISS research in fields including, physiological research, basic fluid physics, combustion science, cellular biotechnology, low-temperature physics, cellular research, materials science, and plant research to be carried out to the maximum extent practicable. This research helps to sustain existing U.S. scientific expertise and capability in microgravity research. The Non-Exploration ISS Research line the above table also includes the Alpha Magnetic Spectrometer (AMS), and costs for MUSS support. The AMS is a particle physics and astrophysics experiment, planned for the ISS, which will look for dark matter, anti-matter, and strange matter.

BUDGET FOR SAFETY OVERSIGHT

The following table provides the Safety and Mission Assurance (S&MA) budget estimates. This includes the Agency-wide safety oversight functions and estimates for project specific safety, reliability, maintainability and quality assurance elements embedded within individual projects.

BUDGET SUMMARY FOR SAFETY OVERSIGHT

$ in Millions	FY 2010	Ann. CR FY 2011[1]	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Total Safety	**452.0**	**432.4**	**442.2**	**448.9**	**461.1**	**470.2**	**479.5**
Agency-wide Safety Oversight	**133.7**	**139.9**	**142.9**	**146.7**	**150.9**	**155.4**	**159.7**
Safety and Mission Assurance	51.3	49.0	49.5	49.9	50.5	51.2	51.8
Institutional Operational Safety	30.8	38.9	39.7	40.7	42.0	43.3	44.5
Technical Authority/S&MA Sup.	51.6	52.0	53.7	56.1	58.4	60.9	63.4
Program Specific	**318.3**	**292.5**	**299.3**	**302.2**	**310.2**	**314.8**	**319.8**
Science	70.3	74.4	77.5	81.0	83.5	84.7	86.1
Aeronautics	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Space Technology	0.0	12.8	21.5	22.0	21.8	25.6	26.0
Exploration	94.1	92.0	102.7	103.4	106.8	112.3	114.0
Space Operations	153.8	113.2	97.5	95.7	98.0	92.1	93.6

Note:
[1] *The FY 2011 appropriation for NASA was not enacted at the time the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111–242, as amended). The amounts included for FY 2011 reflect the annualized level provided by the Continuing Resolution.*

Definitions:

Agency-Wide Safety Oversight - Agency level programs and activities that support the overarching NASA Safety and Mission Success program.

Safety and Mission Assurance - The Safety and Mission Assurance program administers and refines policies, procedural requirements, and technical safety standards. The program participate in forums that provide advice to the Administrator, Mission Directorates, Center Directors, and program managers who are ultimately accountable for the safety and mission success of all NASA programs, projects, and operations. Specific program responsibility include, among other activities, managing NASA's Orbital Debris program, NASA's Electronic Parts program, and the NASA Safety Center.

Institutional Operational Safety - NASA's institutional operational safety program is driven by guidance from the Occupational and Safety and Health Administration (OSHA) and NASA Procedural Requirements (NPR). Guidance includes OSHA Basic Program Elements for Federal Employee Occupational Safety and Health Programs and Related Matters (OSHA 29 CFR 1960), NASA Safety and Health Handbook Occupational Safety and Health Programs (NPR 8715.1), and NASA's general safety program requirements (NPR 8715.3). The program includes multiple safety, training, awareness, prevention, and reporting initiatives, all in accordance with the regulations listed above. The institutional operational safety program requires significant coordination at the federal, state, and local levels.

S&MA Technical Authority and S&MA Support - The S&MA Technical Authority program includes travel and labor only for all S&MA supervisors, branch chiefs or above, and designated deputies. In addition, where the principal job function of a non-supervisory S&MA person consists of rendering authoritative decisions on S&MA requirements (i.e., matters relating to the design or operation of a program or project), that person's salary is included. These positions often are the lead S&MA manager positions for large programs where the decision making process is nearly a full-time demand. This category does not include salary for those whose work only occasionally falls as an authority task, but does includes travel funds in direct support of these individuals when they conduct S&MA activities.

S&MA is mission support, including administrative support, which cannot be directly charged to a program. This budget includes: policy development across the programs; range safety; payload safety (ground processing); independent assessments; metrology and calibration; reliability and maintainability policy; Center-wide S&MA program integration and analysis; business and administrative support to S&MA directorates; and quality assurance for facilities and ground support hardware.

Program Specific - Project specific S&MA costs are included in individual project budgets. These costs include the technical and management efforts of directing and controlling the S&MA elements of the project. This incorporates the design, development, review, and verification of practices and procedures and mission success criteria intended to assure that the delivered spacecraft, ground systems, mission operations, and payload(s) meet performance requirements and function for their intended lifetimes. This element excludes mission and product assurance efforts directed at partners and subcontractors (other than S&MA review/oversight), and the direct costs of environmental testing.

BUDGET FOR PUBLIC RELATIONS BY CENTER

The NASA budget for Public Affairs is funded within Cross-Agency Support under: Center Management and Operations and Agency Management and Operations. All the installations listed below, except for Headquarters, are in the Center Management and Operations account. The Headquarters budget is in the Agency Management and Operations account.

These budgets include dissemination of information about NASA programs to the news media and the general public. Content includes support for public affairs/public relations, Center newsletters, internal communications, guest operations (including bus transportation), public inquiries, NASA TV, the NASA Web site, and other multimedia support.

Public Affairs funding by installation is shown below.

Center ($ in millions)	FY 2010	Ann. CR FY 2011[1]	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016
Ames Research Center	1.7	1.8	1.8	1.9	2.0	2.1	2.1
Dryden Flight Research Center	0.7	0.8	0.8	0.8	0.9	0.9	0.9
Glenn Research Center	3.0	2.9	3.0	3.1	3.2	3.4	3.5
Goddard Space Flight Center	4.4	4.8	5.0	5.2	5.4	5.7	6.0
Headquarters	13.6	14.4	13.5	14.4	14.7	15.1	15.5
Johnson Space Center	4.1	4.0	4.0	3.9	3.9	3.9	3.9
Kennedy Space Center	6.0	6.6	6.5	6.8	6.7	6.9	7.3
Langley Research Center	2.1	2.2	2.3	2.4	2.4	2.5	2.6
Marshall Space Flight Center	5.4	5.5	5.5	5.6	5.8	5.9	6.1
Stennis Space Center	2.1	2.1	1.9	1.9	2.0	2.0	2.1
Total	**43.1**	**45.1**	**44.3**	**46.0**	**47.0**	**48.4**	**50.0**

Note:
[1]The FY 2011 appropriation for NASA was not enacted at the time the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111–242, as amended). The amounts included for FY 2011 reflect the annualized level provided by the Continuing Resolution.

SUMMARY OF CONSULTING SERVICES

NASA uses paid experts and consultants to provide advice and expertise beyond that which is available from its in-house civil service workforce. Management controls ensure that there is ample justification for consulting services before these services are obtained. Much of the Agency's expert and consultant support is for the NASA Advisory Council and the Aerospace Safety Advisory Panel. NASA uses experts and consultants to provide expertise on the selection of experiments for future space missions. The use of these experts and consultants provides the Agency with an independent view that assures the selection of experiments likely to have the greatest scientific merit. Other individuals provide independent views of technical and functional problems in order to provide senior management with the widest possible range of information to support making major decisions.

Expert/Consultants (Total NASA)	FY 2010	Ann. CR FY 2011[1]	FY 2012 Estimate
Number of Paid Experts and Consultants	33	33	33
Annual FTE Usage	5	5	5
Salaries	$0.3	$0.3	$0.3
Total Salary and Benefits Costs	$0.4	$0.4	$0.4
Travel Costs	$0.3	$0.3	$0.3
Total Costs	**$0.7**	**$0.7**	**$0.7**

Note:
[1]The FY 2011 appropriation for NASA was not enacted at the time the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111–242, as amended). The amounts included for FY 2011 reflect the annualized level provided by the Continuing Resolution.

Note: Definition of Consultants and Experts

Consultant – A person who can provide valuable and pertinent advice generally drawn from a high degree of broad administrative, professional, or technical knowledge or experience. When an agency requires public advisory participation, a consultant also may be a person who is affected by a particular program and can provide useful views from personal experience.

Expert – A person who is specially qualified by education and experience to perform difficult and challenging tasks in a particular field beyond the usual range of achievement of competent persons in that field. An expert is regarded by other persons in the field as an authority or practitioner of unusual competence and skill in a professional, scientific, technical, or other activity.

These definitions are located under 5 CFR 304.102. The appointments are made under 5 U.S.C. 3109, and the use of this authority is reported to Office of Personnel Management (OPM) annually.

E-GOV INITIATIVES AND BENEFITS

NASA is providing funding contributions in FY 2012 for each of the following E-Government initiatives:

Initiative	2012 Contributions (Includes In Kind)	2012 Service Fees
E-Rulemaking 026-00-01-99-04-0060-24		$42,021
Grants.gov 026-00-01-99-04-0160-24	$215,549	
E-Training 026-00-01-99-04-1217-24		$1,500,000
Recruitment One-Stop 026-00-01-99-04-1218-24		$107,323
Enterprise HR Integration 026-00-01-99-04-1219-24		$377,229
E-Payroll 026-00-01-99-04-1221-24		$4,105,200
E-Travel 026-00-01-99-04-0220-24		$1,236,635
Integrated Acquisition Environment 026-00-01-99-04-0230-24		$1,721,363
Integrated Acquisition Environment - Loans and Grants 026-00-01-99-04-4300-24		$68,403
Financial Management Lines of Business 026-00-01-99-04-1100-24	$75,000	
Human Resources Management Lines of Business 026-00-01-99-04-1200-24	$65,217	
Grants Management Lines of Business 026-00-01-99-04-1300-24	$59,316	
Geospatial Lines of Business 026-00-01-99-04-3100-24	$15,000	
Budget Formulation and Execution Lines of Business 026-00-01-99-04-3200-24	$105,000	
NASA Total	**$535,082**	**$9,089,771**

Note: Service fees are estimates as provided by the E-Government initiative managing partners

The E-Government initiatives serve citizens, businesses, and Federal employees by delivering high quality services more efficiently and at a lower price. Instead of expensive “stove-piped” operations, agencies work together to develop common solutions that achieve mission requirements at reduced cost, thereby making resources available for higher priority needs. Benefits realized through the use of these initiatives for NASA in FY 2012 include:

E-Rulemaking (Managing Partner EPA) FY 2010 Benefits

NASA’s benefits for the E-Rulemaking initiative are largely focused on public benefits by providing “one-stop” access to NASA and other Federal agency information on rulemakings and non-rulemaking through the Regulations.gov Web site.

In addition to the process benefits the E-Rulemaking solution offers, it is estimated to provide cost avoidance benefits over traditional baseline paper processes to a level of $30 million over five years. The electronic docket solution selected by E-Rulemaking governance bodies is a centralized architecture that is configurable for each participating entity allowing role-based access to develop workflow and collaboration processes to manage their content. This centrally managed solution is estimated to save a range of $106 – $129 million over five years as compared to other alternatives that seek the same benefits but are based on decentralized architectures. These figures were calculated in the summer of 2007 by an independent economist hired by the E-Rulemaking Program to develop a cost-benefit model.

NASA benefits in several ways through its participation and reliance on Federal Docket Management System (FDMS) and Regulations.gov. NASA improves the transparency of its rulemaking actions and increases public participation in the regulatory process. Direct budget cost savings and cost avoidance result from NASA’s transition to FDMS and Regulations.gov, enabling the Agency to discontinue efforts to develop, deploy, and operate specific individual online docket and public comment systems. Over a five-year period, NASA is estimated to save over $700 thousand over alternative options that would provide similar services.

Grants.gov (Managing Partner HHS) FY 2012 Benefits

The Grants.gov initiative benefits NASA and its grant programs by providing a single location to publish grant (i.e., funding) opportunities and application packages, making the process easier for applicants to apply to multiple agencies. In FY 2010, all 26 major Federal grant making agencies posted their synopses for discretionary funding opportunity announcements on Grants.gov.

The Grants.gov initiative benefits NASA and its grant programs by providing broader exposure to a wider community that could potentially apply for NASA funding and bring in new ideas, innovations, and solutions. In addition, Grants.gov provides a single site for the grantee community to apply for grants using a standard set of forms, processes, and systems thereby giving them greater access to and ability in applying for Federal funding. Through the use of Grants.gov, NASA is able to reduce operating costs associated with online posting and application of grants. Additionally, the Agency is able to improve operational effectiveness through use of Grants.gov by increasing data accuracy and reducing processing cycle times.

E-Training (Managing Partner OPM) FY 2012 Benefits

The E-Training initiative provides access to premier electronic training systems and tools that support the training and development of the Federal workforce. The initiative advanced the accomplishment of Agency missions through simplified and one-stop access to E-Training products and services. The availability of an electronic training environment enhances the ability of the Federal Government and NASA to attract, retain, manage, and educate the highly skilled professionals needed for a flexible and high-performing government workforce.

The E-Training initiative benefits NASA and the Federal workforce by reducing redundancies and achieving economies of scale in the purchase and/or development of E-learning content and in purchase of learning technology infrastructure. In 2006, NASA streamlined its three separate online training systems into one centralized, learning management system, SATERN, a one-stop approach offering Web-based access to training and career development resources. This centralized approach allows NASA to reduce and leverage training costs through the elimination of unique systems and standardization of training processes.

Through SATERN, employees can view required training, launch online content, view training history, and self-register for approved courses and conferences. In addition, the system allows NASA officials to identify groups and individuals who have not met basic training requirements, and ensure accountability for mission critical and federally mandated training and development. SATERN also offers employees access to career planning tools, individual development plans, and competency management assistance. SATERN offers learners access to more than 2,000 online courses and 10,000 online books and training videos. SATERN is available 24/7 and can be accessed from work or home.

Recruitment One-Stop (Managing Partner OPM) FY 2012 Benefits

USAJOBS simplifies the Federal job search process for job seekers and Federal agencies. The USAJOBS.gov Web site provides a single site where citizens can easily search for employment opportunities throughout the Federal Government. USAJOBS is a fully operational, state-of-the-art recruitment system that benefits both job seekers and employing agencies. Through USAJOBS.gov users have access to:

- A centralized repository for all competitive service job vacancies;
- A resume repository used by agencies to identify critical skills;
- A standardized online recruitment tool and associated services;
- A standard application process; and
- Intuitive job searches including e-mail notifications for jobs of interest.

USAJOBS enables NASA to better attract individuals who can help accomplish the Agency's missions. The USAJOBS interface allows job seekers to view and apply for all NASA employment opportunities, as well as those from other Federal agencies. On average, USAJOBS.gov receives over 400,000 visitors per day, supports submission of over 500,000 new resumes monthly, and serviced over 21 million applications during FY 2010.

In 2005, NASA adopted the USAJOBS resume as the basic application document for all NASA hirings (except for Astronaut positions). To date, NASA has not identified any specific savings, either in terms of budgeted savings or cost avoidance. Although the Agency believes that implementation of a recruitment one-stop (ROS) has resulted in significant intangible benefits in terms of providing better vacancy information to applicants, it has not resulted in any specific cost savings to NASA. The intangible benefits ROS provides to NASA and other agencies include:

- Decreasing hiring time for managers;
- Providing an integrated solution to agency applicant assessment systems;
- Providing a cost effective marketing and recruitment tool;
- Realizing cost savings over commercial job posting boards;
- Reducing the delay associated with filling critical agency vacancies; and
- Enhancing competition with the private sector for the best and brightest talent for Federal service.

Enterprise HR Integration (Managing Partner OPM) FY 2012 Benefits

The Enterprise HR Integration (EHRI) program supports the strategic management of human capital by providing Agency customers with access to timely and accurate federal workforce data. EHRI has the following goals: 1) streamline and automate the exchange of Federal employee human resources (HR) information Government-wide; 2) provide comprehensive knowledge management and workforce analysis, forecasting, and reporting across the Executive Branch; 3) maximize cost savings captured through automation; and 4) enhance retirement processing throughout the Executive Branch.

A key initiative of EHRI is the electronic Official Personnel Folder (eOPF), a Web-based application that is capable of storing, processing, and displaying the OPFs of all current, separated, and retired Federal employees. When fully implemented, the eOPF will cover the entire Executive Branch as well as some other Federal and local governments with a total user population of more than 1.9 million. The system will replace the existing manual HR process by automating the Federal Government's HR processes and thereby creating a streamlined Federal HR system for all Federal employees. The initiative is achieving cost savings that are recognized on a per-folder basis. The total cost avoidance per folder is estimated at $55.56.

Specific EHRI/eOPF benefits to NASA include improved convenience in searching, better security and safety to electronic files, more economical and streamlined business processes, and the ability to have a central repository of OPF records for the Agency. During FY 2010, NASA also deployed the eOPF capability of electronic transfer of eOPFs between agencies. Specific NASA employee benefits include secure online access to OPFs, automatic notification when documents are added, exchange of retirement and HR data across agencies and systems, and the elimination of duplicate and repetitive personnel data in personnel folders. NASA completed its implementation to eOPF in March 2008, and transitioned personnel actions processing to the NASA Shared Service Center (NSSC).

E-Payroll (Managing Partner OPM) FY 2012 Benefits

The E-Payroll initiative standardizes and consolidates Government-wide Federal civilian payroll services and processes by simplifying and standardizing HR/payroll policies and procedures and better integrating payroll, HR, and finance functions. Prior to beginning the initiative, 26 Federal agencies provided payroll services. Four providers were selected to furnish payroll services for the Executive branch. In 2004, the Department of Interior (DOI) began serving as NASA's payroll provider, using their system, the Federal Personnel and Payroll System (FPPS). FPPS processes NASA's HR and payroll transactions and supplies all key delivery aspects of its payroll operation functions. The E-Payroll initiative benefits NASA by permitting the Agency to focus on its mission related activities, rather than on administrative payroll functions. Payroll processing costs are reduced through economies of scale and avoiding the cost of duplicative capital system modernization activities. The initiative also promotes standardization of business processes and practices and unified service delivery.

E-Travel (Managing Partner GSA) FY 2012 Benefits

The E-Gov Travel Service (ETS) is a Government-wide Web-based service that provides standardized travel management practices to consolidate federal travel, minimize cost, and produce superior customer satisfaction. ETS is commercially hosted to minimize technology development costs to the Government and guarantee refreshed functionality for basic travel services included in the master contract. From travel planning and authorization to the review and approval of post-travel reimbursement, this end-to-end service streamlines travel management and will enable the Government to capture real-time visibility into the buying choices of travelers and assist agencies in optimizing their travel budgets while saving taxpayers money.

The benefits of the ETS include:

- Increased cost savings associated with overall reduction in Travel Management Center transaction service fees;
- Improved strategic source pricing through cross-Government purchasing agreements;
- Improved business process functionality as a result of streamlined travel policies and processes;

- Enhanced security and privacy controls for the protection of Government and personal data; and
- Improved agency oversight and audit capabilities.

As ETS is a fully integrated, end-to-end travel solution, program cost avoidance is realized by a reduction of traveler and manager time for planning, arranging, authorizing, approving, and post-travel reimbursement processing. Travelers also benefit from increased efficiency in the end-to-end electronic solution as their reimbursements are expedited. Additional initiative savings are realized from the elimination of costly paper-based systems, the decommissioning of legacy travel systems, and the reduction of agency overhead by consolidating the number of travel contracts.

In 2009, NASA completed migration of its travel services to HP Enterprise Services (formerly Electronic Data Systems Corporation), one of the three designated E-Travel service providers. Completing this migration has allowed NASA to provide more efficient and effective travel management services. NASA employees are also benefitting through more efficient travel planning, authorization, and reimbursement processes. Prior to ETS, the estimated overall Government-wide online adoption rate for travel reservations was approximately 6 percent. To date, in agencies using the ETS end-to-end, the online booking engine adoption rate is over 76 percent, resulting in dramatic cost savings as a result of lowering travel agent service fees. During FY 2010 the averaged online adoption rate for NASA was 63 percent.

Integrated Acquisition Environment (Managing Partner GSA) FY 2012 Benefits

The Integrated Acquisition Environment (IAE) initiative is designed to streamline the process of reporting on subcontracting plans and to provide agencies with access to analytical data on subcontracting performance. Use of the IAE common functions and services allows agencies to focus on agency-specific needs such as strategy, operations, and management while leveraging shared services for common functions. Furthermore, use of a Government-wide business focused service environment reduces funding and resources for technical services and support for acquisition systems originally housed by individual agencies.

IAE facilitates and supports cost-effective acquisition of goods and services by agencies. The IAE initiative provides common acquisition functions and shared services that benefit all agencies, such as the maintenance of information about business-partner organizations (e.g., banking, certifications, business types, capabilities, performance). IAE provides benefits to the Government and business-partner organizations by improving cross-agency coordination that helps to improve the Government's buying power, while providing business partners maximum visibility and transparency into the process. IAE provides various services, tools, and capabilities that can be leveraged by the acquisition community including buyers, sellers, and the public to conduct business across the Federal Government space.

Government buyers can:

- Search for commercial and government sources;
- Post synopses and solicitations;
- Securely post sensitive solicitation documents;
- Access reports on vendors' performance;
- Retrieve vendor data validated by Small Business Administration and Internal Revenue Service;
- Identify excluded parties; and
- Report contract awards.

Business suppliers can:

- Search business opportunities by product, service, agency, or location;

- Receive e-mail notification of solicitations based on specific criteria;
- Register to do business with the Federal Government;
- Enter representations and certifications one time;
- Revalidate registration data annually; and
- Report subcontracting accomplishments.

Citizens can:

- Retrieve data on contract awards;
- Track Federal spending;
- Search to find registered businesses; and
- Monitor business opportunities.

Through adoption of the tools and services provided by IAE, NASA improves its ability to make informed and efficient purchasing decisions and allows it to replace manual processes. If NASA were not allowed to use the IAE systems, the Agency would need to build and maintain separate systems to record vendor and contract information, and to post procurement opportunities. Agency purchasing officials would not have access to databases of important information from other agencies on vendor performance and could not use systems to replace paper-based and labor-intensive work efforts.

Integrated Acquisition Environment – Loans & Grants FY 2012 Benefits

All agencies participating in the posting and/or awarding of contracts, grants and loans are required by the reporting requirements of the Federal Funding Accountability and Transparency Act (FFATA) of 2006 and the American Recovery and Reinvestment Act of 2009 (ARRA) to disclose award information on a publicly accessible Web site. FFATA requires the Office of Management and Budget (OMB) to lead the development of a single, searchable Web site through which the public can readily access information about grants and contracts provided by Federal Government agencies.

Based on the recommendations of the Transparency Act Taskforce, the Web site leverages functionality provided by the IAE initiative to provide Data Universal Numbering System (DUNS) numbers as the unique identifier. An existing IAE Dun and Bradstreet (D&B) transaction-based contract for the contract community was expanded to provide Government-wide D&B services for the grants and loans community. These services include parent linkage, help desk support, world database lookup, business validation and linkage monitoring, matching services, as well as the use of DUNS numbers. The enterprise D&B contract provides substantial savings to the participating agencies over their previous agency transaction-based D&B contracts.

On December 14, 2007, OMB launched http://www.USASpending.gov to meet the FFATA statutory requirements. Since the launch, OMB has and will continue to work with agencies to improve the quality, timeliness, and accuracy of their data submissions and has released a series of enhancements to the site. The USASpending.gov Web site complements others that provide the public with Federal program performance information (e.g., USA.gov, Results.gov, and ExpectMore.gov).

The USASpending.gov Web site provides:

- the name of the entity receiving the award;
- the amount of the award;
- information on the award including transaction type, funding agency, etc;
- the location of the entity receiving the award; and
- a unique identifier of the entity receiving the award.

In addition to routine enhancements to improve usability and maintainability, USASpending.gov is focused on supporting implementation of sub-contract and sub-grant awards reporting.

Supporting Data: E-Gov Initiatives and Benefits

All agencies participating in the posting and/or awarding of contracts, grants, and loans are required by the FFATA and ARRA reporting requirements to disclose award information on a publicly accessible Web site. Cross Government cooperation with OMB's IAE initiative allows agencies and contributing bureaus (including the bureaus at departments) to meet the requirements of the FFATA by assigning a unique identifier, determining corporate hierarchy, and validating and cleaning up incorrect or incomplete data. FFATA enhances transparency of Federal program performance information and funding.

The FY 2012 funding requirements, as it relates to the IAE loans and grants funding line, supports FFATA for the relationship with D&B and DUNS support services. In addition to provision of DUNS numbers, D&B is now providing business and linkage data seamlessly, and the business arrangement supports the quality of data by real-time updates. NASA and other agencies will leverage the linkages to corporate organizational rollups based on parental and subsidiary relationships.

LINE OF BUSINESS

Financial Management Lines of Business (LoB) FY 2012 Benefits (Managing Partners DOE and DOL)

The Financial Management Line of Business (FM LoB) leverages shared service solutions that improve the quality of Federal financial data and decrease known inefficiencies—and costs—that are typical of redundant financial management systems. FM LoB's Shared Services Providers (SSPs) offer participating agencies the economies of scale and expertise in IT and financial reporting not always available within a single agency. An emphasis is being placed on greater standardization, transparency, and business process improvements as opposed to solely technology improvements.

The FM LoB initiative uses standard business practices and meets Federal accounting standards for financial reporting. This level of standardization across all Federal agencies would provide executive decision makers with accurate information from which to assess program performance and risks, evaluate costs, and improve stewardship across the Federal Government.

Current OMB FM LoB policy requires agencies to conduct a competition among Federal and commercial SSPs before attempting to modernize financial systems. Commercial SSPs have not yet been designated to support the same range of services provided by Federal SSPs.

SSPs offer many benefits.

- Cost Avoidance:
  - Agencies using SSPs will not have to configure, operate and maintain individual financial systems, whether customized or commercial off-the-shelf;
  - Share common costs for standard application management and IT support functions; and
  - Minimize costs of testing and evaluation for upgrades.
- Facilitate Best Practices:
  - Agency SSP customers leverage IT and financial processing expertise to provide shared services to multiple agencies, boards, and commissions;
  - Consistent and reliable financial data can be shared across agency business systems;
  - Standardized, Government-wide financial codes and categorizations of financial transactions improve financial reporting and accountability;
  - Increased efficiency of financial transactions is achieved through reengineered and stream-lined business processes; and
  - Minimization of risks associated with financial system implementation by providing a uniform starting point for configuration

In October 2009, FM LoB released the standard business processes for reporting and reimbursable management. FM LoB is creating tools that will offer agencies a boilerplate solicitation template and guidelines for completing a request for proposals or system migrations. FM LoB is also incorporating public feedback to draft core financial system requirements. Once the requirements have been updated, the certified core accounting software products will be implemented with a federal configuration to help agencies upgrade their existing financial management software or migrate to an SSP.

NASA expressed an interest in becoming a SSP, but awaits OMB direction on the future direction of the FM LoB.

Human Resources Management LoB (Managing Partner OPM) FY 2012 Benefits

The HR LoB vision is to create Government-wide, modern, cost-effective, standardized, and interoperable HR solutions to provide common core functionality to support the strategic management of HR through the establishment of SSCs. Driven from a business perspective rather than a technology focus, the solutions will address distinct business improvements enhancing the Government's performance of HR and payroll services in support of agency missions delivering services to citizens. The HR LoB concept of operations calls for agencies to receive core services from an HR LoB provider. These core HR services are defined as personnel action processing, compensation management (payroll), and benefits management. Leveraging shared services solutions will allow the HR LoB to significantly improve HR and payroll service delivery, save taxpayer dollars, and reduce administrative burdens.

NASA works in partnership with one of the approved service providers, the Department of Interior's National Business Center (NBC). Through this partnership, NASA shares and receives "best-in-class" HR solutions. NBC delivers NASA-developed solutions to their customer agencies, enabling improved efficiencies and system integrations at a fraction of the cost and delivery time than similar solutions could have been produced by NBC. NASA achieves the benefits of these best-in-class HR solutions through implementation and integration of NBC and NASA-developed HR solutions. NASA's participation in HR LoB allows the Agency to participate in the implementation of modern HR solutions and benefit from best practices and Government-wide strategic HR management.

Grants Management LoB (Managing Partners HHS and NSF) FY 2012 Benefits

The Grants Management LoB (GM LoB) will ultimately offer the development of a Government-wide solution to support end-to-end grants management activities promoting citizen access, customer service, and financial and technical stewardship for the Agency. The end result is intended to be a Government-wide streamlined grant making process providing transparency and efficiency in the grant decision-making process. The benefits of GM LoB include increased service to citizens through standardized processes; cost savings for grant-making agencies through use of shared IT infrastructure; a reduction in the number of redundant grants management systems; and improved reporting on Government-wide grant activities and results. GM LoB adopted a "consortia-based" approach to implementation and developed a process for forming consortia and having agencies participate in consortia as members.

In FY 2007, NASA signed a Memorandum of Understanding with its selected consortia partner, the National Science Foundation (NSF). In 2008, NASA implemented NSF's new research-focused initiative, Research.gov, improving public access to detailed information about NASA research awards. Research.gov is a collaborative partnership of Federal research-oriented agencies working together for the ultimate benefit of the research community. The Research Spending and Results Service allows Congress, the general public, and the broader research community to easily search and find in one place the grant award information for NASA and NSF. For 2012 and beyond, NASA and NSF will continue to serve the research community and to provide access to information and services for both agencies in one location. NASA news and information is also now available in Research.gov's "Policy Library and Research Headlines" section. Moving forward, NASA will continue to collaborate with NSF to explore and implement future Research.gov service offerings based on NASA and research community needs.

Geospatial LoB (Managing Partner DOL) FY 2012 Benefits

The Geospatial LoB will better serve the agencies' missions and the Nation's interests developing a more strategic, coordinated, and leveraged approach to producing, maintaining, and using geospatial data and services across the Federal Government. Specific goals of the Geospatial LoB include establishing a collaborative governance mechanism, coordinating a Government-wide planning and investment strategy, and optimizing and standardizing geospatial data and services.

Contributing agencies and bureaus will receive value from the development of the LoB primarily through improved business performance and cost savings. Enhanced governance processes, improved business planning and investment strategies, and optimization and standardization of geospatial business data and services will produce the following results:

- Collaborative management of geospatial investments will be made more adaptable, proactive and inclusive;
- Enterprise business needs and agency core mission requirements will be identified, planned, budgeted, and exploited in a geospatial context;
- Long-term costs of geo-information delivery and access will be reduced while minimizing duplicative development efforts;
- Effective, yet less costly commercial off the shelf systems and contractual business support operations will replace legacy geospatial applications; and
- Business processes will be optimized and knowledge management capabilities will exist for locating geospatial data and obtaining services.

As a science agency, the work of NASA's science and mission professionals is inherently different from duties and functions performed by operational agencies. These differences lead NASA to organize and manage data to best facilitate science activities rather than a central focus of data dissemination. Scientific inquiry often leads scientist to use different schemas for analyzing data and information produced from remote sensing data (e.g. a common grid or projection). NASA will continue to apply the elements of Federal Geographic Data Committee standards where these are appropriate. In FY 2008, NASA signed an MOU with the Department of Labor to continue its active participation in the Geospatial LoB.

Budget Formulation & Execution LOB (Managing Partner Education) FY 2012 Benefits

The Budget Formulation and Execution LoB (BFELoB) provides benefits to NASA and other partner agencies by encouraging best practices crossing all aspects of Federal budgeting -- from budget formulation and execution to performance to human capital needs. To benefit all agencies, BFELoB continues to support the idea of shared service budget systems. As NASA currently has its own budgeting tools, the Agency has not chosen to move to a new budget system; however, NASA is looking into some of the BFELoB components, such as MAX Collect and Analytics, to complement its current budgeting tools.

BFELoB's "MAX Federal Community," a secure Government-only collaborative Web site, provides significant benefits for collaboration across and within agencies, as well as knowledge management. The Community site is commonly used for sharing information, collaboratively drafting documents (including the direct-editing of documents posted on the site), supporting workgroups, submitting central reports, and much more. NASA currently has well over 900 users that are registered and eligible to take advantage of the MAX Federal Community. During FY 2010 year-end planning, NASA made extensive use of the MAX Wiki capability to facilitate work group collaborations and document reviews.

The BFELoB released MAX Collect to facilitate the rapid collection and reporting of agency information. In November 2010, NASA successfully completed its first Agency-wide MAX Collect exercise. Among the benefits NASA realized by using MAX Collect's data collection capabilities were reduced errors, and reduced time spent manually consolidating and publishing data. NASA also benefited from using MAX Collect and its publishing capabilities to collect, store, process, and publish information from multiple sources in an extremely efficient and effective manner, producing professional quality output. To enhance future decision-making within its organization, NASA can benefit from using MAX Analytics' data visualization tools.

In October 2009, the Budgeting Capabilities Self Assessment Tool was published, providing agency budget managers and their staff with a simple survey-like method to assess and gain perspective on how their current operations and processes compare against best practices in a broad range of budgeting capability categories. This allows managers to strategically focus improvement efforts on areas of highest value to their particular organization's activities. NASA will explore use of this tool to assess organizational practices and develop strategic plans to address areas of need.

BFELoB's Human Capital Federal Budget Core Competency Framework is a resource for NASA to use in their internal workforce planning initiatives in 2011/2012. BFELoB is working toward adding proficiency levels to each core competency as well as aligning training with competencies and proficiencies to assist budget professionals in determining a training roadmap for development. During FY 2010, BFELoB released a self-paced budget formulation video training course to users of the MAX Community. In addition, the BFELoB human capital working group offers multiple technical and developmental training opportunities throughout the year. NASA staff have benefitted substantially from these BFELoB sponsored training opportunities, as well as through participation in BFELoB working groups.

Overview

The Management and Performance section provides a comprehensive record of the past and planned performance for NASA's programs and projects. This section includes:

- Progress on NASA's performance improvement initiatives including discussion of the High Priority Performance Goals;
- 2011 Major Program Annual Report (MPAR) Summary of the cost and schedule performance of NASA's projects with estimated life cycle cost above $250 million, including project baselines/cost estimates and confidence levels for each of these projects, and Corrective Action Plan Status Reports (for selected projects as required by section 1203 of the NASA Authorization Act of 2010); and
- FY 2011 and FY 2012 Performance Plans based on Congressional budget action.

NASA's planning and performance management processes are an essential part of the Agency's governance and strategic management system. The Agency has an integrated system to: plan strategy and implementation; monitor, assess, and evaluate performance toward commitments; identify issues; gauge programmatic and organizational health; and provide appropriate data and information to NASA decision makers.

Through its strategic management system, NASA: identifies the Agency's long-term Strategic Goals, multi-year outcomes, and other key performance measures; develops and implements plans to achieve these goals; and continuously measures the Agency's progress toward these goals. NASA managers use performance results as a basis for key investment decisions, and NASA performance data provides a foundation for both programmatic and institutional decision-making processes.

NASA's planning and performance management processes provide data to Agency management via: ongoing monthly and quarterly analysis and reviews; annual assessments in support of budget formulation (for budget guidance and issue identification, analysis, and disposition); annual reporting of performance, management issues, and financial position; periodic, in-depth program or special purpose assessments; and recurring or special assessment reports to internal and external organizations.

NASA's performance system is designed to align with the Agency's internally and externally imposed performance measurement and reporting requirements, tools, and practices, including the Government Performance and Results Act and Executive Order 13450, “Improving Government Program Performance”. Examples of recent activities are provided in the Performance Improvement narrative that follows.

This section includes the FY 2011 and FY 2012 performance commitments, NASA’s target results for the requested resources. The annual performance plans reflect the updated alignment of performance commitments with the Agency’s 2011 Strategic Plan. This section also includes a summary and crosswalk of NASA’s new performance management framework as defined in the latest Strategic Plan. Each performance plan consists of measureable long-term outcomes, near-term objectives, and annual performance goals. The updated performance management framework helps NASA better measure its progress toward achieving the strategic goals for exploration, science, and technology development. NASA uses internal and external assessments to rate progress toward the measures.

NASA continues to use independent program assessments, which are listed in the theme and program sections of this document, and commits to improvement actions in response to the findings.

Management and Performance

NASA strives to find new ways to use performance information to support decisions concerning strategy and budget. A continued focus for NASA in FY 2011 is to improve the metrics and analysis processes for life cycle cost and schedule performance monitoring and reporting. The Major Program Annual Report discussed in this section is one of the reporting tools used to determine how NASA performs this task.

Performance Improvement

NASA's missions demand high levels of performance from our diverse workforce, whose knowledge, skills, and dedication are the backbone of our achievements. NASA has aligned the Agency's performance systems, organizational structure, policies, and processes to ensure programmatic content, institutional capabilities, and other resources are focused on successfully completing the programs and projects tied to our Strategic Goals. The Agency governance councils have joint responsibility for sustaining this alignment through a set of clear, transparent, and repeatable processes that flow to all organizational elements and levels within the Agency. Aligning the entirety of NASA with our Strategic Goals is essential for organizational effectiveness and efficiency. NASA communicates priorities and directions for all components of the Agency through a planning and decision process based on prior year performance and future year objectives. This annual guidance is the benchmark for other processes, including feedback on internal control needs, risk concerns, and safety and mission assurance issues that ripple through our programmatic and institutional framework, ultimately influencing the allocation of resources for each budget year.

The Agency continues to find value in and improve upon its monthly forum, the Baseline Performance Review. As an integrated review of institutional and program activities, interrelated issues that impact performance and program risk are highlighted and actions are assigned for resolution. The Baseline Performance Review forum fosters communication across organizational boundaries to address mutual concerns and interests.

In FY 2011, NASA is participating in an Administration pilot program for impact evaluations. NASA is participating as a way of assessing programs in NASA’s portfolio that do not fall within the space flight program management process, and tobuild additional internal capability for this type of assessment. The intent of this pilot is to compare the change in decision-making performance by partner organizations, primarily through a value-of-information or cost-benefit approach. Two key questions in this pilot evaluation are: What is the type and extent of socioeconomic benefits attributable to applications of NASA Earth science? Is the program’s underlying systems-engineering model effective at demonstrating relevance of NASA Earth science data for societal benefits?

NASA selected the Applied Sciences program as its pilot, which has conducted analyses of two projects during FY 2010 (for the Malaria Early Warning System, and the U.S. Forest Service's BlueSky Smoke Forecasting System). Several techniques were used to attempt to quantify the socioeconomic benefits and impacts of the projects. Information about the two FY 2010 impact assessments and projects scheduled for FY 2011 assessment, will be posted to the Applied Sciences program Web site when available.

In FY 2011, NASA began reporting its Corrective Action Plan Status Report in response to section 1203 of the NASA Authorization Act of 2010 (P.L. 111-267; 42 U.S.C. 18442). The report’s focus is on two key areas: 1) status of significant progress NASA made on transforming program/project management, acquisition strategies and procurements; and 2) specific action plans for projects exceeding cost and schedule thresholds as defined in the requirement.

Management and Performance

In FY 2011 and FY 2012, NASA will continue to examine its policies and processes to enhance its performance management system and use of performance information in planning and decision making.

High Priority Performance Goals (HPPGs)

In FY 2010, NASA began tracking its High Priority Performance Goals (HPPGs) developed in response to a White House initiative for building a high-performing government. NASA has identified five HPPGs with specific action plans and quarterly milestones. NASA expects to set a new education-related HPPG in the future, reflecting Administration interest in cross-agency educational priority goals that foster increased horizontal collaboration. The HPPGs are linked to NASA's Performance Plan and are included in the Annual Performance Plan. NASA's current HPPGs are listed on the new Web site http://www.performance.gov and are as follows:

1. Research and develop new technologies to increase the flexibility and efficiency of the Nation's air traffic system;

2. Study Earth from space to understand climate change, weather, and human impact on our planet;

3. Conserve valuable natural resources by reducing NASA's energy and water use;

4. Safely fly out the Space Shuttle manifest and retire the fleet; and

5. Establish an independent organization to enhance the utilization of the International Space Station as a National Laboratory.

2011 Major Program Annual Report Summary

The 2011 Major Program Annual Report (MPAR) is provided to meet the requirements of section 103 of the NASA Authorization Act of 2005 (P.L. 109-155; 42 U.S.C. 16613). The 2011 MPAR consists of this summary and FY 2012 Budget Estimates MPAR Projects in Development for the sixteen projects included in this year's report. The latter documents constitute each project's annual report, or baseline report, if this is the first year for which it is in reporting. This summary also includes the confidence level information as requested in the Conference Report accompanying the FY 2010 Consolidated Appropriations Act (P.L. 111-117).

Table 1 provides cost, schedule, and confidence level information for NASA projects currently in development with life cycle cost estimates of $250 million or more.

Changes in MPAR Composition since the 2011 NASA Budget Estimates

One project, the Solar Dynamics Observatory (SDO) mission is no longer included in this report. SDO successfully launched in February 2010 and is operational.

Three major projects with estimated life cycle costs greater than $250 million received authority to proceed into development since the 2010 MPAR was prepared for the 2011 NASA Budget Estimates. These projects have a baseline shown in this report:

- Lunar Atmosphere and Dust Environment Explorer (LADEE);
- Mars Atmosphere and Volatile EvolutioN (MAVEN); and
- Orbiting Carbon Observatory-2 (OCO-2).

