

National Aeronautics and Space Administration



OFFICE OF THE CHIEF TECHNOLOGIST

SPACE TECHNOLOGY  
**INDUSTRY FORUM**

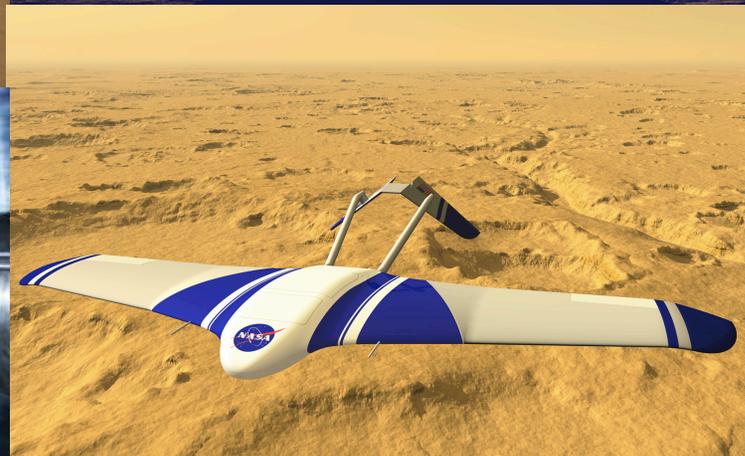
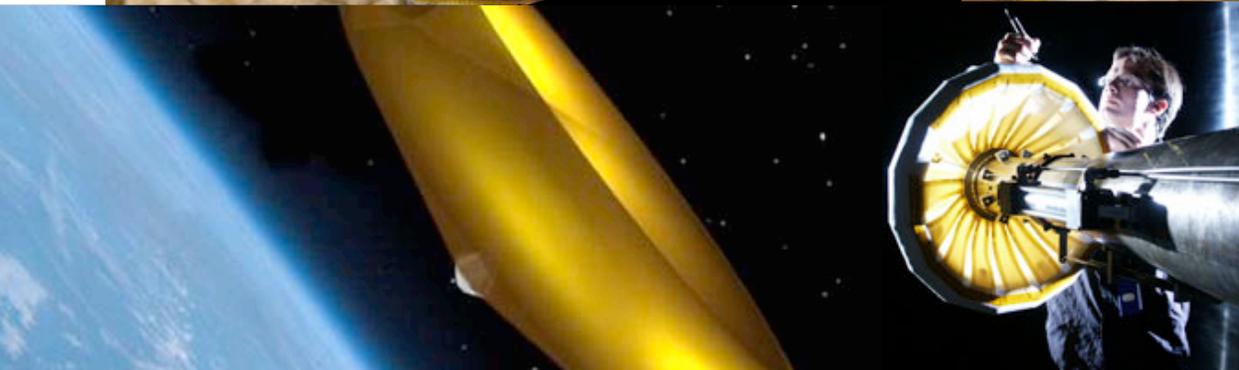
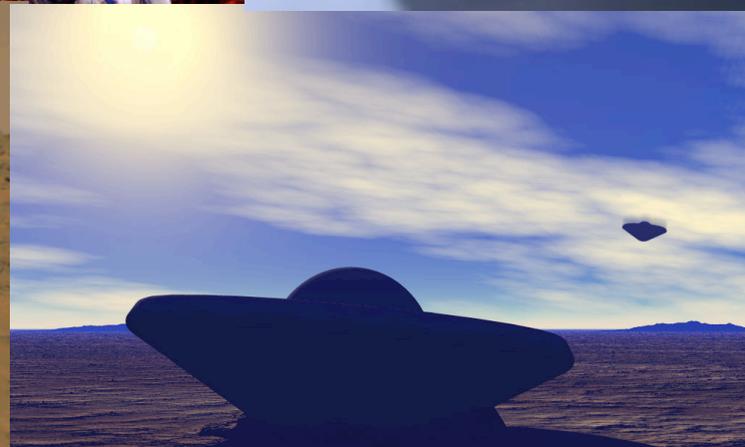
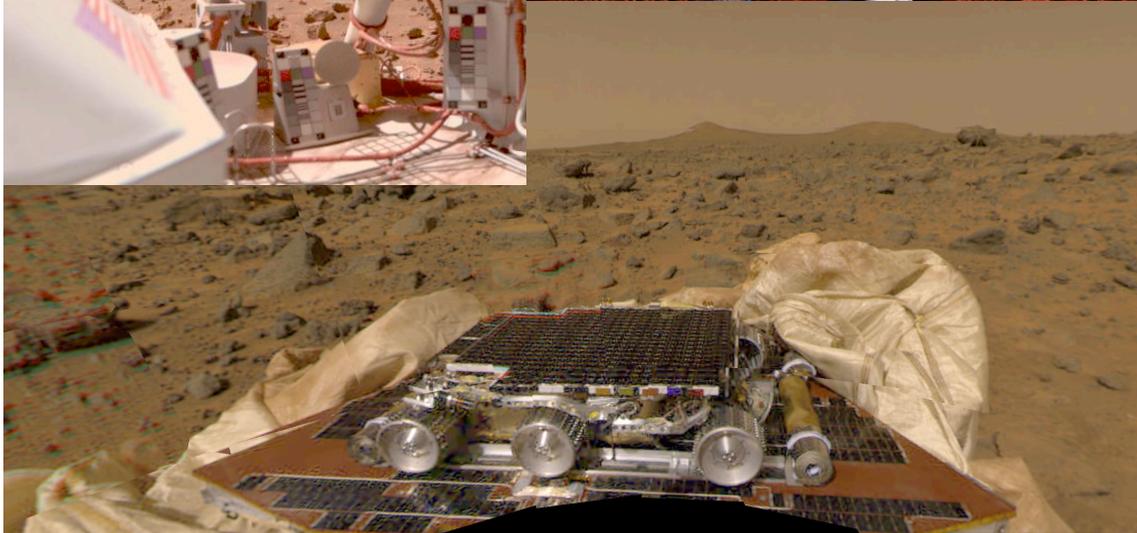
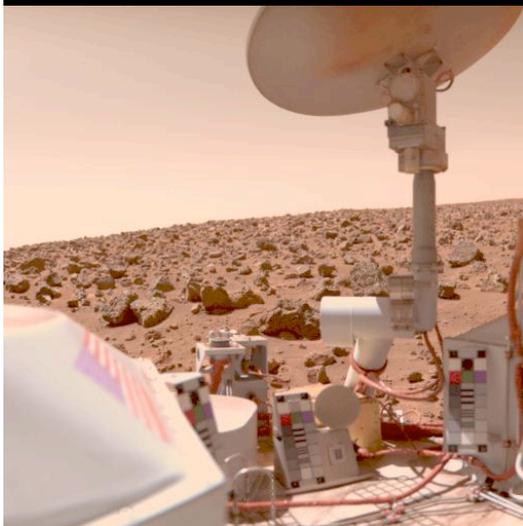
A woman in a dark jacket and pants stands on the right side of a yellow-toned, futuristic industrial or technological environment. The background is filled with complex machinery, pipes, and structural elements, creating a sense of depth and scale.