Four major projects had no cost or schedule growth:

- Gravity Recovery and Interior Laboratory (GRAIL);
- Juno mission;
- Magnetospheric Multiscale mission (MMS); and
- Radiation Belt Storm Probes (RBSP);

One project James Webb Space Telescope (JWST) has reported that the baseline development cost and launch readiness date will be exceeded by more than 15 percent and 6 months.

Updated cost and schedule estimates are provided for eight projects baselined in previous MPAR reports:

- Aquarius mission;
- Glory mission;
- Global Precipitation Measurement (GPM);
- Landsat Data Continuity Mission (LDCM);
- Mars Science Laboratory (MSL);

- National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP);
- Stratospheric Observatory for Infrared Astronomy (SOFIA); and
- Tracking and Data Relay Satellite (TDRS) K&L

The Glory project baseline has been re-established, as required by the Authorization Act when the development cost estimate for a project exceeds 30% of its original baseline. This new baseline reflects previously-reported cost and schedule growth due to the change of the baseline spacecraft payload computer for Glory--from the Maxwell SCS750 single board computer to the BAE Rad750 single board computer.

Changes in Cost and Schedule Estimates from the 2010 MPAR

Two projects exceeded a cost or schedule threshold since the 2010 MPAR:

- JWST cost and schedule have grown since the baseline in 2009. The cost and schedule are under assessment at this time.
- The NPP schedule has grown by 41 months and development costs have grown by 32 percent since the project was baselined in 2006. The NASA-developed spacecraft has been completed since 2005; and the NASA-developed Advanced Technology Microwave Sounder (ATMS) and the Clouds and the Earth's Radiant Energy System (CERES) sensors have been complete and integrated onto the spacecraft since 2005 and 2008, respectively. NASA has delayed the launch of NPP to October 2011 to accommodate late delivery of the NPOESS Integrated Program Office supplied Cross-track Infrared Sounder (CrIS).

The Agency is completing the report required under the Act providing additional information on growth of the JWST mission, which includes the reasons for these changes in cost and schedule, alternatives assessed by the Agency, and the selected actions.

Confidence Levels

NASA utilizes a confidence level approach to budgeting. This approach incorporates program and project risks directly into cost and budget estimates and, as such, is suited to NASA's complex, high-risk portfolio. This approach affords project managers the necessary flexibility to pro-actively manage and mitigate the large technical and other risks associated with NASA's missions. The likelihood of meeting any given estimate is referred to as the confidence level (CL). Implementation of this approach varies depending on the type of program, as described below. NASA has included the confidence level in Table 1 below, where applicable. NASA distinguishes between Space Flight and Ground System projects in development; projects in operations, and Research and Technology projects. All of the projects that are currently subject to MPAR reporting fall within the Space Flight category.

NASA's acquisition strategy policy (NPD 1000.5) requires space flight projects and programs to develop probabilistic cost estimates for space flight projects in development, which incorporate the likely cost impacts of project risks. NASA targets a confidence level of about 70 percent for most of its projects and programs.

NASA is transitioning its probabilistic cost estimation from "cost risk only" to a joint cost and schedule approach designed to increase the likelihood of project success at the specified funding level. The application of the joint cost and schedule confidence level (JCL) approach will increase insight into risks and associated contingencies within a project's integrated technical, cost, schedule, and phasing plan.

NASA started developing estimates using the JCL technique during 2010. Because this approach requires the employment of new tools and techniques, and is performed during key decision points, full implementation will take some time to deploy. Many projects whose key decision points took place earlier before 2010 had baselines established under cost estimating policies that preceded JCL.

Table 1: MPAR Summary and Confidence Levels

Project	Base Year	Confidence Level[1]	Development Cost Est. ($M) Base	Development Cost Est. ($M) 2011	Cost Change (%)	Key Milestone[2]	Key Milestone Base	Key Milestone 2010	Schedule Change (months)	Cost Change > 15%[3]	Schedule Change > 6 Mo[3]	Factors Contributing to Breaches since 2010 MPAR: Internal	Factors Contributing to Breaches since 2010 MPAR: External
Aquarius	2007	75%[5]	$193	$227	18	LRD	Jul-09	Jun-11	23	X	X		
Glory	2011	N/A [6]	$338	$338	0	LRD	Feb-11	Feb-11	0				
GPM	2010	70% [7]	$555	$515	-7	LRD	Jul-13	Jul-13	0				
GRAIL	2009	70%	$427	$427	0	LRD	Sep-11	Sep-11	0				
Juno	2009	70%	$742	$742	0	LRD	Aug-11	Aug-11	0				
JWST	2009	JCL in-process	$2,581	TBD	TBD	LRD	Jun-14	TBD	TBD	**X**	**X**	Cost and schedule are under assess-ment at this time.	
LADEE	2011	70% (JCL)	$168	$168	0	LRD	Nov-13	Nov-13	0				
LDCM[4]	2010	70% (JCL)	$583	$588	1	LRD	Jun-13	Jun-13	0				
MAVEN	2011	70% (JCL) [8]	$567	$567	0	LRD	Nov-13	Nov-13	0				
MMS[4]	2010	70% (JCL)	$857	$857	0	LRD	Mar-15	Mar-15	0				
MSL	2010	70% (JCL)	$1,720	$1,802	5	LRD	Nov-11	Nov-11	0				
NPP	2006	N/A[9]	$593	$780	32	LRD	Apr-08	Oct-11	42	**X**	**X**		Late delivery of the NPOESS IPO-supplied instrument
OCO-2	2011	70% (JCL) [10]	$249	$249	0	LRD	Feb-13	Feb-13					
RBSP	2009	70%	$534	$534	0	LRD	May-12	May-12	0				
SOFIA	2007	70% (JCL)	$920	$1,128	23	FOC	Dec-13	Dec-14	12	X	X		
TDRS-K,L[4]	2010	75%	$209	$192	-8	LRD	K Dec-12 L Dec-13	K Dec-12 L Dec-13	0				

[1]*The confidence level estimates reported here reflect an evolving process as NASA improves its probabilistic estimation techniques and processes. Each estimate reflects the practices and policies at the time it was developed. For example, levels provided in Table 1 for three projects (LDCM, MMS, MSL, and SOFIA) represent a JCL. JWST has a JCL in progress. Estimates that include combined cost and schedule risks are denoted as JCL estimates; all other CLs reflect cost confidence without necessarily factoring the potential impacts of schedule changes on cost. Reported estimates can range up to 80 percent, based on techniques currently available.*
[2]*Key Milestone LRD = Launch Readiness Date; and FOC = Full Operational Capability.*
[3]*Bolded "X" indicates new changes compared to 2010 MPAR.*
[4]*The confidence level estimate addresses the full partnership; the development cost reflects the NASA portion of project costs.*
[5]*CL estimate reflects NASA portion of project; the cost increases reflected here represent the impact of partnership delays.*
[6]*A confidence level for the re-baselined Glory project was not part of the project's continuation (rebaseline) review.*
[7] *Global Precipitation Measurement – The 70% confidence level is based on analysis done by the Standing Review Board (SRB). NASA has required the project to generate a JCL and have it evaluated by the SRB. This has been done, but the results were not available as of this writing*
[8]*JCL included schedule risk of launch vehicle but used the HQ-provided LV cost as a pass-through number per agreement with Standing Review Board (SRB).*
[9]*Pre-dates use of probabilistic analysis.*
[10]*JCL was performed for Phases C&D, excluding project managed unallocated future expenses, JPL fees, launch services, and low-level fixed cost activities at GSFC.*

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Astrophysics
Program: Cosmic Origins
MPAR Project In Development: SOFIA

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**737.5**	**73.6**	**-**	**71.4**	**73.3**	**77.2**	**77.4**	**75.0**	**-**	**-**
FY 2011 Costs			79.9							
CSLE				12.8	12.2	10.8	10.6	11.0	210.4	
Administrative Labor Adjustments		1.3								
2011 MPAR Project Cost Estimate	**737.5**	**74.9**	**79.9**	**84.2**	**85.5**	**88.0**	**88.0**	**86.0**	**1679.0**	**3002.9**
Formulation	35	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.0
Development	702.5	74.9	79.9	84.2	85.5	88.0	13.5	0.0	0.0	1128.4
Operations	0.0	0.0	0.0	0.0	0.0	0.0	74.5	86.0	1679	1839.5

Note:

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C. .*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Explanation of Project Changes

Additional funds were added to the development budget to preserve the new instrument selection schedule and science hours and to fund risk reduction activities. The operations budget was decreased due to risk reduction activities previously planned for operations being moved into development. The SOFIA milestone Full Operational Capability FOC has been redefined as the capability to provide full science operational capability with four available instruments. Outyear budgets reflect NASA's intention to increase the efficiency of the science operations after FOC has been achieved.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
MPAR Project In Development:	SOFIA

Project Purpose

NASA is developing SOFIA as a world-class airborne observatory that will complement the Hubble, Spitzer, Herschel and James Webb space telescopes, and major Earth-based telescopes. SOFIA features a German-built 2.5-meter (100-inch) diameter far-infrared telescope weighing 20 tons, and mounted in the rear fuselage of a highly modified Boeing 747SP aircraft.

The SOFIA mission will study many different kinds of astronomical objects and phenomena, including: star birth and death, formation of new solar systems, identification of complex molecules in space, planets, comets and asteroids in this solar system, nebulae and dust in galaxies (i.e., ecosystems of galaxies), and black holes at the center of galaxies. The infrared light of these objects is only partially visible from the ground due to water vapor in Earth's atmosphere. However, at high altitudes, the influence of water vapor is negligible, allowing better observation of these astronomical objects.

SOFIA'S reflecting telescope provides astronomers with access to the visible, infrared and sub-millimeter spectrum, with optimized performance in the mid-infrared to sub-millimeter range. During its 20-year expected lifetime, SOFIA will be capable of enabling "Great Observatory" class astronomical science.

SOFIA will be NASA's only far-infrared mission, as Spitzer cryogens have been depleted and Herschel's cryogens will be exhausted by 2013. It is the only mid-infrared mission until JWST becomes operational. SOFIA's ability to reconfigure and flexibility ensures the integration of cutting-edge technology and the ability to address emerging scientific questions. For more information, please see http://www.nasa.gov/mission_pages/SOFIA/index.html.

Project Parameters

SOFIA was designed as a highly modified Boeing 747SP aircraft with a large open-port cavity aft of the wings, housing a 2.5-meter telescope optimized for infrared and sub-millimeter wavelength astronomy. SOFIA will operate in flight at 41,000 feet, and at FOC will have four instruments, with additional instruments available after FOC. SOFIA will ramp up to 960 science hours per year, and flights will last six to eight hours on average.

Germany has provided the telescope assembly and assists with mission operations. NASA has provided, refurbished, and modified the airplane, and provides the Science Operations Center.

The U.S.-developed instruments include High-speed Imaging Photometer for Occultation (HIPO), First Light Infrared Test Experiment CAMera (FLITECAM), Faint Object InfrRed CAmera for the SOFIA Telescope (FORCAST), Echelon-Cross-Echelle Spectrograph (EXES), and High-resolution Airborne Wideband Camera (HAWC). The two German instruments are the German Receiver for Astronomy at Terahetz Frequencies (GREAT) and Field Imaging Far-Infrared Line Spectrometer (FIFI LS).

Technology investments for possible future SOFIA instrumentation are made through the Cosmic Origins Supporting Research and Technology program.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Astrophysics**
Program:	**Cosmic Origins**
MPAR Project In Development:	**SOFIA**

Project Commitments

SOFIA initiated science observations in December 2011 with the FORCAST instrument. Designed to work for 20 years, SOFIA will reach FOC as an airborne observatory in December 2014.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Platform DFRC/L3/MPC		Refurbished Boeing 747SP modified to accommodate telescope	Same Same	
Science Operations Center	ARC/USRA	Science Operations Center will schedule observations, and manage data acquisition and processing	Same Same	
Telescope	Germany (DLR)	2.5m diameter, dual mirror	Same	Same
Flight Operations	DFRC/CSC DyneCorp	Flight crew, maintenance, and fuel	Same Same	
HIPO Lo	well Observatory	Simultaneous high-speed time-resolved imaging photometry at two optical wavelengths	Same Same	
FLITECAM UCLA		Large field-of-view, narrow- and broad-band photometric imaging and low-resolution spectroscopy from 1 to 5.5 µm	Same Same	
FORCAST Corn	ell University	Large field-of-view, narrow- and broad-band photometric imaging and moderate-resolution spectroscopy from 4 to 42 µm	Same Same	
EXES ARC		Echelon Spectrometer, 5-28 microns R=105, 104, or 3000	Same Same	
HAWC Univers	ity of Chicago	Far-Infrared Bolometer Camera, 50-240 microns	Same Same	
GREAT Germany	(DLR)	Infrared heterodyne spectrometer, 60-200 microns	Same Same	
FIFI LS	Germany (DLR)	Imaging spectrometer, 42-210 microns	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Astrophysics
Program: Cosmic Origins
MPAR Project In Development: SOFIA

Schedule Commitments

The development and test plan has been modified to enable earlier science observations by the science community, making it concurrent with the late phases of aircraft flight testing. Initial science observations with a subset of science instruments began in December 2011. Completion of the remaining science instruments and refinement of telescope performance will enable FOC in December 2014.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
First Flight	2000	2007	2007
First Science (Early Science)	N/A	2010	2011
FOC	N/A	2014	2014

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Stratospheric Observatory for Infrared Astronomy (SOFIA)	2007	919.5	2011	$1,128.4	23	FOC	12/2013	12/2014	12

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**919.5**	**1,128.4**	**208.9**
Aircraft/Spacecraft	657.7	762.0	104.3
Other Costs	62.2	139.9	77.5
Science/Technology	199.6	226.5	26.9

Project Management

The overall SOFIA project and SOFIA airborne system are managed by Dryden Flight Research Center (DFRC). SOFIA science is managed by Ames Research Center (ARC).

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Astrophysics
Program: Cosmic Origins
MPAR Project In Development: SOFIA

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Platform	DFRC	DFRC	Germany - DLR/DSI
Science	ARC	None	Germany - DLR/DSI
Mission Operations and Data Analysis	ARC	None	Germany - DLR/DSI
Instruments ARC		None	Germany - DLR/DSI

Acquisition Strategy

DFRC manages the program and the platform project (airframe and telescope). DFRC is working with L-3 Communications (Waco, Texas), and MPC Products Corporation (Skokie, Illinois) to support the completion of the development, integration, and test of the airborne platform system. L-3 modified the Boeing 747SP aircraft to install the telescope provided by Germany (DLR/DSI). MPC is developing the telescope cavity door drive system. DFRC is also working with CSC DynCorp (El Segundo, California) to provide aircraft maintenance support.

ARC manages the science project. ARC is working with University Space Research Association (USRA) (Columbia, Maryland) for the SOFIA science planning, ground science facilities, science instrument and technology development, and education and public outreach.

Second generation and later instruments will be solicited through an open competition using a NASA Announcement of Opportunity.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Standing Review Board	4/2010	Early science project review. The board determined that plan for early science had merit.	4/2012

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Loss of science community and DLR support due to late science	Loss of science community support due to delays in science continues to be a concern.	Report program accomplishments as they occur to keep the science community engaged and supportive. Reaction to recent program successes, including the first light accomplishment, has been very positive.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
MPAR Project In Development:	SOFIA

Corrective Action Plan (as submitted in Report on Program and Cost Assessment January 11, 2011 – as required under 1203)

Project Description: The Stratospheric Observatory for Infrared Astronomy (SOFIA) is an airborne observatory that will study the universe in the infrared (IR) spectrum. These IR observations allow scientists to study the dust between stars, the formation of stars and new solar systems, the chemistry of the universe, and the deep universe where the most distance galaxies are seen in IR light. SOFIA will host a complement of scientists, computer engineers, graduate students, and educators on night-long research missions. SOFIA will be a major factor in the development of observational techniques and of new instrumentation and in the education of young scientists and teachers in the discipline of IR astronomy.

NASA and the Deutches Zentrum für Luft- und Raumfahrt (DLR), Germany's Aerospace Research Center and Space Agency, are working together to construct SOFIA, a Boeing 747SP aircraft which was modified by L-3 Communications Integrated Systems to accommodate a 2.5 meter reflecting telescope. SOFIA will be the largest airborne observatory in the world and will make observations that are impossible for even the largest and highest of ground-based telescopes. SOFIA will operate at 41,000 feet using U.S. and German instruments and flights will last, on average, 6 to 8 hours.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Astrophysics
Program:	Cosmic Origins
MPAR Project In Development:	SOFIA

CORRECTIVE ACTION PLAN SUMMARY

2010 ISSUES	CORRECTIVE ACTION PLAN
ISSUE 1: Definition of Full Operational Capability (FOC) Milestone Requirements **CURRENT STATUS:** The Full Operational Capability (FOC) milestone requirements have been revised to emphasize science instrument observational capability (4 science instruments), the overall program has been replanned in terms of schedule (no change in FOC date, however), and the NASA Agency Program Management Council has approved the replan.	Programmatic – Review of the definition of the Full Operational Capability (FOC) milestone technical requirements by the independent Standing Review Board (SRB) resulted in a finding by the SRB that the original definition (800 flight hours per year) was an improper definition in that insufficient science emphasis was contained in the definition. Therefore, the definition of FOC was revised to focus on science instrument capability (the requirement was revised to 4 available science instruments, consistent with the MPAR definition), and the overall program was replanned around that definition. The replanned program plan was approved by the NASA Agency Program Management Council (APMC) on October 6, 2010. This did not cause a change in the externally-committed FOC date of December 2014, but does emphasize science in the definition.
ISSUE 2: Late delivery of Cavity Door Drive System **CURRENT STATUS:** The cavity door drive system controller and actuator was delivered and integrated in the SOFIA observatory, and flight testing to clear the full flight envelope has been completed. This permits the continuation of SOFIA system testing, leading up to the first science flights in December 2010.	Programmatic – Late delivery of software that operates the telescope observation doors on the aircraft resulted in later-than-planned initiation of open door flight testing and science observation. NASA stationed representatives at Woodward's facility to support and oversee the vendor until delivery of the cavity controller and actuator.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**356.4**	**31.8**	**-**	**5.3**	**3.8**	**6.1**	**5.9**	**6.0**	**-**	**-**
FY 2011 Costs			22.2							
CSLE				0.5	0.5	0.3				
Administrative Labor Adjustments		0.4								
Extended Ops Budget not included in LCC						-3.1	-5.9	-6.0		
2011 MPAR Project Cost Estimate	**356.4**	**32.2**	**22.2**	**5.8**	**4.3**	**3.3**	**0.0**	**0.0**	**0.0**	**424.1**
Formulation	70.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	70.8
Development	285.6	32.2	19.8	0.0	0.0	0.0	0.0	0.0	0.0	337.6
Operations	0.0	0.0	2.4	5.8	4.3	3.3	0.0	0.0	0.0	15.8

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*
- *The row titled "Extended Ops Budget not included in LCC" reflects budgeted funds for operations that continue beyond the period of prime operations for which the project was baselined.*

Explanation of Project Changes

In spring 2009, a problem with the Maxwell-supplied spacecraft computer had emerged and NASA changed the baseline Maxwell computer to a BAE Rad750 Single Board Computer, delaying the Glory launch readiness date to November 2010. By May 2010, the BAE unit was delivered and successfully integrated to the Glory Observatory.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

The November 2010 LRD was replanned for February 2011 to allow for completion of the Taurus XL launch vehicle's Return to Flight activities, further risk reduction related to spacecraft subsystems, and resolution of launch range manifest conflicts with other scheduled launches. The approved life cycle cost remained the same and costs associated with the LRD change were covered within the project's existing cost reserves.

The mission was also impacted by the repair of a Solar Array Drive Assembly. In August 2010, an inspection revealed excessive wear to its slip ring assembly and it was deemed not flight-worthy. By November 2010, the SADA was repaired, tested, and successfully integrated to the Glory observatory. The November 2010 LRD was changed to February 23, 2011.

The risk associated with the readiness of the Taurus XL launch vehicle was retired following conclusion of the Mishap Investigation Board (MIB) that reviewed the failure of the Taurus XL fairing system, which resulted in the loss of the Orbiting Carbon Observatory. NASA developed a corrective action plan that incorporated the Mishap Investigation Board recommendations. Once all corrective actions had been closed out, NASA's Flight Planning Board approved the Taurus XL for Return to Flight. By this time, however, the LRD was delayed. The new LRD of February 23, 2011, accommodated this delay concurrent with the spacecraft's solar array drive assembly recovery.

Project Purpose

The Glory mission will contribute to NASA's research on atmospheric conditions that influence climate and will improve understanding of the natural and human-made factors that contribute to climate change. It will also enable a greater understanding of the seasonal variability of aerosol properties. Both advances are essential components of predicting climate change. Aerosols interact with atmospheric conditions in complex ways that can have large effects on climate.

The mission will also provide precision measurements of the solar irradiance; solar radiation is the dominant, direct energy input into the terrestrial ecosystem, affecting all physical, chemical, and biological processes.

Glory's science objectives are specifically to:

1) Determine the global distribution, microphysical properties, and chemical composition of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate; and

2) Continue measurement of the total solar irradiance to determine the Sun's direct and indirect effect on Earth's climate.

For more on the scientific questions addressed by Glory, visit http://glory.gsfc.nasa.gov/.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

Project Parameters

The Glory mission will operate two scientific instruments aboard a modified, preexisting NASA spacecraft. It will fly in NASA's low Earth orbit Afternoon, or A-Train, constellation to enhance the utility of the mission data through synergistic observations from the other satellites. The A-Train constellation currently includes five spacecraft flying in close temporal proximity to each other. The Glory spacecraft will be the sixth satellite in the A-Train when it joins the constellation in FY 2011.

The APS is an advanced polarimeter that will provide measurements to increase our understanding of black carbon soot and other aerosols as causes of climate change. The APS will provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the direct and indirect effects of aerosols on climate. The APS was developed by Raytheon Space and Airborne Systems in El Segundo, CA. As of March 2009, the APS was delivered and successfully integrated to the Glory Observatory.

The TIM instrument provides continuity for the 31-year solar irradiance data record by extending the measurement currently provided by (SORCE. University of Colorado's Laboratory for Atmospheric and Space Physics is developing the TIM sensor, the instrument's Sun pointing platform, and the TIM science operations center.

Orbital Science Corporation in Dulles, VA, is developing the spacecraft and the ground system/mission operations center, and integrated the instruments. Orbital also provides mission systems engineering support and performs mission operations.

Kennedy Space Center is responsible for Glory launch services. The mission will launch on a Taurus XL from Vandenberg Air Force Base, CA.

Project Commitments

Glory will launch in February 2011 to begin a three-year prime mission (with a five-year goal) to gather scientific measurements of atmospheric aerosols and solar irradiance.

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Earth Science
Program: Earth Systematic Missions
MPAR Project In Development: Glory

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
APS	Raytheon	Provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols	Same	Same
TIM	U of Colorado LASP	Maintain an uninterrupted solar irradiance data record	Same	Same
Spacecraft	Orbital	Refurbishment of the Vegetation Canopy Lidar (VCL) mission bus	Same	Same
Launch vehicle	Orbital	Taurus XL	Same	Same
Ground System Ops, TIM Science Ops, APS Science Ops	Orbital / Colorado University-Boulder LASP /GSFC Institute for Space Studies	Combination of the commercial ground stations and the networks that connect them	APS: full data processing for 1 yr w/ 2 addt'l yrs of archiving. TIM: full data processing for 3 yrs	Same
Mission Ops	Orbital	Operations of the spacecraft and the generation of command uplink	Same	Same
Data Archive	GSFC Earth Science Distributed Active Archive Center (GES DAAC)	Archival and distribution of mission data	Same	Same

Schedule Commitments

Glory was confirmed for development on December 13, 2005.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Confirmation Review	12/2005	12/2005	12/2005
Mission Pre-ship review	8/2008	7/2010	12/2010
Launch	12/2008	11/2010	2/2011

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

Development Cost and Schedule Summary

Project	Base Year	Base Year Adjusted* Development Cost Estimate ($M)	Current Year	Current Year Development Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Glory	2011	337.6	2011	337.6	0	Launch Readiness	02/2011	02/2011	0

*Base year adjusted to current accounting.

Development Cost Details

Element	Base Year Adjusted Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**337.6**	**337.6**	**0**
Spacecraft	59.8	59.8	0
Payload	128.2	128.2	0
System I&T	4.6	4.6	0
Launch Vehicle	64.1	64.1	0
Ground System	1.3	1.3	0
Science/Technology	14.9	14.9	0
Other	64.7	64.7	0

Project Management

Goddard Space Flight Center has project management responsibility. The Science Mission Directorate Program Management Council has program oversight responsibility.

The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
APS	GSFC	GSFC	None
TIM	GSFC	GSFC	None

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

Acquisition Strategy

All major procurements for the directed Glory mission were sole-source awarded to meet the objective for an accelerated mission:

Aerosol Polarimetry Sensor: Raytheon Space and Airborne Systems;

Total Irradiance Monitor: University of Colorado Laboratory for Atmospheric and Space Physics; and

Spacecraft/spacecraft support: Orbital Science Corporation.

There are no remaining major procurements, as all instrument and spacecraft contracts are in place.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance NASA	HQ	N/A	Mission Readiness Review (MRR) - Final pre-flight review of the operational readiness of the mission	02/2011
Performance NASA	HQ	N/A	Launch Readiness Review (LRR) - Final pre-launch review of the launch vehicle readiness	02/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch Services Impact of Taurus XL Launch Failure on Glory	If Taurus T-8 (used on OCO mission) launch failure findings and / or corrective actions impact T-9 (Glory) schedule, then the Glory LRD will be impacted.	In October 2010, NASA's Flight Planning Board approved the closure of the KSC/Launch Services program's Return to Flight activities. At this point, the Return to Flight activities had impacted the November 22, 2010 launch readiness date by two months. The new LRD of February 22, 2011, accommodated this delay concurrent with the spacecraft's SADA recovery.

Corrective Action Plan (as submitted in Report on Program and Cost Assessment January 11, 2011 – as required under 1203)

Project Description: Sunlight is the dominant direct energy input into the Earth’s climate system, affecting all physical, chemical, and biological processes. Thus, it is critical to monitor solar output and measure aerosols that affect Earth’s energy budget in complex ways that can have large effects on climate. The Glory mission will contribute to NASA’s Earth science research effort by improving our understanding of atmospheric composition and solar irradiance as they relate to Earth’s energy budget. These measurements will improve understanding of the natural and man-made factors that contribute

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

to climate change. Specifically, the Glory mission will measure the geographical and temporal distribution of atmospheric aerosols, small airborne particles. In addition, Glory will make highly accurate and precise measurements of solar radiation. The Glory prime mission life requirement is for three years of operations, with a goal of five years. The instruments will operate continuously while on orbit.

Glory's science objectives are to: (1) determine the global distribution, microphysical properties, and chemical composition of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate; and (2) measure the total solar irradiance to determine the Sun's direct and indirect effect on Earth's climate.

The Glory mission consists of two scientific instruments—the Aerosol Polarimetry Sensor (APS) and the solar Total Irradiance Monitor (TIM)—aboard a dedicated NASA spacecraft. The following is a description of each instrument:
The APS is an advanced polarimeter used for measurements that will increase our understanding of black carbon soot and other aerosols as causes of climate change. The APS will provide unprecedented measurements of the global distribution of natural and anthropogenic aerosols and clouds with accuracy and coverage sufficient for a reliable quantification of the aerosol direct and indirect effects on climate. The second instrument, the TIM, provides measurement continuity for the more than 30-year solar irradiance data record by extending the measurement currently provided by NASA's Solar Radiation and Climate Experiment (SORCE).''

The Glory satellite will fly in the low Earth orbit A-Train constellation (multiple spacecraft flying in close proximity to provide detailed observations of the Earth system) to assess the effectiveness of combining aerosol data with data from multiple instruments for enhanced scientific value.

The Glory project will respond to the Intergovernmental Panel on Climate Change (IPCC), and the prior Climate Change Science Program (CCSP), by continuing and improving upon NASA's research of the forcings influencing climate change in the atmosphere. The scientific knowledge provided by this project will be essential to predicting future climate change and making sound, scientifically-based economic and policy decisions related to environmental change.

CORRECTIVE ACTION PLAN SUMMARY

ISSUE	CORRECTIVE ACTION PLAN
ISSUE 1: Late delivery of the Aerosol Polarimetry Sensor (APS) instrument due to technical issues and the move to a new facility at the development contractor. The APS was delivered two months later than planned in the April 2008 rebaseline.	Programmatic – In 2007, the APS development contractor, Raytheon Space and Airborne Systems (RSAS), closed the facility where the instrument was being designed and built, relocating all the development activities to a different RSAS facility. The APS

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

ISSUE	CORRECTIVE ACTION PLAN
CURRENT STATUS: As of March 2009, the APS was delivered and successfully integrated to the Glory Observatory.	development contractor experienced high turnover in the project's management and technical staff over this period, and was able to retain only a small fraction of the existing instrument development team as a consequence of the move. The project worked with RSAS to get them back on track by adding management and technical expertise to the instrument development and providing continuous rotational onsite NASA presence at the APS contractor plant. Technical – Due to challenges in the instrument engineering activities, the project added management and technical expertise to the instrument development team at RSAS to facilitate rapid decision-making on technical issues related to the APS instrument and potential related impacts to the Glory observatory. This included providing continuous rotational onsite NASA presence at the APS contractor plant. Additional component-level risk mitigation testing was conducted at NASA's Goddard Space Flight Center. Schedule – As part of the cost mitigation strategy, NASA optimized the mission-level schedule and manpower to allow for the late delivery of the APS. NASA also facilitated the procurement/provisioning of schedule-critical parts.
ISSUE 2: The Glory Project was impacted by the unreliable low production yield of the Maxwell Single Board Computer (SBC). **CURRENT STATUS:** In June 2009, the decision was made to rebaseline the Maxwell SBC with a BAE RAD750. This rebaseline decision drove the launch slip from June 2009 to November 2010 and the associated cost increases.	Programmatic – Development and flight of the Maxwell SBC was originally planned to occur on the NPOESS mission and the Glory mission was to capitalize on the NPOESS SBC development efforts. After delays associated with the NPOESS mission, this removed all opportunities for Glory to benefit from any NPOESS SBC development. The Glory Project adopted completion of the development efforts associated for the Maxwell SBC. By June 2009, due to production issues that led to an unreliable yield, a decision was made to rebaseline the

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Glory

ISSUE	CORRECTIVE ACTION PLAN
	Maxwell SBC to the BAE RAD 750. Cost - The cost for the slip in launch readiness is reflected in the current estimate provided in this report. The Glory project reduced the cost impact (also technical and schedule risks) associated with continuing to improve the unreliable low production yield by rebaselining the SBC to a BAE RAD750, executing risk-mitigation activities, and incorporating the necessary regression testing in the observatory integration and test schedule. Schedule - Glory Integration and Test schedule was reworked to accommodate the late delivery of the BAE RAD 750 Payload Interface Processor (PIP). NASA worked closely with the Glory Project and Earth Systematic Missions Program Office to monitor the development and delivery status. Additionally, the June 2009 launch readiness date was moved 17 months to November 22, 2010.
ISSUE 3: The Glory mission was impacted by the required closure of the Taurus XL launch vehicle's Return to Flight activities following the loss of the Orbiting Carbon Observatory. **CURRENT STATUS:** In October 2010, NASA's Flight Planning Board approved the closure of the KSC/Launch Services	Programmatic –Following conclusion of the Mishap Investigation Board (MIB) that reviewed the loss of the Orbiting Carbon Observatory due to failure of the Taurus XL fairing system, NASA developed a corrective action plan with 19 corrective actions. On August 10, 2010, NASA convened a meeting to review and confirm closure of corrective actions up to that time and closed out 14 of the 19 corrective actions at that meeting. All remaining test activities required for the Taurus XL to return to flight

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**Glory**

ISSUE	CORRECTIVE ACTION PLAN
Program's Return to Flight activities.	were completed in September, and in October 2010, NASA's Flight Planning Board approved the Taurus XL for Return to Flight. At this point, however, the Return to Flight activities necessitated a delay from the November 22, 2010 launch readiness date. The new LRD of February 22, 2011, accommodated this delay as well as the delay caused by Issue 4.
ISSUE 4: The Glory mission was impacted by the repair of the –X Solar Array Drive Assembly (SADA). In August 2010, a previous anomaly led to an inspection of the –X SADA and revealed excessive wear to the Slip Ring Assembly (SRA). As a result, the –X SADA was deemed not worthy for flight. **CURRENT STATUS:** As of Nov. 14, 2010, the –X SADA was repaired, tested, and delivered and successfully integrated to the Glory Observatory.	Programmatic – By late August 2010, the –X SADA was deemed not worthy for flight. The September 2010 –X SADA Recovery Plan included impacts to launch readiness. Cost - The Glory project reduced the cost impact associated with a full replacement of the –X SADA by procuring an Slip Ring Assembly (SRA) replacement for the –X SADA that was successfully designed, built, and tested for the Glory mission requirements. Schedule – The –X SADA SRA replacement was delivered 1 week earlier than planned. To mitigate schedule risk, the Glory Project conducted several technical reviews and pursued 3 parallel options. Upon the successful testing and delivery of a –X SRA replacement, the other 2 options were terminated. NASA's Science Mission Directorate worked closely with the Glory Project and Earth Systematic Missions Program Office to monitor the –X SADA SRA development and delivery status. The November 2010 launch readiness date was moved 3 months to February 23, 2011.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**NPP**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**631.2**	**82.1**	**-**	**13.7**	**6.4**	**6.3**	**6.0**	**5.5**	**-**	**-**
FY 2011 Costs			106.6							
CSLE				2.5	0.9	0.9	0.9	0.9		
Administrative Labor Adjustments		0.5								
2011 MPAR Project Cost Estimate	**631.2**	**82.6**	**106.6**	**16.1**	**7.3**	**7.2**	**6.9**	**6.4**	**0.0**	**864.3**
Formulation	47.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.1
Development	584.1	82.6	106.6	6.8	0.0	0.0	0.0	0.0	0.0	780.1
Operations	0.0	0.0	0.0	9.3	7.3	7.2	6.9	6.4	0.0	37.1

Explanation of Project Changes

The changes to the NPP budget are due to the launch delay from September 2011 until October 2011 caused by late delivery to NASA of the VIIRS instrument and CrIS by the NPOESS Integrated Program Office.

Project Purpose

NPP is a joint mission with NOAA and the U.S. Air Force to extend key environmental measurements for weather prediction and research. The satellite will measure atmospheric and sea surface temperatures, humidity profiles, land and ocean biological productivity, cloud and aerosol properties, and earth radiation budget quantities.

The NPP mission has two objectives: Provide a continuation of select global change observations following the Earth Observing System missions Terra and Aqua; and provide the Nation's operational meteorological satellite system with risk-reduction demonstration and validation for critical sensors, algorithms, and ground processing. Due to NPOESS program delays propagated to the successor Joint Polar Satellite System (JPSS; see "Project Management") program, NPP data will be used operationally to avoid gaps in operational weather data.

For more information, please visit: http://jointmission.gsfc.nasa.gov.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	NPP

Project Parameters

The NPP spacecraft is based on a modified Ball Commercial Platform 2000 bus with a five-year design life. The NPP orbit is a polar, Sun-synchronous orbit at a nominal altitude of 824 kilometers. Four of the instruments are newly developed sensors based on heritage NASA sensors. The ATMS has been developed by NASA, and three of the instruments (VIIRS, CrIS, and OMPS) were developed by the NPOESS Integrated Program Office (IPO). A fifth sensor, CERES was a spare sensor developed by NASA for the EOS Program.

Project Commitments

NPP is being managed for a target launch in October 2011 and will undertake the following scientific measurements over its five-year operating life: atmospheric and sea surface temperatures, humidity soundings, land and ocean biological productivity, cloud and aerosol properties, and Earth radiation budget measurements. NASA's commitment is for an LRD of February 2012 including an additional $35 million mission development costs. The commitment launch readiness date, lifecycle cost, and development cost reflect residual uncertainty with the NPP partner-provided instruments and the ground system development. The commitment LRD considers as well the effects of the crowded launch manifest in late 2011, should an LRD slip be required. Funds will not be reprogrammed unless the actual launch date slips beyond the internal date.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
VIIRS	Raytheon SBRS	Provide global imagery in visible and infrared frequency bands: 0.3 to 14 microns / 400 m resolution.	Same Same	
OMPS	Ball Aerospace	Collection of total column and vertical profile ozone data with 300-380 nm / LIMB 290-1000 nm .	Same Same	
CrIS	ITT Aerospace	Temperature and moisture profiles at 3.9-15.4 microns.	Same Same	
ATMS	NG Electronic Systems	Temperature and moisture profiles at 22 channels / 23-183 ghz.	Same Same	
CERES	NG Space Technology	Provide Earth radiation budget measurements in shortwave (0.3-5micron) and longwave (8-12 micron) bands	Same Same	
Spacecraft	Ball Aerospace	5-year design life, mass is 2228 kg, Power 1400 watts.	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**NPP**

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
CERES	NG Space Technology	Provide Earth radiation budget measurements in shortwave (0.3-5micron) and longwave (8-12 micron) bands	Same	Same
Spacecraft	Ball Aerospace	5-year design life, mass is 2228 kg, Power 1400 watts.	Same	Same
Launch vehicle	Boeing	Delta II 7920.	Same	Same
Ground system	Raytheon	Command, Control, and Communication Segment (C3S) and Interface Data Processing Segment (IDPS).	Same	Same

Schedule Commitments

The NPP mission completed Mission Confirmation Review (MCR) in November 2003.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
CrIS Flight Model Delivery	Oct 2005	June 2010	Same
ATMS Flight Model Delivery	Apr 2005	Oct 2005	Same
OMPS Flight Model Delivery	Sep 2005	Aug 2008	Same
VIIRS Flight Model Delivery	Nov 2005	Dec 2009	Same
CERES Flight Model Delivery	N/A	Oct 2008	Same
Operations Readiness Review	Jun 2006	Apr 2011	Same
Launch	Oct 2006	Sep 2011	Oct 2011

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
NPOESS Preparatory Project (NPP)	2006	592.9	2011	780.1	32	Launch Readiness	04/2008	10/2011	42

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**NPP**

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**592.9**	**780.1**	**187.2**
Aircraft/Spacecraft	160.0	209.4	49.4
Payloads	194.2	220.1	25.9
Launch Vehicle/Services	72.9	90.4	17.5
Ground Systems	48.2	75.9	27.7
Other Direct Project Cost	117.6	163.4	45.8
Science/Technology	0.0	20.9	20.9

Project Management

GSFC is responsible for NPP project management. Agency PMC has program oversight responsibility. NOAA/DOD IPO is responsible for managing development of OMPS, CrIS, and VIIRS instruments. Responsible official is the Earth Science Division Director.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	GSFC	None	None
ATMS Development	GSFC	None	None
OMPS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
CrIS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
VIIRS Development	NPOESS-IPO	None	NOAA / DoD (NPOESS-IPO)
CERES Refurbishment	GSFC	LaRC	NOAA
Data archive and storage	GSFC	None	NOAA
Ground Systems and Ops	NPOESS-IPO	None	NOAA

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	NPP

Acquisition Strategy

Spacecraft, ATMS, and CERES were procured competitively. The VIIRS, OMPS, and CrIS were procured competitively via the NPOESS Integrated Program Office.

The procurement award for each element was as follows:
- Ball Aerospace: Spacecraft and OMPS Development;
- NG Electronic Systems: ATMS Development;
- ITT Aerospace: CrIS Development;
- Raytheon: VIIRS Development;
- NG Space Technology: CERES; and
- Raytheon: Ground systems and operations.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance NPP	IRT	N/A	Operations Readiness Review	4/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Command, Control, and Communcation Segment (C3S) Ground System Development Delay	If the C3S is not ready to support satellite testing, a launch delay may result.	Coordinate closely with partner (NOAA) to ensure all necessary resources are applied to complete C3S development in parallel with satellite testing.

Corrective Action Plan (as submitted in Report on Program and Cost Assessment January 11, 2011 – as required under 1203)

Project Description: The NPOESS Preparatory Project (NPP) is a joint mission with the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Air Force (USAF) to extend key environmental measurements. The satellite will provide ozone measurements, atmospheric and sea surface temperatures, humidity sounding, land and ocean biological productivity, cloud and aerosol properties, and Earth radiation budget measurements.

The NPP project will: provide a continuation of global change observations following the Earth Observing System missions Terra, Aqua, and Aura specifically, atmospheric and sea surface

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	NPP

temperatures, humidity sounding, land and ocean biological productivity, cloud and aerosol properties and Earth radiation budget measurements; and provide the Joint Polar Satellite System (JPSS) (previously the National Polar-orbiting Operational Environmental Satellite System (NPOESS)) with risk-reduction demonstration and validation for the critical JPSS/NPOESS sensors, algorithms, and processing.

The environmental data records (EDRs) scheduled to be produced by the interface data processing segment (IDPS) from the NPP data are: sea-surface temperature; vegetation index; ocean color; imagery; atmospheric temperature; moisture and pressure profiles; clear column radiances; aerosol optical thickness and particle size; surface albedo; land surface temperature; ice surface temperature; surface heat flux; cloud base height; cover and layers; cloud top temperature; height; cloud effective particle size and optical thickness; precipitable water; surface wetness; active fire detection; sea ice characterization; snow cover; suspended atmospheric matter; and surface type. Separate from the IDPS processing system, NPP data from the Clouds and the Earth's Radiant Energy System (CERES) instrument will be processed to produce solar-reflected and Earth-emitted radiation products.

The following describes the instruments that will provide these measurements:

- The Visible Infrared Imaging Radiometer Suite (VIIRS) instrument is a multi-spectral scanning radiometer with a 3000 km swath width and derives its heritage from Advanced Very High Resolution Radiometer (AVHRR), Operational Linescan System (OLS), Moderate Resolution Imaging Spectroradiometer (MODIS), and Sea-viewing Wide Field-of-view Sensor (SeaWIFS).
- The Cross-Track Infrared Sounder (CrIS) instrument is a Michelson interferometer. Its heritage is the High Resolution Infrared Radiation Sounder (HIRS), the Advanced Infrared Sounder (AIRS), and the Infrared Atmospheric Sounding Interferometer (IASI). It will produce daily global sets of high-resolution temperature and moisture profiles for scenes with less than 50 percent cloud cover. It is co-registered with the Advanced Technology Microwave Sounder (ATMS) and is designed to work in conjunction with it.
- The ATMS instrument is a passive microwave radiometer with a swath width of 2300 km. Its heritage is the Advance Microwave Sounding Unit (AMSU) A1/A2 and the AMSU-B instrument. It provides the initial estimate of temperature and moisture profiles for input to an infrared algorithm, as well as an all-weather set of profiles.
- The Ozone Mapping and Profiler Suite (OMPS) will measure solar scattered radiation to map the vertical and horizontal distribution of ozone in Earth's atmosphere using a nadir ultraviolet (UV) sensor and limb-scanning UV/visible (VIS) sensors.
- The Clouds and the Earth's Radiant Energy System (CERES) will measure solar-reflected and Earth-emitted radiation products continuing the measurements started with the Earth Observing System satellites and the Earth Radiation Budget Experiment.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**NPP**

CORRECTIVE ACTION PLAN SUMMARY

2010 ISSUES	CORRECTIVE ACTION PLAN
ISSUE 1: The NPP Project continued to be impacted by the late delivery of the Cross-track Infrared Sounder (CrIS) sensors provided by the NPOESS Integrated Program Office. The CrIS instrument delivery slipped from September 2009 to June 2010. This late delivery drove the launch date from January 2011 to October 2011 and resulted in an the associated cost increase of $ 47M. **NOTE:** This issue is outside of NASA's responsibility in the partnership with NOAA and DoD. **CURRENT STATUS:** As of June 2010, the last sensor Cross-track Infrared Sounder (CrIS) was delivered for integration onto the NPP spacecraft.	Programmatic – In February 2010, the Administration directed the restructuring of the NPOESS Program into separate civil and defense operational satellite systems. NOAA and NASA were assigned primary responsibility for the afternoon orbit. NASA's role in the restructured program is modeled after the procurement structure of the POES and GOES programs, with NASA performing work on a reimbursable basis for NOAA. Although the restructure occurred too late to improve the delivery date for the remaining sensor for NPP it has allowed NASA to manage the JPSS ground segment, which will be used for NPP and was also delayed under the NPOESS management structure. The ground segment is now on track for the October 2011 launch of NPP. Schedule-NASA has worked closely with the Integrated Program Office to monitor the instrument development and delivery status. The NPP project has worked to reduce the cost impact of the late delivery of the CrIS sensor by developing work-around activities and opportunities in the integration and test schedule. Specifically the Visible Infrared Imaging Radiometer Suite (VIIRS) instrument integration was pulled forward while the spacecraft team waited for the CrIS delivery, which allowed for some additional risk reduction testing to be performed. An expanded VIIRS end-to-end radiometric spectral response test was performed in March to verify the VIIRS performance, earlier than planned in the original test flow. This opportunity reduced risk to the overall test flow by avoiding additional delays due to issues identified earlier in the flow.

Management and Performance

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**GPM**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**349.2**	**155.0**	**-**	**83.8**	**68.7**	**41.4**	**27.2**	**20.1**	**-**	**-**
FY 2011 Costs			128.8							
CSLE				14.7	14.9	6.1	3.4	1.4	1.6	
Administrative Labor Adjustments		0.6								
2011 MPAR Project Cost Estimate	**349.2**	**155.6**	**128.8**	**98.4**	**83.6**	**47.5**	**30.6**	**21.5**	**13.7**	**928.9**
Formulation	349.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	349.2
Development	0.0	155.6	128.8	98.4	80.3	33.4	14.4	3.0	0.9	514.8
Operations	0.0	0.0	0.0	0.0	3.3	14.1	16.2	18.5	12.8	64.9

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Explanation of Project Changes

The changes to the project's budget reflect the deletion of a second GPM Microwave Imager (GMI-2), which would have been available to fly on a future Low-Inclination Observatory (LIO).

Project Purpose

The GPM mission will advance the measurement of global precipitation, making possible high spatial resolution precipitation measurements available at a three-hour or less refresh rate over much of the globe. A joint mission with JAXA, GPM will provide the first opportunity to calibrate measurements of global precipitation (including the distribution, amount, rate, and associated heat released) across tropic, mid-latitude, and polar regions.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	GPM

The GPM mission has the following scientific objectives:

- Advance precipitation measurement capability from space through combined use of active and passive remote-sensing techniques. These advanced measurements will be used to calibrate dedicated and operational passive microwave sensors, with the goal of achieving global sampling;

- Advance understanding of global water/energy cycle variability and fresh water availability. Improved measurements of the space-time variability of global precipitation will substantially close the water/energy budget and elucidate the interactions between precipitation and other climate parameters;

- Improve climate prediction by providing the foundation for better understanding of surface water fluxes, soil moisture storage, cloud/precipitation microphysics and latent heat release in Earth's atmosphere;

- Advance Numerical Weather Prediction (NWP) skills through more accurate and frequent measurements of instantaneous rain rates with better error characterizations, and the development of improved assimilation methods; and

- Improve flood-hazard and fresh-water-resource prediction capabilities through better temporal sampling and wider spatial coverage of high-resolution precipitation measurements, and innovative designs in hydro-meteorological modeling.

For more information see http://gpm.gsfc.nasa.gov/.

Project Parameters

The GPM project includes a Core Observatory Spacecraft and a robust set of spare GPM Microwave Imager (GMI) instrument subsystems to ensure the GMI instrument, NASA's instrument contribution to the Core Observatory, is ready on schedule. The Core Observatory will leverage passive microwave measurements from other operating and planned "satellites of opportunity" by calibrating their measurements to its own. The resulting sampling rate over different areas of the globe will depend on the number and orbits of the satellites of opportunity, but given the prevalence of passive microwave instruments on operational satellite systems, the global sampling will be robust.

The NASA Core Observatory will fly in a 65 degree inclined orbit at an altitude of 407 kilometers; the 65 degree orbit provides improved latitude coverage over TRMM (whose orbit was inclined 35 degrees). The Core Observatory's two scientific instruments will provide active and passive microwave measurements of precipitation.

The JAXA-supplied Dual-frequency Precipitation Radar (DPR) instrument has cross-track swath widths of 245 and 120 kilometers, in Ku-band and Ka-band, providing three-dimensional observation of rain and an accurate estimation of rainfall rate. The KuPR (13.6 GHz) subsystem of the DPR is an updated version of the highly successful radar flown on TRMM.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	GPM

The GMI instrument is a conically-scanning radiometer that will provide significantly improved spatial resolution compared to the TRMM Microwave Imager (TMI).

The Core Observatory Spacecraft will be launched from Tanegashima Space Center, Japan, on an H-IIA launch vehicle. The DPR and GMI data will be relayed using the TDRSS multiple access and single access service.

Project Commitments

The GPM Core Observatory is planned for a launch in July 2013 to begin a three-year prime mission (five-year goal). When calibrated with existing and planned passive microwave measurements from other satellites, GPM will provide global measurements of precipitation with a sampling frequency of three hours or less over much of the globe.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Core Observatory	GSFC	Provides platform for the GMI and JAXA-supplied DPR instruments.	Same Same	
Low-Inclination Observatory	N/A N/A		Changed to be partner-provided	Second GMI instrument deleted
Dual-frequency Precipitation Radar (DPR)	JAXA	Provides cross-track swath widths of 245 and 120 kilometers, for the Ku precipitation radar (KuPR) and Ka-band precipitation radar (KaPR).	Same Same	
GMI GSFC		Provides 13 microwave channels ranging in frequency from 10 GHz to 183 GHz; four high frequency, millimeter-wave, channels about 166 GHz and 183 GHz. 1.2 meter diameter antenna.	Same Same	
Launch Vehicle	JAXA	H-IIA	Same	Same

Management and Performance

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**GPM**

Schedule Commitments

GPM entered formulation in July 2002. The below milestone dates reflect the December 2009 KDP-C commitments.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	Dec 2009	Dec 2009	Dec 2009
Core Observatory LRD	Jul 2013	Jul 2013	Jul 2013

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Global Precipitation Measurement (GPM)	2010	555.2	2011	514.8	-7	Launch Readiness	07/2013	07/2013	0

Note: The changes to the project's budget reflect the deletion of a second GPM Microwave Imager (GMI-2), which would have been available to fly on a future LIO.

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**555.2**	**514.8**	**-40.4**
Aircraft/Spacecraft	151.2	156.2	5
Payloads	91.2	60.3	-30.9
Systems I&T	6.8	7.2	0.4
Launch Vehicles/Services	1.5	2.0	0.5
Ground Systems	30.5	24.9	-5.6
Science/Technology	28.4	28.1	-0.3
Other direct project cost	245.6	236.1	-9.5

Note: The changes to the project's budget reflect the deletion of a second GPM Microwave Imager (GMI-2), which would have been available to fly on a future LIO.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	GPM

Project Management

GSFC has project management responsibility. The Agency Program Management Council has program oversight responsibility.

The Earth Sciences Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Core Observatory	GSFC	GSFC	None
Core Observatory: GMI	GSFC	GSFC	None
Core Observatory: DPR	GSFC	GSFC	JAXA
Launch vehicle and services: Core Observatory	GSFC N	one	JAXA
Ground Systems	GSFC	GSFC	None

Acquisition Strategy

The GPM instrument was selected through open competition in FY 2005. The Ball Aerospace and Technologies Corporation (BATC) will build the GMI instrument for GPM. The GPM core spacecraft will be an in-house development at GSFC. The DPR instrument and launch vehicle for the Core Observatory will be provided by a foreign partner (JAXA).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ and GSFC	12/2009	System Integration Review (SIR)	5/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Non-NASA Constellation elements	Expanded global sampling depends on data from "spacecraft of opportunity" that are not part of this project.	NASA is developing data algorithms that allow GPM to make the broadest possible use of microwave instruments on other spacecraft; NASA participates in interagency and international planning processes for operational Earth observation measurements to maximize the leverage opportunities for GPM.

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Earth Science
Program: Earth Systematic Missions
MPAR Project In Development: LDCM

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**434.5**	**106.0**	**-**	**152.0**	**64.1**	**1.5**	**1.5**	**1.6**	**-**	**-**
FY 2011 Costs			163.0							
CSLE				7.4	3.8	0.7	0.7	0.7	1.2	
Administrative Labor Adjustments		0.6								
2011 MPAR Project Cost Estimate	**434.5**	**106.6**	**163.0**	**159.3**	**67.9**	**2.2**	**2.2**	**2.3**	**3.6**	**941.6**
Formulation	341.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	341.4
Development	93.1	106.6	163	159.3	65.6	0.0	0.0	0.0	0.0	587.6
Operations	0.0	0.0	0.0	0.0	2.2	2.2	2.2	2.3	3.6	12.5

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Explanation of Project Changes

The LDCM project, which was approved to proceed with development in December 2009, now has a fully integrated budget including the development and accommodation of TIRS.

Project Purpose

Unprecedented changes in land cover and use are having profound consequences for weather and climate change, ecosystem function and services, carbon cycling and sequestration, resource management, the national and global economy, human health, and society. The Landsat data series, begun in 1972, is the longest continuous record of changes in Earth's surface as seen from space and the only satellite system designed and operated to repeatedly observe the global land surface at moderate resolution. Landsat data are available at an affordable cost, providing a unique resource for

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	LDCM

people who work in agriculture, geology, forestry, regional planning, education, mapping, and global change research.

The purpose of LDCM is to extend the record of multi-spectral, moderate resolution Landsat-quality data, and to meet U.S. Government operational and scientific requirements for observing land use and land change.

For additional information, visit the LDCM mission Home Page: http://ldcm.nasa.gov/.

Project Parameters

LDCM is being developed for an LRD that will minimize a potential data gap in the archive due to the fuel-limited life of Landsat-7. Recent analyses by the USGS and NASA have estimated the Landsat-7 mission should continue to operate through at least the end of 2012. The LDCM mission completed its Confirmation Review on November 30, 2009, and its KDP-C transition review on December 16, 2009. Due to the high national importance of the mission and the need to maintain the continuity of the Landsat data record, NASA and USGS will implement the LDCM mission for a December 2012 launch, providing necessary budget and other resources to ensure all mission elements are ready for this launch date. A probabilistic analysis has determined that the launch date could move as far as June 2013, driven by the late addition of the TIRS instrument. However, the LDCM project has been directed to execute all necessary contracts and actions to accomplish the December 2012 Launch Readiness Date.

LDCM consists of a two science instruments (the Operational Land Imager and the Thermal Infrared Sensor), a spacecraft, and a mission operations element. The LDCM is in implementation and system level requirements are baselined to provide the following system-level performance parameters:

- Earth Spatial-Temporal Coverage: 16-day repeat coverage of the global land mass;
- - Spatial Resolution: 30 meters (visible, NIR, SWIR), 120 meters (thermal); 15 meters (panchromatic);
- - Radiometric Performance: accuracy, dynamic range, and precision sufficient to detect land cover change using historic Landsat data;
- - Data: 185-kilometer cross track-by-180-kilometer along track multi-spectral image of Earth's surface; and
- - Mission Life: five years

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	LDCM

Project Commitments

After launch, the spacecraft and OLI instrument will operate for a minimum of five years. The TIRS instrument will operate for a minimum of three years.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
OLI	Ball Aerospace and Technology Corporation	Provide Landsat-equivalent data to extend the Landsat data of Earth's land surface for five years.	Same	Same
TIRS GSFC		Provide Landsat-equivalent thermal data to extend the Landsat data of Earth's land surface for three years.	New Same	
Spacecraft	General Dynamics	Provide performance and reliability commensurate with OLI and TIRS data requirements.	Same	Same
Launch Vehicle	ULA	Provide launch service access to space.	Same	Same
Mission Operations Element	Hammers Corporation	Provide capability for command and control, mission scheduling, long-term trending and analysis, and flight dynamics analysis.	Same	Same

Schedule Commitments

LDCM completed its spacecraft CDR and mission CDR in FY 2010. Due to the high national importance of the mission and the need to maintain continuity of the Landsat data record, NASA and USGS will strive to launch LDCM in December 2012. The LDCM project has been directed to execute all necessary contracts and actions to accomplish the December 2012 launch. Consistent with NASA policies regarding commitments to cost and schedule, the LDCM launch shall be no later than June 2013.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Formulation			
Award OLI contract	July 2007	July 2007	July 2007
Confirmation Review	Dec 2009	Dec 2009	Dec 2009
Critical Design Review (CDR)	Apr 2010	Apr 2010	Apr 2010

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Earth Science
Program: Earth Systematic Missions
MPAR Project In Development: LDCM

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
PSR	Sep 2012	Sep 2012	Sep 2012
Launch	Jun 2013	Jun 2013	Jun 2013

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Landsat Data Continuity Mission (LDCM)	2010	583.4	2011	587.6	1	Launch Readiness	6/2013 6/201	3	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**583.4**	**587.6**	**4.2**
Aircraft/Spacecraft	116.7	113.0	-3.7
Payloads	131.3	145.7	14.4
Systems I&T	1.7	2.0	0.3
Launch Vehicle	126.4	127.2	0.8
Ground Systems	10.7	15.8	5.1
Science/Technology	13.3	9.5	-3.8
Other Direct Project Costs	183.3	174.4	-8.9

Project Management

LDCM is under the Earth Systematic Missions program within the Earth Science Division (ESD) of SMD. The NASA Associate Administrator (AA) is the decision authority; the ESD Director is the responsible official; and GSFC is the lead management organization.

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Earth Science
Program: Earth Systematic Missions
MPAR Project In Development: LDCM

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Operational Land Imager	GSFC	GSFC	None
Thermal Infrared Sensor	GSFC	GSFC	None
Spacecraft	GSFC	GSFC	None
Ground System	GSFC	GSFC	U.S. Department of Interior-U.S. Geological Survey
Mission Operations	GSFC	GSFC	U.S. Department of Interior-U.S. Geological Survey

Acquisition Strategy

NASA's acquisition plan includes acquiring separate elements of the LDCM mission through open competition, with GSFC acting as the mission integrator and leading the element source selections. NASA has issued competitively selected contracts for the following major elements: Ball Aerospace and Technology Corporation for the development of the Operational Land Imager in July 2007; General Dynamics Corporation for the development of the spacecraft in April 2008; and Hammers Corporation for the development of the Mission Operations Element (MOE) in September 2008. The Thermal Infrared Sensor will be designed and built in-house at GSFC utilizing civil servants and support contractor personnel.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ and GSFC	9/2008	Systems Requirement Review - Successful	N/A
Performance	HQ and GSFC	7/2009	Mission Preliminary Design Review - Successful	N/A
Performance	HQ and GSFC	5/2010	Mission Critical Design Review	N/A
Performance	HQ and GSFC	N/A	Systems Integration Review	08/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Thermal Infrared Sensor (TIRS) development risk	The TIRS instrument has an aggressive development schedule due to late addition to the instrument complement and there is a risk that TIRS will not be delivered on schedule to meet the LDCM launch readiness date.	The LDCM project will develop alternative observatory integration and test scenarios to allow for late arrival of TIRS. In the event that TIRS cannot be delivered in time to meet the LDCM launch date, a flyable mass model will be developed.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**Aquarius**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**221.5**	**22.3**	**-**	**4.9**	**4.6**	**4.9**	**5.1**	**5.2**	**-**	**-**
FY 2011 Costs			21.0							
CSLE				0.5	0.5	0.3				
Extended Ops Budget not included in LCC						-1.5	-5.1	-5.2		
2011 MPAR Project Cost Estimate	**221.5**	**22.3**	**21.0**	**5.4**	**5.1**	**3.7**	**0.0**	**0.0**	**0.0**	**279.0**
Formulation	35.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.6
Development	185.9	22.3	19.1	0.0	0.0	0.0	0.0	0.0	0.0	227.3
Operations	0.0	0.0	1.9	5.4	5.1	3.7	0.0	0.0	0.0	16.1

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Extended Ops Budget not included in LCC" reflects budgeted funds for operations that continue beyond the period of prime operations for which the project was baselined.*

Explanation of Project Changes

The FY 2011 budget for Aquarius reflected the cost for a launch no earlier than December 2010. Spacecraft development delays at NASA's foreign partner, Argentina's National Committee of Space Activities (CONAE) spacecraft have delayed the launch to no earlier than June 2011.

Project Purpose

The Aquarius mission will investigate the links between the global water cycle, ocean circulation, and climate. It will observe and model variations of sea surface salinity, and how these relate to changes in the water cycle and ocean circulation. This will yield an unprecedented view of the oceans' role in climate and weather. For more information visit: http://aquarius.gsfc.nasa.gov/.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**Aquarius**

Project Parameters

Aquarius is an instrument on Argentina's CONAE spacecraft, Satellite de Aplicaciones Cientificas-D (SAC-D). The combined NASA and CONAE instruments and spacecraft form the Aquarius/SAC-D observatory. This observatory will be launched into a polar, Sun-synchronous orbit that allows global coverage of ice-free ocean surfaces consistent with Aquarius/SAC-D science observational targets. The Aquarius instrument includes an L-band microwave radiometer (1.413 GHz) and scatterometer (1.26 GHz). The radiometer will measure the surface brightness temperature, which is related to the surface emissivity and physical temperature of the seawater. The surface emissivity is determined by the dielectric constant of seawater, which is related to salinity. The scatterometer is required to provide coincident information of sea surface roughness, a critical correction term for retrieval of sea surface salinity.

Project Commitments

Aquarius is manifested to launch no earlier than June 2011 to begin a three-year prime mission to measure sea surface salinity with the precision, resolution, and coverage needed to characterize salinity variations and investigate the linkage between ocean circulation, Earth's water cycle, and climate variability.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Aquarius Instrument (integrated radiometer/ scatterometer)	JPL	L-band microwave radiometer at 1.413 GHz; scatterometer at 1.26 GHz; SSS measurements with root-mean-sq random errors and systematic biases <= 0.2 psu on 150 km sq scales over ice-free oceans.	Same	Same
Spacecraft	CONAE	SAC-D	Same	Same
Launch Vehicle	Boeing	Delta II	Same	Same
Data Management	GSFC N/A		Same	Same
Operations	CONAE	Command and telemetry	Same	Same

Schedule Commitments

The Aquarius mission entered a Risk Mitigation Phase (RMP) in July 2002. Following the RMP, the project was authorized to proceed to a formulation phase in December 2003. The Aquarius mission was authorized by the NASA Science Mission Directorate to proceed to development on October 12, 2005. In November 2007, the NASA Science Mission Directorate Program Management Council approved a replan of Aquarius, including a launch delay to May 2010. In December 2009, the NASA Science Mission Directorate Program Management Council approved another replan of Aquarius, including a launch delay manifesting the Aquarius/SAC-D mission for a January 2011 launch.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**Aquarius**

In September 2010, NASA, in coordination with CONAE, made the decision to delay the launch readiness date to June 2011 based on the progress on SAC-D testing and assessment of the remaining schedule. The rebaseline of the Aquarius project for this change is scheduled to take place in March 2011.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Confirmation Review	September 2005	September 2005	September 2005
Mission CDR	August 2007	July 2008	July 2008
Aquarius Instrument Pre-ship Review [FY 2008 APG]	May 2008	May 2009	May 2009
Launch	March 2009	January 2011	June 2011

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Aquarius	2007	192.6	2011	227.3	18	Launch Readiness	07/2009	06/2011	23

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**192.6**	**227.3**	**34.7**
Payloads	55.4	98.2	42.8
Launch Vehicle/Services	78.9	82.1	3.2
Ground Systems	5.5	5.2	-0.3
Science/Technology	10.9	11.6	0.7
Other Direct Project Cost	41.9	30.2	-11.7

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Aquarius

Project Management

The Jet Propulsion Laboratory is responsible for project management. The Science Mission Directorate Program Management Council is responsible for program oversight. The Earth Science Division Director is the responsible official for this project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Launch Vehicle	KSC	KSC	None
Ground System	JPL	GSFC	None
Aquarius Instrument	JPL	JPL	None
Spacecraft	CONAE	None	CONAE
Radiometer	JPL	GSFC	None
Data management	GSFC	GSFC/JPL	None
Mission operations	CONAE	None	CONAE

Acquisition Strategy

Aquarius was competitively selected from proposals submitted in response to ESSP AO 3. All elements of the project were included in that selection, and there are no other planned major procurements.

The launch vehicle procurement was awarded to Boeing. GSFC and JPL were selected for the remaining project elements not provided by CONAE.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Aquarius Standing Review Board	7/2010	Aquarius Replan Review -- Determined readiness of Aquarius instrument integration with the SAC-D Observatory (Phase D). Recommendation to proceed to Phase D.	3/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft Development Delays	Further delays could impact launch date.	Monitor Comision Nacional De Actividades Espaciales (CONAE) progress and confirm commitments; reassess available schedule reserves.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Aquarius

Corrective Action Plan (as submitted in Report on Program and Cost Assessment January 11, 2011 – as required under 1203)

Project Description: NASA's Aquarius project is part of a joint undertaking with the Comisión Nacional de Actividades Espaciales (CONAE), the space agency of Argentina, and referred to as the Aquarius/SAC-D project. The implementation of Aquarius/SAC-D is governed by a Memorandum of Understanding (MOU), dated March 2, 2004. The Aquarius prime mission life is planned and funded for three years with a minimum requirement of one year of operations. The Aquarius project will implement an exploratory sensor capability designed to make pioneering space-based measurements of sea surface salinity (SSS) with the precision, resolution, and coverage needed to characterize salinity variations and investigate the linkage between ocean circulation, Earth's water cycle, and climate variability. Salinity data are required to determine seawater density, which in turn governs ocean circulation. SSS variations are governed by freshwater fluxes due to precipitation, evaporation, runoff, and the freezing and melting of ice.

The Aquarius SSS measurements will be used to address two key areas of NASA's Earth Science research strategy: 1) how global precipitation, evaporation, and the cycling of water are changing; and 2) how climate variations induce changes in the global ocean circulation. In meeting these objectives, Aquarius will also validate a space-based measurement approach and analysis concept that could be used for future systematic SSS monitoring missions.

The Aquarius/SAC-D project will be conducted using an observatory made up of the NASA-provided Aquarius instrument, SAC-D science instruments, and the SAC-D spacecraft bus (service platform) contributed by CONAE. CONAE's SAC-D requirements are technically and scientifically compatible with Aquarius. However, Aquarius is designated in the MOU as the prime mission instrument on SAC-D. The Aquarius/SAC-D mission operations will be conducted using an integrated mission operations system consisting of the CONAE observatory operations control center in Argentina, the Goddard Space Flight Center (GSFC) Aquarius science planning and data processing center, and the Jet Propulsion Laboratory (JPL) Physical Oceanography Distributed Active Archive Center (PODAAC) for data archive and distribution. NASA will be providing the Delta-II launch vehicle.

The NASA instrument, Aquarius, will retrieve SSS by microwave remote sensing of surface brightness temperature at L-band, which is governed by the surface salinity, temperature, and roughness (due to wind and waves). An integrated L-band microwave radiometer/scatterometer will be developed and deployed as the salinity measuring instrument, consisting of three beams in a pushbroom configuration. The radiometer (1.413 GHz) will measure the surface brightness temperature, which is related to the surface emissivity and physical temperature of the seawater. The surface emissivity is determined by the dielectric constant of seawater, which is related to salinity. The scatterometer (1.26 GHz) is required to provide coincident information of sea surface roughness, a critical correction term for retrieval of sea surface salinity. The Baseline Science Mission enables study of the relevant oceanic processes on intraseasonal to interannual time scales by resolving the SSS with 0.2 practical salinity units (psu) accuracy on monthly time scales for at least three years.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth Systematic Missions
MPAR Project In Development:	Aquarius

CORRECTIVE ACTION PLAN SUMMARY

ISSUE	CORRECTIVE ACTION PLAN
ISSUE 1: Delays in the CONAE (Argentina Space Agency) SAC-D development (primarily associated with several minor technical issues and insufficient planning for integration and test activities) have led to NASA cost overruns and schedule slips. **NOTE:** This issue is entirely outside of NASA's responsibility in the partnership with Argentina. **CURRENT STATUS:** NASA has taken steps to improve insight and provide assistance to CONAE, within the limitations of ITAR.	Programmatic – NASA instituted a weekly teleconference with senior CONAE management to review project status and ensure all parties are well informed. Technical - JPL has placed a senior systems engineer on site at the integration and tests facilities in Argentina and Brazil, respectively with the purpose of monitoring CONAE progress and advising within the bounds of the JPL technical assistance agreement. Cost - The Aquarius project has worked to minimize the cost impact of schedule delays by reducing workforce to the lowest level required to support the remaining work. The resulting cost avoidance is estimated to be approximately $1.5M. Schedule - NASA has been working closely with CONAE to ensure the schedule is appropriate (based on NASA experience on missions of similar scope) for the remaining work, while ensuring mission success. In the past, the schedules have been optimistic, with not enough detail to make realistic assessments of the effort to complete the mission.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth Systematic Missions**
MPAR Project In Development:	**Aquarius**

ISSUE	CORRECTIVE ACTION PLAN
ISSUE 2: Contamination of the SAC-D Observatory Dual Thruster Modules (DTMs) has led to CONAE schedule delays. **NOTE**: This issue is the responsibility of CONAE. **CURRENT STATUS:** The refurbishment of all of the DTM flight units has been completed and the flight units were re-integrated with the observatory in October 2010.	Technical - NASA/JPL provided support to CONAE on the removal, shipment to the US vendor, and refurbishment of the DTMs. Without NASA support, it is estimated that the refurbishment effort would have resulted in a significant delay of four months. The work NASA conducted minimized the schedule delay (by as much as 2 months) and reduced the potential for further damage to the Observatory and/or an on-orbit failure. Schedule – Since this issue occurred concurrently with the other issues noted in ISSUE 1, it is difficult to determine the exact impact of the DTMs contamination on the overall schedule. However, while the entire refurbishment process took approximately 2 months, the impact to the project schedule was more likely 4-6 weeks.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Earth Science**
Program:	**Earth System Science Pathfinder**
MPAR Project In Development:	**OCO-2**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**29.1**	**62.0**	**-**	**91.0**	**41.0**	**13.0**	**4.0**	**0.0**	**-**	**-**
FY 2011 Costs			109.8							
2011 MPAR Project Cost Estimate	**29.1**	**62.0**	**109.8**	**91.0**	**41.0**	**13.0**	**4.0**	**0.0**	**0.0**	**349.9**
Formulation	28.9	32.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.9
Development	0.2	30.0	109.8	91.0	18.0	0.0	0.0	0.0	0.0	249.0
Operations	0.0	0.0	0.0	0.0	23.0	13.0	4.0	0.0	0.0	40.0

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*

Project Purpose

Data received from OCO-2 will support climate research by enabling an improved understanding of natural, distributed CO2 sources and sinks and ocean/atmosphere and land/atmosphere CO2 exchange processes. OCO-2 measurements will initiate a global time series of atmospheric CO2 for direct support of policy development and verification of regulations and environmental treaties. Rapid development and launch of OCO-2 is a key element of the President's Budget.

OCO-2 replaces the original OCO, which failed to reach orbit in February 2009 due to a launch vehicle anomaly. OCO-2 will utilize OCO's detailed design and implementation approach to the greatest possible degree to reduce risk. The mission objectives of OCO and OCO-2 are identical.

Project Parameters

The OCO-2 mission consists of a dedicated spacecraft with a single instrument, flying in a near-polar, Sun-synchronous orbit launched by an expendable launch vehicle. The orbit's early afternoon equator crossing time maximizes the available signal and minimizes diurnal biases in CO2 measurements associated with photosynthesis. The OCO-2 flight system uses hardware components, software, and processes with space flight heritage, in particular drawing from the spacecraft and mission design implemented for the OCO mission. The spacecraft structure is made of honeycomb panels that form a hexagonal shape. This structure houses the instrument and the spacecraft bus components. Panels with solar cells are attached and stowed such that the whole structure fits inside the small fairing of the

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
MPAR Project In Development:	OCO-2

Taurus XL launch vehicle. For the OCO-2 mission, the spacecraft has been elongated to accommodate the instrument and the instrument has been embedded into the structure of the spacecraft, exactly as was done for the OCO spacecraft. The instrument consists of a single telescope feeding three high-resolution grating spectrometers. The optics will be cooled to approximately 270 Kelvin (K) and the Focal Plane Arrays (FPAs) to approximately 120 K. The instrument will measure CO2 and O2 near-infrared absorptions from reflected sunlight. Remote sensing retrieval algorithms will process these data to yield estimates of the column-averaged CO2 dry air mole fraction, XCO2. The total weight of the observatory is about 530 kilograms. The original OCO successfully completed qualification of this configuration prior to launch.

Project Commitments

The OCO-2 is planned to launch in February 2013 to begin a two-year mission. OCO-2 will provide atmospheric CO2 measurements with near global coverage of the sunlit portion of Earth on a 16-day repeat cycle.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	Orbital Sciences Corp	Provides platform for the instrument	New Same	
OCO-2 Instrument	JPL	Three channel, high-resolution grating spectrometer measuring CO2 and O2 near-infrared absorptions from reflected sunlight	New Same	
Launch Vehicle	Orbital Sciences Corp	Taurus XL	New	Same

Schedule Commitments

Based on design maturity due to the heritage of OCO, OCO-2 entered Formulation in February 2010. Completion of KDP-C and transition to Development occurred in September 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	N/A	December 2010	September 2010
LRD	N/A	February 2013	February 2013

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
MPAR Project In Development:	OCO-2

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
OCO-2	2011	249.0	2011	249.0	0	Launch Readiness	02/2013	02/2013	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**249.0**	**249.0**	**0**
Spacecraft	42.0	42.0	0
Payload	39.4	39.4	0
System I&T	2.4	2.4	0
Launch Vehicle	67.6	67.6	0
Ground System	7.5	7.5	0
Science/Technology	10.0	10.0	0
Other	80.1	80.1	0

Project Management

JPL has project management responsibility for OCO-2. The Science Mission Directorate Program Management Council has program oversight responsibility. The Earth Sciences Division Director is the responsible official.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Spacecraft	JPL	None	None
Instrument	JPL	JPL	None
Ground System	JPL	JPL	None
Launch Vehicle	JPL	KSC	None

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Earth Science
Program:	Earth System Science Pathfinder
MPAR Project In Development:	OCO-2

Acquisition Strategy

The OCO-2 spacecraft will be built by Orbital Sciences Corporation. A sole source procurement is being pursued to maintain the same configuration as OCO. The OCO-2 instrument will be built in-house at JPL.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance OCO-2	SRB	09/2010	OCO-2 will complete a KDP-C Confirmation Review, to establish the mission development baseline.	02/2012

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Launch Vehicle Failure	If Taurus XL launch vehicle failure occurs, then there will be a loss of mission.	NASA is employing a rigorous Return-to-Flight program on the Taurus XL launch vehicle for the Glory mission. The OCO team is being provided insight into these results.
Single String Component Failure	If an OCO-2 single string (i.e. no redundancy) component fails, then there may be a loss of mission.	OCO-2 (based on the competed OCO design) was designed to have some single string components. Thorough analyses and testing is being performed to mitigate this risk as much as possible.

Management and Performance

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
MPAR Project In Development:	RBSP

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**271.3**	**121.0**	**-**	**91.2**	**29.7**	**21.5**	**8.7**	**0.0**	**-**	**-**
FY 2011 Costs			140.0							
CSLE				1.0	0.5	0.5	0.4			
Administrative Labor Adjustments		0.2								
2011 MPAR Project Cost Estimate	**271.3**	**121.2**	**140.0**	**92.2**	**30.2**	**22.0**	**9.1**	**0.0**	**0.0**	**686.0**
Formulation	88.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	88.2
Development	183.1	121.2	140.0	81.6	8.3	0.0	0.0	0.0	0.0	534.2
Operations	0.0	0.0	0.0	10.7	21.9	22.0	9.1	0.0	0.0	63.7

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
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Explanation of Project Changes

RBSP was confirmed in FY 2009 to proceed into the development phase, and will launch in May 2012. The total funding for RBSP has not changed.

Project Purpose

The RBSP mission will observe the fundamental processes that energize and transport radiation particles in Earth's inner magnetosphere (the area in and around the Earth's radiation belts). These dynamic processes operate throughout the universe at other planets and stars, and they continuously operate within Earth's immediate space environment.

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Heliophysics
Program: Living with a Star
MPAR Project In Development: RBSP

The primary science objective of the RBSP mission is to provide understanding, ideally to the point of predictability, of how populations of relativistic electrons and penetrating ions in space form or change in response to variable inputs of energy from the Sun. The RBSP mission lifetime will provide sufficient local time, altitude, and event coverage to improve understanding, and determine the relative significance of the various mechanisms that operate within the radiation belts.

RBSP observations will provide new knowledge on the dynamics and extremes of the radiation belts that are important to all technological systems that fly in and through geospace.

Project Parameters

The RBSP mission is comprised of two identical spacecraft in elliptical, low-inclination orbits that travel independently through Earth's radiation belts to distinguish time and space variations in the measured ions, electrons, and fields.

Project Commitments

The RBSP project will launch two identical spacecraft in FY 2012 to begin a two-year prime mission.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
EELV	KSC	Deliver a spacecraft to operational orbit	Same Same	
Energetic Particle, Composition and Thermal Plasma Suite (ECT)	University of New Hampshire	Measure the electron and ion spectra, and composition to understand the electron and ion changes	Same Same	
Radiation Belt Storm Probes Ion Composition Experiment (RBSPICE)	New Jersey Institute of Technology	Measure the ring current in the magnetosphere during geomagnetic storms	Same Same	
Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS)	University of Iowa	Measure the magnetic fields and plasma waves	Same Same	
Electric Field and Waves Instrument for the NASA RBSP Mission (EFW)	University of Minnesota	Measure the electric fields in the radiation belts	Same Same	
Proton Spectrometer Belt Research (PSBR)	National Reconnaissance Office	Measure the inner Van Allen belt protons	Same Same	
Spacecraft	JHU-APL	Operate science instruments in high radiation; transmit science data to ground	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Heliophysics
Program: Living with a Star
MPAR Project In Development: RBSP

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Ground System	Primary ground station at JHU-APL; instrument operation is distributed among investigators	Receive science data from two spacecraft; distribute to archive	Same	Same

Schedule Commitments

The RBSP project was authorized to begin formulation in September 2006 when the selections for science investigations were announced. It was confirmed to proceed into development on December 19, 2009.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Begin Implementation	January 2009	January 2009	January 2009
Critical Design Review	December 2009	December 2009	December 2009
System Integration Review	November 2010	November 2010	October 2010
Launch Readiness Review	May 2012	May 2012	May 2012

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Radiation Belt Storm Probes (RBSP)	2009	533.9	2011	534.2	0	Launch Readiness	05/2012	05/2012	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**533.9**	**534.2**	**0.3**
Spacecraft	85.6	113.0	27.4
Payload	95.4	96.4	1.0

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science

Theme: Heliophysics

Program: Living with a Star

MPAR Project In Development: RBSP

System I&T	36.9	39.4	2.5
Launch Vehicle	133.6	133.6	0.0
Ground System	16.3	19.5	3.2
Science/Technology	3.1	3.9	0.8
Other	163.0	128.4	-34.6

Project Management

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Ground Systems	JHU-APL	None	None
Data Analysis	JHU-APL	None	National Reconnaissance Office
Instrument Development	JHU-APL	None	National Reconnaissance Office
Spacecraft design, integration with instrument, and test	JHU-APL Non	e	None
Mission Operations	JHU-APL	None	None
Expendable Launch Vehicle	KSC	None	None

Acquisition Strategy

The RBSP spacecraft and ground system are being designed, developed, and tested at the JHU-APL. The acquisition of sub-contracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the JHU-APL Procurement Office. Instrument development participants include the University of Iowa, University of Minnesota, New Jersey Institute of Technology, and the University of New Hampshire, as well as contributions from the National Reconnaissance Office and the Czech Republic.

The ground system components were defined during the formulation phases (Phases A and B) and include a mission operations center at the JHU-APL.

The Energetic Particle, Composition and Thermal Plasma Suite (ECT), Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS), Electric Field and Waves Instrument for the NASA RBSP mission (EFW), and Radiation Belt Storm Probes Ions Composition Experiment (RBSPICE) science investigations were procured through announcements of opportunity. The Proton Spectrometer Belt Research (PSBR) instrument is being contributed through an agreement with the National Reconnaissance Office.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Living with a Star
MPAR Project In Development:	RBSP

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	Senior Review Board	10/2008	Preliminary Design Review. The review concluded that the RBSP design was sufficiently mature to proceed to KDP-C.	N/A
Performance SRB		12/2009	Critical Design Review: The review concluded that there were no significant issues and the project should continue as planned.	N/A
Performance SRB		10/2010	System Integration Review: The review concluded that the project was ready to proceed with I&T.	N/A

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Complete Electric and Magnetic Field Instrument Suite and Integrated Science End-to-End testing	If the Electric and Magnetic Field Instrument Suite and Integrated Science (EMFISIS) main Electronics Box Engineering Model 2 (EM2) is not successfully integrated and tested per the EM2 test plan and schedule, then the flight build and delivery will be delayed.	Hold Flight Manufacturing Readiness Reviews. Complete EM 2 environmental testing and characterization. Complete EM2 I&T peer review.
XCVR Qualification program	If the transceiver qualification program does not perform to their re-planned schedule, then the project's I&T schedule will be delayed.	Provide bi-weekly schedule updates to the integrated master schedule. Burn Qualification model on the RTAX, the field programmable gate array. Conduct Engineering Design Review of Qualification model.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Heliophysics**
Program:	**Solar Terrestrial Probes**
MPAR Project In Development:	**MMS**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**226.0**	**130.1**	**-**	**146.2**	**153**	**153**	**30.5**	**18.6**	**-**	**-**
FY 2011 Costs			156.8							
CSLE				18	15.3	13	4.1	1.9	1.0	
Administrative Labor Adjustments		0.7								
2011 MPAR Project Cost Estimate	**226.0**	**130.8**	**156.8**	**164.3**	**168.3**	**166.0**	**34.5**	**20.4**	**15.4**	**1082.6**
Formulation	172.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	172.9
Development	53.0	130.8	156.8	164.3	168.3	166.0	17.9	0.0	0.0	857.3
Operations	0.0	0.0	0.0	0.0	0.0	0.0	16.6	20.4	15.4	52.4

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Explanation of Project Changes

MMS has no change in life cycle cost. Sweden is not able to deliver the deployment mechanism of their electric field instrument contribution as planned. This mechanism will now be built by NASA through an existing partner institution, the University of New Hampshire.