**Office of the Chief Technologist**

**Dr. Bobby Braun**  
**NASA Chief Technologist**  
**July 13, 2010**

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# An Abbreviated CV of NASA's Chief Technologist



# Themes of the President's FY11 NASA Budget Request



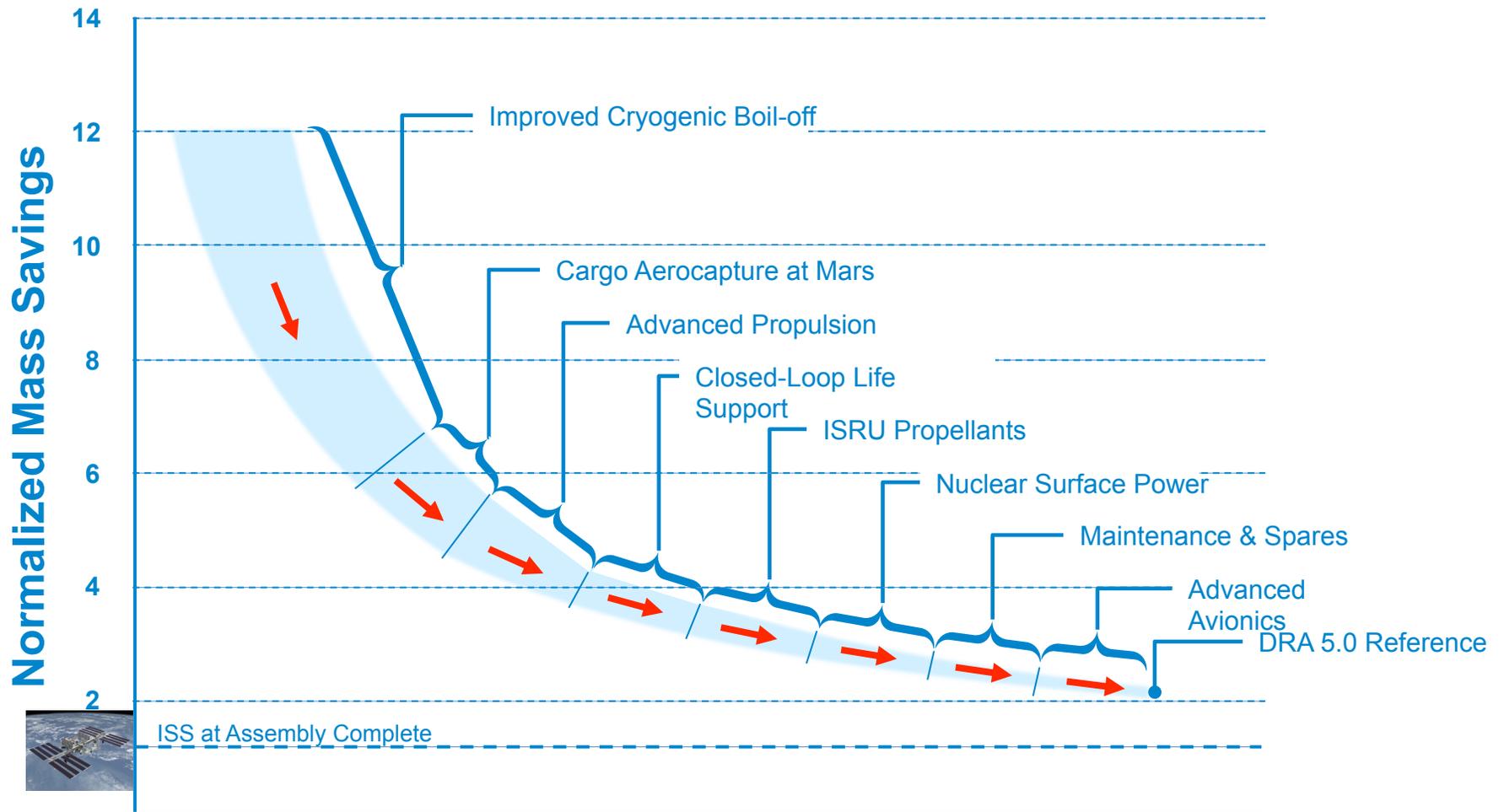
- **Technology Development is a strong theme across the President's FY11 NASA budget request**
  - Central principle of new Human Exploration strategy
  - Reverse of past decline and modest increase for Aeronautics (~15% or \$75M/yr)
  - Mission-focused technology investments maintained within the Science Mission Directorate
  - Utilization of ISS for technology development by the Space Operations Mission Directorate
  - New ARPA-like Space Technology Program (\$5B over 5 years)
- **This renewed emphasis balances the long-standing NASA core competencies of R&T, spaceflight hardware development, and mission operations.**
- **Increased emphasis on partnerships and STEM education**
  - Other government agencies, academia, industry and international
  - Theme of National Space Policy
  - Casting a wide net will allow any innovator to be part of our Space program
- **Overarching goal is to reposition NASA on the cutting-edge**

# External Input Has Driven Development of NASA's Technology-Enabled Approach



- **NASA Authorization Act of 2008:** *“A robust program of long-term exploration-related research and development will be essential for the success and sustainability of any enduring initiative of human and robotic exploration of the solar system.”*
- **NRC report, A Constrained Space Exploration Technology Program: A Review of NASA’s ETDP, 2008:** *“NASA has created a supporting technology program very closely coupled to the near-term needs of the Constellation Program. This program contains only incremental gains in capability and two programmatic gaps. NASA has effectively suspended research in a number of technology areas traditionally within the agency’s scope. This could have important consequences for those portions of the VSE beyond the initial short-duration lunar missions, including extended human presence on the Moon, human exploration of Mars, and beyond.”*
- **NRC report, America’s Future in Space, 2009:** *“NASA should revitalize its advanced technology development program by establishing a DARPA-like organization within NASA as a priority mission area to support preeminent civil, national security (if dual-use), and commercial space programs.”*
- **NRC report, Fostering Visions for the Future: A Review of the NASA Institute for Advanced Concepts, 2009:** *“To improve the manner in which advanced concepts are infused into its future systems, the committee recommends that NASA consider reestablishing an aeronautics and space systems technology development enterprise. Its purpose would be to provide maturation opportunities and agency expertise for visionary, far-reaching concepts and technologies.”*
- **Augustine Committee, 2009:** *“The Committee strongly believes it is time for NASA to reassume its crucial role of developing new technologies for space. Today, the alternatives available for exploration systems are severely limited because of the lack of a strategic investment in technology development in past decades.”*
- **NRC report, Capabilities for the Future: An Assessment of NASA Laboratories for Basic Research, 2010:** *“To restore the health of the fundamental research laboratories, including their equipment, facilities, and support services, NASA should restore a better funding and leadership balance between long-term fundamental research/technology development and short- term mission-focused applications.”*

# The Value of Technology Investments Mars Mission Example\*



- Without technology investments, the mass required to initiate a human Mars mission in LEO is approximately twelve times the mass of the International Space Station
- Technology investments of the type proposed in the FY 2011 budget are required to put such a mission within reach

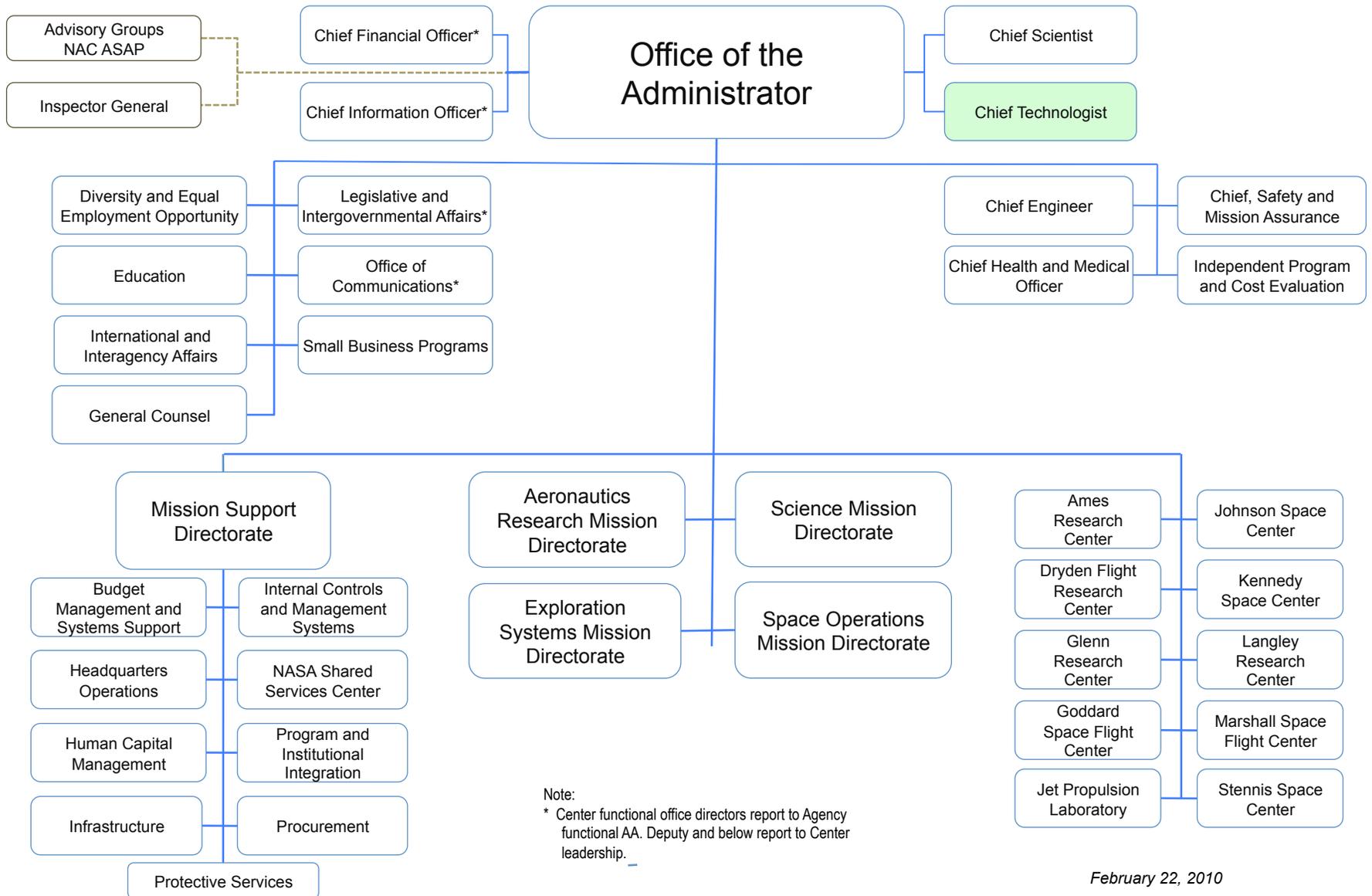
\* The ordering and impact of these technologies are an example valid for one particular architecture and is not intended as an architecture endorsement nor technology development prioritization

# Office of Chief Technologist Roles/Responsibilities



- **OCT established in February 2010**
- **OCT has six main goals and responsibilities:**
  - 1) Principal NASA advisor and advocate on matters concerning Agency-wide technology policy and programs.
  - 2) Up and out advocacy for NASA research and technology programs. Communication and integration with other Agency technology efforts.
  - 3) Direct management of Space Technology Programs.
  - 4) Coordination of technology investments across the Agency, including the mission-focused investments made by the NASA mission directorates. Perform strategic technology integration.
  - 5) Change culture towards creativity and innovation at NASA Centers, particularly in regard to workforce development.
  - 6) Document/demonstrate/communicate societal impact of NASA technology investments. Lead technology transfer and commercialization opportunities across Agency.
- Mission Directorates manage the mission-focused technology programs for directorate missions and future needs
- Beginning in FY 2011, activities associated with the Innovative Partnerships Program are integrated into the Office of the Chief Technologist

# National Aeronautics and Space Administration



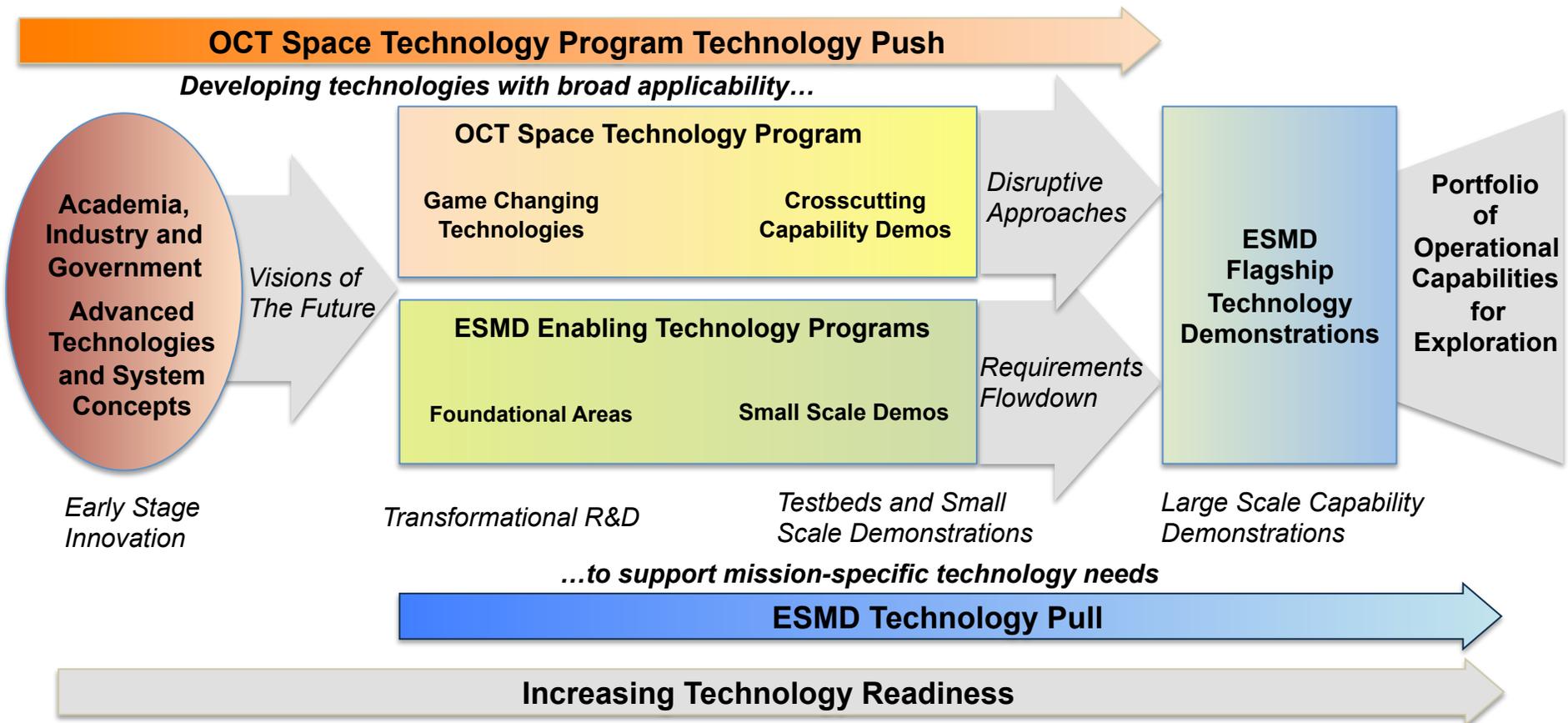
Note:  
 \* Center functional office directors report to Agency functional AA. Deputy and below report to Center leadership.