Project Purpose

MMS will use four identically instrumented spacecraft to perform the first definitive study of magnetic reconnection in space. Reconnection occurs in all astrophysical plasma systems but can be studied efficiently only in the Earth's magnetosphere. Magnetic reconnection is thought to be of great importance for energy transfer throughout the universe and is an efficient and fast acceleration mechanism. Reconnection is the primary process by which energy is transferred from the solar wind to

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Heliophysics
Program:	Solar Terrestrial Probes
MPAR Project In Development:	MMS

Earth's magnetosphere and is the critical physical process determining the size of a space weather geomagnetic storm. MMS will determine why magnetic reconnection occurs, where it occurs, how it varies, how magnetic energy is coupled into heat and particle kinetic energy, and how this energy is coupled into the surrounding plasma.

For more information about MMS, please see http://stp.gsfc.nasa.gov/missions/mms/mms.htm.

Project Parameters

The MMS instrument payload will measure electric and magnetic fields and plasmas within the small-scale diffusion regions where magnetic reconnection occurs. High temporal and spatial resolution measurements will permit direct observation of these physical processes. The four spacecraft and instrument suites have identical design requirements. A two-phase, low-inclination orbit will probe both the dayside magnetopause and the nightside magnetotail neutral sheet where reconnection is known to frequently occur. The primary target of Phase 1 is the dayside magnetopause reconnection region. Phase 2 will focus on the near-Earth neutral line in the nightside magnetotail. The four spacecraft will fly in a tetrahedron formation and the separation between the observatories will be adjustable over a range of 10 to 400 kilometers during science operations in the area of interest. The mission design life is two years.

Project Commitments

NASA plans to launch four identically-instrumented spacecraft on an Evolved Expendable Launch Vehicle (EELV) into a highly elliptical Earth orbit in March 2015 and begin two years of scientific measurements that will enable an understanding of fundamental plasma physics processes associated with magnetic reconnection.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Launch Vehicle	KSC	Deliver ~4,000 kg payload consisting of four observatories to a highly elliptical Earth orbit.	Same Same	
Ground Systems	GSFC	Provide during operations minimum science data payback of ~4 Gbits of data per observatory each day.	Same Same	
Spacecraft	GSFC	Deliver high-rate data from instruments to ground station with a high accuracy for two years.	Same Same	
Electric Field Instruments	UNH	Provide measurements of electric fields (time resolution 1 ms) and magnetic fields (time resolution 10 ms)	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Heliophysics**
Program:	**Solar Terrestrial Probes**
MPAR Project In Development:	**MMS**

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Fast Plasma Investigation	GSFC	Provide plasma wave measurements (electric vector to 100 KHz).	Same Same	
Energetic Particle Detectors	JHU-APL	Provide high-resolution measurement of energetic particles.	Same Same	
Hot Plasma Composition Analyzers	Southwest Research Institute	Three-dimensional measurements of hot plasma composition (time resolution 10s).	Same Same	
Science Operations Center	University of Colorado/ Laboratory for Atmospheric and Space Physics	Provide science data to the community and archive.	Same Same	

Schedule Commitments

MMS began formulation in FY 2002. The project's confirmation review was held in June 2009 and the project was approved to enter implementation. As a result of the confirmation review, the launch date was moved to March 2015. The Mission Critical Design Review was successfully completed in August 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Mission Definition Review	September 2007	September 2007	September 2007
Initial Confirmation Review	November 2007	November 2007	November 2007
Confirmation Review	June 2009	June 2009	June 2009
Critical Design Review	August 2010	August 2010	August 2010
System Integration review	January 2012	January 2012	January 2012
Launch	March 2015	March 2015	March 2015

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Heliophysics
Program: Solar Terrestrial Probes
MPAR Project In Development: MMS

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Magnetospheric Multiscale (MMS)	2010	857.4	2011	857.3	0	Launch Readiness	03/2015	03/2015	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**857.4**	**857.3**	**-0.1**
Payload	131.9	143.6	11.7
Spacecraft	169.0	182.1	13.1
Systems I&T	55.3	28.4	-26.9
Ground Systems	19.1	18.4	-0.7
Science/Technology	19.9	17.2	-2.7
Other (Project Management)	268.0	273.2	5.2
Launch Services	194.2	194.4	0.2

Project Management

The STP Program has program management responsibility for the MMS project.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Four Instrument Suites	GSFC, Southwest Research Institute	GSFC	Austrian Space Agency, France (CNES), and Japan (JAXA), Sweden (SNSB)
Launch Vehicle	KSC	KSC	None
Four Spacecraft	GSFC	GSFC	None
Mission Operations	GSFC	GSFC	None
Science Operations	GSFC, LASP	None	None

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Heliophysics
Program: Solar Terrestrial Probes
MPAR Project In Development: MMS

Acquisition Strategy

The MMS spacecraft is being designed, developed, and tested in-house at GSFC using a combination of GSFC civil servants and local support service contractors. The acquisition of subcontracted spacecraft sub-assemblies, components, and parts is through procurement contracts issued by the MMS procurement office. Instrument development activities are under contract with SwRI. Instrument development subcontracts include Lockheed Martin, JAXA/MEISEI, University of New Hampshire, JHU-APL, Aerospace Corporation, and a team at GSFC. The Mission Operations Center and the Flight Dynamics Operations Area will be developed and operated at GSFC using a combination of GSFC civil servants and local support service contractors. The Science Operations Center for the instruments will be developed and operated at the Laboratory for Atmospheric and Space Physics at the University of Colorado and is under contract to SwRI.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
All SRB		08/2010	The Critical Design Review (CDR), an NPR 7120.5D review to assess the technical, cost, and schedule status of MMS. MMS was approved to proceed to manufacturing.	01/2012
All SRB		N/A	System Integration Review - Evaluate the readiness of the project to start flight system assembly, test, and launch operations.	03/2014
All SRB		N/A	Flight Readiness Review - Evaluate system assembly, integration, and test, preparing for the flight.	TBD

Management and Performance

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Lunar Quest Program**
MPAR Project In Development:	**LADEE**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**35.3**	**48.2**	**-**	**63.2**	**33.1**	**0.0**	**0.0**	**0.0**	**-**	**-**
FY 2011 Costs			62.9							
CSLE				8.5	11.1					
Administrative Labor Adjustments		.6								
2011 MPAR Project Cost Estimate	**35.3**	**48.8**	**62.9**	**71.7**	**44.2**	**0.0**	**0.0**	**0.0**	**0.0**	**262.9**
Formulation	35.3	44.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	79.5
Development	0.0	4.7	62.9	71.7	28.9	0.0	0.0	0.0	0.0	168.2
Operations	0.0	0.0	0.0	0.0	15.2	0.0	0.0	0.0	0.0	15.2

- *Consistent with the August 23, 2010 KDP-C decision, funding for SOMD-sponsored Lunar Laser Communications Demonstration (LLCD), $65.3 million, is not included in the above number.*
- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
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- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Explanation of Project Changes

LADEE was confirmed to proceed into development phase on August 23, 2010, supporting a November 2013 launch date. The project's development and life cycle cost estimates and schedule in this document are consistent with the KDP-C memo and its baseline (NSPD 49) report.

Project Purpose

LADEE, the first mission developed within LQP, is a cooperative effort between ARC and GSFC. LADEE will address high-priority science goals, as identified by the NRC, that determine the global density, composition, and time variability of the fragile lunar atmosphere. LADEE's measurements will

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
MPAR Project In Development:	LADEE

also determine the size, charge, and spatial distribution of electrostatically transported dust grains. LADEE will carry an optical laser communications demonstrator to be provided by SOMD. The optical laser will technically demonstrate high-bandwidth communication from the lunar orbit.

Project Parameters

The LADEE spacecraft design is based on a reusable common bus concept, and will be the first spacecraft based on this bus design.

Project Commitments

The spacecraft is planned a near circular, lunar equatorial orbit at approximately 50 km. After launch in November 2013, science operations are planned for 100 days.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Spacecraft	NASA ARC	Small spacecraft based on reusable design	New	Same
Integrated Payload	NASA GSFC	3 science Instruments (UVS, NMS, LDEX)	New	Same
Launch Vehicle	U.S. Air Force's Orbital/Suborbital Program (OSP) Orbital Sciences Corporation	Medium Class/Minotaur V	New	Nomenclature of rocket (IV+ to V)

Schedule Commitments

SMD announced the LADEE project in April 2008 and assigned leadership of the mission to ARC. The LADEE project was confirmed to proceed into development phase on August 23, 2010, supporting a November 2013 launch date.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
KDP-C	08/23/2010	11/2010	08/23/2010
SIR	11/2012	N/A	11/2012
LRD/IOC/IC	11/2013	1/2013	11/2013
End of Prime Mission	03/2014	N/A	03/2014

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Lunar Quest Program**
MPAR Project In Development:	**LADEE**

Development Cost and Schedule Summary

The development estimate reflects the August 23, 2010 KDPC decision, which does not include $65M for the SOMD-sponsored Lunar Laser Communications Demonstration (LLCD).

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
LADEE	2011	168.2	2011	168.2	0	Launch Readiness	11/2013	11/2013	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**168.2**	**168.2**	**0.0**
Spacecraft	34.8	34.8	0.0
Payloads	15.0	15.0	0.0
Systems I&T	6.7	6.7	0.0
Launch Vehicle/Services	45.7	45.7	0.0
Ground Systems	3.5	3.5	0.0
Science/Technology	0.8	0.8	0.0
Other direct project cost	61.7	61.7	0.0

Project Management

LADEE operates under the LQP of the SMD Planetary Science Division. The decision authority is the SMD Associate Administrator.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project Management	Overall, day-to-day management	ARC	N/A
Spacecraft	Design, build and deliver the spacecraft	ARC	N/A
Neutral Mass Spectrometer (NMS) Instrument	Design, build and deliver the NMS instrument. Also responsible for integrating of LDEX and UVS	GSFC	N/A

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Lunar Quest Program
MPAR Project In Development:	LADEE

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
UV Spectrometer (UVS) Instrument	Design, build, and deliver	ARC	N/A
Lunar Dust EXperiment (LDEX) Instrument	Design, build, and deliver	University of Colorado, LASP	N/A
Launch Vehicle	Integrate vehicle and provide launch service	TBD N	/A

Acquisition Strategy

All major acquisitions are in place. The spacecraft bus was directed to ARC (UVS) in partnership with GSFC (NMS). LDEX was competitively selected through SALMON and awarded to the University of Colorado/LASP. The USAF Orbital/Suborbital Program and Orbital Sciences Corporation are providing the launch vehicle.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance SRB		07/2010	Reviewed implementation plan, technical readiness, schedule, costs. Passed Preliminary Design Review (PDR), and confirmed to proceed into implementation phase (C). Critical Design Review (CDR) will be the next independent review.	08/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Spacecraft design outgrows mass margin allocation	Spacecraft design may outgrow launch vehicle performance if alternative components are required in the spacecraft design as mass margins are extremely limited.	Mitigate through spacecraft design planning, including management of margins and contingencies per LADEE System Engineering Master Plan, carefully watch Min V performance margins through frequent updates from launch vehicle provider.
Minotaur V launch loads unknown	Delay of launch vehicle contract delayed coupled loads analysis which may impact CDR.	Coupled loads analysis is currently under contract for delivery immediately prior to CDR peer reviews. Small residual risk of short delay in CDR.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Discovery**
MPAR Project In Development:	**GRAIL**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**221.2**	**124.1**	**-**	**40.5**	**4.4**	**0.0**	**0.0**	**0.0**	**-**	**-**
FY 2011 Costs			105.4							
CSLE				0.3	0.3					
2011 MPAR Project Cost Estimate	**221.2**	**124.1**	**105.4**	**40.8**	**4.7**	**0.0**	**0.0**	**0.0**	**0.0**	**496.2**
Formulation	50.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.6
Development	170.6	124.1	105.1	27.1	0.0	0.0	0.0	0.0	0.0	427.0
Operations	0.0	0.0	0.3	13.7	4.7	0.0	0.0	0.0	0.0	18.7

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Explanation of Project Changes

NASA confirmed GRAIL to proceed into implementation phase (KDP-C or Phase C/D) on January 28, 2009, and entered ATLO in July 2010. GRAIL approved baseline development ($427 million) and the LCC ($496.2 million) numbers remain unchanged since KDP-C.

Project Purpose

GRAIL was selected in December 2007 under the 2006 Discovery AO. The overarching scientific goal of the GRAIL mission is to determine the structure of the lunar interior from crust to core. The GRAIL mission will also advance our understanding of the thermal evolution of the Moon and extend our knowledge gained from the Moon to the other terrestrial-type planets.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Discovery**
MPAR Project In Development:	**GRAIL**

GRAIL has six lunar science objectives:

- To map the structure of the crust and lithosphere;
- To study the moon's asymmetric thermal evolution;
- To determine the subsurface structure of impact basins and the origin and of masons (i.e., high-gravity areas);
- To study the temporal evolution of crustal brecciation, and magmatism;
- To study affect on the structure of the deep lunar interior from lunar tides; and
- To understand the size of the possible lunar inner core.

Project Parameters

GRAIL will achieve its science objectives by placing twin spacecraft in a nearly circular low altitude (50 km) polar orbit. The two spacecraft will perform high-precision range-rate measurements between them. Analysis of changes in the spacecraft-to-spacecraft range-rate data caused by gravitational differences will provide direct and high-precision measurements of the lunar gravity. GRAIL will ultimately provide a global, high-accuracy (<10 mGal), high-resolution (30 km) gravity map of the moon. The instrument is based on the successful Earth orbiting Gravity Recovery and Climate Experiment (GRACE) mission.

Project Commitments

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Flight System	Lockheed Martin	2 spacecraft with s/c separation of 175-225 km, conducting 90-day science phase	Same Same	
Lunar Gravity Ranging System	JPL	Ka-band ranging system determines the precise instantaneous relative range-rate of the two s/c	Same Same	
E/PO MoonKam	Sally Ride Science (SRS)	Taking images of the moon, the data will enrich the middle school space science education	Same Same	
Launch Vehicle	ULA	CLIN23 - Delta II Heavy	Same	Same

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Discovery**
MPAR Project In Development:	**GRAIL**

Schedule Commitments

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Development (Phase C/D or KDP-C)	January 28, 2009	Same	Same
Critical Design Review (CDR)	November 2009	Same	Same
System Integration Review	June 2010	June 2010	Same
Launch Readiness Review	September 2011	Same	Same
End of Prime Mission	June 2012	Same	Same

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Gravity Recovery and Interior Laboratory	2009	427.0	2011	427.0	0	Launch Readiness	09/2011	09/2011	0

Development Cost Details

NASA confirmed GRAIL to proceed into implementation phase (KDP-C or Phase C/D) on January 28, 2009. GRAIL approved baseline development ($427 million) and the LCC ($496.2 million) estimates and schedule remain unchanged since KDP-C. Development Cost Details includes funding for CSLE/ULA.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**427.0**	**427.0**	**0.0**
Payload	18.1	20.4	2.3
Spacecraft	133.3	157.0	23.7
Ground System	12.3	13.7	1.4
Science	10.8	11.1	0.3
Launch Vehicle	152.8	152.8	0.0
Other	99.7	72.0	-27.7

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Discovery
MPAR Project In Development:	GRAIL

Project Management

GRAIL is part of the Discovery program managed by MSFC. The PI from MIT has delegated day-to-day project management to JPL.

Acquisition Strategy

GRAIL was selected competitively on December 13, 2007, under a Discovery program AO (AO-NNH06ZDA001O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance SRB/I	PAO	05/2010	Assess cost, schedule, and risk status of the project. The findings for the review showed that cost and schedule for the 2011 launch are consistent with the project's plans.	06/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single String Spacecraft	Both GRAIL spacecraft are primarily single string for major components. If there is an in flight failure, then there is no ability to switch over to a total redundant component.	The mission is of relatively short duration and the single string risks are mitigated by use of proven designs, high reliability parts, and additional testing of critical systems, consistent with the cost and schedule constraints of the project.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
MPAR Project In Development:	Juno

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**485.9**	**257.1**	**-**	**31.2**	**17.6**	**17.9**	**16.7**	**29.6**	**-**	**-**
FY 2011 Costs			194.2							
CSLE				0.2	0.2	0.2	0.2	0.3		
2011 MPAR Project Cost Estimate	**485.9**	**257.2**	**194.2**	**31.4**	**17.8**	**18.1**	**16.8**	**29.9**	**55.7**	**1107.0**
Formulation	186.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	186.3
Development	299.6	257.2	178.5	7.0	0.0	0.0	0.0	0.0	0.0	742.3
Operations	0.0	0.0	15.7	24.4	17.8	18.1	16.8	29.9	55.7	178.4

- *Other than the rephasing adjustments, the project remains within its lifecycle ($1107M) and development ($742.3M) baseline cost estimates.*
- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*

Explanation of Project Changes

The funding profile has been modified consistent with NASA risk management plan and strategy. There are no changes to the Juno approved development ($742.3 million) nor the LCC ($1,107 million) baselines since KDP-C.

Project Purpose

NASA selected Juno on July 15, 2005, under the New Frontiers AO. The overarching scientific goal of the Juno mission is to improve understanding of the origin and evolution of Jupiter. However, as the archetype of giant planets, Jupiter can also provide knowledge that will improve understanding of both the origin of our solar system and of planetary systems being discovered around other stars. The investigation focuses on four science objectives.

Origin: Determine the oxygen-to-hydrogen ratio to determine water abundance and estimate core mass to decide among alternative theories of planetary origin.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Planetary Science
Program:	New Frontiers
MPAR Project In Development:	Juno

Interior: Understand Jupiter's interior structure and dynamic properties through mapping of its gravitational and magnetic fields with unprecedented accuracy, leading to observations of internal convection and the size and mass of its core.

Atmosphere: Map variations in atmospheric composition, temperature, and cloud opacity and dynamics, to depths greater than 100 bars, at all latitudes.

Magnetosphere: Characterize and explore the three-dimensional structure of Jupiter's polar magnetosphere and auroras.

These objectives have been rated very highly in the National Academies' Solar System Exploration Decadal Survey and Sun-Earth Connections Decadal Survey. The Astrophysics decadal survey identified the study of star formation, their planetary systems, as well as giant and terrestrial planet birth and evolution as high priority. Juno fulfills key goals outlined in recent NASA and NRC studies.

Project Parameters

Juno achieves the science objectives by using a simple spinning, solar-powered spacecraft to make global maps of the gravity, magnetic fields, and atmospheric composition of Jupiter from a unique elliptical polar orbit with a close perijove. The spacecraft carries precise, high-sensitivity radiometers, magnetometers, and gravity science systems. Juno's 32 polar orbits extensively sample Jupiter's full range of latitudes and longitudes. From its polar perspective, Juno combines in-situ and remote sensing observations to explore the polar magnetosphere and determine the composition and phenomena of Jupiter's auroras.

Project Commitments

The Juno launch date is August 2011. After a five-year cruise to Jupiter, Juno will enter Jupiter Orbit Insertion (JOI) during August 2016. Juno will perform one year of science operations.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Waves	University of Iowa	Measures radio and plasma emissions; 4 m electric dipole and search coil	Same Same	
Jupiter Energetic particle Detector Instrument (JEDI)	John Hopkins Applied Physics Lab (JHU-APL)	Measures auroral distributions of electrons and ions; TOF vs. energy, and ion & electron sensors	Same Same	
Gravity Science	Jet Propulsion Lab (JPL)	Maps Jupiter's gravitational field to determine structure of core; X and Ka-band precision Doppler	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science

Theme: Planetary Science

Program: New Frontiers

MPAR Project In Development: Juno

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Flux-Gate Magnetometer (FGM)	GSFC	Maps Jupiter's magnetic field (Vector)	Same Same	
Launch Vehicle	KSC	Atlas 551	Same	Same
UV Spectrometer (UVS)	Southwest Research Institute (SwRI)	FUV spectral imager for auroral emissions	Same Same	
Microwave Radiometer (MWR)	Jet Propulsion Lab (JPL)	6 wavelengths (1.3-50 cm); sounds atmosphere to determine water and ammonia abundances	Same Same	
Spacecraft	Lockheed Martin	Solar-powered, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure	Same Same	
Jovian Auroral Distributions Experiment (JADE)	Southwest Research Institute (SwRI)	Ion mass spectrometer and electron analyzers; measures auroral distributions of electrons and ions	Same Same	
Juno Camera (JunoCam)	Malin Space Studies Institute	EPO instrument that will take auroral images and Jovian atmospheric activity	Same Same	

Schedule Commitments

Formulation started at project selection in July 2005. Juno proceeded into the implementation phase on August 5, 2008, and entered ATLO in April 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR	5/2008	same	same
Development			
CDR	3/2009	4/2009	same
SIR (formerly ATLO)	3/2010	same	4/2010
FRR 7/2011		same	same
Launch	8/2011	same	same
End of Prime Mission	10/2017	same	same

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Planetary Science
Program: New Frontiers
MPAR Project In Development: Juno

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Flux-Gate Magnetometer (FGM)	GSFC	Maps Jupiter's magnetic field (Vector)	Same	Same
Launch Vehicle	KSC	Atlas 551	Same	Same
UV Spectrometer (UVS)	Southwest Research Institute (SwRI)	FUV spectral imager for auroral emissions	Same	Same
Microwave Radiometer (MWR)	Jet Propulsion Lab (JPL)	6 wavelengths (1.3-50 cm); sounds atmosphere to determine water and ammonia abundances	Same	Same
Spacecraft	Lockheed Martin	Solar-powered, spin-stabilized spacecraft in an elliptical polar orbit that minimizes radiation exposure	Same	Same
Jovian Auroral Distributions Experiment (JADE)	Southwest Research Institute (SwRI)	Ion mass spectrometer and electron analyzers; measures auroral distributions of electrons and ions	Same	Same
Juno Camera (JunoCam)	Malin Space Studies Institute	EPO instrument that will take auroral images and Jovian atmospheric activity	Same	Same

Schedule Commitments

Formulation started at project selection in July 2005. Juno proceeded into the implementation phase on August 5, 2008, and entered ATLO in April 2010.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR	5/2008	same	same
Development			
CDR	3/2009	4/2009	same
SIR (formerly ATLO)	3/2010	same	4/2010
FRR	7/2011	same	same
Launch	8/2011	same	same
End of Prime Mission	10/2017	same	same

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Planetary Science
Program: New Frontiers
MPAR Project In Development: Juno

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
UVS and JADE instruments	JPL/Juno Project Office	JPL	None
Flight System, Integration and Test	Jet Propulsion Lab (JPL)	None	None
Overall responsibility for the development, implementation, operation, and success of the mission	MSFC/New Frontiers Program Office	None N	one
JunoCam	Jet Propulsion Lab (JPL)	None	None
KaBand and IR science	Jet Propulsion Lab (JPL)	None	Italian Space Agency (ASI)

Acquisition Strategy

All major acquisitions are in place. Juno was selected competitively on July 15, 2005 under the second New Frontiers program AO (AO-03-OSS-03).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance IPAO	/SRB	03/2010	Assess cost, schedule, and risk status of project. The findings from the review showed that cost and schedule for the August 2011 launch are consistent with the project's plans. The project received approval to proceed to ATLO.	06/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Jupiter Orbit Insertion	If Jupiter Orbit Insertion fails to put the spacecraft in the desired orbit, then science goals will not be obtainable.	Review baseline Phase E plan and compare with previously flown missions. Develop a recommended operational approach consistent with a Category 1, Class B mission to minimize the risk of an orbital insertion anomaly.

Management and Performance

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Mars Exploration**
MPAR Project In Development:	**Mars Science Lab**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**1744.4**	**258.4**	**-**	**136.43**	**40.5**	**37.0**	**0.0**	**0.0**	**-**	**-**
FY 2011 Costs			254.9							
CSLE				1.5	1.5	1.5				
Administrative Labor Adjustments		0.1								
2011 MPAR Project Cost Estimate	**1744.4**	**258.5**	**254.9**	**138.0**	**42.0**	**38.5**	**0.0**	**0.0**	**0.0**	**2476.3**
Formulation	515.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	515.5
Development	1228.9	258.5	254.9	59.7	0.0	0.0	0.0	0.0	0.0	1802.0
Operations	0.0	0.0	0.0	78.3	42.0	38.5	0.0	0.0	0.0	158.8

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Explanation of Project Changes

The project continues to make technical, cost, and schedule progress. The Sample Analysis of Mars (SAM) instrument has been delivered to the project and difficulties are being resolved for Sample Acquisition, Processing, and Handling (SA/SPaH) drill. To ensure mission success, NASA continues to adopt more conservative posture consistent with NASA risk management plan and strategy. The current life cycle cost is estimated at $2,476.3 million. NASA anticipates reprogramming additional funds to MSL in the initial FY 2011 operating plan to address the technical problems and related issues that have occurred during assembly and testing. The project remains on track to meet its November 2011 launch readiness date (LRD).

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
MPAR Project In Development:	Mars Science Lab

Project Purpose

The Mars Science Laboratory (MSL) mission is the most technologically challenging interplanetary rover ever designed. It will use new technologies to adjust its flight while descending through the Martian atmosphere, and to set the rover on the surface by lowering it on a tether from a hovering descent stage. Advanced research instruments make up a science payload ten times the mass of instruments on NASA's Spirit and Opportunity Mars rovers. MSL is engineered to drive longer distances over rougher terrain than previous rovers. It will also employ a new surface propulsion system.

MSL will make detailed measurements of element composition, elemental isotopes and abundance, mineralogy, and organic compounds to determine if Mars has, or ever had an environment capable of supporting life within the regions explored by MSL.

MSL has four science objectives:
- Assess the biological potential of at least one selected site on Mars;
- Characterize the geology and geochemistry of the landing region at all appropriate spatial scales;
- Identify planetary processes relevant to past habitability; and
- Characterize the broad spectrum of the Martian surface radiation environment.

For more information, see the MSL homepage at http://marsprogram.jpl.nasa.gov/missions/future/msl.html.

Project Parameters

The MSL is a surface rover that will collect Martian soil and rock samples and analyze them for organic compounds and environmental conditions that could have supported microbial life now or in the past. MSL will be a long-duration (two years) roving science laboratory that will be twice as long and four times as heavy (900 kilograms) as the Mars Exploration Rovers, Spirit and Opportunity.

Key technologies developed for MSL include: throttle-controlled, high-thrust engines, required during Martian entry, descent, and landing (EDL); sample acquisition and processing equipment used to acquire and distribute samples to the analytic instrument suite; and long-life, high-reliability, thermal-cycle-resistant electronics for use in the rover.

The EDL system will accommodate a wide range of possible latitude and altitude locations on Mars in order to be discovery-responsive and to have the capability to reach very promising, but difficult-to-reach scientific sites.

Project Commitments

The MSL will be ready to launch in November 2011 and will arrive at Mars approximately nine months (August 2012) later. MSL will operate for two Earth years on the surface of Mars and will travel approximately 20 kilometers on the Martian surface.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Mars Exploration**
MPAR Project In Development:	**Mars Science Lab**

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Rover	JPL	Travel 20 kilometers over the Martian surface.	Same Same	
Stereoscopic and microscopic cameras	Malin Space Systems	Acquire color, stereo images with resolutions up to 0.2 mm/pixel at 2 m range.	Same	Added MastCam zoom capability
Robotic arm tools	Honeybee Robotics	Acquire, process and deliver 75 rock and soil samples to analytic instruments.	Changed the rock grinder to a brush, sample quantity unchanged acquired by drill.	Same
Chemistry camera (ChemCam)	Department of Energy/Los Alamos National Laboratory; France	Remotely measure elemental composition of rocks and soil up to 9m from rover.	Same Same	
Alpha Particle X-ray Spectrometer	Canada (CSA)	Measure with high precision the elemental composition of in situ rocks and soil.	Same Same	
Rover Environmental Monitoring System (REMS)	Spain	Monitor key atmospheric measurements including temperature, pressure, wind speed/direction and humidity.	Same Same	
Dynamic Albedo of Neutrons (DAN)	Russia (IKI)	Measure hydrogen content in subsurface deposits.	Same Same	
Cruise stage and entry system	Lockheed Martin	Transport rover to Martian surface and land with impact speed below 1 m/s	Same Same	
Mission operations and data archive	JPL	Conduct one-year cruise and two-year rover primary mission with remotely located science team.	Same Same	
Sample Analysis at Mars (SAM)	NASA/GSFC	Analysis of elemental and isotopic composition of Mars samples	Same Same	
Sample Cache	ARC	Hockey puck-sized container will collect sample of Martian soil for possible later collection by a Mars sample return mission.	Deleted Same	
Chemistry and Mineralogy Instrument (CheMin)	NASA/ARC	Analysis of mineral and chemical content of Mars samples	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Mars Exploration**
MPAR Project In Development:	**Mars Science Lab**

Schedule Commitments

The MSL entered formulation phase in November 2004 and proceeded into implementation phase in August 2006. The project is currently scheduled for launch in November 2011, to be followed by landing and surface science operations beginning in August 2012.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Critical Design Review	June 2007	June 2007	Same
System Integration Review (formerly ATLO)	February 2008	February 2008	Same
Launch Readiness Review	September 2009	4QTR CY 2011	Same

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
2009 Mars Science Lab	2010	1,719.9	2011	1,802.0	5	Launch Readiness	11/2011	11/2011	0

Development Cost Details

The table below reflects a revised estimate to accommodate technical and cost risks as approved in the December 2011 APMC.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**1,719.9**	**1,802.0**	**82.1**
Spacecraft	930.9	1,034.1	103.2
Payloads	130.3	155.0	24.7
Systems I&T	89.9	107.7	17.8
Launch Vehicle/Services	232.8	234.0	1.2
Ground Systems	74.2	78.2	4.0
Science/Technology	15.9	15.6	-0.3
Other direct project cost	245.9	177.4	-68.5

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Mars Exploration**
MPAR Project In Development:	**Mars Science Lab**

Project Management

MSL is a JPL-managed in-house project. Instrument implementation has been assigned to JPL.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Rover	JPL	JPL	None
Stereoscopic and microscopic cameras	JPL	None	None
Robotic arm tools	JPL	JPL	None
Chemistry camera (ChemCam)	JPL	None	Department of Energy and France
Alpha Particle X-ray Spectrometer	JPL	None	Canada
Rover Environmental Monitoring System (REMS)	JPL	None	Spain
Dynamic Albedo of Neutrons (DAN)	JPL	None	Russia
Cruise stage and entry system	JPL	JPL, AMES, LaRC	None
Spacecraft	JPL	JPL	None
Sample Analysis at Mars (SAM)	JPL GSF	C	CNES (France)
Chemistry and Mineralogy Instrument (CheMin)	JPL AR	C	None

Acquisition Strategy

All major acquisitions are in place. All major instruments were competitively selected. Malin Space Systems, Honeybee Robotics, Lockheed Martin, and Aeroflex are providing support and hardware for the MSL mission.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
MPAR Project In Development:	Mars Science Lab

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	HQ/SRB	11/2010	Assess maturity of MSL design, technical state, and adequacy of resources. Design was deemed adequate to achieve mission science goals, but project needs additional time and resources to work the technical problems and perform adequate testing. The finding resulted in an additional $82.11 million, consistent with NASA risk management plan and strategy, to resolve problems and to ensure mission success.	03/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
MSL Landing Risk	If the MSL spacecraft does not successfully land on the Martian surface, then the science objectives will not be achieved.	To ensure success, conduct thorough verification and validation program that includes simulations of trajectory, approach, and landing operations to validate and refine procedures, and apply lessons learned from Phoenix and MER.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Mars Exploration**
MPAR Project In Development:	**MAVEN**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**9.9**	**48.1**	**-**	**240.3**	**140.6**	**34.9**	**15.4**	**4.7**	**-**	**-**
FY 2011 Costs			160.6							
CSLE				5.4	5.8	2.7	1.9	0.5		
Administrative Labor Adjustments		0.3								
2011 MPAR Project Cost Estimate	**9.9**	**48.4**	**160.6**	**245.7**	**146.4**	**37.6**	**17.3**	**5.3**	**0.0**	**671.2**
Formulation	9.9	48.4	5.5	0.0	0.0	0.0	0.0	0.0	0.0	63.9
Development	0.0	0.0	155.0	245.7	146.4	20.1	0.0	0.0	0.0	567.2
Operations	0.0	0.0	0.0	0.0	0.0	17.5	17.3	5.3	0.0	40.1

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Explanation of Project Changes

MAVEN received KDP-C decision approval on October 4, 2010. The above funding estimate reflects the October 2010 KDP-C decision, which included Electra and the awarded launch vehicle costs.

Project Purpose

Mars Atmosphere and Volatile EvolutioN (MAVEN) was selected in September 2008 under the 2006 Mars Scout AO. The MAVEN mission will provide a comprehensive picture of the Mars upper atmosphere, ionosphere, solar energetic drivers, and atmospheric losses. MAVEN will deliver answers to long-standing questions regarding the loss of Mars' atmosphere, climate history, liquid water, and habitability. MAVEN will provide the first direct measurements ever taken to address key scientific questions about Mars' evolution.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	Planetary Science
Program:	Mars Exploration
MPAR Project In Development:	MAVEN

Specific MAVEN science objectives are to:

- Determine structure and composition of the atmosphere and ionosphere;
- Determine the physical and chemical processes that control loss processes;
- Determine escape rates of neutrals;
- Determine escape rates of ions;
- Determine the external inputs that control upper atmosphere and ionosphere structure and that drive escape; and
- Determine the relative escape rates of the stable isotopes and the resulting isotopic fractionation.

Additional information can be found at http://www.nasa.gov/maven.

Project Parameters

MAVEN will deliver its science using three instrument packages: a stand-alone neutral gas and ion mass spectrometer (NGIMS), capable of measuring thermal neutrals and ions; a stand-alone imaging ultraviolet spectrometer (IUVS); and the Particles and Fields package, consisting of six instruments measuring ionospheric properties, energetic ions, solar wind and solar energetic particles, magnetic fields, and solar extreme ultraviolet irradiance.

Project Commitments

The MAVEN measurements will be made from an elliptical orbit with periapsis at 150 km and apoapsis at 6220 km (4.5-hour period). MAVEN will use a sun-pointing, three-axis stabilized spacecraft, with a two-axis gimballed, Mars-pointing platform for the NGIMS, IUVS, and the SupraThermal And Thermal Ion Composition (STATIC) instruments. The spacecraft has a body-mounted high-gain antenna.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Launch Services	United Launch Services	Atlas V Launch Service	New	Same (reported as intermediate class launch service; Atlas V now selected)
Spacecraft	Lockheed Martin	MRO-heritage spacecraft bus and avionic suite, with cross strapping and monopropellant propulsion system	New Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Planetary Science
Program: Mars Exploration
MPAR Project In Development: MAVEN

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Neutral Gas and Ion Mass Spectrometer (NGIMS)	GSFC	Mass Spectrometry Instrument	New Same	
Supra Thermal and Thermal Ion Composition (STATIC)	SSL	Part of the MAVEN particle and fields instrument package	New Same	
Solar Energetic Particles (SEP)	SSL	Part of the MAVEN particle and fields instrument package	New Same	
Solar Wind Electron Analyzer (SWEA)	SSL	Part of the MAVEN particle and fields instrument package	New Same	
Solar Wind Ion Analyzer (SWIA)	SSL	Part of the MAVEN particle and fields instrument package	New Same	
Lanamuir Probe and Waves and EUV (LPW/EUV)	LASP	Part of the MAVEN particle and fields instrument package	New Same	
Magnetometer GSF	C	Part of the MAVEN particle and fields instrument package	New Same	
Imaging Ultraviolet Spectrometer (IUVS)	LASP	Remote-Sensing Instrument package	New Same	
Electra	JPL	UHF Data Relay payload	New	Same

Schedule Commitments

NASA selected the second Mars Scout mission, MAVEN, for formulation on September 15, 2008. MAVEN was confirmed to proceed into implementation phase on October 4, 2010, with a November 2013 launch date and arrival at Mars in September 2014.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Formulation			
PDR 07/20	10	New	Same
Development			
CDR 07/20	11	New	Same
ATLO 07/20	12	New	Same
Launch 11/20	13	New	Same
Mars Orbit Insertion	09/2014	New	Same

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: Planetary Science
Program: Mars Exploration
MPAR Project In Development: MAVEN

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
Mars Atmosphere & Volatile EvolutioN	2011	567.2	2011	567.2	0	LRD	11/2013	11/2013	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**567.2**	**567.2**	**0.0**
Spacecraft	146.0	146.0	0.0
Payload(s)	51.1	51.1	0.0
Systems I&T	23.0	23.0	0.0
Launch Vehicle/Services	187.0	187.0	0.0
Ground Systems	5.2	5.2	0.0
Science/Technology	2.2	2.2	0.0
Other Direct Project Cost (w/project and HQ held UFE and ULA UFE)	152.7	152.7 0.0	

Project Management

The MAVEN project is part of the Mars Exploration Program managed for NASA by the Mars Program Office at JPL. The PI for MAVEN is from the University of Colorado and has delegated the day-to-day management of the MAVEN Project to GSFC.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Project management, mission systems engineering, safety and mission assurance, and project scientist	GSFC GSFC		
Neutral gas and ion mass spectrometer (NGIMS)	GSFC GSFC		

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**Planetary Science**
Program:	**Mars Exploration**
MPAR Project In Development:	**MAVEN**

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Navigation, trajectory, and orbit maintenance analysis	GSFC	JPL	
Magnetometer (MAG) - Measures interplanetary, solar wind, and ionospheric magnetic fields	GSFC	GSFC	
Payloads	GSFC	GSFC	CNES
Spacecraft	GSFC		
Mission Operations	GSFC		
Launch Vehicle	KSC	KSC	
Ground Systems	GSFC		
Systems Integration and Testing	GSFC	GSFC	
E/PO	HQ	GSFC	
Science	HQ	GSFC	

Acquisition Strategy

All major acquisitions are in place. MAVEN was selected competitively on September 15, 2008, under the Mars Scout 2006 Announcement of Opportunity (AO-NNH06ZDA002O).

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance	SRB	07/2010	The MAVEN Project passed the Preliminary Design Review (PDR)/Non-Advocacy Review (NAR) conducted by the independent Standing Review Board in July 2010.	07/2011

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
Single Point Failures on High Efficiency Power Supply (HEPS) Card	If single point failures on the input of the HEPS card occur, then permanent loss of spacecraft electrical power will result.	The project and Goddard Mission Assurance Office are identifying and understanding HEPS-specific manufacturing techniques; identifying all single point failures to inspect during assembly to mitigate against shorts; developing a plan for insight/oversight of the MAVEN-specific HEPS card build; and reviewing board requirements with an eye towards design robustness and remaining design requirements.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**James Webb Space Telescope**
Program:	**James Webb Space Telescope**
MPAR Project In Development:	**James Webb Space Telescope**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**2,552.30**	**438.7**	**-**	**354.87**	**359.35**	**365.26**	**371.60**	**371.62**	**-**	**-**
FY 2011 Costs			444.8							
CSLE				19.1	15.7	9.7	3.4	3.4		
Administrative Labor Adjustments		1.1								
CoF Adjustments		21.6	26.5	1.0						
2011 MPAR Project Cost Estimate	**2,552.3**	**461.4**	**471.3**	**375.0**	**375.0**	**375.0**	**375.0**	**375.0**	**TBD**	**TBD**

- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*
- *The row titled "CoF Adjustments" reflects the transfer of programmatic CoF (Construction of Facilities) to the Construction and Environmental Compliance and Restoration (CECR) account.*

Explanation of Project Changes

During 2010, JWST identified cost growth and schedule issues, which resulted in the formation of the ICRP. The ICRP charter was to determine the technical, management, and budgetary root causes of cost growth and schedule delay on JWST, to estimate the minimum cost to launch JWST, and to assess the associated launch date and budget profile. The ICRP report concluded that the problems causing cost growth and schedule delays on the JWST project are primarily associated with cost estimation and program management. The panel recommended several managerial changes at Headquarters and GSFC and some of these have already been implemented. The schedule for completing the JWST project within the budget provided will be re-evaluated as part of a replanning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

MPAR BASELINE & COST ESTIMATES	
Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
MPAR Project In Development:	James Webb Space Telescope

As indicated in NASA's letter to Congress on October 28, 2010, it is certain that the JWST baseline development cost and launch readiness date will be exceeded by more than 15 percent and six months.