February 22, 2010

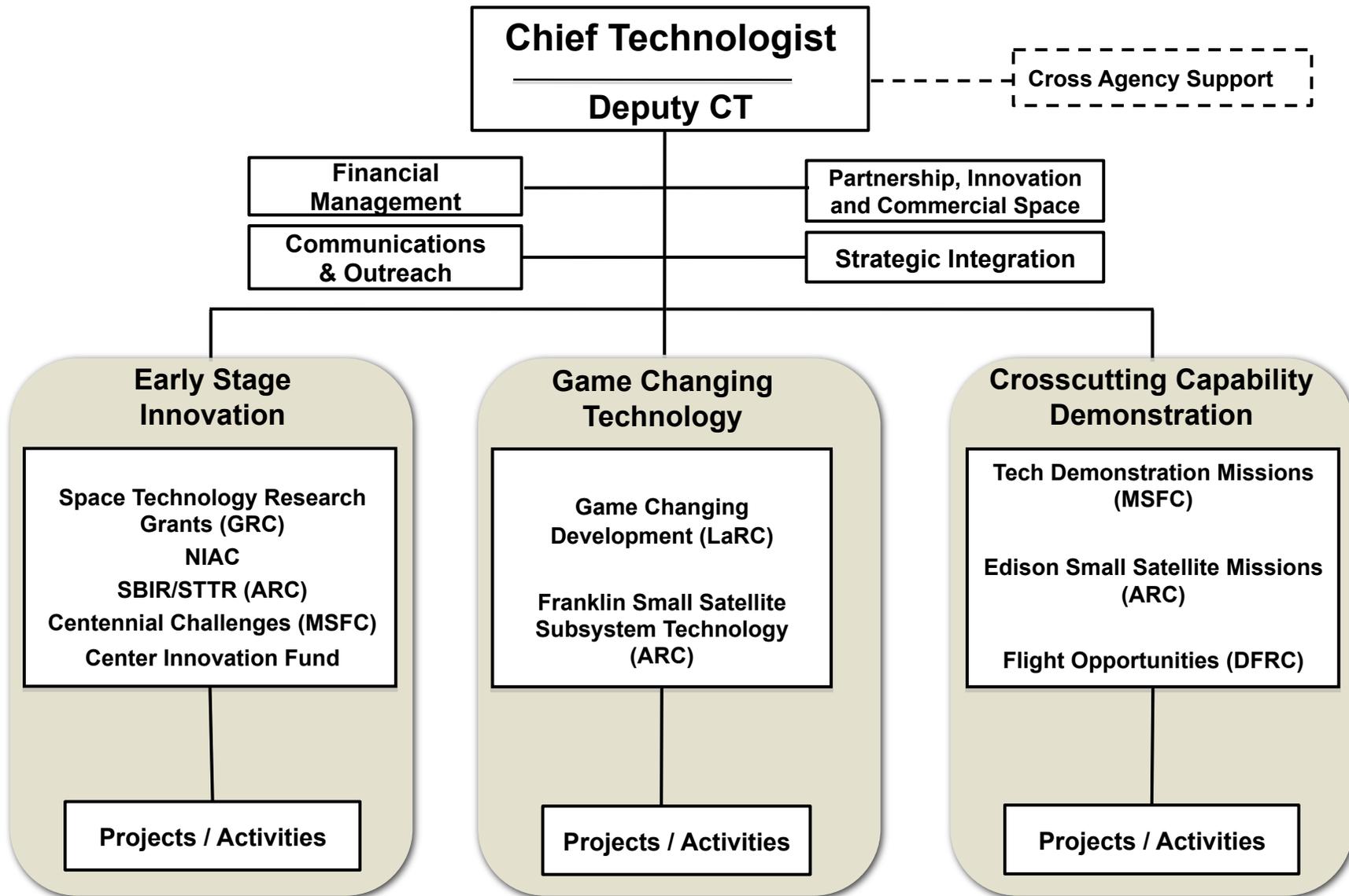
# Integration of NASA's Technology Investments



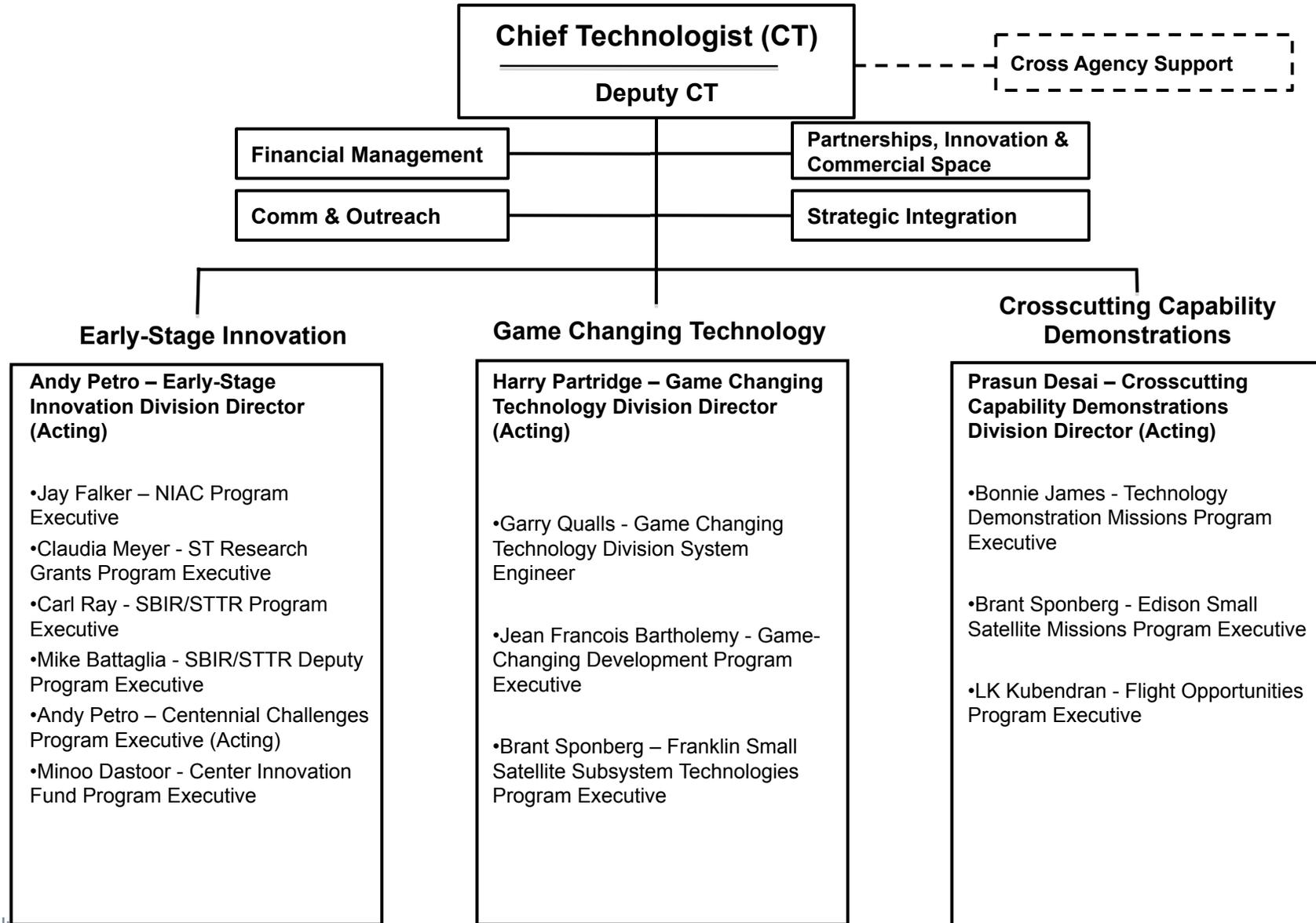
- OCT in partnership with ARMD, SMD, SOMD and ESMD will invest in a portfolio of technology investments enabling new approaches to NASA's current mission set, and allowing the Agency to pursue entirely new missions of science and exploration.
- The example below shows how the OCT and ESMD technology program relate. Similar relationships are in place for SMD, SOMD and ARMD.