Project Purpose

JWST is a large, deployable, space-based infrared astronomical observatory. The mission is a logical successor to the Hubble Space Telescope (HST), extending beyond Hubble's discoveries by looking into the infrared spectrum, where the highly red-shifted early universe must be observed, where cool objects like protostars and protoplanetary disks emit infrared light strongly, and where dust obscures shorter wavelengths.

The four main science goals are to:

- Search for the first galaxies or luminous objects formed after the Big Bang;
- Determine how galaxies evolved from their formation until now;
- Observe the formation of stars from the first stages to the formation of planetary systems; and
- Measure the physical and chemical properties of planetary systems and investigate the potential for life in those systems.

Hubble has greatly improved knowledge about distant objects, but its infrared coverage is limited. Light from distant galaxies is redshifted by the expansion of the universe into the infrared part of the spectrum (from the visible). By examining light redshifted beyond Hubble's sight, JWST will be able to observe things farther away, as their light has taken longer to reach us. Hence it will be looking back further in time.

JWST will explore the mysterious epoch when the first luminous objects in the universe came into being after the Big Bang. The focus of scientific study will include first light of the universe, assembly of galaxies, origins of stars and planetary systems, and origins of the elements necessary for life.

The telescope will launch from Kourou, French Guiana, on a ESA-supplied Ariane 5 rocket. Its operational location is the L2 point, which is about one million miles from the Earth.

For more information, please see: http://www.jwst.nasa.gov.

Project Parameters

JWST will be optimized for infrared astronomy, with some capability in the visible range. JWST's instruments are the Near Infrared Camera (NIRCam), MIRI, NIRSpec, and the Fine Guidance Sensor (FGS).

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Science
Theme:	James Webb Space Telescope
Program:	James Webb Space Telescope
MPAR Project In Development:	James Webb Space Telescope

NIRCam is an imager with a large field of view and high angular resolution. It covers a wavelength range of 0.6 - 5 micrometers and has 10 mercury-cadmium-telluride (HgCdTe) detector arrays. These are analogous to charge coupled devices found in ordinary digital cameras. NIRCam is a science instrument but also a wavefront sensor, which is used to align and focus the optical telescope.

NIRSpec enables scientists to obtain simultaneous spectra of more than 100 objects in a 9-square-arcminute field of view. It provides medium-resolution spectroscopy over a wavelength range from 0.6 - 5 micrometers. NIRSpec employs a micro-electromechanical system "microshutter array" for aperture control, and it has two HgCdTe detector arrays.

MIRI is an imager/spectrograph that covers the wavelength range of 5 - 28 micrometers and it has three arsenic-doped silicon detector arrays. The camera module provides wide-field broadband imagery, and the spectrograph module provides medium-resolution spectroscopy over a smaller field of view compared to the imager. The nominal operating temperature for MIRI is 7 degrees above absolute zero, which is possible through an on-board cooling system.

The FGS is a guider camera that is incorporated into the instrument payload in order to meet the image motion requirements of JWST. This sensor is used for both guide star acquisition and fine pointing. The sensor operates over a wavelength range of 1 - 5 micrometers and has two HgCdTe detector arrays. Its field of view provides a 95 percent probability of acquiring a guide star for any valid pointing direction. The FGS tunable filter camera is a wide-field, narrow-band camera that provides imagery over a wavelength range of 1.6 - 4.9 micrometers, via tunable Fabry-Perot etalons that are configured to illuminate the detector array with a single order of interference at a user-selected wavelength. The camera has a single HgCdTe detector array.

The JWST ground operations, Science Support Center, and archives will be at the Space Telescope Science Institute in Baltimore, MD.

Project Commitments

After launch, JWST will complete six months of on-orbit checkout and commissioning and five years of prime mission operations. JWST has a goal of 10 years of operations.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Observatory	Northrop Grumman Aerospace Systems, Redondo Beach, California	Includes Optical Telescope Element (OTE), Spacecraft, Sunshield, Observatory AI&T and commissioning. The Observatory shall be designed for at least a 5-year lifetime.	Same Same	

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science

Theme: James Webb Space Telescope

Program: James Webb Space Telescope

MPAR Project In Development: James Webb Space Telescope

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
Integrated Science Instrument Module (ISIM)	NASA Goddard Space Flight Center	Contains the Science Instruments (SIs) and Fine Guidance Sensor (FGS). Provides structural, thermal, power, command and data handling resources to the SIs and FGS.	Same Same	
Near-Infrared Camera (NIRCam) instrument	University of Arizona; Lockheed Martin	Optimized for finding first light sources, and operating over the wavelength range 0.6-5 microns.	Same Same	
Near-Infrared Spectrometer (NIRSpec)	European Space Agency (ESA)	Operating over the wavelength range 0.6-5 microns with three observing modes.	Same Same	
Mid-Infrared Instrument (MIRI)	ESA; University of Arizona; Jet Propulsion Laboratory	Operating over the wavelength range 5-27 microns, providing imaging, coronagraphy, and spectroscopy.	Same Same	
Fine Guidance Sensor	Canadian Space Agency (CSA)	Provides scientific target pointing information to the observatory's attitude control sub-system.	Same Same	
Launch Vehicle	European Space Agency (ESA)	Ariane V ECA	Same	Same
Science Operations Center and Mission Operations	Space Telescope Science Institute (STScI)	Mission Operations and Science Operations Center	Same Same	

Schedule Commitments

JWST was approved to enter implementation in July 2008 and completed CDR in April 2010.

The JWST project schedule, given the budget provided, is being re-evaluated as part of a re-planning activity and a new plan is expected in 2011. The results of this re-planning activity will be presented to Congress immediately upon completion of the work. In addition, NASA will keep Congress apprised of progress during development of the new baseline.

MPAR BASELINE & COST ESTIMATES

Mission Directorate: Science
Theme: James Webb Space Telescope
Program: James Webb Space Telescope
MPAR Project In Development: James Webb Space Telescope

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
Non-Advocate Review/Preliminary Design Review	March, 2008	Same	Same
Start phase C/Implementation	July 2008	Same	Same
Critical Design Review	April 2010	Same	Same
Systems Integration Review (SIR)	May 2012	February 2013	TBD
Launch Readiness Date	June 2014	Same	TBD
Start Phase E	December 2014	Same	TBD

Development Cost and Schedule Summary

Note: A current year cost and schedule estimate for JWST is being developed as part of the replanning activity which will be completed in 2011.

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
James Webb Space Telescope	2009	2,581.1	2011	TBD	TBD	Launch	06/2014	TBD	TBD

Development Cost Details

The JWST project development cost breakout is being developed as part of the replanning activity which will be completed in 2011.

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**2,581.1**	TBD	TBD
Payload	178.4	TBD	TBD
Spacecraft	875.4	TBD	TBD
Systems I&T	67.3	TBD	TBD
Ground Systems	206.8	TBD	TBD
Science/technology	10.5	TBD	TBD
Other (launch services and project management)	1,242.7	TBD	TBD
Programmatic Construction of Facilities (transferred to Construction appropriation)	0.0	TBD	TBD

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**James Webb Space Telescope**
Program:	**James Webb Space Telescope**
MPAR Project In Development:	**James Webb Space Telescope**

Project Management

Goddard Space Flight Center is responsible for JWST project management.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
Observatory	GSFC	GSFC	None
Mission management and System Engineering	GSFC	GSFC	None
Integrated Science Instrument Module (ISIM)	GSFC	GSFC	None
NIRCam	GSFC	GSFC	None
NIRSpec	ESA	None	ESA
MIRI	GSFC	JPL, ARC	ESA
Fine Guidance Sensor - Tunable Filter (FGS-TF)	CSA	None	CSA
Ariane 5 ESA launch vehicle and launch operations	ESA	None	ESA
Ground control systems and science operations and control center	GSFC	None	None

Acquisition Strategy

JWST is being built by Northrop Grumman Aerospace Systems (Redondo Beach, CA), with major subcontractors including Ball Aerospace (Boulder, CO), ITT (Rochester, NY), and Alliant Techsystems (Edina, MN). Selections were made via a NASA request for proposal.

The Space Telescope Science Institute (STScI), in Baltimore, MD, is developing the Science and Operations Center and associated services.

The Integrated Science Instrument Module (ISIM) is being provided by GSFC.

The University of Arizona at Tucson is providing NIRCam, along with Lockheed Martin's Advanced Technology Center in Palo Alto, CA. The selection was made via a NASA announcement of opportunity.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**James Webb Space Telescope**
Program:	**James Webb Space Telescope**
MPAR Project In Development:	**James Webb Space Telescope**

ESA is providing MIRI, with management and technical participation by ARC and JPL. ARC and JPL were selected for this role after an internal NASA competition. ESA is also providing NIRSpec and an Ariane 5 launch vehicle.

The Canadian Space Agency is providing the Fine Guidance Sensor.

Independent Reviews

Review Type	Performer	Last Review	Purpose/Outcome	Next Review
Performance SRB		04/2010	Critical Design Review. SRB found that mission design is mature and recommended a more in depth review of the integration and testing plan.	TBD
Quality	Test Assessment Team	08/2010	The TAT evaluated JWST plans for integration and testing. The TAT recommended several changes to the test plan. See the full report at http://www.jwst.nasa.gov/publications.html.	n/a
Other	Independent Comprehensive Review Panel	10/2010	The ICRP charter was to determine the technical, management and budgetary root causes of cost growth and schedule delay on JWST, and estimate the minimum cost to launch JWST, along with the associated launch date and budget profile, including adequate reserves. The report made 22 recommendations covering several areas of management and performance.	n/a
Performance	SRB	N/A	Systems Integration Review	TBD
Performance	SRB	N/A	Flight Readiness Review	TBD

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
JWST Cost and Schedule Growth	Projected FY 2011 ISIM and Northrop Grumman Aerospace Systems cost growth will exceed available budget, resulting in a work delay, and delaying the LRD. Inclusion of SRB-recommended verification enhancements will further impact cost and schedule.	Project replan is underway and will be complete in 2011.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Science**
Theme:	**James Webb Space Telescope**
Program:	**James Webb Space Telescope**
MPAR Project In Development:	**James Webb Space Telescope**

Title	Risk Statement	Risk Management Approach and Plan
JWST Sunshield Deployment	If the sunshield fails to deploy to its prescribed operational shape then mission science requirements cannot be met.	Full-scale deployment demonstration test bed will be used to verify all deployment designs. Extensive deployment testing will be conducted at temperature of all sunshield assemblies and components.

Corrective Action Plan (as submitted in Report on Program and Cost Assessment January 11, 2011 – as required under 1203)

NASA is undertaking multiple actions to correct the problems that resulted in the identified JWST cost and schedule issues. A detailed report of these actions is provided in NASA's detailed response to the recommendations of the Independent Comprehensive Review Team, provided to Congress separately. Changes already made include restructuring management and changing personnel at both NASA Headquarters and GSFC. In addition, the Headquarters Science Mission Directorate (SMD) is moving rapidly to provide rigorous, independent assessments of cost and schedule performance. SMD is arranging for experienced personnel to be dedicated to JWST cost and schedule analysis for the duration of JWST development. These personnel will report to the new JWST Program Director at NASA Headquarters. Moreover, utilizing the new management structure personnel and processes, the project is developing a revised cost and schedule baseline, to be completed, reviewed independently, and approved in 2011. NASA will keep Congress apprised of progress during development of the new baseline.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Space Operations Mission Directorate**
Theme:	**Space and Flight Support (SFS)**
Program:	**Space Communications and Navigation**
MPAR Project In Development:	**TDRS Replenishment**

2011 MPAR Project Cost Estimate

Budget Authority ($ millions)	Prior	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	BTC	LCC TOTAL
FY 2012 President's Budget Request	**369.0**	**25.4**	**-**	**1.0**	**11.4**	**0.0**	**0.0**	**0.0**	**-**	**-**
FY 2011 Costs			19.0							
CSLE				4.1	2.3					
Administrative Labor Adjustments		0.6								
2011 MPAR Project Cost Estimate	**370.3**	**26.0**	**19.0**	**5.1**	**13.7**	**0.0**	**0.0**	**0.0**	**0.0**	**434.1**
Formulation	241.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	241.9
Development	128.4	26.0	19.0	5.1	13.7	0.0	0.0	0.0	0.0	192.2
Operations	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

- *$1.3 difference in Prior accounts for FY 2006 expenditures under the Space Communications project, which was the initialization of TDRS Replenishment project.*
- *Space flight projects, per NASA's policy, are baselined and then budgeted to a confidence level of 70%. This confidence level is reflected in the project's estimated Life Cycle Cost Estimate (LCCE) at key decision point C.*
- *The row titled "FY 2012 President's Budget Request" is the equivalent of the same row in the Project in Development pages.*
- *The row titled "FY 2011 Costs" is the project's cost estimate for that year based on the 2010 Authorization Act as a guide for planning purposes. The FY 2011 appropriation for NASA was not enacted at the time that the FY 2012 Request was prepared; therefore, NASA is operating under a Continuing Resolution (P.L. 111-242, as amended).*
- *The row titled "CSLE" reflects the civil service labor and expenses (CSLE) in FY 2012 and beyond. CSLE funds are administered within a single consolidated account in each of the appropriations, and not allocated within the project's FY 2012 President's Budget Request amounts. CSLE funds are included in the projects' cost estimates (a full cost view).*
- *The row titled "Administrative Labor Adjustments" represents administrative costs in FY 2010 that transferred out of the project budget lines into the Center Management and Operations account. Administrative labor was defined as all civil servants not classified as scientists, engineers, mathematicians, medical, or quality assurance. These costs are included in the project LCCE.*

Project Purpose

The existing TDRSS fleet supports tracking, data, voice, and video services to the ISS, space and Earth science missions, as well as other Government agency users. The total mission load is predicted to increase, which will require additional satellites to be added to the fleet. The existing fleet is aging and reliability analyses predict a shortage of flight assets to support NASA missions and the user community by FY 2011. To meet this requirement, in FY 2007, NASA began the acquisition of two additional spacecraft, TDRS-K and TDRS-L. TDRS-K is scheduled to be launched in December 2012, although NASA is evaluating the possibility of launching as early as April 2012. TDRS-L is scheduled for launch in December 2013. By adding these two spacecraft to the TDRSS fleet, continuity of service will be insured for NASA and other Government agency user missions through at least FY 2016. The

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Space Operations Mission Directorate**
Theme:	**Space and Flight Support (SFS)**
Program:	**Space Communications and Navigation**
MPAR Project In Development:	**TDRS Replenishment**

TDRS Replenishment project supports future Agency requirements and technology initiatives consistent with the approved baseline of the SCaN architecture.

Project Parameters

TDRSS consists of in-orbit telecommunications satellites stationed at a geosynchronous altitude with associated ground stations located at White Sands and Guam. This system of satellites and ground stations is SN providing services for near-Earth user satellites and orbiting resources. SN supports spacecraft that depend on it for reliable services to continue their missions. The TDRSS constellation includes first and the second generation satellites.

Project Commitments

The TDRS-K and TDRS-L spacecraft will be fully compatible and capable of functioning as a part of the existing TDRSS. Contract requirements are design, development, fabrication, integration, test, on-orbit acceptance, and launch vehicle and services. Launch dates for TDRS-K and TDRS-L are in December 2012 (or possibly as early as April 2012) and December 2013, respectively. The spacecraft are required to have an operational life of 11 years. The basic requirement will also include modification of the White Sands SGLT to provide compatibility with the new spacecraft.

Project Element	Provider	Description	FY 2011 PB Request	FY 2012 PB Request
TDRS Replenishment	NASA	Aging hardware replacement	Same Same	

Schedule Commitments

The TDRS Replenishment project was approved for entry into Phase C, development, in July 2009. The launch vehicle and payload will be delivered to KSC for processing to meet the TDRS-K and TDRS-L launch dates.

Milestone Name	Confirmation Baseline	FY 2011 PB Request	FY 2012 PB Request
Development			
TDRS System Critical Design Review (CDR)	January 2010	N/A	Same
TDRS Systems Integration Review (SIR)	January 2011	N/A	Same
TDRS Flight Readiness Review (FRR)	November 2012	N/A	Same
TDRS K Launch Readiness Date (LRD)	December 2012	N/A	Same
TDRS L Launch Readiness Date (LRD)	December 2013	N/A	Same

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	**Space Operations Mission Directorate**
Theme:	**Space and Flight Support (SFS)**
Program:	**Space Communications and Navigation**
MPAR Project In Development:	**TDRS Replenishment**

Development Cost and Schedule Summary

Project	Base Year	Base Year Develop-ment Cost Estimate ($M)	Current Year	Current Year Develop-ment Cost Estimate ($M)	Cost Change (%)	Key Milestone	Base Year Milestone Date	Current Year Milestone Date	Milestone Change (months)
TDRS Replenishment	2010	209.4	2011	192.2	-8	LRD	12/2013	12/2013	0

Development Cost Details

Element	Base Year Development Cost Estimate ($M)	Current Year Development Cost Estimate ($M)	Delta
Total:	**209.4**	**192.2**	**-17.2**
Aircraft/Spacecraft	56.7	71.7	15
Ground Systems	53.7	53.7	0
Other Direct Project Cost	99.0	66.8	-32.2

Project Management

The Deputy Associate Administrator for SCaN reports to the Associate Administrator for Space Operations at NASA Headquarters.

Project Element	Project Management Responsibility	NASA Center Performers	Cost-Sharing Partners
TDRS Replenishment	Space Communications and Navigation (SCAN) Program Office - NASA Headquarters	Goddard Space Flight Center, Kennedy Space Center	US Government Agencies

Acquisition Strategy

The TDRS K and L project is providing follow-on and replacement spacecraft necessary to maintain and expand the Space network. The contract to build two additional TDRS spacecraft was awarded to Boeing Satellite Systems in December 2007. In addition to building the TDRS K and L spacecraft, the contract also includes the modifications to the White Sands Complex ground system required to support these new spacecraft. The contract also provides fixed price options to procure two additional satellites, and NASA is using the TDRS reliability model -- in consultation with TDRS users -- to assess future requirements for the TDRS constellation and determine whether the Government needs to exercise the options.

MPAR BASELINE & COST ESTIMATES

Mission Directorate:	Space Operations Mission Directorate
Theme:	Space and Flight Support (SFS)
Program:	Space Communications and Navigation
MPAR Project In Development:	TDRS Replenishment

Project Risk Management

Title	Risk Statement	Risk Management Approach and Plan
TDRS-K and TDRS-L Obsolescence Risk Management	Aging spacecraft requires replacement hardware by FY 2013. The mission load is predicted to exceed current capacity and will need additional spacecraft to provide enough capacity.	The project has awarded a firm fixed price with incentive fee contract as of December 2007 to Boeing Satellite Systems, Inc. Spacecraft will launch in December 2012 and December 2013, respectively.

NASA's FY 2011 and FY 2012 Annual Performance Plans

NASA's 2011 Strategic Plan unveils the Agency's new direction and new strategic goals. NASA has updated its annual performance plans (APPs) to reflect this new direction. In concert with this effort, NASA is transitioning to a new performance framework with a focus on increased transparency and accountability. A brief discussion of the new framework appears below, followed by NASA's FY 2011 and FY 2012 APPs. Due to the change in NASA's performance structure, performance trends for past years mapped to the new performance framework are presented in the following FY 2011 and FY 2012 APPs.

The new performance framework consists of five levels of performance measures. The strategic goals form the top of the framework with four distinct levels supporting the achievement of the overarching goals. Those supporting levels are outcomes, objectives, performance goals, and annual performance goals. Each performance measure level is associated with a specific timeframe.

The strategic goals and outcomes form the top tier of NASA's new performance framework and reflect NASA's long-term plans for the next 10 to 20 years and beyond. These strategic goals may be supported by multiple NASA directorates and offices (see figure 1). In NASA's previous performance framework, Agency-wide activities (formerly represented in Cross-Agency Support) were not previously linked to a specific strategic goal. In NASA's new framework, these activities are now fully incorporated into the goal structure. Strategic goals and outcomes represent the overall direction of the Agency and are the result of intense internal planning and external consultation with the Agency's stakeholders. Reaching out to external stakeholders for their input ensures that NASA has the Nation's goals in mind as the Agency sets its course.

While the strategic goals and outcomes are focused on long-term activities, the objectives, performance goals, and APGs set quantifiable targets for programs, projects, and offices within NASA. Objectives identify targets that span the next 10 years and form the measureable framework for NASA's APPs. These objectives, in turn, are supported by performance goals which focus on planned progress over the next three to five years, with specific annual performance goals (APGs) aligned to the annual budget request.

NASA's former performance framework, consisted of three levels of performance measures: strategic goals (and sub-goals), outcomes, and annual performance goals (APGs). The addition of objectives and performance goals to the new performance framework provides increased transparency into NASA's mid- and near-term plans and performance. (Please see figure 2 for a comparison of NASA's former performance framework to the new performance framework.)

NASA reports progress on each APP to Congress and the public in the Agency's annual Performance and Accountability Report, which supports programmatic decision-making at a government-wide level as well as providing feedback to NASA regarding progress towards its Strategic Goals. NASA's performance framework is also an important tool for communicating with stakeholders and the public. Through this framework, NASA is held accountable for the Nation's investment in NASA's programs and missions, reporting on achievements as well as shortfalls, and informing planning performance for the next year.

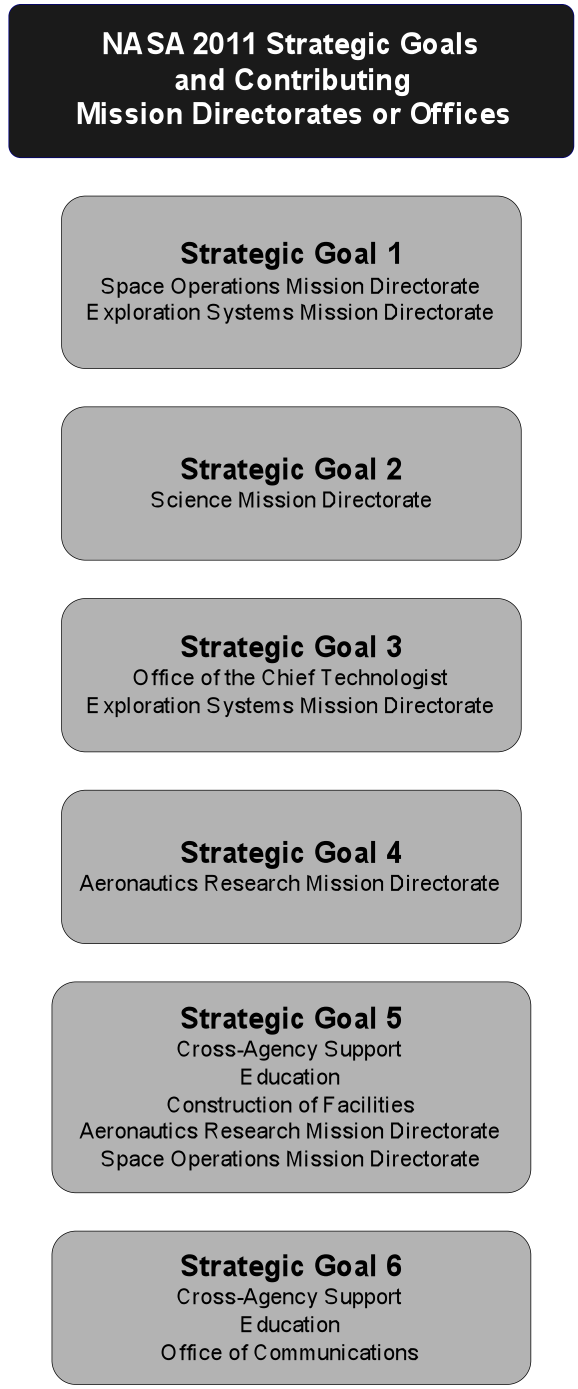

Figure 1: NASA's strategic goals and the Mission Directorates and Mission Support Offices that contribute to each goal.

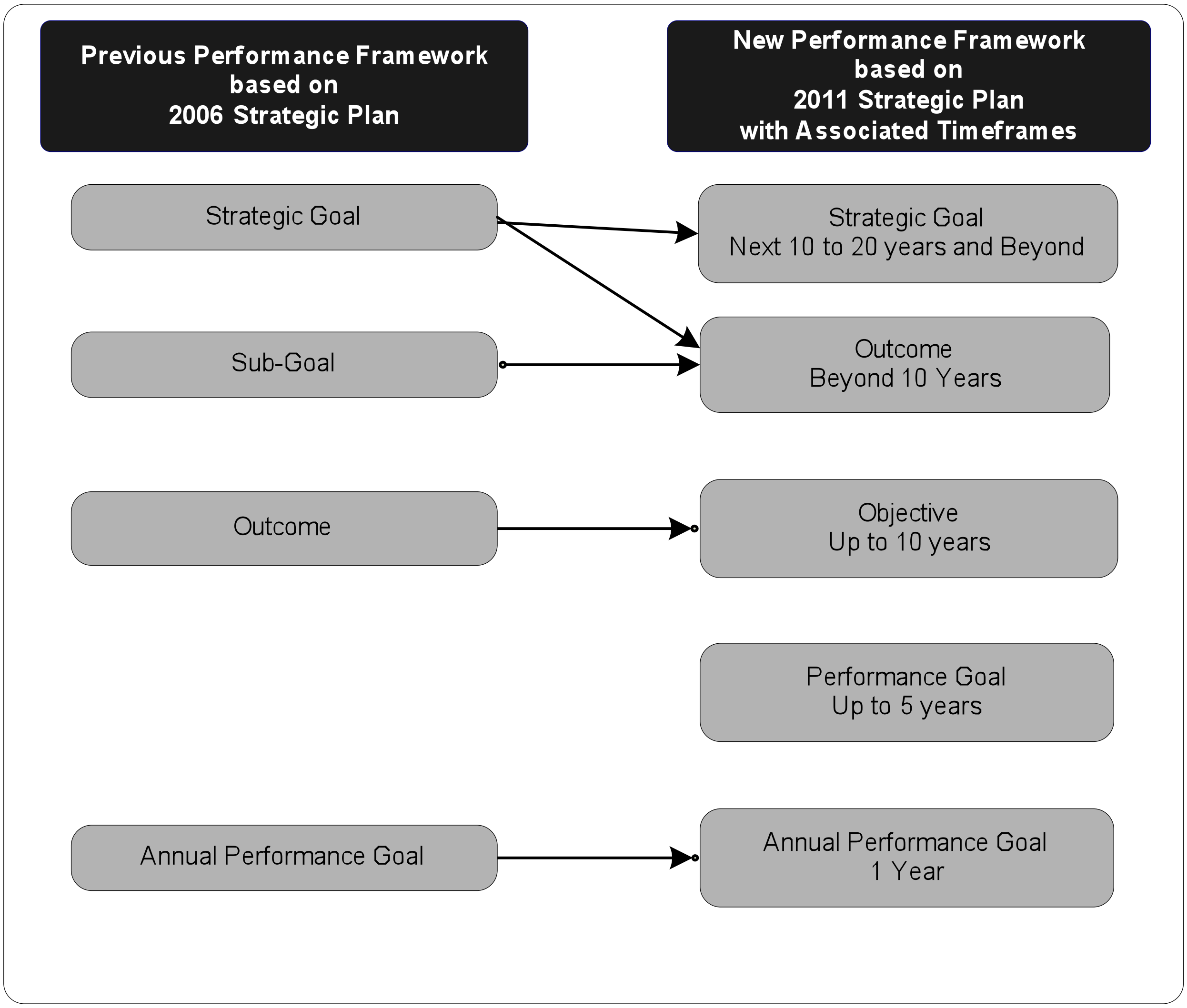

Figure 2: NASA's new performance framework compared to NASA's previous performance framework.

FY 2011 Performance Plan Narrative

The enclosed FY 2011 Performance Plan reflects the current prioritization of Agency programs and projects. In NASA's FY 2011 Budget Estimates, NASA did not include the FY 2011 Performance Plan due to programmatic shifts in direction from the President. NASA chose to align the FY 2011 Performance Plan with the Agency's new 2011 Strategic Plan, hence, the FY 2011 Performance Plan is being presented here for the first time.

The following table provides a summary of all of the Agency commitments identified in the preceding sections of this document.

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 1	**Extend and sustain human activities across the solar system.**		
Outcome 1.1	**Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.**		
Objective 1.1.1	**Maintain resources (on orbit and on the ground) to operate and utilize the ISS.**		
Performance Goal 1.1.1.1	***Maintain capability for six on-orbit crew members.***		
APG 1.1.1.1: ISS-11-1	In concert with the International Partners, maintain a continuous crew presence on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station Program	International Space Station
Performance Goal 1.1.1.2	***HPPG: Safely fly out the Space Shuttle manifest and retire the fleet.***		
APG 1.1.1.2: SSP-11-1	Release major Space Shuttle operations facilities at Kennedy Space Center for future institutional and programmatic use.	Space Shuttle Program	Space Shuttle
Performance Goal 1.1.1.3	***Provide cargo and crew transportation to support on-orbit crew members and utilization.***		
APG 1.1.1.3: ISS-11-2	Fly the ISS elements, spares, logistics, and utilization hardware as agreed to by the International Partners in the ISS transportation plan.	International Space Station Program	International Space Station
Performance Goal 1.1.1.4	***Maintain and operate a safe and functional ISS.***		
APG 1.1.1.4: ISS-11-3	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.	International Space Station Program	International Space Station
APG 1.1.1.4: ISS-11-4	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps.	International Space Station Program	International Space Station

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 1.1.2	**Advance engineering, technology, and research capabilities on the ISS.**		
Performance Goal 1.1.2.1	***Advance knowledge of long-duration human space flight by establishing agreements with organizations to enable full utilization of the ISS.***		
APG 1.1.2.1: ISS-11-5	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2011.	International Space Station Program	International Space Station
Performance Goal 1.1.2.2	***Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.***		
APG 1.1.2.2: ERD-11-1	Develop at least two life sciences flight payloads for ISS or Free Flyer platforms.	Advanced Explorations Systems	Exploration Research and Development
APG 1.1.2.2: ERD-11-2	Deliver at least five physical sciences payloads for launch to the ISS.	Advanced Explorations Systems	Exploration Research and Development
APG 1.1.2.2: ERD-11-3	Conduct at least five experiments in combustion, fluids, or materials sciences on the ISS.	Advanced Explorations Systems	Exploration Research and Development
Outcome 1.2	**Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.**		
Objective 1.2.1	**Enable the commercial sector to provide cargo and crew services to the International Space Station (ISS).**		
Performance Goal 1.2.1.1	***Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.***		
APG 1.2.1.1: CS-11-1	Conduct a minimum of one commercial cargo demonstration flight of new cargo transportation systems.	Commercial Cargo	Commercial Spaceflight
APG 1.2.1.1: CS-11-2	Conduct a minimum of one commercial cargo demonstration flight of proximity operations with ISS.	Commercial Cargo	Commercial Spaceflight
APG 1.2.1.1: CS-11-3	Conduct a minimum of one safe berthing of commercial cargo transportation systems with the ISS.	Commercial Cargo	Commercial Spaceflight
APG 1.2.1.1: CS-11-4	Release announcement for the development of commercial crew transportation systems (CCDev2).	Commercial Crew	Commercial Spaceflight
Performance Goal 1.2.1.2	***Develop and document evaluation and certification processes for an integrated commercial crew transportation system.***		
APG 1.2.1.2: CS-11-5	Develop NASA processes and requirements required to ensure crew safety to and from the ISS and other NASA and low Earth orbit destinations.	Commercial Crew	Commercial Spaceflight

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 1.3	**Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.**		
Objective 1.3.1	**Execute development of an integrated architecture to conduct human space exploration missions beyond low Earth orbit.**		
Performance Goal 1.3.1.1	***Complete design reviews for Space Launch System (SLS).***		
APG 1.3.1.1: HEC-11-1	Develop top-level Agency requirements and draft Program Plan for Space Launch System (SLS).	Space Launch System	Human Exploration Capabilities
Performance Goal 1.3.1.2	***Complete design reviews for Multi-Purpose Crew Vehicle (MPCV).***		
APG 1.3.1.2: HEC-11-2	Develop top-level Agency requirements and Program Plan for Multi-Purpose Crew Vehicle (MPCV).	Multi-Purpose Crew Vehicle	Human Exploration Capabilities
Objective 1.3.2	**Develop a robust biomedical research portfolio to mitigate space human health risks.**		
Performance Goal 1.3.2.1	***Develop technologies that enable biomedical research and mitigate space human health risks associated with human space exploration missions.***		
APG 1.3.2.1: ERD-11-4	Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Human Research	Exploration Research and Development
Performance Goal 1.3.2.2	***Perform research to ensure that future human crews are protected from the deleterious effects of space radiation.***		
APG 1.3.2.2: ERD-11-5	Complete the independent assessment of the updated NASA Space Radiation Cancer Risk Model used to project the cancer risk for current ISS crews and future exploration missions.	Human Research	Exploration Research and Development
Performance Goal 1.3.2.3	***Develop exploration medical capabilities for long-duration space missions.***		
APG 1.3.2.3: ERD-11-6	Develop and begin implementation of a research plan to address a recently discovered risk to crewmembers involving microgravity-induced visual alterations.	Human Research	Exploration Research and Development

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**		
Outcome 2.1	**Advance Earth system science to meet the challenges of climate and environmental change.**		
Objective 2.1.1	**Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**		
Performance Goal 2.1.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.1.1: ES-11-1	Demonstrate planned progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.1.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.1.2: ES-11-2	Complete the Aquarius Launch Readiness Review.	Earth System Science Pathfinder	Earth Science
APG 2.1.1.2: ES-11-3	Initiate the Orbiting Carbon Observatory-2 (OCO-2) Instrument and Spacecraft System-Level Testing.	Earth System Science Pathfinder	Earth Science
APG 2.1.1.2: ES-11-4	Release Earth Venture 2 (EV-2) Announcement of Opportunity.	Earth System Science Pathfinder	Earth Science
Objective 2.1.2	**Enable improved predictive capability for weather and extreme weather events.**		
Performance Goal 2.1.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.2.1: ES-11-5	Demonstrate planned progress in enabling improved predictive capability for weather and extreme weather events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.2.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.2.2: ES-11-6	Complete the Global Precipitation Mission (GPM) Systems Integration Review.	Earth Systematic Missions	Earth Science

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.1.3	**Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity.**		
Performance Goal 2.1.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.3.1: ES-11-7	Demonstrate planned progress in quantifying, understanding, and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.3.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.3.2: ES-11-8	Complete the Landsat Data Continuity Mission (LDCM) Mission Operations Review.	Earth Systematic Missions	Earth Science
APG 2.1.3.2: ES-11-3	Initiate the Orbiting Carbon Observatory-2 (OCO-2) Instrument and Spacecraft System-Level Testing.	Earth System Science Pathfinder	Earth Science
Objective 2.1.4	**Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.**		
Performance Goal 2.1.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.4.1: ES-11-9	Demonstrate planned progress in quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.4.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.4.2: ES-11-10	Complete the Soil Moisture Active-Passive (SMAP) Confirmation Review.	Earth Systematic Missions	Earth Science
APG 2.1.4.2: ES-11-3	Complete the Aquarius Launch Readiness Review.	Earth System Science Pathfinder	Earth Science
APG 2.1.4.2: ES-11-6	Complete the Global Precipitation Mission (GPM) Systems Integration Review.	Earth Systematic Missions	Earth Science
Objective 2.1.5	**Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.**		
Performance Goal 2.1.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.5.1: ES-11-11	Demonstrate planned progress in understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 2.1.5.2	***HPPG: Study Earth from space to understand climate change, weather, and human impact on our planet by launching at least two missions by 2015.***		
APG 2.1.5.2: ES-11-12	Complete the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP) Mission Readiness Review.	Earth Systematic Missions	Earth Science
APG 2.1.5.2: ES-11-13	Complete the Glory Launch Readiness Review.	Earth Systematic Missions	Earth Science
Performance Goal 2.1.5.3	***By 2015, launch at least three missions in support of this objective.***		
APG 2.1.5.3: ES-11-14	Complete the ICESat-2 Spacecraft System Requirements Review.	Earth System Science Pathfinder	Earth Science
APG 2.1.5.3: ES-11-3	Initiate the Orbiting Carbon Observatory-2 (OCO-2) Instrument and Spacecraft System-Level Testing.	Earth System Science Pathfinder	Earth Science
Objective 2.1.6	**Characterize the dynamics of Earth's surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.**		
Performance Goal 2.1.6.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.6.1: ES-11-15	Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.6.2	***By 2015, launch at least one mission in support of this objective.***		
APG 2.1.6.2: ES-11-8	Complete the Landsat Data Continuity Mission (LDCM) Mission Operations Review.	Earth Systematic Missions	Earth Science
Objective 2.1.7	**Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.**		
Performance Goal 2.1.7.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.7.1: ES-11-16	Conduct impact analyses of two projects that apply NASA Earth science research to support decision-making activities.	Applied Sciences	Earth Science
APG 2.1.7.1: ES-11-17	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science Research	Earth Science
APG 2.1.7.1: ES-11-18	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research	Earth Science

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 2.2	**Understand the Sun and its interactions with Earth and the solar system.**		
Objective 2.2.1	**Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**		
Performance Goal 2.2.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.2.1.1: HE-11-1	Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Heliophysics
Performance Goal 2.2.1.2	***By 2015, launch two missions in support of this outcome.***		
APG 2.2.1.2: HE-11-2	Complete the Magnetospheric MultiScale (MMS) Mission Operations Center and Science Operations Center Preliminary Design Review.	Solar Terrestrial Probes	Heliophysics
APG 2.2.1.2: HE-11-3	Complete the Geospace Radiation Belt Storm Probes Systems Integration Review.	Living with a Star	Heliophysics
Objective 2.2.2	**Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.**		
Performance Goal 2.2.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.2.2.1: HE-11-4	Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Heliophysics
Performance Goal 2.2.2.2	***By 2015, launch two missions in support of this outcome.***		
APG 2.2.2.2: HE-11-2	Complete the Magnetospheric MultiScale (MMS) Mission Operations Center/Science Operations Center Preliminary Design Review.	Solar Terrestrial Probes	Heliophysics
APG 2.2.2.2: HE-11-3	Complete the Geospace Radiation Belt Storm Probes Systems Integration Review.	Living with a Star	Heliophysics

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.2.3	**Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.**		
Performance Goal 2.2.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.2.3.1: HE-11-5	Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Heliophysics
Performance Goal 2.2.3.2	***By 2017, launch at least two missions in support of this outcome.***		
APG 2.2.3.2: HE-11-3	Complete the Geospace Radiation Belt Storm Probes Systems Integration Review.	Living with a Star	Heliophysics
Outcome 2.3	**Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.**		
Objective 2.3.1	**Inventory solar system objects and identify the processes active in and among them.**		
Performance Goal 2.3.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.1.1: PS-11-1	Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
APG 2.3.1.1: PS-11-2	Achieve arrival of Dawn at Vesta.	Discovery	Planetary Science
Performance Goal 2.3.1.2	***By 2015, launch at least two missions in support of this outcome.***		
APG 2.3.1.2: PS-11-3	Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers	Planetary Science
Objective 2.3.2	**Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.**		
Performance Goal 2.3.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.2.1: PS-11-4	Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
APG 2.3.2.1: PS-11-5	Complete the MESSENGER Mercury Orbit Insertion.	Discovery	Planetary Science

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 2.3.2.2	***By 2015, launch at least three missions in support of this outcome.***		
APG 2.3.2.2: PS-11-3	Complete the mission concept studies for the New Frontiers 3 mission.	New Frontiers	Planetary Science
APG 2.3.2.2: PS-11-6	Complete the Juno Launch Readiness Review.	New Frontiers	Planetary Science
APG 2.3.2.2: PS-11-7	Complete the Gravity Recovery and Interior Laboratory (GRAIL) Pre-Ship Review.	Discovery	Planetary Science
Objective 2.3.3	**Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.**		
Performance Goal 2.3.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.3.1: PS-11-8	Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
Performance Goal 2.3.3.2	***By 2015, launch at least two missions in support of this outcome.***		
APG 2.3.3.2: PS-11-10	Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Confirmation Review.	Mars Exploration	Planetary Science
APG 2.3.3.2: PS-11-9	Complete the Mars Science Laboratory (MSL) Pre-Ship Review.	Mars Exploration	Planetary Science
Objective 2.3.4	**Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.**		
Performance Goal 2.3.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.4.1: PS-11-11	Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.3.5	**Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.**		
Performance Goal 2.3.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.5.1: PS-11-12	Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
Performance Goal 2.3.5.2	***Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.***		
APG 2.3.5.2: PS-11-13	Develop an archive of high resolution images of the moon from the Lunar Reconnaissance Orbiter (LRO) necessary for human space exploration to determine potential landing sites.	Multiple Programs	Planetary Science
Outcome 2.4	**Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.**		
Objective 2.4.1	**Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity.**		
Performance Goal 2.4.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.4.1.1: AS-11-1	Demonstrate planned progress in understanding the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Astrophysics
Performance Goal 2.4.1.2	***By 2015, launch at least one mission in support of this outcome.***		
APG 2.4.1.2: AS-11-2	Complete the Nuclear Spectroscopic Telescope Array (NuSTAR) Systems Integration Review.	Astrophysics Explorer	Astrophysics