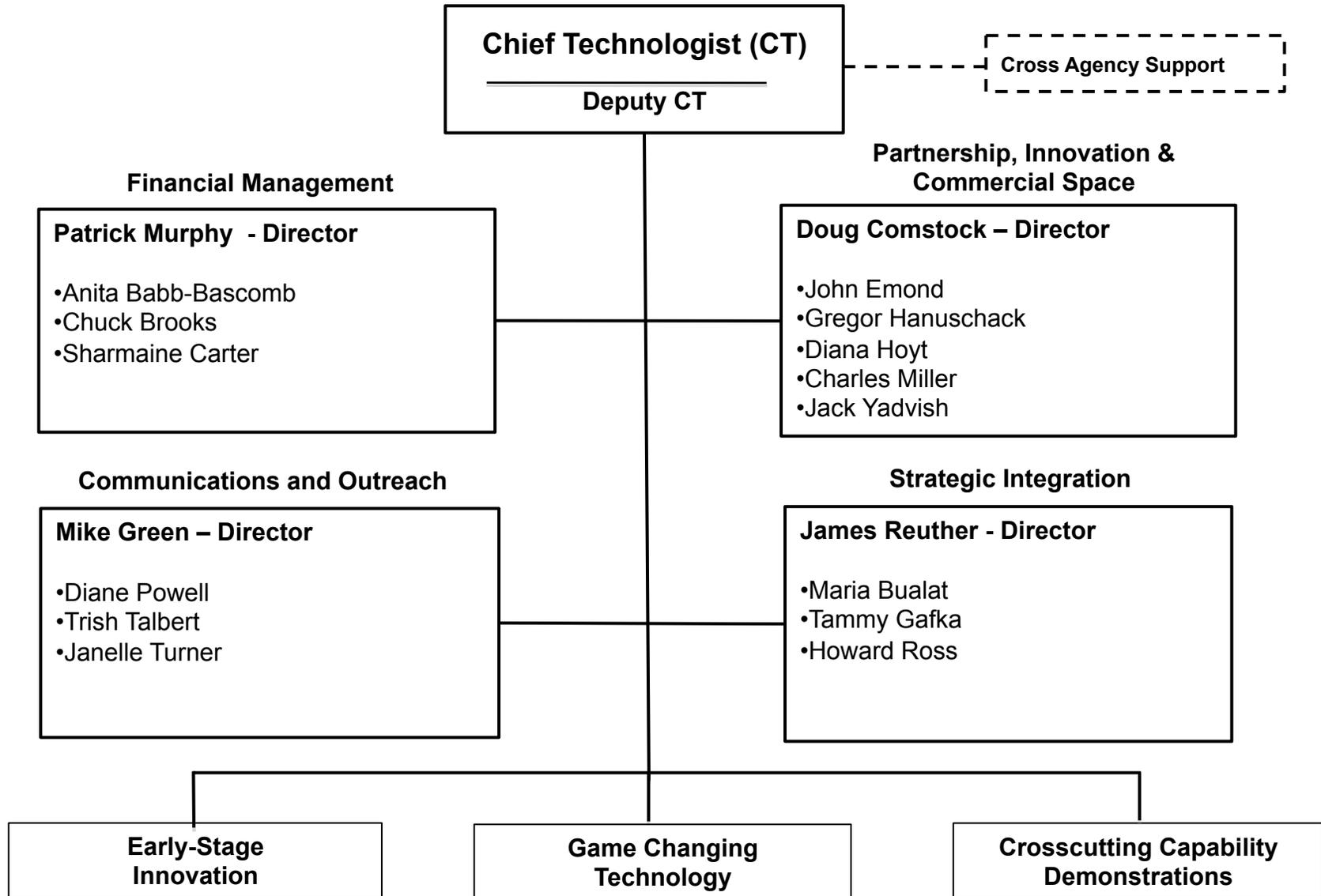
# Office of the Chief Technologist Organization



# NASA Office of the Chief Technologist



# NASA Office of the Chief Technologist



# Space Technology: A Different Approach



- **Strategic Guidance**
  - Grand challenges
  - Technology roadmaps
- **Full spectrum of technology programs that provide an infusion path to advance innovative ideas from concept to flight**
- **Competitive peer-review and selection**
  - Competition of ideas building an open community of innovators for the Nation.
- **Projectized approach to technology development**
  - Defined start and end dates
  - PMs with full authority and responsibility
  - Project focus in selected set of strategically defined capability areas
- **Overarching goal is to reposition NASA on the cutting-edge**
  - Technical rigor
  - Pushing the boundaries
  - Take informed risk and when we fail, fail fast and learn in the process
  - Seek disruptive innovation such that with success the future will no longer be a straight line.
  - Foster an emerging commercial space industry

**Space Technology: The Innovation Engine required to fuel the Agency's long-term needs in aeronautics, science and exploration while advancing our Nation's technological future.**



- **Building on the success of NASA's Innovative Partnerships Program**
  - Centennial Challenges
  - SBIR/STTR
  - IPP Seed Fund → Center Innovation Fund
  - FAST and CRuSR → Flight Opportunities
  - IPP Partnerships, Technology Transfer, Commercialization and Commercial Space → Partnerships, Innovation and Commercial Space
  - IPP Center field offices → Center Chief Technologist offices
- **In FY11, \$234 of \$572M and over FY11-FY15, \$1.2B of \$4.9B is IPP-related content**
- **Formulation of all Space Technology programs was initiated in February and has proceeded rapidly and effectively. We are ready for FY11 initiation of the new Space Technology programs.**