FY 2011 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.4.2	**Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.**		
Performance Goal 2.4.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.4.2.1: AS-11-3	Demonstrate planned progress in understanding the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Astrophysics
Performance Goal 2.4.2.2	***Design and assemble James Webb Space Telescope (JWST).***		
APG 2.4.2.2: JWST-11-1	Complete new James Webb Space Telescope (JWST) mission re-baseline.	James Webb Space Telescope	James Webb Space Telescope
Performance Goal 2.4.2.3	***Develop and operate an airborne infrared astrophysics observatory.***		
APG 2.4.2.3: AS-11-4	Initiate the Stratospheric Observatory for Infrared Astronomy (SOFIA) science observations.	Cosmic Origins	Astrophysics
Objective 2.4.3	**Generate a census of extra-solar planets and measure their properties.**		
Performance Goal 2.4.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.4.3.1: AS-11-5	Demonstrate planned progress in generating a census of extra-solar planets and measuring their properties. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Astrophysics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**		
Outcome 3.1	**Sponsor early-stage innovation in space technologies in order to improve the future capabilities of NASA, other government agencies, and the aerospace industry.**		
Objective 3.1.1	**Create a pipeline of new low Technology Readiness Levels (TRL) innovative concepts and technologies for future NASA missions and national needs.**		
Performance Goal 3.1.1.1	***Explore revolutionary aerospace concepts, with an initial research phase for preliminary assessment of a broad range of ideas, and a second phase for further development of the most promising concepts.***		
APG 3.1.1.1: ST-11-1	Initiate 10 Phase I research efforts to explore revolutionary aerospace ideas.	Crosscutting Space Technology Development	Space Technology
Performance Goal 3.1.1.2	***Provide cash prize incentives to non-traditional sources for innovations of interest and value to NASA and the Nation.***		
APG 3.1.1.2: ST-11-2	Conduct at least two Centennial Challenge competitions.	Crosscutting Space Technology Development	Space Technology
Performance Goal 3.1.1.3	***Establish and maintain a culture of innovation at each of the 10 NASA Centers through the development of new Center ideas and technologies.***		
APG 3.1.1.3: ST-11-3	Twenty innovative projects will be initiated across the NASA Centers.	Crosscutting Space Technology Development	Space Technology
Performance Goal 3.1.1.4	***Increase the proportion of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies successfully infused into NASA programs/projects.***		
APG 3.1.1.4: ST-11-4	At least 24 percent of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase II technology projects awarded between 2006-2010 will be infused into NASA programs and projects.	SBIR and STTR	Space Technology
Performance Goal 3.1.1.5	***Increase the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase III contracts initiated or expanded.***		
APG 3.1.1.5: ST-11-5	At least 40 of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies will be advanced to Phase III (received non-SBIR/STTR funding).	SBIR and STTR	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 3.1.1.6	***Accelerate the development of push technologies to support the future space, science and exploration needs of NASA, other government agencies, and the commercial space sector.***		
APG 3.1.1.6: ST-11-6	Select 100 NASA space technology research activities.	Crosscutting Space Technology Development	Space Technology
Outcome 3.2	**Infuse game changing and crosscutting technologies throughout the Nation's space enterprise to transform the Nation's space mission capabilities.**		
Objective 3.2.1	**Prove the technical feasibility of potentially disruptive new space technologies for future missions.**		
Performance Goal 3.2.1.1	***Transition developed game changing technologies to the technology demonstration programs or directly to Mission Directorates for mission insertion.***		
APG 3.2.1.1: ST-11-7	Initiate 10 conceptual studies to define potential game changing development projects.	Crosscutting Space Technology Development	Space Technology
Objective 3.2.2	**Spur the development of routine, low-cost access to space through small payloads and satellites.**		
Performance Goal 3.2.2.1	***Mature technologies that enable small satellites to provide game changing capabilities for the government and commercial space sectors.***		
APG 3.2.2.1: ST-11-8	Initiate development of at least one new technology with game changing potential for small satellites.	Crosscutting Space Technology Development	Space Technology
Objective 3.2.3	**Demonstrate new space technologies and infuse them into future science and exploration small satellite missions and/or commercial use.**		
Performance Goal 3.2.3.1	***Demonstrate small satellite capabilities with game changing and crosscutting potential for the government and commercial space sectors.***		
APG 3.2.3.1: ST-11-9	Initiate at least one new small satellite mission that will demonstrate game changing or crosscutting technologies in space.	Crosscutting Space Technology Development	Space Technology
Objective 3.2.4	**Demonstrate new space technologies and infuse them into missions.**		
Performance Goal 3.2.4.1	***Infuse game changing and crosscutting technologies into future NASA missions through flight or relevant environment demonstrations.***		
APG 3.2.4.1: ST-11-10	Select two candidate system level technologies that will provide new capabilities for future missions.	Crosscutting Space Technology Development	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 3.2.5	**Provide flight opportunities and relevant environments to demonstrate new space technologies.**		
Performance Goal 3.2.5.1	***Perform sub-orbital, simulated zero-gravity and other space analog flight opportunities to develop and demonstrate emerging ideas and technologies.***		
APG 3.2.5.1: ST-11-11	Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least three commercial reusable suborbital and parabolic platform providers.	Crosscutting Space Technology Development	Space Technology
Outcome 3.3	**Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.**		
Objective 3.3.1	**Demonstrate in-space operations of robotic assistants working with crew.**		
Performance Goal 3.3.1.1	***Demonstrate robotic technologies that support in-space operations, scientific discovery, and work as assistants with the crew.***		
APG 3.3.1.1: ERD-11-7	Launch Robonaut 2 to the ISS and demonstrate teleoperation from the ground.	Exploration Technology Development	Space Technology
Objective 3.3.2	**Develop and demonstrate critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.**		
Performance Goal 3.3.2.1	***Develop advanced spacesuits to improve the ability of astronauts to conduct Extra-Vehicular Activity (EVA) operations in space including assembly and service of in-space systems and exploration of surfaces of the Moon, Mars, near-Earth objects (NEOs), and other small bodies.***		
APG 3.3.2.1: ERD-11-8	Test breadboard Extra-Vehicular Activity (EVA) Portable Life Support System (PLSS) technologies to enable advanced spacesuits for human deep space exploration.	Advanced Explorations Systems	Exploration Research and Development
Performance Goal 3.3.2.2	***Develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer making exploration and science missions more affordable and capable.***		
APG 3.3.2.1: ST-11-12	Develop and test Liquid Acquisition Devices (LADs) and mass-gauging to support future Cryogenic Propellant Storage And Transfer (CRYOSTAT) missions.	Exploration Technology Development	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 3.4	**Facilitate the transfer of NASA technology and engage in partnerships with other government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.**		
Objective 3.4.1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and national interests.**		
Performance Goal 3.4.1.1	***Establish 12 technology-related significant partnerships that create value for programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g., reduced volume or mass, improved safety) per year.***		
APG 3.4.1.1: ST-11-13	Establish at least 12 technology-related significant partnerships during FY 2011.	Partnership Development and Strategic Integration	Space Technology
Performance Goal 3.4.1.2	***Complete 30 technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements per year.***		
APG 3.4.1.2: ST-11-14	Complete at least 30 technology transfer agreements during FY 2011.	Partnership Development and Strategic Integration	Space Technology
Performance Goal 3.4.1.3	***Successful application of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies into commercial products or services.***		
APG 3.4.1.3: ST-11-15	Greater than 35 percent of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase II technology projects awarded between 2006-2010 will be transferred into commercial products or services.	SBIR and STTR	Space Technology
Performance Goal 3.4.1.4	***Document 40-50 of the most notable examples of successful transfer and commercialization of NASA-derived technology per year and publish in Spinoff annually.***		
APG 3.4.1.4: ST-11-16	Document at least 40 notable technology transfer successes in NASA's Spinoff publication.	Partnership Development and Strategic Integration	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 3.4.1.5	***Document, coordinate, and prioritize Agency-level technology strategic investments to ensure NASA has a balanced portfolio of both near-term NASA mission (pull) technologies and longer-term transformational (push) technologies that benefit both Agency programs and national needs.***		
APG 3.4.1.5: ST-11-17	Develop an Agency technology portfolio database to track technology investments and create space technology roadmaps that prioritize these investments.	Partnership Development and Strategic Integration	Space Technology
Strategic Goal 4	**Advance aeronautics research for societal benefit.**		
Outcome 4.1	**Develop innovative solutions and advanced technologies through a balanced research portfolio to improve current and future air transportation.**		
Objective 4.1.1	**Develop advanced technologies to improve the overall safety of the future air transportation system.**		
Performance Goal 4.1.1.1	***Transfer knowledge to the aviation community to better manage safety in aviation.***		
APG 4.1.1.1: AR-11-1	Demonstrate scalable anomaly detection on heterogeneous data.	Aviation Safety	Aeronautics
APG 4.1.1.1: AR-11-2	Demonstrate self-healing material concepts to mitigate damage in structural elements.	Aviation Safety	Aeronautics
Objective 4.1.2	**Develop innovative solutions and technologies to meet future capacity and mobility requirements of the Next Generation Air Transportation System (NextGen).**		
Performance Goal 4.1.2.1	***HPPG: Increase efficiency and throughput of aircraft operations during arrival phase of flight.***		
APG 4.1.2.1: AR-11-3	Conduct simulations of initial tactical conflict prediction and resolution advisory functions to address reduction in false alerts and increase in time to detect a loss of separation in terminal operations.	Airspace Systems	Aeronautics
APG 4.1.2.1: AR-11-4	Specify operational requirements for performing Multi-Sector Planning (MSP) functions in the mid-term, including technical and conceptual requirements, with consideration of how requirements might change as the National Airspace System (NAS) evolves towards NextGen.	Airspace Systems	Aeronautics
APG 4.1.2.1: AR-11-5	Report on human-in-the-loop (HITL) simulation and model results. (HPPG milestone)	Airspace Systems	Aeronautics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 4.1.3	**Develop tools, technologies, and knowledge that enable significantly improved performance and new capabilities for future air vehicles.**		
Performance Goal 4.1.3.1	***Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components that overcome national performance and capability challenges.***		
APG 4.1.3.1: AR-11-6	Achieve validated accuracy for conventional and unconventional aircraft, respectively, for nitrogen dioxide (NOx), takeoff and landing performance, cruise performance, take-off gross weight (TOGW), and noise.	Fundamental Aeronautics	Aeronautics
APG 4.1.3.1: AR-11-7	Demonstrate the ability to predict the effect of impact dynamics on a full-scale airframe within 10 percent of measured acceleration.	Fundamental Aeronautics	Aeronautics
APG 4.1.3.1: AR-11-8	Demonstrate the ability to optimize a baseline aircraft design to simultaneously achieve high cruise efficiency and low sonic boom using Multidisciplinary Design, Analysis and Optimization (MDAO) with a two-week cycle time.	Fundamental Aeronautics	Aeronautics
APG 4.1.3.1: AR-11-9	Validate NASA propulsion Computational Fluid Dynamics (CFD) codes using Hypersonic International Flight Research Experimentation (HIFiRE) scramjet flight data and ground-based test results.	Fundamental Aeronautics	Aeronautics
Outcome 4.2	**Conduct systems-level research on innovative and promising aeronautics concepts and technologies to demonstrate integrated capabilities and benefits in a relevant flight and/or ground environment.**		
Objective 4.2.1	**Develop advanced tools and technologies that reduce the technical risk associated with system-level integration of promising aeronautical concepts.**		
Performance Goal 4.2.1.1	***Reduce technical risk by conducting research at an integrated system-level on promising aeronautical concepts and technologies in a relevant environment.***		
APG 4.2.1.1: AR-11-10	Optimize fuel injector designs through flametube and/or sector tests and demonstrate their performance in meeting futuristic aircraft emission goals.	Integrated Systems Research	Aeronautics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**		
Outcome 5.1	**Identify, cultivate, and sustain a diverse workforce and inclusive work environment that is needed to conduct NASA missions.**		
Objective 5.1.1	**Establish and maintain a workforce that possesses state-of-the-art technical and business management competencies.**		
Performance Goal 5.1.1.1	***Define and build the federal workforce skills and competencies needed for the Agency's future directions in technology development and deep space exploration.***		
APG 5.1.1.1: AMO-11-1	Seventy-five percent or more of Shuttle workforce has been realigned for new Agency needs.	Agency Management	Agency Management and Operations
APG 5.1.1.1: AMO-11-2	Twenty percent or more of annual recruitments will be through the early career hiring initiatives.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.2	***Build skills across all levels of the workforce through Leadership Development Opportunities.***		
APG 5.1.1.2: AMO-11-3	Evaluate current state of Agency leadership training and development and publish findings and recommendations in a comprehensive report to guide future program direction.	Agency Management	Agency Management and Operations
APG 5.1.1.2: AMO-11-4	Seventy-five percent of the Agency's leadership training and development programs include "leading through transformation" content.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.3	***Achieve and sustain an effective labor-management dialogue.***		
APG 5.1.1.3: AMO-11-5	Identify and address at least three significant labor-management challenges identified during the year during periodic Agency-led Labor Management Forums.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.4	***Adopt and respond to innovative employee feedback mechanisms.***		
APG 5.1.1.4: AMO-11-6	Identify and address at least two topics that employees identified in the latest Federal Employee Viewpoint Survey.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.5	***Establish and maintain a workplace environment free of illegal discrimination, harassing conduct, and retaliation for Equal Employment Opportunity (EEO) activity and that provides reasonable accommodations to individuals with disabilities.***		
APG 5.1.1.5: AMO-11-7	Complete FY 2011 actions described in the NASA Model Equal Employment Opportunity (EEO) Agency Plan.	Agency Management	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 5.1.1.6	***Implement an Agency-wide Diversity and Inclusion Framework to develop a more demographically diverse workforce and a more inclusive work environment.***		
APG 5.1.1.6: AMO-11-8	Establish a baseline for diversity by developing and implementing an Agency-wide diversity-inclusion survey.	Agency Management	Agency Management and Operations
Objective 5.1.2	**Provide opportunities and support systems that recruit, retain, and develop undergraduate and graduate students in STEM-related disciplines.**		
Performance Goal 5.1.2.1	***Assure that student participants in NASA higher education projects are representative of the diversity of the Nation.***		
APG 5.1.2.1: ED-11-1	Achieve 40 percent participation of underserved and underrepresented (in race and/or ethnicity) in NASA higher education projects.	STEM Education and Accountability	Education
APG 5.1.2.1: ED-11-2	Achieve 45 percent participation of women in NASA higher education projects.	STEM Education and Accountability	Education
Outcome 5.2	**Ensure vital assets are ready, available, and appropriately sized to conduct NASA's missions.**		
Objective 5.2.1	**Achieve mission success by factoring safety, quality, risk, reliability, and maintainability as integral features of programs, projects, technologies, operations, and facilities.**		
Performance Goal 5.2.1.1	***Through 2015, assure zero fatalities or permanent disabling injuries to the public.***		
APG 5.2.1.1: AMO-11-9	Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during the fiscal year.	Safety and Mission Success	Agency Management and Operations
Performance Goal 5.2.1.2	***By 2015, achieve a four percent reduction in the total case rate and lost time rate for the NASA civil service work force.***		
APG 5.2.1.2: AMO-11-10	Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	Safety and Mission Success	Agency Management and Operations
Performance Goal 5.2.1.3	***By 2015, reduce damage to NASA assets by eight percent from the 2010 baseline.***		
APG 5.2.1.3: AMO-11-11	Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.	Safety and Mission Success	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 5.2.2	**Provide information technology that advances NASA space and research program results and promotes open dissemination through efficient, innovative, reliable, and responsive services that are appropriately secure and valued by stakeholders and the public.**		
Performance Goal 5.2.2.1	***By 2014, consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, enterprise applications, enterprise data centers, and web services.***		
APG 5.2.2.1: AMO-11-12	Achieve Initial Operating Capability (IOC) for five Service Offices (Web Services, Communications, Enterprise Service Desk, End User Services, and NASA Enterprise Applications) as part of the NASA Information Technology Infrastructure Integration Program (I3P).	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.2	***By 2015, implement a capability to identify and prevent unauthorized intrusions on the NASA institutional and mission networks.***		
APG 5.2.2.2: AMO-11-13	Implement intrusion detection sensors monitored by the NASA Security Operations Center (SOC) on 75 percent of NASA institutional network monitoring sites.	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.3	***By 2014, decommission the Agency Administrative mainframe computer.***		
APG 5.2.2.3: AMO-11-14	Implement, in the SAP environment, the replacement for the mainframe-based NASA Supply Management System.	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.4	***By 2015, reduce data center energy consumption by 30 percent.***		
APG 5.2.2.4: AMO-11-15	Develop a data center consolidation plan for NASA that includes an enterprise assessment of NASA's data center footprint.	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.5	***By 2015, establish at least four innovation laboratories that provide more effective, efficient, and responsive information technology (IT) across NASA in support of the Agency's Mission.***		
APG 5.2.2.5: AMO-11-16	Implement a Core Information Technology (IT) Innovation Laboratory infrastructure to support experimental technology incubation activities in areas ranging from communications, information dissemination, and collaboration application interoperability in a cloud environment.	Agency IT Services (AITS)	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 5.2.3	**Develop and implement long-range infrastructure plans that address institutional capabilities and critical assets, directly link to mission needs, ensure the leveraging of external capabilities, and provide a framework for Agency infrastructure decision-making.**		
Performance Goal 5.2.3.1	***Consolidate functions and offices to reduce real property need, and use Agency Integrated Master Plan to identify and dispose of excess and aged facilities beyond useful life.***		
APG 5.2.3.1 AMO-11-17	Finalize 8 of 10 Center Master Plans and incorporate into the Agency Integrated Master Plan.	Agency Management	Agency Management and Operations
APG 5.2.3.1: COF-11-1	Initiate facilities demolition process for five significant Agency facilities.	Institutional CoF	Construction of Facilities
Performance Goal 5.2.3.2	***HPPG: Conserve valuable natural resources by reducing NASA's energy and water use.***		
APG 5.2.3.2: ECR-11-1	Reduce energy intensity use annually by three percent from an FY 2003 baseline.	Environmental Compliance and Restoration	Environmental Compliance and Restoration
APG 5.2.3.2: ECR-11-2	Reduce potable water use annually by two percent from an FY 2007 baseline.	Environmental Compliance and Restoration	Environmental Compliance and Restoration
APG 5.2.3.2: ECR-11-3	Reduce fleet vehicle energy use annually by two percent of petroleum products from an FY 2005 baseline.	Environmental Compliance and Restoration	Environmental Compliance and Restoration
Outcome 5.3	**Ensure the availability to the Nation of NASA-owned, strategically important test capabilities.**		
Objective 5.3.1	**Work with the National Rocket Propulsion Test Alliance to identify NASA, Department of Defense and commercial capabilities and requirements.**		
Performance Goal 5.3.1.1	***Develop and execute the Rocket Propulsion Test (RPT) Master Plan.***		
APG 5.3.1.1: SFS-11-1	Release the Rocket Propulsion Test (RPT) Master Plan.	Rocket Propulsion Test	Space and Flight Support (SFS)
Objective 5.3.2	**Ensure that Aeronautics Test Program (ATP) facilities are available and capable of supporting research, development, test and engineering goals and objectives for NASA and national aerospace programs.**		
Performance Goal 5.3.2.1	***Ensure that testing capabilities are available in order to support the research, development, test, and engineering milestones of NASA and Department of Defense (DoD) programs.***		
APG 5.3.2.1: AR-11-11	Achieve ratings greater than 86 percent for overall quality and timeliness of Aeronautics Test Program (ATP) facility operations.	Aeronautics Test	Aeronautics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 5.4	**Implement and provide space communications and launch capabilities responsive to existing and future science and space exploration missions.**		
Objective 5.4.1	**Ensure reliable and cost-effective access to space for missions critical to achieving the National Space Policy of the United States of America.**		
Performance Goal 5.4.1.1	***Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.***		
APG 5.4.1.1: SFS-11-2	Sustain 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.	Launch Services	Space and Flight Support (SFS)
Performance Goal 5.4.1.2	***Continue utilizing existing contract mechanisms and agreements with emerging launch vehicle providers to gain information for future Launch Service orders and to provide technical exchanges to enhance early launch success.***		
APG 5.4.1.2: SFS-11-3	Develop processes for crew transportation partner information sharing between NASA's Launch Services Program (LSP), Exploration Systems Mission Directorate (ESMD), ISS, and other government customers, including but not limited to Department of Defense (DoD).	Launch Services	Space and Flight Support (SFS)
Objective 5.4.2	**Transform the Florida launch and range complex to provide a robust launch and range infrastructure for future users.**		
Performance Goal 5.4.2.1	***By FY 2014, enable future government and commercial launching and testing from the Florida launch and range complex.***		
APG 5.4.2.1: SFS-11-4	Develop a 21st Century Space Launch Complex (21st CSLC) plan.	21st Century Space Launch Complex	Space and Flight Support (SFS)
Objective 5.4.3	**Build and maintain a scalable, integrated, mission support infrastructure that can readily evolve to accommodate new and changing technologies, while providing integrated, comprehensive, robust, and cost-effective space communications services at order-of-magnitude higher data rates to enable NASA's science and exploration missions.**		
Performance Goal 5.4.3.1	***By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) spacecraft in geosynchronous orbits to replenish the Tracking and Data Relay Satellite System (TDRSS) constellation.***		
APG 5.4.3.1: SFS-11-5	Complete Tracking and Data Relay Satellite (TDRS) K Payload and Bus Integration and test.	Space Communications and Navigation	Space and Flight Support (SFS)

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 5.4.3.2	***By FY 2016, replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).***		
APG 5.4.3.2: SFS-11-6	Complete the Space Network Ground Support Sustainment (SGSS) Integrated Baseline Review (IBR) and Systems Requirements Review (SRR).	Space Communications and Navigation	Space and Flight Support (SFS)
Performance Goal 5.4.3.3	***By FY 2018, replace aging and obsolete Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).***		
APG 5.4.3.3: SFS-11-7	Complete Deep Space Station-35 (DSS-35) Pedestal Excavation and Azimuth track at Canberra Deep Space Communications Complex (CDSCC).	Space Communications and Navigation	Space and Flight Support (SFS)
Outcome 5.5	**Establish partnerships, including innovative arrangements, with commercial, international, and other government entities to maximize mission success.**		
Objective 5.5.1	**Facilitate the use of the ISS as a National Laboratory for cooperative research, technology development, and education.**		
Performance Goal 5.5.1.1	***HPPG: Establish an independent non-profit (NPO) organization to enhance the utilization of the ISS as a National Laboratory.***		
APG 5.5.1.1: ISS-11-6	Transition management of the ISS U.S. National Laboratory for non-NASA research to the non-profit organization (NPO).	International Space Station Program	International Space Station
Objective 5.5.2	**Enhance international and interagency partnerships through increased use of international and interagency coordination mechanisms.**		
Performance Goal 5.5.2.1	***Actively engage and provide leadership in international and interagency forums.***		
APG 5.5.2.1: AMO-11-18	Complete the International Space Exploration Coordination Group (ISECG) roadmap to identify common interests among international space agencies in human and robotic exploration of the solar system.	Agency Management	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 6	**Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation and contribute to a strong national economy.**		
Outcome 6.1	**Improve retention of students in STEM disciplines by providing opportunities and activities along the full length of the education pipeline.**		
Objective 6.1.1	**Provide quality STEM curricular support resources and materials.**		
Performance Goal 6.1.1.1	***Provide educators nationwide with knowledge and tools with which to inspire students in STEM fields.***		
APG 6.1.1.1: ED-11-3	75,000 educators participate in NASA education programs.	STEM Education and Accountability	Education
Objective 6.1.2	**Provide NASA experiences that inspire student interest and achievement in STEM disciplines.**		
Performance Goal 6.1.2.1	***Provide higher education students with authentic NASA mission-based opportunities that build knowledge and skills needed for STEM careers.***		
APG 6.1.2.1: ED-11-4	25,000 undergraduate and graduate students participate in NASA education opportunities.	STEM Education and Accountability	Education
Performance Goal 6.1.2.2	***Provide elementary and secondary students with authentic NASA mission-based opportunities that build STEM knowledge, skills, and career awareness.***		
APG 6.1.2.2: ED-11-5	600,000 elementary and secondary students participate in NASA instructional and enrichment activities.	STEM Education and Accountability	Education
APG 6.1.2.2: ED-11-6	75 percent of elementary and secondary students express interest in STEM careers following their involvement in NASA education programs.	STEM Education and Accountability	Education
Objective 6.1.3	**Assess grant recipient institutions throughout the education pipeline to ensure that grant recipients demonstrate a consistent commitment to civil rights compliance.**		
Performance Goal 6.1.3.1	***Promote equal opportunity compliance and encourage promising practices among NASA grant recipient institutions through a fully-realized program of civil rights compliance reviews, policy guidance, and technical assistance.***		
APG 6.1.3.1: AMO-11-19	Equal opportunity (EO) assessment and technical assistance provided, or onsite compliance assessment performed, on-location at five STEM or STEM-related programs that receive NASA funding.	Agency Management	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 6.2	**Promote STEM literacy through strategic partnerships with formal and informal organizations.**		
Objective 6.2.1	**Develop NASA's leadership role in national STEM improvement efforts, as demonstrated by provision of meaningful educator professional development and student experiences, adoption of education technologies, and contributions to STEM education policies and strategies.**		
Performance Goal 6.2.1.1	***Provide educator professional development experiences and materials that align to needs and opportunities identified by districts, states, Department of Education, professional organizations, and other stakeholders.***		
APG 6.2.1.1: ED-11-7	5,000 educators use NASA resources in their curricula after participating in NASA professional development.	STEM Education and Accountability	Education
Performance Goal 6.2.1.2	***Provide expertise in the development of STEM education policies and strategies.***		
APG 6.2.1.2: ED-11-8	Provide expertise to support the National Academies development of a framework for integrated science and engineering standards.	STEM Education and Accountability	Education
Outcome 6.3	**Engage the public in NASA's missions by providing new pathways for participation.**		
Objective 6.3.1	**Extend the reach of participatory engagement across NASA.**		
Performance Goal 6.3.1.1	***By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.***		
APG 6.3.1.1: AMO-11-20	Identify candidate mechanisms to encourage public engagement in NASA programs and missions.	Agency Management	Agency Management and Operations
Outcome 6.4	**Inform, engage, and inspire the public by sharing NASA's missions, challenges, and results.**		
Objective 6.4.1	**Use strategic partnerships with formal and informal educational organizations to provide NASA content to promote interest in STEM.**		
Performance Goal 6.4.1.1	***Leverage communities of practice to facilitate sharing of NASA successes and challenges with the public.***		
APG 6.4.1.1: ED-11-9	420 museums and science centers across the country actively engage the public in major NASA events.	STEM Education and Accountability	Education

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 6.4.2	**Provide clear, accurate, timely, and consistent information that is readily available and suitable for a diverse audience.**		
Performance Goal 6.4.2.1	***Use current and emerging communications technologies to reach increasingly broad audiences.***		
APG 6.4.2.1: AMO-11-21	Establish an Agency-wide portfolio of communication tools.	Agency Management	Agency Management and Operations
Objective 6.4.3	**Provide the communications infrastructure to enable NASA's commitment to make government more open, transparent, and participatory.**		
Performance Goal 6.4.3.1	***Make available Agency records through the Freedom of Information (FOIA), Privacy Act, and Open Government Initiative in accordance with federal laws and regulations.***		
APG 6.4.3.1: AMO-11-22	Issue Agency-wide Freedom of Information Act (FOIA) tools to support consistent responses to requesters.	Agency Management	Agency Management and Operations

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Uniform and Efficiency Measures

Measure #	Description
International Space Station Theme	
APG EFF 1.1.1.4: ISS-11-3	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.
APG EFF 1.1.2.1: ISS-11-5	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2011.
Earth Science Theme	
APG EFF 2.1.7.1: ES-11-17	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.
APG EFF 2.1.7.1: ES-11-18	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.
APG EFF: ES-11-19	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: ES-11-20	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: ES-11-21	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: ES-11-22	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.
Agency Management and Operations Theme	
APG EFF 5.2.1.2: AMO-11-10	Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.
APG EFF 5.2.1.3: AMO-11-11	Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.
APG EFF: AMO-11-21	Maintain system execution time during the year-end close process at FY 2010 baseline.
Environmental Compliance and Restoration Theme	
APG EFF 5.2.3.2: ECR-11-1	Reduce energy intensity use annually by three percent from an FY 2003 baseline.
APG EFF 5.2.3.2: ECR-11-2	Reduce potable water use annually by two percent from an FY 2007 baseline.
APG EFF 5.2.3.2: ECR-11-3	Reduce fleet vehicle energy use annually by two percent of petroleum products from an FY 2005 baseline.
Aeronautics Theme	
APG EFF: AR-11-12	Deliver at least 86 percent of on-time availability for operations and research facilities.
Astrophysics Theme	
APG EFF: AS-11-6	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: AS-11-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: AS-11-8	Peer-review and competitively award at least 95 percent, by budget, of research projects.

FY 2011 Performance Plan

Uniform and Efficiency Measures

Measure #	Description
APG EFF: AS-11-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.
Heliophysics Theme	
APG EFF: HE-11-6	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: HE-11-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: HE-11-8	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: HE-11-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.
Planetary Science Theme	
APG EFF: PS-11-14	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: PS-11-15	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: PS-11-16	Peer-review and competitively award at least 95 percent, by budget, of research projects.
APG EFF: PS-11-17	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

FY 2012 Performance Plan Narrative

NASA's updated strategic goals are reflected below. Each is clearly defined and supported by multi-year Outcomes, Objectives, and Performance Goals. These in turn are supported by annual performance goals (APGs) that enhance NASA's ability to measure and report on the Agency's progress in achieving its strategic goals.

To better communicate the contribution of NASA's mission support elements, those performance measures are now structured as function-based, rather than Theme-based. Performance measures that were previously listed under Cross-Agency Support, including Education, information technology services, construction of facilities, human capital management, safety and mission assurance, launch services, and space communications have now been incorporated into the appropriate strategic goal.

The following table provides a summary of all of the Agency commitments identified in the preceding sections of this document.

FY 2012 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 1	**Extend and sustain human activities across the solar system.**		
Outcome 1.1	**Sustain the operation and full use of the International Space Station (ISS) and expand efforts to utilize the ISS as a National Laboratory for scientific, technological, diplomatic, and educational purposes and for supporting future objectives in human space exploration.**		
Objective 1.1.1	**Maintain resources (on orbit and on the ground) to operate and utilize the ISS.**		
Performance Goal 1.1.1.1	***Maintain capability for six on-orbit crew members.***		
APG 1.1.1.1: ISS-12-1	In concert with the International Partners, maintain a continuous crew presence on the ISS by coordinating and managing resources, logistics, systems, and operational procedures.	International Space Station Program	International Space Station
Performance Goal 1.1.1.2	***HPPG: Safely fly out the Space Shuttle manifest and retire the fleet.***		
APG 1.1.1.2: SSP-12-1	Ensure the Space Shuttle Endeavour is ready for transport to its final display location.	Space Shuttle Program	Space Shuttle
Performance Goal 1.1.1.3	***Provide cargo and crew transportation to support on-orbit crew members and utilization.***		
APG 1.1.1.3: ISS-12-2	Fly the ISS spares, logistics, and utilization hardware as agreed to by the International Partners in the ISS transportation plan.	International Space Station Program	International Space Station
APG 1.1.1.3: ISS-12-3	Complete at least two flights to the ISS by U.S. developed cargo delivery systems.	International Space Station Program	International Space Station
Performance Goal 1.1.1.4	***Maintain and operate a safe and functional ISS.***		
APG 1.1.1.4: ISS-12-4	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.	International Space Station Program	International Space Station

FY 2012 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
APG 1.1.1.4: ISS-12-5	Achieve zero Type-A (damage to property at least $1 million or death) or Type-B (damage to property at least $250 thousand or permanent disability or hospitalization of three or more persons) mishaps.	International Space Station Program	International Space Station
Objective 1.1.2	**Advance engineering, technology, and research capabilities on the ISS.**		
Performance Goal 1.1.2.1	***Advance knowledge of long-duration human space flight by establishing agreements with organizations to enable full utilization of the ISS.***		
APG 1.1.2.1: ISS-12-6	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2012.	International Space Station Program	International Space Station
Performance Goal 1.1.2.2	***Conduct basic and applied biological and physical research to advance and sustain U.S. scientific expertise.***		
APG 1.1.2.2: ERD-12-1	Conduct flight definition review for at least five flight experiments in fundamental space biology that were selected through the 2010 International Space Life Sciences Research Announcement.	Advanced Explorations Systems	Exploration Research and Development
APG 1.1.2.2: ERD-12-2	Deliver at least four physical sciences payloads for launch to the ISS.	Advanced Explorations Systems	Exploration Research and Development
APG 1.1.2.2: ERD-12-3	Conduct at least six experiments in combustion, fluids, or materials sciences on the ISS.	Advanced Explorations Systems	Exploration Research and Development
Outcome 1.2	**Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.**		
Objective 1.2.1	**Enable the commercial sector to provide cargo and crew services to the International Space Station (ISS).**		
Performance Goal 1.2.1.1	***Develop competitive opportunities for the commercial community to provide best value products and services to low Earth orbit and beyond.***		
APG 1.2.1.1: CS-12-1	Conclude the commercial crew transportation systems (CCDev2) agreements and make initial selections for the design, development, and demonstration of commercial crew transportation systems.	Commercial Crew	Commercial Spaceflight
Performance Goal 1.2.1.2	***Develop and document evaluation and certification processes for an integrated commercial crew transportation system.***		
APG 1.2.1.2: CS-12-2	Begin evaluation and certification of integrated commercial crew transportation system.	Commercial Crew	Commercial Spaceflight

FY 2012 Performance Plan

Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 1.3	**Develop an integrated architecture and capabilities for safe crewed and cargo missions beyond low Earth orbit.**		
Objective 1.3.1	**Execute development of an integrated architecture to conduct human space exploration missions beyond low Earth orbit.**		
Performance Goal 1.3.1.1	***Complete design reviews for Space Launch System (SLS).***		
APG 1.3.1.1: HEC-12-1	Successfully complete Space Launch System's (SLS) Systems Requirements Review (SRR).	Space Launch System	Human Exploration Capabilities
Performance Goal 1.3.1.2	***Complete design reviews for Multi-Purpose Crew Vehicle (MPCV).***		
APG 1.3.1.2: HEC-12-2	Complete testing of Multi-Purpose Crew Vehicle (MPCV) Ground Test Article (GTA).	Multi-Purpose Crew Vehicle	Human Exploration Capabilities
Objective 1.3.2	**Develop a robust biomedical research portfolio to mitigate space human health risks.**		
Performance Goal 1.3.2.1	***Develop technologies that enable biomedical research and mitigate space human health risks associated with human space exploration missions.***		
APG 1.3.2.1: ERD-12-4	Develop and release two NASA Research Announcements that solicit from the external biomedical research community the highest quality proposals to mitigate space human health risks.	Human Research	Exploration Research and Development
Performance Goal 1.3.2.2	***Perform research to ensure that future human crews are protected from the deleterious effects of space radiation.***		
APG 1.3.2.2: ERD-12-5	Release Acute Radiation Risk Model Version 2 to assess effects of solar particle events during exploration missions.	Human Research	Exploration Research and Development
Performance Goal 1.3.2.3	***Develop exploration medical capabilities for long-duration space missions.***		
APG 1.3.2.3: ERD-12-6	Deliver the next-generation space biomedical ultrasound device to enhance the Human Research Facility capability on the ISS through 2020.	Human Research	Exploration Research and Development
Objective 1.3.3	**Identify hazards, opportunities, and potential destinations, to support future safe and successful human space exploration missions.**		
Performance Goal 1.3.3.1	***Prioritize the knowledge of hazards, opportunities, and potential destinations for human space exploration that will be of use to future operations of an integrated architecture for human space exploration.***		
APG 1.3.3.1: ERD-12-7	In collaboration with the Planetary Science Division, develop a plan to return data that will support the selection of destinations and reduce risk for future human space exploration missions.	Advanced Explorations Systems	Exploration Research and Development

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 2	**Expand scientific understanding of the Earth and the universe in which we live.**		
Outcome 2.1	**Advance Earth system science to meet the challenges of climate and environmental change.**		
Objective 2.1.1	**Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.**		
Performance Goal 2.1.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.1.1: ES-12-1	Demonstrate planned progress in understanding and improving predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.1.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.1.2: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth System Science Pathfinder	Earth Science
APG 2.1.1.2: ES-12-3	Complete the Earth Venture 1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder	Earth Science
Objective 2.1.2	**Enable improved predictive capability for weather and extreme weather events.**		
Performance Goal 2.1.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.2.1: ES-12-4	Demonstrate planned progress in enabling improved predictive capability for weather and extreme weather events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.2.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.2.2 ES-12-5	Complete the Global Precipitation Mission (GPM) Pre-Environmental Review.	Earth Systematic Missions	Earth Science
APG 2.1.2.2: ES-12-3	Complete the EV-1 Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder	Earth Science

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.1.3	**Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity.**		
Performance Goal 2.1.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.3.1: ES-12-6	Demonstrate planned progress in quantifying, understanding, and predicting changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.3.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.3.2 ES-12-7	Complete the Landsat Data Continuity Mission (LDCM) Systems Integration Review.	Earth Systematic Missions	Earth Science
APG 2.1.3.2: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth System Science Pathfinder	Earth Science
APG 2.1.3.2: ES-12-3	Complete the Earth Venture 1 (EV-1) Investigation Readiness Reviews (IRR) and begin initial field campaigns.	Earth System Science Pathfinder	Earth Science
Objective 2.1.4	**Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.**		
Performance Goal 2.1.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.4.1: ES-12-8	Demonstrate planned progress in quantifying the key reservoirs and fluxes in the global water cycle and assessing water cycle change and water quality. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.4.2	***By 2015, launch at least two missions in support of this objective.***		
APG 2.1.4.2: ES-12-5	Complete the Global Precipitation Mission (GPM) Pre-Environmental Review.	Earth Systematic Missions	Earth Science
APG 2.1.4.2: ES-12-9	Successfully complete the Soil Moisture Active-Passive (SMAP) Critical Design Review.	Earth Systematic Missions	Earth Science

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.1.5	**Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.**		
Performance Goal 2.1.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.5.1: ES-12-10	Demonstrate planned progress in understanding the roles of ocean, atmosphere, land, and ice in the climate system and improving predictive capability for future evolution. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
APG 2.1.5.1: ES-12-11	Achieve mission success criteria for the Ocean Surface Topography Mission (OSTM).	Earth Systematic Missions	Earth Science
Performance Goal 2.1.5.2	***HPPG: Study Earth from space to understand climate change, weather, and human impact on our planet by launching at least two missions by 2015.***		
APG 2.1.5.2: ES-12-12	Launch the National Polar-orbiting Operational Environmental Satellite System (NPOESS) Preparatory Project (NPP).	Earth Systematic Missions	Earth Science
Performance Goal 2.1.5.3	***By 2015, launch at least three missions in support of this objective.***		
APG 2.1.5.3: ES-12-13	Complete the ICESat-2 Preliminary Design Review.	Earth System Science Pathfinder	Earth Science
APG 2.1.5.3: ES-12-2	Complete the Orbiting Carbon Observatory-2 (OCO-2) Systems Integration Review.	Earth System Science Pathfinder	Earth Science
Objective 2.1.6	**Characterize the dynamics of Earth's surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.**		
Performance Goal 2.1.6.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.6.1: ES-12-14	Demonstrate planned progress in characterizing the dynamics of Earth's surface and interior and forming the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Earth Science
Performance Goal 2.1.6.2	***By 2015, launch at least one mission in support of this objective.***		
APG 2.1.6.2: ES-12-7	Complete the Landsat Data Continuity Mission (LDCM) Systems Integration Review.	Earth Systematic Missions	Earth Science