# Grand Challenges (DRAFT)



## *Make space part of our routine environment...*



Achieve fast and economical space transportation

Enable in-space commercial/ marketable services

Improve spacecraft safety and protect astronaut health

Communications that enable virtual presence

## *Manage space as a natural resource...*



Gain knowledge of climate change and natural disasters

Provide economical energy on demand

Improve Knowledge of the near-earth environment

Invent the materials of exploration using in-situ manufacturing

## *Quests of the Future...*



Exploit machine intelligence/robotic autonomy

Understand laws of the universe

Discover life and earth-like worlds



# Building Disruptive and Game Changing Technology



## Strategic Opportunities

## Enabling Capabilities

## Transformational Technology Demonstration

**Scientific Discovery**

**Human and Robotic Exploration**

**New and Innovative Space Technologies and Mission Capabilities**

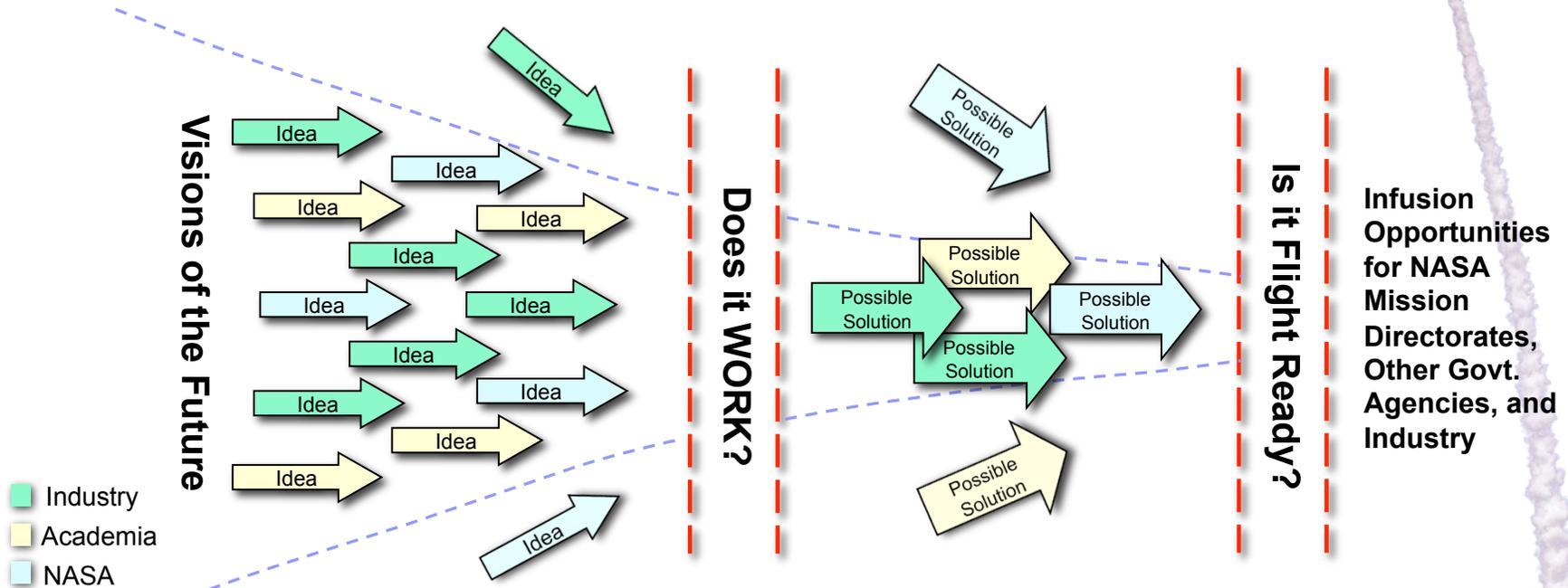
Challenge Goals

**Systems Capabilities**

- Energetic Materials
- Inflatable Aerocapture
- Optical Communication
- Nano electronics
- Radiation Shielding
- Expandable Structures
- Robotic Repair
- Engineered Materials

**Examples of New Technologies**

# Space Technology Development Approach



**Early Stage Innovation**  
Creative ideas regarding future NASA systems or solutions to national needs.



**Game Changing Technology**  
Prove feasibility of novel, early-stage ideas with potential to revolutionize a future NASA mission and/or fulfill national need.



**Crosscutting Capability Demonstration**  
Mature crosscutting capabilities that advance multiple future space missions to flight readiness status



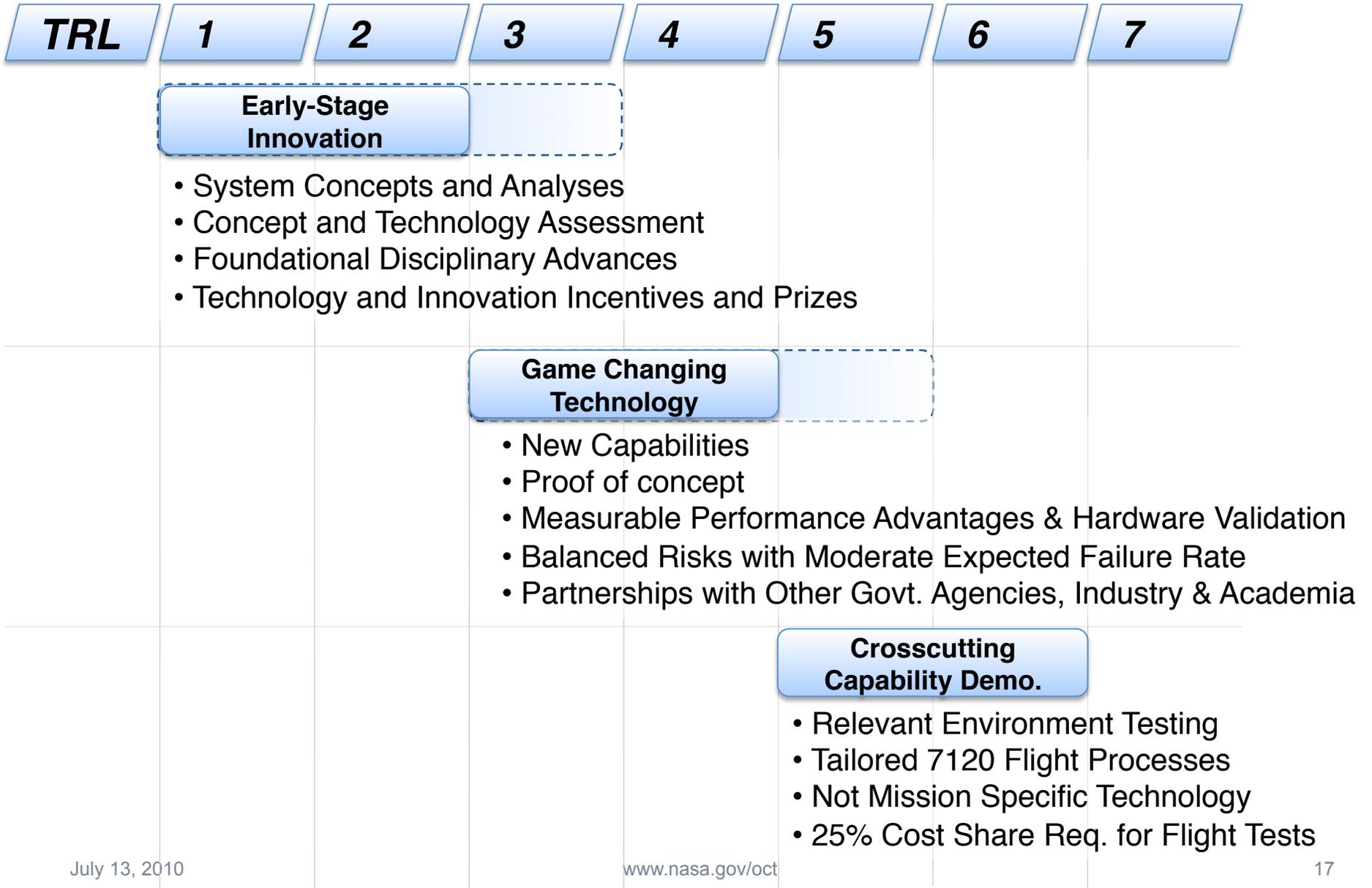
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# Space Technology Program Elements



# Early Stage Innovation



*The Early-Stage Innovation Division sponsors a wide range of low TRL efforts for advanced space system concept and initial technology development across academia, industry and at the NASA field Centers.*

## Early-Stage Innovation includes:

- **Space Technology Research Grants Program** that focuses on innovative research in advanced space technology & graduate fellowships for student research in space technology
- **NIAC Program** that focuses on innovative aeronautics and space system concepts for future NASA missions.
- **Center Innovation Fund Program** to stimulate aerospace creativity and innovation at the NASA field Centers
- **SBIR/STTR Program** to engage small businesses in our Nation's space enterprise and infuse these products across NASA missions
- **Centennial Challenges Prize Program** to address key technology needs with new sources of innovation outside the traditional aerospace community.

**All Early Stage Innovation selections will be made competitively.**

# Game Changing Technology Division



- *The Game Changing Technology Division focuses on maturing advanced space technologies that may lead to entirely new approaches for the Agency's future space missions and solutions to significant national needs.*
- *Through significant ground-based testing and/or laboratory experimentation, the Game Changing Technology Division matures technologies in preparation for potential system level flight demonstration. Success is not assured with each investment; however, on the whole and over time, dramatic advances in technology, enabling entirely new NASA missions and potential solutions for a variety of society's technological challenges are expected.*
- *A broad spectrum of space system technologies will be developed ranging from launch vehicle subsystems, spacecraft technologies, in-space capabilities, and surface systems that support robotic and human exploration.*

## Game Changing Technology Division includes:

- **Game Changing Development Program** which focuses on innovative ideas enabling new capabilities or radically altering our current approaches to space systems
- **Franklin Small Satellite Subsystem Technology Program** which enables small satellites to provide game changing capabilities for the government and commercial sectors

**Greater than 70% of GCT funds (FY11-FY15)  
will be applied to competitive selections**

# Crosscutting Capability Demonstrations Division



- *The Cross-Cutting Capability Demonstrations Division focuses on maturation to flight readiness of cross-cutting capabilities that advance multiple future space missions, including flight test projects where in-space demonstration is needed before the capability can transition to direct mission application.*
- *Matures a small number of technologies that benefit multiple customers to flight readiness status (TRL 6) through Projects that perform relevant environment testing.*