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.1.7	**Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.**		
Performance Goal 2.1.7.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.1.7.1: ES-12-15	Advance at least 25 percent of decision-support projects at least one Applications Readiness Level.	Applied Sciences	Earth Science
APG 2.1.7.1: ES-12-16	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.	Earth Science Research	Earth Science
APG 2.1.7.1: ES-12-17	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.	Earth Science Research	Earth Science
Outcome 2.2	**Understand the Sun and its interactions with Earth and the solar system.**		
Objective 2.2.1	**Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.**		
Performance Goal 2.2.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.2.1.1: HE-12-1	Demonstrate planned progress in understanding the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Heliophysics
Performance Goal 2.2.1.2	***By 2015, launch two missions in support of this outcome.***		
APG 2.2.1.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Solar Terrestrial Probes	Heliophysics
APG 2.2.1.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star	Heliophysics
Objective 2.2.2	**Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.**		
Performance Goal 2.2.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.2.2.1: HE-12-4	Demonstrate planned progress in understanding how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Heliophysics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 2.2.2.2	***By 2015, launch two missions in support of this outcome.***		
APG 2.2.2.2: HE-12-2	Complete the Magnetospheric MultiScale (MMS) Systems Integration Review.	Solar Terrestrial Probes	Heliophysics
APG 2.2.2.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star	Heliophysics
Objective 2.2.3	**Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.**		
Performance Goal 2.2.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.2.3.1: HE-12-5	Demonstrate planned progress in maximizing the safety and productivity of human and robotic explorers by developing the capability to predict the extreme and dynamic conditions in space. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Heliophysics
Performance Goal 2.2.3.2	***By 2017, launch at least two missions in support of this outcome.***		
APG 2.2.3.2: HE-12-3	Complete the Geospace Radiation Belt Storm Probes Launch Readiness Review.	Living with a Star	Heliophysics
Outcome 2.3	**Ascertain the content, origin, and evolution of the solar system and the potential for life elsewhere.**		
Objective 2.3.1	**Inventory solar system objects and identify the processes active in and among them.**		
Performance Goal 2.3.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.1.1: PS-12-1	Demonstrate planned progress in inventorying solar system objects and identifying the processes active in and among them. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
Performance Goal 2.3.1.2	***By 2015, launch at least two missions in support of this outcome.***		
APG 2.3.1.2: PS-12-2	Complete the New Frontiers 3 Preliminary Design Review.	New Frontiers	Planetary Science
APG 2.3.1.2: PS-12-3	Complete the Discovery 12 mission concept studies.	Discovery	Planetary Science

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.3.2	**Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.**		
Performance Goal 2.3.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.2.1: PS-12-4	Demonstrate planned progress in understanding how the Sun's family of planets, satellites, and minor bodies originated and evolved. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
APG 2.3.2.1: PS-12-5	Complete MESSENGER mission success criteria.	Discovery	Planetary Science
Performance Goal 2.3.2.2	***By 2015, launch at least three missions in support of this outcome.***		
APG 2.3.2.2: PS-12-2	Complete the New Frontiers 3 Preliminary Design Review.	New Frontiers	Planetary Science
APG 2.3.2.2: PS-12-6	Complete the Lunar Atmosphere and Dust Environment Explorer (LADEE) Systems Integration Review.	Lunar Quest Program	Planetary Science
Objective 2.3.3	**Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.**		
Performance Goal 2.3.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.3.1 : PS-12-7	Demonstrate planned progress in understanding the processes that determine the history and future of habitability of environments on Mars and other solar system bodies. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
Performance Goal 2.3.3.2	***By 2015, launch at least two missions in support of this outcome.***		
APG 2.3.3.2: PS-12-10	Complete the Mars 16 Mission Confirmation Review.	Mars Exploration	Planetary Science
APG 2.3.3.2: PS-12-8	Complete the Mars Science Laboratory (MSL) Launch Readiness Review.	Mars Exploration	Planetary Science
APG 2.3.3.2: PS-12-9	Complete the Mars Atmosphere and Volatile EvolutioN Mission (MAVEN) Systems Integration Review.	Mars Exploration	Planetary Science

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 2.3.4	**Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.**		
Performance Goal 2.3.4.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.4.1 : PS-12-11	Demonstrate planned progress in understanding the origin and evolution of life on Earth and throughout the biosphere to determine if there is or ever has been life elsewhere in the universe. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
Objective 2.3.5	**Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.**		
Performance Goal 2.3.5.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.3.5.1: PS-12-12	Demonstrate planned progress in identifying and characterizing small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Planetary Science
Performance Goal 2.3.5.2	***Return data for selection of destinations in order to lower risk for human space exploration beyond low Earth orbit.***		
APG 2.3.5.2: PS-12-13	Demonstrate planned progress in characterizing potentially hazardous objects that are possible destinations for future human space exploration.	Multiple Programs	Planetary Science
Outcome 2.4	**Discover how the universe works, explore how it began and evolved, and search for Earth-like planets.**		
Objective 2.4.1	**Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity.**		
Performance Goal 2.4.1.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.4.1.1: AS-12-1	Demonstrate planned progress in understanding the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Astrophysics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 2.4.1.2	***By 2015, launch at least one mission in support of this outcome.***		
APG 2.4.1.2: AS-12-2	Complete the Nuclear Spectroscopic Telescope Array (NuSTAR) Launch Readiness Review.	Astrophysics Explorer	Astrophysics
Objective 2.4.2	**Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.**		
Performance Goal 2.4.2.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.4.2.1: AS-12-3	Demonstrate planned progress in understanding the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Astrophysics
Performance Goal 2.4.2.2	***Design and assemble James Webb Space Telescope (JWST).***		
APG 2.4.2.2: JWST-12-1	Begin integration of James Webb Space Telescope (JWST) flight optics into Optical Telescope Element (OTE).	James Webb Space Telescope	James Webb Space Telescope
Performance Goal 2.4.2.3	***Develop and operate an airborne infrared astrophysics observatory.***		
APG 2.4.2.3: AS-12-4	Initiate the Stratospheric Observatory for Infrared Astronomy (SOFIA) Segment 3 Aircraft modifications and upgrades.	Cosmic Origins	Astrophysics
Objective 2.4.3	**Generate a census of extra-solar planets and measure their properties.**		
Performance Goal 2.4.3.1	***Provide national scientific capabilities through necessary skilled researchers and supporting knowledge base.***		
APG 2.4.3.1: AS-12-5	Demonstrate planned progress in generating a census of extra-solar planets and measuring their properties. Progress relative to the objectives in NASA's 2010 Science Plan will be evaluated by external expert review.	Multiple Programs	Astrophysics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 3	**Create the innovative new space technologies for our exploration, science, and economic future.**		
Outcome 3.1	**Sponsor early-stage innovation in space technologies in order to improve the future capabilities of NASA, other government agencies, and the aerospace industry.**		
Objective 3.1.1	**Create a pipeline of new low Technology Readiness Levels (TRL) innovative concepts and technologies for future NASA missions and national needs.**		
Performance Goal 3.1.1.1	***Explore revolutionary aerospace concepts, with an initial research phase for preliminary assessment of a broad range of ideas, and a second phase for further development of the most promising concepts.***		
APG 3.1.1.1: ST-12-1	Initiate Phase II studies to further develop two of the most promising prior (FY 2011 and predecessor NASA Institute for Advanced Concepts (NIAC)) Phase I concepts.	Crosscutting Space Technology Development	Space Technology
Performance Goal 3.1.1.2	***Provide cash prize incentives to non-traditional sources for innovations of interest and value to NASA and the Nation.***		
APG 3.1.1.2: ST-12-2	Conduct at least three Centennial Challenges competitions.	Crosscutting Space Technology Development	Space Technology
Performance Goal 3.1.1.3	***Establish and maintain a culture of innovation at each of the 10 NASA Centers through the development of new Center ideas and technologies.***		
APG 3.1.1.3: ST-12-3	Twenty innovative projects will be initiated across the NASA Centers.	Crosscutting Space Technology Development	Space Technology
Performance Goal 3.1.1.4	***Increase the proportion of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies successfully infused into NASA programs/projects.***		
APG 3.1.1.4: ST-12-4	At least 25 percent of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase II technology projects awarded between 2007-2011 will be infused into NASA programs and projects.	SBIR and STTR	Space Technology
Performance Goal 3.1.1.5	***Increase the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) Phase III contracts initiated or expanded.***		
APG 3.1.1.5: ST-12-5	At least 40 of the Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies will be advanced to Phase III (received non-SBIR/STTR funding).	SBIR and STTR	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 3.1.1.6	***Accelerate the development of push technologies to support the future space, science and exploration needs of NASA, other government agencies, and the commercial space sector.***		
APG 3.1.1.6: ST-12-6	Complete 100 research plans.	Crosscutting Space Technology Development	Space Technology
Outcome 3.2	**Infuse game changing and crosscutting technologies throughout the Nation's space enterprise to transform the Nation's space mission capabilities.**		
Objective 3.2.1	**Prove the technical feasibility of potentially disruptive new space technologies for future missions.**		
Performance Goal 3.2.1.1	***Transition developed game changing technologies to the technology demonstration programs or directly to Mission Directorates for mission insertion.***		
APG 3.2.1.1: ST-12-7	Initiate five game changing technology projects.	Crosscutting Space Technology Development	Space Technology
Objective 3.2.2	**Spur the development of routine, low-cost access to space through small payloads and satellites.**		
Performance Goal 3.2.2.1	***Mature technologies that enable small satellites to provide game changing capabilities for the government and commercial space sectors.***		
APG 3.2.2.1: ST-12-8	Initiate development of at least two new technologies with game changing potential for small satellites.	Crosscutting Space Technology Development	Space Technology
Objective 3.2.3	**Demonstrate new space technologies and infuse them into future science and exploration small satellite missions and/or commercial use.**		
Performance Goal 3.2.3.1	***Demonstrate small satellite capabilities with game changing and crosscutting potential for the government and commercial space sectors.***		
APG 3.2.3.1: ST-12-9	Initiate at least one new small satellite mission that will demonstrate game changing or crosscutting technologies in space.	Crosscutting Space Technology Development	Space Technology
Objective 3.2.4	**Demonstrate new space technologies and infuse them into missions.**		
Performance Goal 3.2.4.1	***Infuse game changing and crosscutting technologies into future NASA missions through flight or relevant environment demonstrations.***		
APG 3.2.4.1: ST-12-10	Complete preliminary design of at least two system-level technologies for flight or relevant environment demonstration.	Crosscutting Space Technology Development	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 3.2.5	**Provide flight opportunities and relevant environments to demonstrate new space technologies.**		
Performance Goal 3.2.5.1	***Perform sub-orbital, simulated zero-gravity and other space analog flight opportunities to develop and demonstrate emerging ideas and technologies.***		
APG 3.2.5.1: ST-12-11	Select and fly technology payloads from NASA, other government agencies, industry, and academia using flight services procured from at least three commercial reusable suborbital and parabolic platform providers.	Crosscutting Space Technology Development	Space Technology
Outcome 3.3	**Develop and demonstrate the critical technologies that will make NASA's exploration, science, and discovery missions more affordable and more capable.**		
Objective 3.3.1	**Demonstrate in-space operations of robotic assistants working with crew.**		
Performance Goal 3.3.1.1	***Demonstrate robotic technologies that support in-space operations, scientific discovery, and work as assistants with the crew.***		
APG 3.3.1.1: ERD-12-8	Demonstrate Robonaut 2 assisting the crew to perform tasks inside the ISS.	Exploration Technology Development	Space Technology
Objective 3.3.2	**Develop and demonstrate critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.**		
Performance Goal 3.3.2.1	***Develop advanced spacesuits to improve the ability of astronauts to conduct Extra-Vehicular Activity (EVA) operations in space including assembly and service of in-space systems and exploration of surfaces of the Moon, Mars, near-Earth objects (NEOs), and other small bodies.***		
APG 3.3.2.1: ERD-12-9	Initiate tests of Extra-Vehicular Activity (EVA) Portable Life Support System (PLSS) technologies in a vacuum chamber environment.	Advanced Explorations Systems	Exploration Research and Development
Performance Goal 3.3.2.2	***Develop technologies and mission concepts for demonstrating in-space cryogenic propellant storage and transfer making exploration and science missions more affordable and capable.***		
APG 3.3.2.1: ST-12-12	Test automated fluid couplings for cryogenic propellant transfer to support Cryogenic Propellant Storage And Transfer (CRYOSTAT) systems requirements.	Exploration Technology Development	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 3.4	**Facilitate the transfer of NASA technology and engage in partnerships with other government agencies, industry, and international entities to generate U.S. commercial activity and other public benefits.**		
Objective 3.4.1	**Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and national interests.**		
Performance Goal 3.4.1.1	***Establish 12 technology-related significant partnerships that create value for programs and projects. Track both quantitative dollar value and qualitative benefits to NASA (e.g., reduced volume or mass, improved safety) per year.***		
APG 3.4.1.1: ST-12-13	Establish at least 12 technology-related significant partnerships during FY 2012.	Partnership Development and Strategic Integration	Space Technology
Performance Goal 3.4.1.2	***Complete 30 technology transfer agreements with the commercial and academic community through such mechanisms as licenses, software use agreements, facility use agreements, and Space Act Agreements per year.***		
APG 3.4.1.2: ST-12-14	Complete at least 30 technology transfer agreements during FY 2012.	Partnership Development and Strategic Integration	Space Technology
Performance Goal 3.4.1.3	***Successful application of Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technologies into commercial products or services.***		
APG 3.4.1.3: ST-12-15	Greater than 35 percent of the Phase II Small Business Innovation Research and Small Business Technology Transfer (SBIR/STTR) technology projects awarded between 2007-2011 will be transferred into commercial products or services.	SBIR and STTR	Space Technology
Performance Goal 3.4.1.4	***Document 40-50 of the most notable examples of successful transfer and commercialization of NASA-derived technology per year and publish in Spinoff annually.***		
APG 3.4.1.4: ST-12-16	Document at least 40 notable technology transfer successes in NASA's Spinoff publication.	Partnership Development and Strategic Integration	Space Technology

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 3.4.1.5	***Document, coordinate, and prioritize Agency-level technology strategic investments to ensure NASA has a balanced portfolio of both near-term NASA mission (pull) technologies and longer-term transformational (push) technologies that benefit both Agency programs and national needs.***		
APG 3.4.1.5: ST-12-17	Ensure that 75 percent of all NASA technology projects are recorded in the portfolio database and are analyzed against the prioritizations in the space technology roadmaps.	Partnership Development and Strategic Integration	Space Technology
Strategic Goal 4	**Advance aeronautics research for societal benefit.**		
Outcome 4.1	**Develop innovative solutions and advanced technologies through a balanced research portfolio to improve current and future air transportation.**		
Objective 4.1.1	**Develop advanced technologies to improve the overall safety of the future air transportation system.**		
Performance Goal 4.1.1.1	***Transfer knowledge to the aviation community to better manage safety in aviation.***		
APG 4.1.1.1: AR-12-1	Develop first generation engine icing performance degradation parametric simulation capability.	Aviation Safety	Aeronautics
APG 4.1.1.1: AR-12-2	Provide static code analysis techniques for certification.	Aviation Safety	Aeronautics
APG 4.1.1.1: AR-12-3	Develop concept of operations for an integrated vehicle health assurance system.	Aviation Safety	Aeronautics
APG 4.1.1.1: AR-12-4	Demonstrate algorithm to predict at least three anomalies in massive datasets.	Aviation Safety	Aeronautics
Objective 4.1.2	**Develop innovative solutions and technologies to meet future capacity and mobility requirements of the Next Generation Air Transportation System (NextGen).**		
Performance Goal 4.1.2.1	***HPPG: Increase efficiency and throughput of aircraft operations during arrival phase of flight.***		
APG 4.1.2.1: AR-12-5	Develop Initial Weather Translation Models.	Airspace Systems	Aeronautics
APG 4.1.2.1: AR-12-6	Demonstrate safe Interval Management Procedures to a Single Airport with dependent parallel runways.	Airspace Systems	Aeronautics
APG 4.1.2.1: AR-12-7	NASA will provide the results of the human-in-the-loop (HITL) simulations and the field trial to the Federal Aviation Administration (FAA) as they are completed, with the final report being provided in September 2012. (HPPG milestone)	Airspace Systems	Aeronautics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 4.1.3	**Develop tools, technologies, and knowledge that enable significantly improved performance and new capabilities for future air vehicles.**		
Performance Goal 4.1.3.1	***Deliver tools, technologies, and knowledge that can be used to more efficiently and effectively design future air vehicles and their components that overcome national performance and capability challenges.***		
APG 4.1.3.1: AR-12-10	Validate the effectiveness of Micro-array Flow Control devices for improving performance and flow quality in low-boom supersonic propulsion inlets.	Fundamental Aeronautics	Aeronautics
APG 4.1.3.1: AR-12-11	Demonstrate First Generation Integrated Multidisciplinary Simulation Tool for Analysis and Design of Reusable Air-Breathing Launch Vehicles.	Fundamental Aeronautics	Aeronautics
APG 4.1.3.1: AR-12-8	Characterize gaseous and particulate emissions of hydro treated renewable jet fuel as a potential carbon dioxide (CO2) neutral aviation fuel.	Fundamental Aeronautics	Aeronautics
APG 4.1.3.1: AR-12-9	Demonstrate drag reduction benefits of active flow control for a representative rotorcraft fuselage configuration.	Fundamental Aeronautics	Aeronautics
Outcome 4.2	**Conduct systems-level research on innovative and promising aeronautics concepts and technologies to demonstrate integrated capabilities and benefits in a relevant flight and/or ground environment.**		
Objective 4.2.1	**Develop advanced tools and technologies that reduce the technical risk associated with system-level integration of promising aeronautical concepts.**		
Performance Goal 4.2.1.1	***Reduce technical risk by conducting research at an integrated system-level on promising aeronautical concepts and technologies in a relevant environment.***		
APG 4.2.1.1: AR-12-12	Demonstrate low-weight, damage-tolerant stitched composite structural concept on curved panel subjected to combined tension and internal pressure loads.	Integrated Systems Research	Aeronautics
APG 4.2.1.1: AR-12-13	Develop integrated Human Systems Integration, Communications, and Separation Assurance subproject test concept and Phase 2 test objectives necessary to achieve human-in-the-loop simulation and flight test series milestones supporting the Unmanned Aircraft Systems (UAS) Integration in the National Airspace System (NAS) Project.	Integrated Systems Research	Aeronautics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 5	**Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**		
Outcome 5.1	**Identify, cultivate, and sustain a diverse workforce and inclusive work environment that is needed to conduct NASA missions.**		
Objective 5.1.1	**Establish and maintain a workforce that possesses state-of-the-art technical and business management competencies.**		
Performance Goal 5.1.1.1	***Define and build the federal workforce skills and competencies needed for the Agency's future directions in technology development and deep space exploration.***		
APG 5.1.1.1: AMO-12-1	Ninety percent of Shuttle workforce is assigned to follow-on work by FY 2012 year-end.	Agency Management	Agency Management and Operations
APG 5.1.1.1: AMO-12-2	Twenty percent or more of annual recruitments will be through the early career hiring initiatives.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.2	***Build skills across all levels of the workforce through Leadership Development Opportunities.***		
APG 5.1.1.2: AMO-12-3	Install an Agency-wide mentoring program that includes an automated system for matching mentors and mentees.	Agency Management	Agency Management and Operations
APG 5.1.1.2: AMO-12-4	Eighty percent of the Agency's leadership training and development programs include "leading through transformation" content.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.3	***Achieve and sustain an effective labor-management dialogue.***		
APG 5.1.1.3: AMO-12-5	Identify and address at least three significant labor-management challenges identified during the year during periodic Agency-led Labor Management Forums.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.4	***Adopt and respond to innovative employee feedback mechanisms.***		
APG 5.1.1.4: AMO-12-6	Seventy-five percent of NASA's primary installations implement improvement initiatives derived from the Federal Employee Viewpoint Survey.	Agency Management	Agency Management and Operations
Performance Goal 5.1.1.5	***Establish and maintain a workplace environment free of illegal discrimination, harassing conduct, and retaliation for Equal Employment Opportunity (EEO) activity and that provides reasonable accommodations to individuals with disabilities.***		
APG 5.1.1.5: AMO-12-7	Complete all FY 2012 actions described in the NASA Model Equal Employment Opportunity (EEO) Agency Plan.	Agency Management	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 5.1.1.6	***Implement an Agency-wide Diversity and Inclusion Framework to develop a more demographically diverse workforce and a more inclusive work environment.***		
APG 5.1.1.6: AMO-12-8	Adopt diversity improvement targets derived from the results of the Agency-wide diversity-inclusion survey and other relevant workforce and U.S. population data.	Agency Management	Agency Management and Operations
Objective 5.1.2	**Provide opportunities and support systems that recruit, retain, and develop undergraduate and graduate students in STEM-related disciplines.**		
Performance Goal 5.1.2.1	***Assure that student participants in NASA higher education projects are representative of the diversity of the Nation.***		
APG 5.1.2.1: ED-12-1	Achieve 40 percent participation of underserved and underrepresented (in race and/or ethnicity) in NASA higher education projects.	STEM Education and Accountability	Education
APG 5.1.2.1: ED-12-2	Achieve 45 percent participation of women in NASA higher education projects.	STEM Education and Accountability	Education
Outcome 5.2	**Ensure vital assets are ready, available, and appropriately sized to conduct NASA's missions.**		
Objective 5.2.1	**Achieve mission success by factoring safety, quality, risk, reliability, and maintainability as integral features of programs, projects, technologies, operations, and facilities.**		
Performance Goal 5.2.1.1	***Through 2015, assure zero fatalities or permanent disabling injuries to the public.***		
APG 5.2.1.1: AMO-12-9	Assure zero fatalities or permanent disabling injuries to the public resulting from NASA activities during the fiscal year.	Safety and Mission Success	Agency Management and Operations
Performance Goal 5.2.1.2	***By 2015, achieve a four percent reduction in the total case rate and lost time rate for the NASA civil service work force.***		
APG 5.2.1.2: AMO-12-10	Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.	Safety and Mission Success	Agency Management and Operations
Performance Goal 5.2.1.3	***By 2015, reduce damage to NASA assets by eight percent from the 2010 baseline.***		
APG 5.2.1.3: AMO-12-11	Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.	Safety and Mission Success	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 5.2.2	**Provide information technology that advances NASA space and research program results and promotes open dissemination through efficient, innovative, reliable, and responsive services that are appropriately secure and valued by stakeholders and the public.**		
Performance Goal 5.2.2.1	***By 2014, consolidate and centralize the management of information technology (IT) enterprise services for end user services, communications, enterprise applications, enterprise data centers, and web services.***		
APG 5.2.2.1: AMO-12-12	Achieve Initial Operating Capability (IOC) for one Service Office (NASA Enterprise Data Center) and Full Operational Capacity (FOC) for the initial five Service Offices as part of the NASA Information Technology Infrastructure Integration Program (I3P).	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.2	***By 2015, implement a capability to identify and prevent unauthorized intrusions on the NASA institutional and mission networks.***		
APG 5.2.2.2: AMO-12-13	Implement intrusion detection sensors monitored by the NASA Security Operations Center (SOC) on 75 percent of NASA institutional network monitoring sites.	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.3	***By 2014, decommission the Agency Administrative mainframe computer.***		
APG 5.2.2.3: AMO-12-14	Migrate or retire all administrative systems from the Agency Administrative mainframe computer.	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.4	***By 2015, reduce data center energy consumption by 30 percent.***		
APG 5.2.2.4: AMO-12-15	Reduce the number of NASA data centers by 10 percent.	Agency IT Services (AITS)	Agency Management and Operations
Performance Goal 5.2.2.5	***By 2015, establish at least four innovation laboratories that provide more effective, efficient, and responsive information technology (IT) across NASA in support of the Agency's Mission.***		
APG 5.2.2.5: AMO-12-16	Implement a Communications and Collaboration Lab that conducts five evaluations to assess new approaches for the dissemination of information, and real-time, multi-participant knowledge creation and management.	Agency IT Services (AITS)	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 5.2.3	**Develop and implement long-range infrastructure plans that address institutional capabilities and critical assets, directly link to mission needs, ensure the leveraging of external capabilities, and provide a framework for Agency infrastructure decision-making.**		
Performance Goal 5.2.3.1	***Consolidate functions and offices to reduce real property need, and use Agency Integrated Master Plan to identify and dispose of excess and aged facilities beyond useful life.***		
APG 5.2.3.1: AMO-12-17	Finalize remaining Center Master Plans into the Agency Integrated Master Plan.	Agency Management	Agency Management and Operations
APG 5.2.3.1: COF-12-1	Initiate facilities demolition process for five significant Agency facilities in addition to demolition processes initiated in FY 2011.	Institutional CoF	Construction of Facilities
Performance Goal 5.2.3.2	***HPPG: Conserve valuable natural resources by reducing NASA's energy and water use.***		
APG 5.2.3.2: ECR-12-1	Reduce energy intensity use annually by three percent from an FY 2003 baseline.	Environmental Compliance and Restoration	Environmental Compliance and Restoration
APG 5.2.3.2: ECR-12-2	Reduce potable water use annually by two percent from an FY 2007 baseline.	Environmental Compliance and Restoration	Environmental Compliance and Restoration
APG 5.2.3.2: ECR-12-3	Reduce fleet vehicle energy use annually by two percent of petroleum products from an FY 2005 baseline.	Environmental Compliance and Restoration	Environmental Compliance and Restoration
Outcome 5.3	**Ensure the availability to the Nation of NASA-owned, strategically important test capabilities.**		
Objective 5.3.1	**Work with the National Rocket Propulsion Test Alliance to identify NASA, Department of Defense and commercial capabilities and requirements.**		
Performance Goal 5.3.1.1	***Develop and execute the Rocket Propulsion Test (RPT) Master Plan.***		
APG 5.3.1.1: SFS-12-1	Meet Rocket Propulsion Test (RPT) Master Plan requirements for year one.	Rocket Propulsion Test	Space and Flight Support (SFS)
Objective 5.3.2	**Ensure that Aeronautics Test Program (ATP) facilities are available and capable of supporting research, development, test and engineering goals and objectives for NASA and national aerospace programs.**		
Performance Goal 5.3.2.1	***Ensure that testing capabilities are available in order to support the research, development, test, and engineering milestones of NASA and Department of Defense (DoD) programs.***		
APG 5.3.2.1: AR-12-14	Achieve ratings greater than 86 percent for overall quality and timeliness of Aeronautics Test Program (ATP) facility operations.	Aeronautics Test	Aeronautics

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Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 5.4	**Implement and provide space communications and launch capabilities responsive to existing and future science and space exploration missions.**		
Objective 5.4.1	**Ensure reliable and cost-effective access to space for missions critical to achieving the National Space Policy of the United States of America.**		
Performance Goal 5.4.1.1	***Complete Launch Services Program (LSP) objectives for all NASA-managed expendable launches.***		
APG 5.4.1.1: SFS-12-2	Sustain 100 percent success rate with the successful launch of NASA-managed expendable launches as identified on the Launch Services Flight Planning Board manifest.	Launch Services	Space and Flight Support (SFS)
Performance Goal 5.4.1.2	***Continue utilizing existing contract mechanisms and agreements with emerging launch vehicle providers to gain information for future Launch Service orders and to provide technical exchanges to enhance early launch success.***		
APG 5.4.1.2: SFS-12-3	Incorporate information sharing processes into programmatic policies and incorporate into crew demonstration activities and future crew transportation service contracts.	Launch Services	Space and Flight Support (SFS)
Objective 5.4.2	**Transform the Florida launch and range complex to provide a robust launch and range infrastructure for future users.**		
Performance Goal 5.4.2.1	***By FY 2014, enable future government and commercial launching and testing from the Florida launch and range complex.***		
APG 5.4.2.1: SFS-12-4	Implement FY 2012 milestones within the 21st Century Space Launch Complex (21st CSLC) plan.	21st Century Space Launch Complex	Space and Flight Support (SFS)
Objective 5.4.3	**Build and maintain a scalable, integrated, mission support infrastructure that can readily evolve to accommodate new and changing technologies, while providing integrated, comprehensive, robust, and cost-effective space communications services at order-of-magnitude higher data rates to enable NASA's science and exploration missions.**		
Performance Goal 5.4.3.1	***By 2014, launch two functionally identical Tracking and Data Relay Satellite (TDRS) spacecraft in geosynchronous orbits to replenish the Tracking and Data Relay Satellite System (TDRSS) constellation.***		
APG 5.4.3.1: SFS-12-5	Complete Tracking and Data Relay Satellite (TDRS) K Pre-ship review.	Space Communications and Navigation	Space and Flight Support (SFS)

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Measure #	Description	Contributing Program (s)	Contributing Theme
Performance Goal 5.4.3.2	***By FY 2016, replace or upgrade obsolete and unsustainable systems of the Tracking and Data Relay Satellite System (TDRSS) Ground Segment at the White Sands Complex (WSC).***		
APG 5.4.3.2: SFS-12-6	Complete the Space Network Ground Segment Sustainment (SGSS) Preliminary Design Review (PDR).	Space Communications and Navigation	Space and Flight Support (SFS)
Performance Goal 5.4.3.3	***By FY 2018, replace aging and obsolete Deep Space Network (DSN) 70-meter antenna at Canberra Deep Space Communications Complex (CDSCC).***		
APG 5.4.3.3: SFS-12-7	Complete Deep Space Station-35 (DSS-35) antenna fabrication at vendor.	Space Communications and Navigation	Space and Flight Support (SFS)
Outcome 5.5	**Establish partnerships, including innovative arrangements, with commercial, international, and other government entities to maximize mission success.**		
Objective 5.5.1	**Facilitate the use of the ISS as a National Laboratory for cooperative research, technology development, and education.**		
Performance Goal 5.5.1.1	***HPPG: Establish an independent non-profit (NPO) organization to enhance the utilization of the ISS as a National Laboratory.***		
APG 5.5.1.1: ISS-12-7	Facilitate non-profit organization (NPO) implementation of its initial grants solicitation process.	International Space Station Program	International Space Station
Objective 5.5.2	**Enhance international and interagency partnerships through increased use of international and interagency coordination mechanisms.**		
Performance Goal 5.5.2.1	***Actively engage and provide leadership in international and interagency forums.***		
APG 5.5.2.1: AMO-12-18	Establish an internal Interagency Partnerships Working Group (IPWG) led by the Office of International and Interagency Relations (OIIR) to improve Agency-wide coordination of interagency partnerships and related interagency working groups.	Agency Management	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Strategic Goal 6	**Share NASA with the public, educators, and students to provide opportunities to participate in our Mission, foster innovation and contribute to a strong national economy.**		
Outcome 6.1	**Improve retention of students in STEM disciplines by providing opportunities and activities along the full length of the education pipeline.**		
Objective 6.1.1	**Provide quality STEM curricular support resources and materials.**		
Performance Goal 6.1.1.1	***Provide educators nationwide with knowledge and tools with which to inspire students in STEM fields.***		
APG 6.1.1.1: ED-12-3	100,000 educators participate in NASA education programs.	STEM Education and Accountability	Education
Objective 6.1.2	**Provide NASA experiences that inspire student interest and achievement in STEM disciplines.**		
Performance Goal 6.1.2.1	***Provide higher education students with authentic NASA mission-based opportunities that build knowledge and skills needed for STEM careers.***		
APG 6.1.2.1: ED-12-4	25,000 undergraduate and graduate students participate in NASA education opportunities.	STEM Education and Accountability	Education
Performance Goal 6.1.2.2	***Provide elementary and secondary students with authentic NASA mission-based opportunities that build STEM knowledge, skills, and career awareness.***		
APG 6.1.2.2: ED-12-5	600,000 elementary and secondary students participate in NASA instructional and enrichment activities.	STEM Education and Accountability	Education
APG 6.1.2.2: ED-12-6	85 percent of elementary and secondary students express interest in STEM careers following their involvement in NASA education programs.	STEM Education and Accountability	Education
Objective 6.1.3	**Assess grant recipient institutions throughout the education pipeline to ensure that grant recipients demonstrate a consistent commitment to civil rights compliance.**		
Performance Goal 6.1.3.1	***Promote equal opportunity compliance and encourage promising practices among NASA grant recipient institutions through a fully-realized program of civil rights compliance reviews, policy guidance, and technical assistance.***		
APG 6.1.3.1: AMO-12-19	Equal opportunity (EO) assessment and technical assistance provided, or onsite compliance assessment performed, on-location at five STEM or STEM-related programs that receive NASA funding.	Agency Management	Agency Management and Operations

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Measure #	Description	Contributing Program (s)	Contributing Theme
Outcome 6.2	**Promote STEM literacy through strategic partnerships with formal and informal organizations.**		
Objective 6.2.1	**Develop NASA's leadership role in national STEM improvement efforts, as demonstrated by provision of meaningful educator professional development and student experiences, adoption of education technologies, and contributions to STEM education policies and strategies.**		
Performance Goal 6.2.1.1	***Provide educator professional development experiences and materials that align to needs and opportunities identified by districts, states, Department of Education, professional organizations, and other stakeholders.***		
APG 6.2.1.1: ED-12-7	5,000 educators use NASA resources in their curricula after participating in NASA professional development.	STEM Education and Accountability	Education
Performance Goal 6.2.1.2	***Provide expertise in the development of STEM education policies and strategies.***		
APG 6.2.1.2: ED-12-8	Provide expertise to support the development of integrated science and engineering standards.	STEM Education and Accountability	Education
Outcome 6.3	**Engage the public in NASA's missions by providing new pathways for participation.**		
Objective 6.3.1	**Extend the reach of participatory engagement across NASA.**		
Performance Goal 6.3.1.1	***By 2015, establish an Agency-wide portfolio of participatory engagement opportunities.***		
APG 6.3.1.1: AMO-12-20	Issue a competitive opportunity to engage the public in NASA's activities.	Agency Management	Agency Management and Operations
Outcome 6.4	**Inform, engage, and inspire the public by sharing NASA's missions, challenges, and results.**		
Objective 6.4.1	**Use strategic partnerships with formal and informal educational organizations to provide NASA content to promote interest in STEM.**		
Performance Goal 6.4.1.1	***Leverage communities of practice to facilitate sharing of NASA successes and challenges with the public.***		
APG 6.4.1.1: ED-12-9	450 museums and science centers across the country actively engage the public in major NASA events.	STEM Education and Accountability	Education

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Measure #	Description	Contributing Program (s)	Contributing Theme
Objective 6.4.2	**Provide clear, accurate, timely, and consistent information that is readily available and suitable for a diverse audience.**		
Performance Goal 6.4.2.1	***Use current and emerging communications technologies to reach increasingly broad audiences.***		
APG 6.4.2.1: AMO-12-21	Evaluate communication tools for impact and establish Agency best practices.	Agency Management	Agency Management and Operations
Objective 6.4.3	**Provide the communications infrastructure to enable NASA's commitment to make government more open, transparent, and participatory.**		
Performance Goal 6.4.3.1	***Make available Agency records through the Freedom of Information (FOIA) and Privacy Act and Open Gov in accordance with federal laws and regulations.***		
APG 6.4.3.1: AMO-12-22	Finalize NASA Freedom of Information Act (FOIA) regulations.	Agency Management	Agency Management and Operations

FY 2012 Performance Plan

Uniform and Efficiency Measures

Measure #	Description
International Space Station Theme	
APG EFF 1.1.1.4: ISS-12-3	Provide 100 percent of planned on-orbit resources (including power, data, crew time, logistics, and accommodations) needed to support research.
APG EFF 1.1.2.1: ISS-12-6	Accomplish a minimum of 90 percent of the on-orbit research objectives as established one month prior to a given increment, as sponsored by NASA, baselined for FY 2012.
Earth Science Theme	
APG EFF 2.1.7.1: ES-12-16	Increase the number of science data products delivered to Earth Observing System Data and Information System (EOSDIS) users.
APG EFF 2.1.7.1: ES-12-17	Maintain a high level of customer satisfaction, as measured by exceeding the most recently available federal government average rating of the Customer Satisfaction Index.
APG EFF: ES-12-20	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: ES-12-21	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: ES-12-22	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: ES-12-23	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.
Space Technology Theme	
APG EFF 3.4.1.5: ST-12-17	Ensure that 75 percent of all NASA technology projects are recorded in the portfolio database and are analyzed against the prioritizations in the space technology roadmaps.
Agency Management and Operations Theme	
APG EFF 5.2.1.2: AMO-12-10	Reduce Total Case Rate and Lost Time Case Rate by one percent, in accordance with the President's Protecting Our Workers and Ensuring Reemployment (POWER) initiative.
APG EFF 5.2.1.3: AMO-12-11	Reduce damage to NASA assets by two percent per fiscal year, based on a five-year running average.
APG EFF: AMO-12-20	Maintain system execution time during the year-end close process at FY 2010 baseline.
Environmental Compliance and Restoration Theme	
APG EFF 5.2.3.2: ECR-12-1	Reduce energy intensity use annually by three percent from an FY 2003 baseline.
APG EFF 5.2.3.2: ECR-12-2	Reduce potable water use annually by two percent from an FY 2007 baseline.
APG EFF 5.2.3.2: ECR-12-3	Reduce fleet vehicle energy use annually by two percent of petroleum products from an FY 2005 baseline.
Aeronautics Theme	
APG EFF: AR-12-16	Deliver at least 86 percent of on-time availability for operations and research facilities.
Astrophysics Theme	
APG EFF: AS-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.

FY 2012 Performance Plan

Uniform and Efficiency Measures

Measure #	Description
APG EFF: AS-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: AS-12-8	Peer-review and competitively award at least 95 percent, by budget, of research projects.
APG EFF: AS-12-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.
Heliophysics Theme	
APG EFF: HE-12-6	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: HE-12-7	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: HE-12-8	Peer-review and competitively award at least 90 percent, by budget, of research projects.
APG EFF: HE-12-9	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.
Planetary Science Theme	
APG EFF: PS-12-14	Complete all development projects within 110 percent of the cost and schedule baseline.
APG EFF: PS-12-15	Deliver at least 90 percent of scheduled operating hours for all operations and research facilities.
APG EFF: PS-12-16	Peer-review and competitively award at least 95 percent, by budget, of research projects.
APG EFF: PS-12-17	Reduce time within which 80 percent of NASA Research Announcement (NRA) grants are awarded, from proposal due date to selection, by four percent per year, with a goal of 180 days.