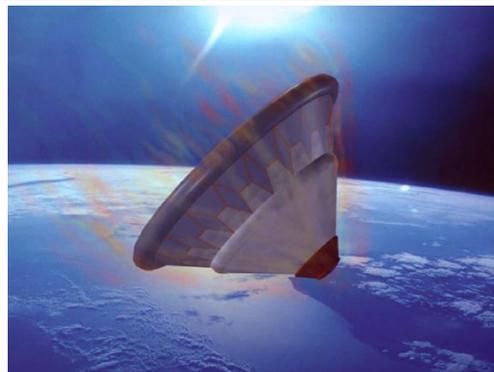
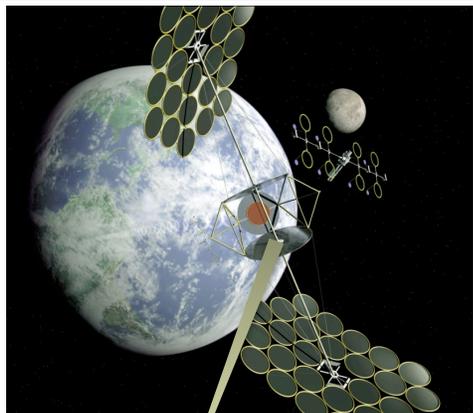
## Crosscutting Capability Demonstrations Division includes:

- **Technology Demonstration Missions Program** which matures, through flight demonstrations, a small number of Agency crosscutting technologies in partnerships with the Mission Directorates
- **Edison Small Satellite Missions Program** which develops and operates a series of NASA-focused small satellite demonstration missions in collaboration with academia and small business
- **Flight Opportunities Program** which provides flight opportunities of reduced-gravity environments, brief periods of weightlessness, and high-altitude atmospheric research

**Greater than 70% of CCD funds (FY11-FY15)  
will be applied to competitive selections**

20

# Potential Space Technology Demonstrations



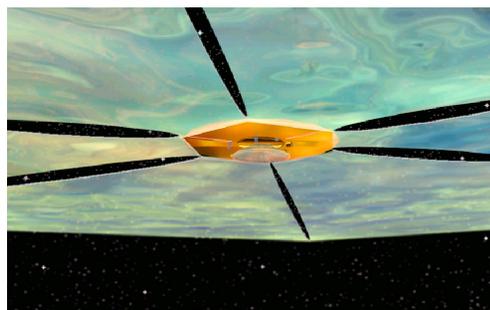
**Inflatable Decelerators**



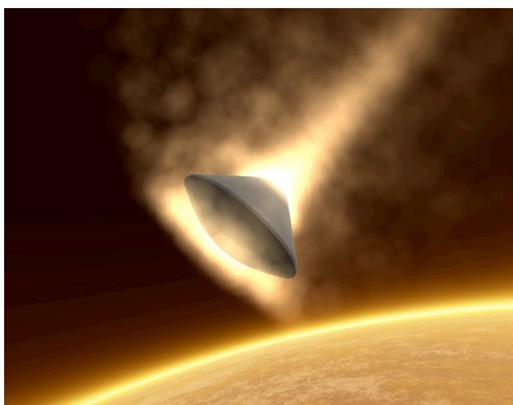
**25-40 m Class Telescopes**



**Space Solar Power:  
In-Space Power  
Transmission**

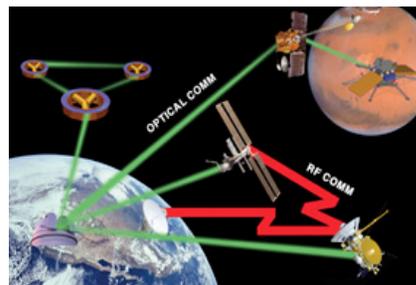


**Solar Sail Propulsion**



**Aerocapture**

July 13, 2010



**Optical Communications**

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**Electrodynamic  
Tether Propulsion**  
Artist Concept of ISS  
Reboost

# Management of Space Technology Programs



- **The NASA Chief Technologist is the final authority of the Space Technology Programs.**
- **Management of the Space Technology Programs will report through the equivalent of Directorate Program Management Council (DPMC) within the Office of the Chief Technologist.**
- **Agency Reporting and Management:**
  - All Space Technology Programs will be subject to tailored versions of 7120.8 at the Program Level
  - As flight projects, the Technology Demonstration Missions will report through the Baseline Performance Reporting (BPR) and the Agency level PMC. These flight projects will be subject to tailored versions of 7120.5
- **The Space Technology Programs (with exception of NIAC and Center Innovation Fund) have Level 2 Center Program Offices.**
  - The Center Program Offices report to Level 1 Program Executives at HQ who report through the OCT Division Directors to the NASA Chief Technologist.

# NASA Technology Integration Governance



## **NASA Technology Executive Council**

- The NASA Technology Executive Council (NTEC) is organized and chaired by the NASA Office of the Chief Technologist.
- Council membership includes the Mission Directorate AAs (or their designees), and the NASA Chief Engineer (or designee).
- The function of NTEC is to perform Agency-level technology integration, coordination and strategic planning

## **Center Technology Council**

- The Center Technology Council (CTC) is organized and chaired by the NASA Office of the Chief Technologist.
- Council membership includes the Center Chief Technologist (CCT) from each NASA Center, and a representative from OCE.
- The CTC will focus upon institutionally funded activities and development of OCT programs.

## **Governance model approved in May 2010**

# Center Chief Technologists



- **A Center Chief Technologist has been appointed at each NASA Center by the Center Director**
- **Center Chief Technologists responsibilities:**
  - Report to Center management. Serve as the principal advisor to Center leadership on matters concerning Center-wide technology development and leverage.
  - Communicate Center technology capabilities through representation on Center Technology Council.
  - Serve as Center POC for the NASA Center Innovation Fund. Responsible for reporting and programmatic management of the Center Innovation Fund at the Center level.
  - Serve as Center focal point for Space Technology Research Fellowships.
  - Lead technology transfer, SBIR/STTR and commercialization opportunities across the center, including activities of solicitation, evaluation, and selection.
  - Serve as Center change agent, particularly regarding the workforce's capacity to innovate.
  - Document, demonstrate and communicate societal impact of Center technology accomplishments.
  - Serve to encourage partnerships and inter-Center collaborations
- **Center Chief Technologists have significant technical experience within the core competencies of their Center and also technical experience at other NASA Centers, within industry or academia.**
- **Center Chief Technologists not only have significant technical depth, but also the ability to think at a system-level and apply technical knowledge to significant societal challenges.**

# Technology Roadmapping



- **The Aero-Space Technology Area Roadmap is a set of roadmap documents that provides recommendations covering NASA's current and planned technology investments over a 20-year horizon, with greater detail provided over the first 10 years.**
  - Starting with documentation produced in 2004-2005
- **Provide recommendations regarding the identity and prioritization of technology pathways needed to meet NASA Strategic Goals, Outcomes and Objectives, as well as National needs.**
  - Will not attempt to cover all technology work within the NASA. The 15 chosen technology areas will focus upon capabilities where significant technology investments are anticipated, and where substantial enhancements in NASA mission capabilities are needed.
  - Will provide strategic guidance to future Space Technology solicitations
- **NASA will augment internal roadmap teams with members from other Agencies, academia and industry.**
  - NRC has been engaged
  - Open workshop forums