2011 Strategic Plan Objectives		FY 2010	FY 2009	FY 2008	FY 2007
1.1.1	Maintain resources (on-orbit and on the ground) to operate and utilize the ISS.	2.2 Green	2.2 Green	2.2 Green	2.2 Green
1.1.2	Advance engineering, technology, and research capabilities on the ISS.	2.1 Green	2.1 Green	2.1 Green	2.1 Green
		2.3 Green	2.3 Green	2.3 Green	None
1.2.1	Enable the commercial sector to provide cargo and crew services to the International Space Station (ISS).	5.2 Yellow	5.2 Green	5.2 Green	5.2 Green
1.3.1	Execute development of an integrated architecture to conduct human space exploration missions beyond low Earth orbit.	6.4 White	6.5 Green	6.5 Green	None
1.3.2	Develop a robust biomedical research portfolio to mitigate space human health risks.	2.3 Green	2.3 Green	2.3 Green	None
1.3.3	Identify hazards, opportunities and potential destinations, to support future safe and successful human space exploration missions.	3B.3 Green	3B.3 Green	3B.3 Green	3B.3 Green
		3C.3 Green	3C.3 Green	3C.3 Green	3C.3 Green
		3C.4 Green	3C.4 Green	3C.4 Green	3C.4 Green
		6.4 White	6.5 Green	6.5 Green	None
2.1.1	Improve understanding of and improve the predictive capability for changes in the ozone layer, climate forcing, and air quality associated with changes in atmospheric composition.	3A.1 Green	3A.1 Green	3A.1 Green	3A.1 Green
2.1.2	Enable improved predictive capability for weather and extreme weather events.	3A.2 Green	3A.2 Green	3A.2 Green	3A.2 Green
2.1.3	Quantify, understand, and predict changes in Earth's ecosystems and biogeochemical cycles, including the global carbon cycle, land cover, and biodiversity.	3A.3 Green	3A.3 Green	3A.3 Green	3A.3 Green
2.1.4	Quantify the key reservoirs and fluxes in the global water cycle and assess water cycle change and water quality.	3A.4 Green	3A.4 Green	3A.4 Green	3A.4 Green
2.1.5	Improve understanding of the roles of the ocean, atmosphere, land and ice in the climate system and improve predictive capability for its future evolution.	3A.5 Green	3A.5 Green	3A.5 Yellow	3A.5 Yellow
2.1.6	Characterize the dynamics of Earth's surface and interior and form the scientific basis for the assessment and mitigation of natural hazards and response to rare and extreme events.	3A.6 Green	3A.6 Green	3A.6 Green	3A.6 Green
		3A.2 Green	3A.2 Green	3A.2 Green	3A.2 Green
2.1.7	Enable the broad use of Earth system science observations and results in decision-making activities for societal benefits.	3A.7 Green	3A.7 Green	3A.7 Green	3A.7 Green

2011 Strategic Plan Objectives		FY 2010	FY 2009	FY 2008	FY 2007
2.2.1	Improve understanding of the fundamental physical processes of the space environment from the Sun to Earth, to other planets, and beyond to the interstellar medium.	3B.1 Green	3B.1 Green	3B.1 Green	3B.1 Green
2.2.2	Improve understanding of how human society, technological systems, and the habitability of planets are affected by solar variability interacting with planetary magnetic fields and atmospheres.	3B.2 Green	3B.2 Green	3B.2 Green	3B.2 Green
2.2.3	Maximize the safety and productivity of human and robotic explorers by developing the capability to predict extreme and dynamic conditions in space.	3B.3 Green	3B.3 Green	3B.3 Green	3B.3 Green
2.3.1	Inventory solar system objects and identify the processes active in and among them.	3C.2 Green	3C.2 Green	3C.2 Green	3C.2 Green
2.3.2	Improve understanding of how the Sun's family of planets, satellites, and minor bodies originated and evolved.	3C.1 Green	3C.1 Green	3C.1 Green	3C.1 Green
2.3.3	Improve understanding of the processes that determine the history and future of habitability of environments on Mars and other solar system bodies.	3C.3 Green	3C.3 Green	3C.3 Green	3C.3 Green
2.3.4	Improve understanding of the origin and evolution of Earth's life and biosphere to determine if there is or ever has been life elsewhere in the universe.	3C.2Green	3C.2Green	3C.2Green	3C.2Green
2.3.5	Identify and characterize small bodies and the properties of planetary environments that pose a threat to terrestrial life or exploration or provide potentially exploitable resources.	3B.3 Green	3B.3 Green	3B.3 Green	3B.3 Green
		3C.4 Green	3C.4 Green	3C.4 Green	3C.4 Green
2.4.1	Improve understanding of the origin and destiny of the universe, and the nature of black holes, dark energy, dark matter, and gravity.	3D.1 Green	3D.1 Green	3D.1 Green	3D.1 Green
2.4.2	Improve understanding of the many phenomena and processes associated with galaxy, stellar, and planetary system formation and evolution from the earliest epochs to today.	3D.2 Green	3D.2 Green	3D.2 Green	3D.2 Green
2.4.3	Generate a census of extra-solar planets and measure their properties.	3D.4 Green	3D.4 Green	3D.4 Green	3D.4 Yellow
3.1.1	Create a pipeline of new low Technology Readiness Levels (TRL) innovative concepts and technologies for future NASA missions and national needs.	None	None	None	None
3.2.1	Prove the technical feasibility of potentially disruptive new space technologies for future missions.	None	None	None	None
3.2.2	Spur the development of routine, low-cost access to space through small payloads and satellites.	None	None	None	None
3.2.3	Demonstrate new space technologies and infuse them into future science and exploration small satellite missions and/or commercial use.	None	None	None	None
3.2.4	Demonstrate new space technologies and infuse them into missions.	5.3 Green	None	5.3 Green	5.3 Green

2011 Strategic Plan Objectives		FY 2010	FY 2009	FY 2008	FY 2007
3.2.5	Provide flight opportunities and relevant environments to demonstrate new space technologies.	5.1 Green	5.1 Green	5.1 Green	5.1 Green
3.3.1	Demonstrate in-space operations of robotic assistants working with crew.	None	None	None	None
3.3.2	Develop and demonstrate critical technologies for safe and affordable cargo and human space exploration missions beyond low Earth orbit.	6.2 Green	6.2 Green	6.2 Green	6.2 Green
		6.3 Green	6.3 Green	6.3 Green	None
3.4.1	Promote and develop innovative technology partnerships among NASA, U.S. industry, and other sectors for the benefit of Agency programs and projects and national interests.	5.3 Green	None	5.3 Green	5.3 Green
4.1.1	Develop advanced technologies to improve the overall safety of the future air transportation system.	3E.1 Green	3E.1 Green	3E.1 Green	3E.1 Green
4.1.2	Develop innovative solutions and technologies to meet future capacity and mobility requirements of the Next Generation Air Transportation System (NextGen).	3E.2 Green	3E.2 Green	3E.2 Green	3E.2 Green
4.1.3	Develop tools, technologies, and knowledge that enable significantly improved performance and new capabilities for future air vehicles.	3E.3 Green	3E.3 Green	3E.3 Green	3E.3 Green
4.2.1	Develop advanced tools and technologies that reduce the technical risk associated with system-level integration of promising aeronautical concepts.	3E.5 Yellow	3E.5 Yellow	3E.5 Yellow	3E.5 Yellow
5.1.1	Establish and maintain a workforce that possesses state-of-the-art technical and business management competencies.	AS.2 Green	None	None	None
5.1.2	Provide opportunities and support systems that recruit, retain, and develop undergraduate and graduate students in STEM-related disciplines.	ED.1 Green	ED.1 Green	ED.1 Green	ED.1 Green
		ED.2 Green	ED.2 Green	ED.2 Green	None
5.2.1	Achieve mission success by factoring safety, quality, risk, reliability and maintainability as integral features of programs, projects, technologies, operations, and facilities.	AS.4 Green	None	None	None
5.2.2	Provide information technology that advances NASA space and research program results and promotes open dissemination through efficient, innovative, reliable, and responsive services that are appropriately secure and valued by stakeholders and the public.	AS.1 Green	None	None	None
5.2.3	Develop and implement long-range infrastructure plans that address institutional capabilities and critical assets, directly link to mission needs, ensure the leveraging of external capabilities, and provide a framework for Agency infrastructure decision-making.	AS.3 Green	None	None	None
5.3.1	Work with the National Rocket Propulsion Test Alliance to identify NASA, Department of Defense	AS.5 Green	6.4 Green	6.4 Green	6.4 Green

2011 Strategic Plan Objectives		FY 2010	FY 2009	FY 2008	FY 2007
	and commercial capabilities and requirements.	5.1 Green	5.1 Green	5.1 Green	5.1 Green
5.3.2	Ensure that Aeronautics Test Program (ATP) facilities are available and capable of supporting research, development, test and evaluation goals and objectives for NASA and national aerospace programs.	3E.4 Green	3E.4 Green	3E.4 Green	3E.4 Green
5.4.1	Ensure reliable and cost-effective access to space for missions critical to achieving the National Space Policy of the United States of America.	AS.5 Green	6.4 Green	6.4 Green	6.4 Green
		5.1 Green	5.1 Green	5.1 Green	5.1 Green
5.4.2	Transform the Florida launch and range complex to provide a robust launch and range infrastructure for future users.	AS.5 Green	6.4 Green	6.4 Green	6.4 Green
5.4.3	Build and maintain a scalable, integrated, mission support infrastructure that can readily evolve to accommodate new and changing technologies, while providing integrated, comprehensive, robust, and cost-effective space communications services at order-of-magnitude higher data rates to enable NASA's science and exploration missions.	AS.5 Green	6.4 Green	6.4 Green	6.4 Green
5.5.1	Facilitate the use of the ISS as a National Laboratory for cooperative research, technology development, and education.	None	None	None	None
5.5.2	Enhance international and interagency partnerships through increased use of international and interagency coordination mechanisms.	6.4 White	6.5 Green	6.5 Green	None
6.1.1	Provide quality STEM curricular support resources and materials.	ED.2 Green	ED.2 Green	ED.2 Green	None
6.1.2	Provide NASA experiences that inspire student interest and achievement in STEM disciplines.	ED.2 Green	ED.2 Green	ED.2 Green	None
6.1.3	Assess grant recipient institutions throughout the education pipeline to ensure that grant recipients demonstrate a consistent commitment to civil rights compliance.	ED.1 Green	ED.1 Green	ED.1 Green	ED.1 Green
6.2.1	Develop NASA's leadership role in national STEM improvement efforts, as demonstrated by provision of meaningful educator professional development and student experiences, adoption of education technologies, and contributions to STEM education policies and strategies.	ED.1 Green	ED.1 Green	ED.1 Green	ED.1 Green
6.3.1	Extend the reach of participatory engagement across NASA.	None	None	None	None
6.4.1	Use strategic partnerships with formal and informal educational organizations to provide NASA content to promote interest in STEM.	ED.3 Green	ED.3 Green	ED.3 Green	ED.3 Green
6.4.2	Provide clear, accurate, timely, and consistent information that is readily available and suitable for a diverse audience.	None	None	None	None

National Aeronautics and Space Administration Proposed Appropriations Language

SCIENCE

For necessary expenses, not otherwise provided for, in the conduct and support of science research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901-5902; travel expenses; purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $5,016,800,000, to remain available until September 30, 2013.

AERONAUTICS

For necessary expenses, not otherwise provided for, in the conduct and support of aeronautics research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $569,400,000 to remain available until September 30, 2013.

SPACE TECHNOLOGY

For necessary expenses, not otherwise provided for, in the conduct and support of space research and technology development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities, program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft,$1,024,200,000 to remain available until September 30, 2013.

EXPLORATION

For necessary expenses, not otherwise provided for, in the conduct and support of exploration research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; space flight, spacecraft control, and communications activities; program management, personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,948,700,000, to remain available until September 30, 2013: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until September 30, 2017.

SPACE OPERATIONS

For necessary expenses, not otherwise provided for, in the conduct and support of space operations research and development activities, including research, development, operations, support, and services; maintenance; construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law; space flight, spacecraft control and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance and operation of mission and administrative aircraft, $4,346,900,000, to remain available until September 30, 2013: Provided, That when any activity has been initiated by the incurrence of obligations for construction of facilities or environmental compliance and restoration activities as authorized by law, such amount available for such activity shall remain available until September 30, 2017.

EDUCATION

For necessary expenses, not otherwise provided for, in carrying out aerospace and aeronautical education research and development activities, including research, development, operations, support, and services; program management; personnel and related costs, uniforms or allowances therefor, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $138,400,000, to remain available until September 30, 2013.

CROSS AGENCY SUPPORT

For necessary expenses, not otherwise provided for, in the conduct and support of science, aeronautics, exploration, space operations and education research and development activities, including research, development, operations, support, and services; maintenance and repair, facility planning and design; space flight, spacecraft control, and communications activities; program management; personnel and related costs, including uniforms or allowances therefor, as authorized by 5 U.S.C. 5901–5902; travel expenses; purchase and hire of passenger motor vehicles; not to exceed $120,000 for official reception and representation expenses; and purchase, lease, charter, maintenance, and operation of mission and administrative aircraft, $3,192,000,000, to remain available until September 30, 2013: Provided, That of the funds made available under this heading, $3,600,000 is for strengthening the Agency's acquisition workforce capacity and capabilities: Provided further, That, with respect to the previous proviso, such funds shall be available for training, recruitment, retention, and hiring members of the acquisition workforce as defined by the Office of Federal Procurement Policy Act, as amended (41 U.S.C. 401 et seq.): Provided further, That, with respect to the first proviso, such funds shall be available for information technology in support of acquisition workforce effectiveness or for management solutions to improve acquisition management.

CONSTRUCTION AND ENVIRONMENTAL COMPLIANCE AND RESTORATION

For necessary expenses for construction of facilities including repair, rehabilitation, revitalization, and modification of facilities, construction of new facilities and additions to existing facilities, facility planning and design, and restoration, and acquisition or condemnation of real property, as authorized by law, and environmental compliance and restoration, $450,400,000, to remain available until September 30, 2017: Provided, That 51 U.S.C. 20145(b) is amended by inserting “(A)” immediately following “(1)” and adding at the end thereof the following new subparagraph (B) as follows: “B) Notwithstanding subparagraph (A), the Administrator may accept in-kind consideration for leases entered into for the purpose of developing renewable energy production facilities.”.

OFFICE OF INSPECTOR GENERAL

For necessary expenses of the Office of Inspector General, in carrying out the Inspector General Act of 1978, $37,500,000.

ADMINISTRATIVE PROVISIONS

Funds for announced prizes otherwise authorized shall remain available, without fiscal year limitation, until the prize is claimed or the offer is withdrawn.

Not to exceed 5 percent of any appropriation made available for the current fiscal year for the National Aeronautics and Space Administration in this Act may be transferred between such appropriations, but no such appropriation, except as otherwise specifically provided, shall be increased by more than 10 percent by any such transfers. Balances so transferred shall be merged and available for the same purposes and the same time period as the appropriations to which transferred. Any transfer pursuant to this provision shall be treated as a reprogramming of funds under section 505 of this Act and shall not be available for obligation except in compliance with the procedures set forth in that section.

The unexpired balances of previous accounts, for activities for which funds are provided under this Act, may be transferred to the new accounts established in this Act that provide such activity. Balances so transferred shall be merged with the funds in the newly established accounts, but shall be available under the same terms, conditions and period of time as previously appropriated.

Section 40902 of title 51, United States Code, is amended by adding at the end thereof: "(d) Availability of Funds—The interest accruing from the National Aeronautics and Space Administration Endeavor Teacher Fellowship Trust Fund principal shall be available in FY 2012 and hereafter for the purpose of the Endeavor Science Teacher Certificate Program.".

Of funds provided under the heading "Science" in this Act, up to $10,000,000, shall be available for a reimbursable agreement with the Department of Energy for the purpose of re-establishing facilities to produce fuel required for radioisotope thermoelectric generators to enable future missions.

21st CSLC	21st Century Space Launch Complex
AA	Associate Administrator
AAAC	Astronomy and Astrophysics Advisory Committee
ACCESS	Advanced Collaborative Connections for Earth System Science
ACE	Advanced Composition Explorer
ACRIMSat	Active Cavity Radiometer Irradiance Monitor Satellite
ACS	Advanced Camera for Surveys (Hubble Space Telescope instrument)
ADAP	Astrophysics Data Analysis Program
ADCAR	Astrophysics Data Curation and Archival Research
ADS	Astrophysics Data System
AEMC	Advanced Environmental Monitoring and Control
AES	Advanced Exploration Systems
AFOSR	Air Force Office of Scientific Research
AFRL	Air Force Research Laboratory
AIM	Aeronomy of Ice in the Mesosphere
AIRS	Advanced Infrared Sounder
AITS	Agency Information Technology Services
ALHAT	Autonomous Landing and Hazard Avoidance Technology
ALI	Advanced Land Imager
AMMOS	Advanced Multi-Mission Operations System
AMO	Agency Management and Operations
AMS	Alpha Magnetic Spectrometer
AMSR-E	Advanced Microwave Scanning Radiometer for the Earth Observing System
AMSU	Advance Microwave Sounding Unit
ANN. CR	Annualized Continuing Resolution
APP	Annual Performance Plan
APRET	Astrophysics Research and Enabling Technology Program (replaces APRA)
APG	Annual Performance Goal
APL	Applied Physics Laboratory (Johns Hopkins University)
APPEL	Academy of Program/Project and Engineering Leadership
APMC	Aeropropulsion Management Council
APMS	Aviation Performance Measuring System
APRA	Astronomy and Physics Research and Analysis, replaced by APRET
APS	Aerosol Polarimetry Senor
ARC	Ames Research Center
ARMD	Aeronautics Research Mission Directorate
ARRA	American Recovery and Reinvestment Act
ASAP	Aerospace Safety Advisory Panel
ASCENDS	Active Sensing of Carbon dioxide Emissions over Nights, Days and Seasons
ASEB	Aeronautics and Space Engineering Board of the National Academies
ASI	Agenzia Spaziale Italiana (Italian Space Agency)
ASP	Airspace Systems Program
ASPERA-3	Analyzer of Space Plasma and Energetic Atoms-3
ASM	Acquisition Strategy Meeting
ASP	Acquisition Strategy Planning
ASRG	Advanced Stirling Radioisotope Generator
ASTER	Advanced Spaceborne Thermal Emission Reflection Radiometer
ATLO	Assembly, Test, Launch Operations
ATMS	Advanced Technology Microwave Sounder (NPOESS Preparatory Project instrument)
ATP	Aeronautics Test Program
AURA	Association of Universities for Research in Astronomy
AuRA	Autonomous Robust Avionics
AVHRR	Advanced Very High Resolution Radiometer
AvSP	Aviation Safety Program
BAA	Broad Agency Announcement
BAE	British Aerospace
BAH	Booz-Allen Hamilton
BARREL	Balloon Array for Radiation-belt Relativistic Electron Losses
BATC	Ball Aerospace and Technology Corporation
BHP	Behavioral Health and Performance
BIM	Building Information Modeling
BIRA	Belgian Institute for Space Aeronomy
BWB	Blended Wing Body
C/NOFS	Air Force Research Laboratory's Communication/Navigation Outage Forecast System

C3S	Command, Control, and Communication Segment
CALIPSO	Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observations
CARA	California Association for Research in Astronomy
CAS	Cross-Agency Support
CAST	Commercial Aviation Safety Team
CC	Commercial Crew
CCDev	Commercial Crew Development
CCSP	Climate Change Science Program
CDC	Centers for Disease Control
CDR	Climate Data Records
CDR	Critical Design Review
CDSSC	Canberra Deep Space Communications Complex
CECR	Construction and Environmental Compliance and Restoration
CERES	Clouds and the Earth's Radiant Energy System
CESR	Centre d'Etude Spatiale des Rayonnements Mars exploration
CFD	Computational Fluid Dynamics
CFO	Chief Financial Officer
CheMin	Chemistry and Mineralogy Instrument (MSL)
ChemCam	Chemistry Camera
CHS	Crew Health and Safety
CIF	Central Instrumentation Facility
CINDI	Coupled Ion Neutral Dynamics Investigation
CIO	Chief Information Officer
CJ	Congressional Justification (Budget)
CL	Confidence Level
CLARREO	Climate Absolute Radiance and Refractivity Observatory
cm	Centimeter
CMO	Center Management Operations
CMS	Carbon Monitoring System
CNES	Centre Nationale D’Etudes Spatiale (French Space Agency)
CO2	Carbon Dioxide
CoF	Construction of Facilities
CONAE	Argentina’s National Committee of Space Activities
CoNNeCT	Communications, Navigation, and Networking reConfigurable Test Bed
COTS	Commercial Orbital Transportation Services
CRF	Capability Reliance Framework
CRI	Center for Rotorcraft Innovation
CRS	Commercial Resupply Services
CrIS	Cross-track Infrared Sounder (NPOESS Preparatory Project instrument)
CRYOSTAT	Cryogenic Propellant Storage And Transfer
CSA	Canadian Space Agency
CSBF	Columbia Scientific Balloon Facility
CSC	Computer Sciences Corporation
CSLE	Civil Service Labor and Expenses
CSTD	Crosscutting Space Technology Development
CTC	Chief Technologist Council
CY	Calendar Year
CSPE	Colorimetric Solid Phase Extraction
CVB	Constrained Vapor Bubble
DAAC	Distributed Active Archive Centers
DAN	Dynamic Albedo of Neutrons
DARPA	Defense Advanced Research Projects Agency
dB	Decibel
DDT&E	Design, Development, Test, and Evaluation
DESDynI	Deformation, Ecosystem Structure, and Dynamics of Ice
DFRC	Dryden Flight Research Center
DLR	Deutches Zentrum für Luft- Raumfahrt (German Aerospace Center)
DME	Development, Modernization, and Enhancement
DNA	Deoxyribonucleic Acid
DoD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DORIS	Doppler Orbitography by Radiopositioning Integrated by Satellite (Ocean Surface Topography Mission instrument)
DOT	Department of Transportation
DPMC	Directorate Program Mgmt Council
DPR	Dual-frequency Precipitation Radar (Global Precipitation Measurement instrument)
DR	Decommissioning Review
DRS	Disturbance Reduction System

DSI	Deutsches SOFIA Institut
DSN	Deep Space Network
DSS	Deep Space Station
DTN	Disruption Tolerant Networking
E/PO	Education and Public Outreach
ECA	An Arianne rocket
ECT	Energetic Particle, Composition and Thermal Plasma
ED	Department of Education
ED	NASA Education
EDA	Efficient Descent Advisor
EDL	Entry, Descent, and Landing
EDLT	Entry, Descent and Landing Technologies
EDR	Environmental Data Record
EDT	Education Design Team
EEE	Evolution of EOSDIS Elements
EELV	Evolved Expendable Launch Vehicle
EEO	Equal Employment Office
EFW	Electric Field and Waves Instrument
ELC	ExPRESS Logistics Carrier
ELV	Expendable Launch Vehicle
EM2	Electronics Box Engineering Model 2
EMFISIS	Electric and Magnetic Field Instrument Suite and Integrated Science
EMTGO	ExoMars Trace Gas Orbiter
EO	Equal opportunity
EO-1	Earth Observing One Mission
EONS	Education Opportunities in NASA STEM
EOS	Earth Observing System
EOSDIS	Earth Observing System Data and Information System
EPA	Environmental Protection Agency
EPOXI	Extrasolar Planet Observation and Deep Impact Extended Investigation
EPSCoR	Experimental Program to Stimulate Competitive Research
ERA	Environmentally Responsible Aviation
ERD	Exploration Research and Development
ESA	European Space Agency
ESD	Earth Science Division
ESDR	Earth System Data Records
ESM	Earth Systematic Missions
ESMD	Exploration Systems Mission Directorate
ESMP	Earth Systematic Missions Program
ESS	Earth Science Subcommittee (of the NASA Advisory Committee)
ESSP	Earth System Science Pathfinder
ESTO	Earth Science Technology Office
ESTP	Earth Science Technology Program
ET	External Tank
ETD	Exploration Technology Development
ETDD	Enabling Technology Development and Demonstration
ETM+	Enhanced Thematic Mapper Plus
ETU	Engineering Test Unit
EUL	Enhanced Use Lease
EUMETSAT	European Meterological Satellite
EV	Earth Venture
EVA	Extravehicular Activity
EX	Explorer Missions
ExEP	Exoplanet Exploration Program
EXES	Echelon-Cross-Echelle Spectrograph
ExMC	Exploration Medical Capability
FAA	Federal Aviation Administration
FAP	Fundamental Aeronautics Program
FAR	Federal Acquisition Regulation
FGM	Fluxgate Magnetometer (Thermal Emission Imaging System instrument)
FGS	Fine Guidance Sensor
FGS-TF	Fine Guidance Sensor - Tunable Filter
FIFI LS	Field Imaging Far-Infrared Line Spectrometer
FLITECAM	First Light Infrared Test Experiment Camera
FMI	Finnish Meteorological Institute
FO	Follow On (to a mission)
FOC	Full Operational Capability
FOIA	Freedom of Information Act
FOR	Flight Operations Review
FORCAST	Faint Object InfrRed CAmera for the SOFIA Telescope
FPA	Focal Plane Array
FPD	Flight Projects Directorate
FRR	Flight Readiness Review
FTE	Full Time Equivalency
FUV	Far Ultraviolet
FY	Fiscal Year
GALEX	Galaxy Evolution Explorer
GAO	Government Accountability Office
GCD	Game Changing Development

GEMS	Gravity and Extreme Magnetism
GEO	Geosynchronous Earth Orbit
GES DAAC	GSFC Earth Science Distributed Active Archive Center
GeV	Gigaelectron volt
GHz	Gigahertz
GLAST	Gamma–ray Large Area Space Telescope (now Fermi Gamma-ray Space Telescope)
GLOBE	Global Learning and Observations to Benefit the Environment
GMI	GPM Microwave Imager (Global Precipitation Measurement instrument)
GOES	Geostationary Operational Environmental Satellite
GPM	Global Precipitation Measurement
GPS	Global Positioning System
GRACE	Gravity Recovery and Climate Experiment
GRAIL	Gravity Recovery and Interior Laboratory
GRC	Glenn Research Center
GRC-PBS	Glenn Research Center–Plum Brook Station
GREAT	German Receiver for Astronomy at Terahetz
GRGT	Guam Remote Ground Terminal
GRIP	Genesis and Rapid Intensification Processes
GSFC	Goddard Space Flight Center
GWAC	Government Wide Acquisition Contracts
HAVT	Hypersonic Air-breathing Vehicle Technologies
HAWC	High-resolution Airborne Wideband Camera
HEC	Human Exploration Capability
HECC	High End Computing Columbia
HgCdTe	Mercury-Cadmium-Telluride (type of array used in many instruments)
HHC	Health and Human Countermeasures
HH&P	Human Health & Performance
HIPO	High-speed Imaging Photometer for Occultation
HIRDLS	High Resolution Dynamic Limb Sounder
HIRES	High Resolution Echelle Spectrometer
HIRS	High Resolution Infrared Radiation Sounder
HITL	Human-in-the-loop
HLV	Heavy Lift Vehicle
HPIW	High Pressure Industrial Water
HPPG	High Priority Performance Goal
HQ	NASA Headquarters
HRP	Human Research Program
HSB	Humidity Sounder for Brazil
HSFO	Human Space Flight Operations
HSPD	Homeland Security Presidential Directive
HST	Hubble Space Telescope
HTV	H-II Transfer Vehicle
Hydros	Hydrosphere State Project
I&T	Integration and Test
I3P	Information Technology Infrastructure Integration Program
IASI	Infrared Atmospheric Sounding Interferometer
IBEX	Interstellar Boundary Explorer
IBPD	Integrated Budget and Performance Document
ICA	Innovative Concepts for Aviation
ICESat	Ice, Cloud, and Land Elevation Satellite
ICEScape	SMD Earth
ICRP	Independent Comprehensive Review Panel
IDPS	Interface Data Processing Segment
IG	Inspector General
IKI	Institut Kosmitscheski Isledowani (Russian Space Institute)
ILN	International Lunar Network
INPE	Brazilian Institute for Space Research
INTA	Instituto Nacional de Técnica Aerospacial
IPWG	Interagency Partnerships Working Group
IPAC	Infrared Processing and Analysis Center
IPAO	Independent Program Assessment Office
IPCC	International Panel on Climate Change
IPO	Integrated Program Office
IPP	Innovative Partnerships Program
IPWG	Interagency Partnerships Working Group
IR	Infrared
IRAC	Integrated Resilient Aircraft Controls
IRIS	Interface Region Imaging Spectrograph
IRR	Investigation Readiness Reviews
IRSA	NASA/IPAC Infrared Science Archive
IRT	Independent Review Team

ISAS	Institute of Space and Astronautical Science
ISP	In-Space Propulsion
ISRO	Indian Space Research Organisation
ISRP	Integrated Systems Research Program
ISRU	In-Situ Resource Utilization
ISS	International Space Station
ISSMP	International Space Station Medical Program
IT	Information Technology
IV&V	Independent Verification and Validation
IXO	International X-ray Observatory
JADE	Jovian Auroral Distributions Experiment
JAXA	Japan Aerospace Exploration Agency
JCL	Joint Cost and Schedule Confidence Level
JDEM	Joint Dark Energy Mission
JEDI	Jupiter Energetic particle Detector Instrument
JHU	John Hopkins University
JHU-APL	Johns Hopkins University–Applied Physics Laboratory
JOI	Jupiter Orbit Insertion
JPDO	Joint Planning and Development Office
JPL	Jet Propulsion Laboratory
JPSS	Joint Polar Satellite System
JSC	Johnson Space Center
JWST	James Webb Space Telescope
K	Kelvin (degrees)
KaPR	Ka-band Precipitation Radar
KDP	Key Decision Point Review
KeV	Kiloelectron Volts
KHz	Kilohertz
kG	Kilogram
KI	Keck Interferometer
km	Kilimeter
KNMI	Royal Netherlands Meteorological Institute
KSA	Keck Single Aperture
KSC	Kennedy Space Center
KuPR	Ku Precipitation Radar
kVAR	Kilovolt Ampere Reactive
kW	Kilowatt
L2	Second Sun-Earth Libration, or Lagrange Point
L3	L-3 Communications Corporation
LADEE	Lunar Atmosphere and Dust Environment Explorer
LaRC	Langley Research Center
LASER	Lunar Advanced Science and Exploration Research
LASP	Laboratory for Atmospheric and Space Physics (University of Colorado, Boulder)
LBT	Large Binocular Telescope
LBTI	Large Binocular Telescope Interferometer
LCAS	Low-Cost Access to Space
LCC	Life Cycle Cost
LCCE	Life Cycle Cost Estimate
LDCM	Landsat Data Continuity Mission
LDEX	Lunar Dust EXperiment
LEED	Leadership in Energy and Environment Design
LEO	Low Earth Orbit
LH2	Liquid Hydrogen
LISA	Laser Interferometer Space Antenna
LL	Lincoln Laboratory
LLC	Limited Liability Company
LLCD	Lunar Laser Communications Demonstration
LM	Lockheed Martin
LoB	Lines of Business
LOX	Liquid Oxygen
LQP	Lunar Quest Program
LRD	Launch Readiness Date
LRO	Lunar Reconnaissance Orbiter
LRR	Launch Readiness Review
LSP	Launch Services Program
LTO	LTO NOx subsonic
LV	Launch Vehicle
LWS	Living with a Star
$M	Million (of Dollars)
μm	Microns (micrometers)
m	Meter
M3	Moon Mineralogy Mapper
MA	Multiple Access
MACPEX	Mid-latitude Airborne Cirrus Properties Experiment
MAV	Mars Ascent Vehicle
MAVEN	Mars Atmosphere and Volatile EvolutioN
MCR	Mission Confirmation Review

MD	Mission Directorate
MDR	Mission Design Review
MEaSUREs	Making Earth System data records for Use in Research Environments
MEDLI	Mars Science Laboratory Entry, Descent, and Landing Instrument
MER	Mars Exploration Rovers
MESSENGER	Mercury Surface, Space Environment, Geochemistry and Ranging
METI	Ministry of Economy Trade and Industry (Japan)
MeV	Mega electron Volts
MEX	Mars Express
mGal	milligallon
MIB	Mishap Investigation Board
MICINN	Spanish Space Agency
MIDEX	Medium-Class Explorer
MIRI	Mid-infrared Instrument (James Webb Space Telescope instrument)
MIT	Massachusetts Institute of Technology
MK	megakelvin
MLS	Microwave Limb Sounder
MMO	Mars Mission Operations
MMOD	Micrometeoroid/ Orbital Debris
MMS	Magnetospheric Multiscale
MO	Missions of Opportunity
MODIS	Moderate Resolution Imaging Spectroradiometer
MOE	Mission Operations Element
MOPITT	Measurements of Pollution in the Troposphere
MOU	Memorandum of Understanding
MPAR	Major Program Annual Report
MPCV	Multi-Purpose Crew Vehicle
MRO	Mars Reconnaissance Orbiter
MRR	Mission Requirement Request
MRSA	Methicillin-resistant *Staphylococcus aureus*
MSFC	Marshall Space Flight Center
MSL	Mars Science Laboratory
MUREP	Minority University Research and Education Project
MUSS	Multi-User Systems and Support
MWR	Microwave Radiometer
N/A	Not applicable
NAC	NASA Advisory Committee
NACA	National Advisory Committee on Aeronautics
NAR	Non-Advocacy Review
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NEBULA	NASA's Cloud Computing Platform
NEN	Near Earth Network
NEO	Near-Earth Object
NEOO	Near-Earth Object Observations
NES	NASA Explorer Schools
NESC	NASA Engineering and Safety Center
NETS	NASA Educational Technology Services
NextGen	Next Generation Air Transportation System
NEXT	NASA Evolutionary Xenon Thruster
NExScI	NASA Exoplanet Science Institute
NGAS	Northrup Grumman Aerospace Systems
NGO	Non-Governmental Organization
NGST	Northrop Grumman Space Technology
NH	Northern Hemisphere
NIAC	NASA Institute for Advanced Concepts
NIH	National Institute for Health
NIR	Near-Infrared
NIRCam	Near-Infrared Camera
NIRSpec	Near-Infrared Spectrometer
NISN	NASA Integrated Services Network
NIVR	Netherlands Agency for Aerospace Programs
NLR	National Aerospace Laboratory of the Netherlands
NLS	NASA Launch Services
NLSI	NASA Lunar Science Institute
nm	Nanometer
NMSU	New Mexico State University
NOAA	National Oceanic and Atmospheric Administration
NOx	Nitrogen Oxide
NPAT	National Partnership for Aeronautic Testing
NPD	NASA Policy Directive
NPO	Non-Profit Organization
NPOESS	National Polar–orbiting Operational Environmental Satellite System

NPP	NPOESS Preparatory Project
NPR	NASA Procedural Requirement
NRA	NASA Research Announcement
NRC	National Research Council
NRCC	National Research Council Canada
NRL	Naval Research Laboratory
NRO	National Reconnaissance Office
NSBRI	National Space Biomedical Research Institute
NSC	NASA Safety Center
NSF	National Science Foundation
NSPD	National Space Policy Directive
NSSC	NASA Shared Services Center
NSSDC	National Space Science Data Center
NSWPC	National Space Weather Program Council
NTEC	NASA Technology Executive Council
NuSTAR	Nuclear Spectroscopic Telescope Array
NUV	Near Ultraviolet
NWP	Numerical Weather Prediction
O2	Oxygen
OA	Office of Audits
OCE	Office of the Chief Engineer
OCFO	Office of Chief Financial Officer
OCHMO	Office of the Chief Health and Medical Officer
OCIO	Office of Chief Information Officer
OCO	Orbiting Carbon Observatory
OCT	Office of the Chief Technologist
OHCM	Office of Human Capital Management
OI	Office of Investigations
OIG	Office of Inspector General
OIIR	Office of International and Interagency Relations
OLI	Operational Land Imager (Landsat Data Continuity Mission instrument)
OLS	Operational Linescan System
OMB	Office of Management and Budget
OMC	Operations Management Council
OMEGA	Offshore Membrane Enclosures for Growing Algae
OMI	Ozone Monitoring Instrument
OMPS	Ozone Mapping and Profiler Suite (NPOESS Preparatory Project instrument)
ONERA	Office National d'Études et de Recherches Aérospatiales
OPM	Office of Personnel Management
ORR	Operations Readiness Review
OSC	Orbital Sciences Corporation
OSCAT	Indian Space Agency's scatterometer instrument
OSHA	Occupational and Safety and Health Administration
OSMA	Office of Safety and Mission Assurance
OSP	Orbital/Suborbital Program (of the USAF)
OSTP	Office of Science and Technology Policy
OSTST	Ocean Surface Topography Science Team
OTE	Optical Telescope Element
OTIS	Optical Telescope Element/ Integrated Science Module (JWST)
OVWST	Ocean Vector Winds Science Team
P.L.	Public Law
PACE	Pre-Aerosols, Carbon and Ecosystems
PAR	Performance and Accountability Report
PAR	Program Acceptance Review
PARASOL	Polarization & Anisotropy of Reflectances for Atmospheric Sciences coupled with Observations from a Lidar
PART	Program Assessment Rating Tool
PB	President’s Budget
PBR	President’s Budget Request
PBS	President’s Budget Submit
PCA	Program Commitment Agreement
PCAD	Propulsion Cryogenics Advanced Development
PCBs	Polychlorinated biphenyls
PCOS	Physics of the Cosmos
PDR	Preliminary Design Review
PDS	Planetary Data System
PI	Principal Investigator
PICS	Partnerships, Innovation and Commercial Space
PIP	Payload Interface Processor
PIR	Program Implementation Review
PLAR	Post Launch Assessment Review
PLSS	Portable Life Support System
PMA	President's Management Agenda
PMC	Program Management Council
PNAR	Preliminary Non-Advocate Review

PNT	Positioning, Navigation, and Timing
POWER	Protecting Our Workers and Ensuring Reemployment Presidential Initiative
PPS	Precipitation Processing System
PR	Precipitation Radar
PSBR	Proton Spectrometer Belt Research
PSL	Propulsion Systems Laboratory
psu	practical salinity units
QTR	Quarter
QuickSCAT	Quick Scatterometer
R&A	Research and Analysis
R&D	Research and Development
R2	Robonaut 2
RAP	Robotics Alliance Project
RBSP	Radiation Belt Storm Probes
RBSPICE	Radiation Belt Science of Protons, Ions, Composition, and Electrons
RCT	Randomized controlled trials
REMS	Rover Environmental Monitoring System
RF	Radio Frequency
RFI	Request for Information
RFP	Request for Proposal
RHESSI	Reuven Ramaty High Energy Solar Spectroscopic Imager
RMP	Risk Mitigation Phase
ROSES	Research Opportunities in Space and Earth Science
RPS	Radioisotope Power System
RTF	Return to Flight
RPT	Rocket Propulsion Testing
RR	Readiness Review
RS	Russian Segment
RSAS	Raytheon Space and Airborne Systems
RSDO	Rapid Spacecraft Development Office
RSRB	Reusable Solid Rocket Booster
RSRM	Reusable Solid Rocket Motor
RTAX	A field programmable gate array on RSBP
RTF	Return to Flight
RVT	Remote Visual Testing
RTT	Research Transition Teams
S/A	Solar array
s/c	Spacecraft
S&MA	Safety and Mission Assurance
S, R and Q	Safety, Reliability, and Quality
SA	Single Access
SA/SPaH	Sample Acquisition, Processing, and Handling (drill for MSL)
SAA	Space Act Agreement
SAC-D	Satellite de Aplicaciones Cientificas–D (Argentina)
SADA	Solar Array Drive Assembly
SAGE	Stratospheric Aerosol and Gas Experiment
SALMON	Stand Alone Missions of Opportunity NRA
SAM	Sample Analysis of Mars (MSL)
SAP	NASA's Core Financial System
SAR	Synthetic Aperture Radar
SAU	Strategic Airspace Usage
SBC	Single Board Computer
SBIR	Small Business Innovative Research
SBRS	Santa Barbara Remote Sensing (Division of Raytheon)
SCADA	Supervisory Control and Data Acquisition
SCaN	Space Communications and Navigation
SCAP	Shared Capability Assets Program
SCEM	"The Scientific Context for Exploration of the Moon," NRC Planetary Science report
SCNS	Space Communications Network Services
SDO	Solar Dynamics Observatory
SeaWiFS	Sea-viewing Wide Field-of-view Sensor
SE&I	System Engineering and Integration
SEMAA	Science Engineering Mathematics Aerospace Academy
SET	Space Environment Testbeds
SFCO	Space Flight Crew Operations
SFS	Space and Flight Support
SFW	Subsonic Fixed Wing
SH	Southern Hemisphere
SI	Strategic Integration
SGLT	Space-to-Ground Link Terminals
SI	Science Instrument(s)
SIM	Space Interferometry Mission
SIR	System Integration Review
SLS	Space Launch System
SM-4	Servicing Mission–4 (Hubble)
SMAP	Soil Moisture Active/Passive
SMD	Science Mission Directorate
SMEX	Small Explorer

SN	Space Network
SNGG	Space Network Ground Segment Sustainment
SNSB	Swedish National Space Board
SoI	Summer of Innovation
SMC/TEL	Space and Mission Command/Test and Evaluation Directorate
SMD	Science Mission Directorate
SMEX	Small Explorer
SOC	Security Operations Center
SOC	Solar Orbiter Collaboration
SOFIA	Stratospheric Observatory for Infrared Astronomy
SOHO	Solar Heliospheric Observer
SOMD	Space Operations Mission Directorate
SORCE	Solar Radiation and Climate Experiment
SOST	Subcommittee on Ocean Science and Technology
SpaceX	Space Exploration and Technology
SPHERES	Synchronized Position Hold, Engage, Reorient, Experimental Satellites
SPOC	Space Program Operations Contract
SPP	Solar Probe Plus
SR	Senior Review
SR	Space Radiation
SRA	Slip Ring Assembly
SR&T	Supporting Research and Technology
SRB	Standing Review Board
SRG	Stirling Radioisotope Generator
SRR	System Requirement Review
SRW	Subsonic Rotary Wing
SSC	Stennis Space Center
SSME	Space Shuttle Main Engines
SSO	Swiss Space Agency
SSP	Space Shuttle Program
SSS	Sea Surface Salinity
ST	Space Technology
ST7	Space Technology 7 mission
STEM	Science, Technology, Engineering, and Mathematics (Education)
STEREO	Solar Terrestrial Relations Observatory
STI	Scientific and Technical Information
STRG	Space Technology Research Grants Program
STS	Space Transportation System
STScI	Space Telescope Science Institute
STTR	Small Business Technology Transfer Program
SWIR	Short Wave Infrared
SWOT	Surface Water and Ocean Topography
SwRI	Southwest Research Institute
SXS	High-Resolution Soft X-Ray Spectrometer
TAT	Test Assessment Team (JWST)
TBD	To be determined
TDEM	Technology Development for Exoplanet Missions
TDRS	Tracking and Data Relay Satellite
TDRSS	Tracking and Data Relay Satellite System
THEMIS	Time History of Events and Macroscale Interactions during Substorms
TIM	Total Irradiance Monitor (Glory instrument)
TIMED	Thermosphere, Ionosphere, Mesosphere, Energetics and Dynamics
TIMS	Thermal Infrared Multispectral Scanner
TIRS	Thermal Infrared Sensor
TMI	TRMM Microwave Imager
TNO TPD	Netherlands Organization for Applied Scientific Research - Institute of Applied Physics
TOF	Time of Flight
TPS	Thermal Protection System
T&R	Transition and Retirement
TRL	Technology Readiness Level
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
TT&C	Flight Tracking Telemetry and Command
TWINS	Two Wide–angle Imaging Neutral–atom Spectrometers
U.S.C.	United States Code
UAS	Uninhabited Air Systems
UAV	Unmanned Aerial Vehicle
UCLA	University of California at Los Angeles
UKSA	United Kingdom Space Agency
ULA	United Launch Alliance
USA	United Space Alliance
USAF	United States Air Force
USAID	U.S. Agency for International Development
USDA	United States Department of Agriculture

USE	Upper Stage Engine
USGCRP	U.S. Global Change Research Program
USGS	United States Geological Survey
USRA	Universities Space Research Association
UTD	University of Texas at Dallas
UV	Ultraviolet
UVS	UV Spectrometer
VAO	Virtual Astronomical Observatory
VCL	Vegetation Canopy Lidar
VIIRS	Visible-Infrared Imager Radiometer Suite (NPOESS Preparatory Project instrument)
VTT	VTT Technical Research Centre of Finland
WFF	Wallops Flight Facility (NASA, managed by GSFC)
WFIRST	Wide-Field Infrared Survey Telescope
WISE	Wide-field Infrared Survey Explorer
WMAP	Wilkinson Microwave Anisotropy Probe
WSC	White Sands Complex
WSTF	White Sands Test Facility
XCVR	Transceiver
XMM	X-ray Multi-mirror Mission (Newton Observatory)
XPI	X-ray Polarimeter Instrument