# Space Technology Engagement with External Community To Date



- **Three Space Technology Programs - SBIR/STTR and Centennial Challenges and Flight Opportunities are proceeding with standard cycle of external engagements as part of FY10 NASA IPP activities.**
- **On May 4, 2010, OCT released a NASA Technology Research Fellowship letter to NASA Field Centers and Federal Laboratories requesting research area topics.**
- **OCT issued on May 25, 2010, three RFIs for the Technology Demonstration Missions Program, the Edison Small Satellite Missions Program, and the Small Satellite Subsystem Technology Program.**
- **Space Technology Industry Day on July 13-14, 2010**
- **Internal program formulation process is proceeding on pace to allow release of Space Technology solicitations in late summer or early fall pending Congressional approval.**

# FY11 Space Technology Award Goals



- **Approximate number of planned Space Technology awards (competed and guided) in FY11**
  - 100 Space Technology Research Grants
  - 350 Space Technology Graduate Fellowships
  - 16 NIAC Phase I awards
  - 125 Center Innovation Fund awards
  - 400 SBIR/STTR Phase I awards
  - 200 SBIR/STTR Phase II awards
  - 5 New Centennial Challenges
  - 10 Large Project Game Changing Development awards
  - 20 Small Project Game Changing Development awards
  - 2 Franklin Small Satellite Technologies
  - 3 Technology Demonstration Missions
  - 1 or 2 Edison Small Satellite Missions
  - 40 FAST awards
  - 4 CRuSR awards

# NASA: Part of a Broader National Strategy



- **As evidenced in its FY11 budget request, the Obama administration is committed to a research, technology and innovation agenda for the Nation as a means of stimulating the economy and building our Nation's global economic competitiveness through the creation of new products and services, new business and industries, and high-quality, sustainable jobs .**
- **The NASA budget request is aligned with this National strategy.**
  - A renewed technology emphasis balances NASA's long-standing core competencies of research and technology, spaceflight hardware development, and mission operations.
  - An enhanced technology and innovation focus at NASA responds to the recommendations of multiple external stakeholders.
- **Pushing the boundaries and taking informed-risk, NASA's new Space Technology Program will develop crosscutting, game-changing solutions to the Agency's technological needs.**
- **In addition to providing a more more vital and productive aerospace future than our country has today, a NASA focused on technology and innovation,**
  - Drives our Nation's economic competitiveness.
  - Serves as a strong inspiration for young people to pursue STEM education and career paths.
  - Allows NASA to apply its intellectual capital to the develop technological solutions addressing broader National needs in energy, weather & climate, health & wellness, and National security.

*I am 100 percent committed to the mission of NASA and its future. Because broadening our capabilities in space will continue to serve our society in ways we can scarcely imagine. Because exploration will once more inspire wonder in a new generation: sparking passions, launching careers. And because, ultimately, if we fail to press forward in the pursuit of discovery, we are ceding our future. President Obama, April 15, 2010.*

National Aeronautics and Space Administration



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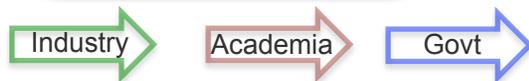
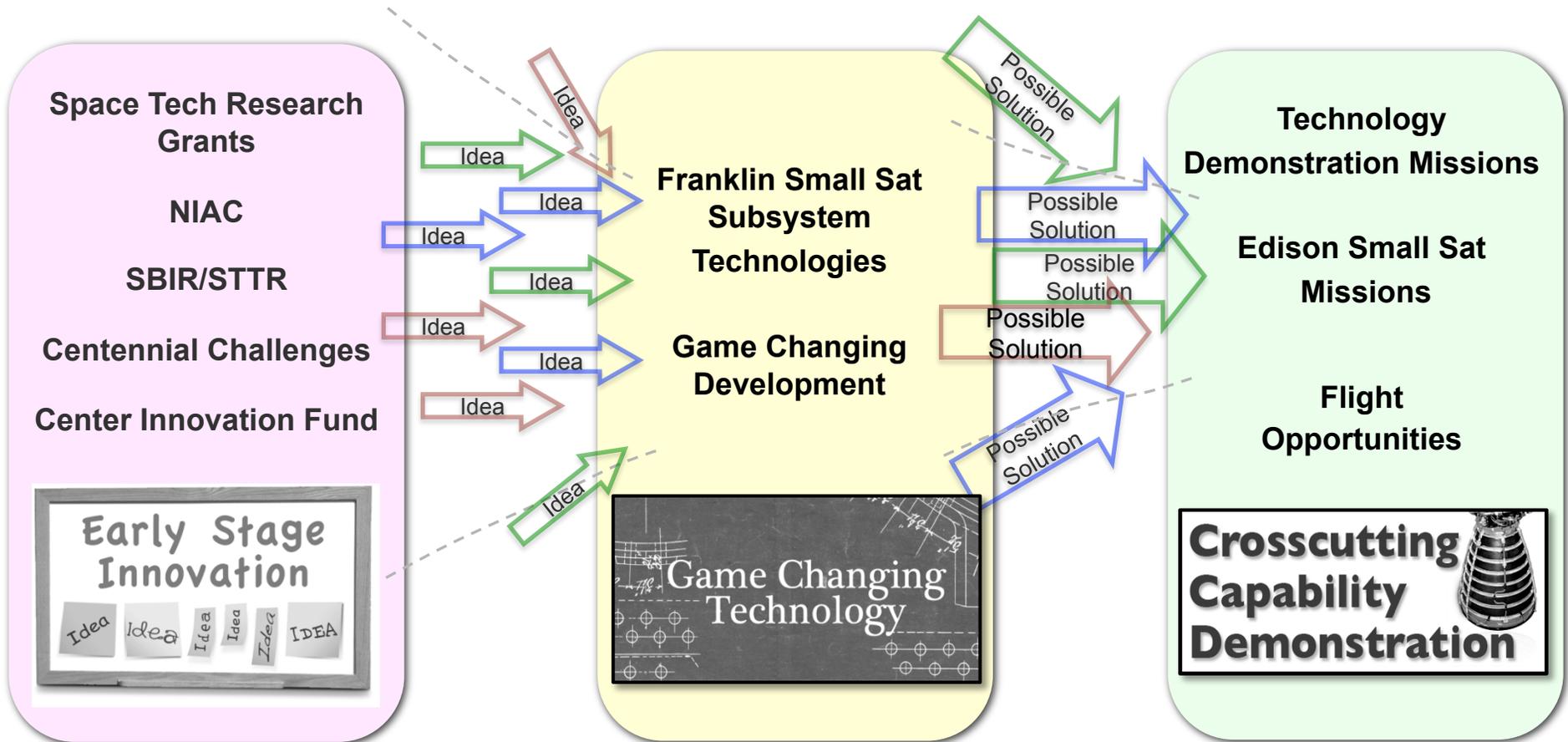
SPACE TECHNOLOGY  
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A woman in a dark jacket and pants stands on the right side of a yellow-toned, futuristic industrial or technological environment. The background is filled with complex machinery, pipes, and structural elements, creating a sense of depth and scale.

**Backup**



# OCT Program Overview



Technology Readiness Level (TRL)

# Office of the Chief Technologist Divisions



	Early-Stage Innovation	Game-Changing Technology	Crosscutting Capability Demos
<b>Development Stage</b>	Concept Validation (TRL 1-2)	Tech Demonstration (TRL 3-4/5)	System Qualification (TRL 6)
<b>Programs</b>	Space Tech Research Grants NIAC Center Innovation Fund SBIR/STTR Centennial Challenges	Game Changing Development  Small Satellite Subsystem Technology	Technology Demonstration Missions Edison Small Satellite Missions Flight Opportunities
<b>Number of Projects</b>	100+	10-20	TDM: 3-8 ESSM: 1-3 FO: 20-40
<b>Typical Project Cost</b>	\$50K-\$800K	GCD: Large: \$25M; Small: \$6M SSST: \$6M	TDM: \$150M from OCT ESSM: \$10M FO: < \$5M
<b>Project Duration</b>	6 months – 2 years	2 yrs w/potential 1 yr extension	TDM: < 3 years ESSM: < 2 years FO: 6 months – 2 years
<b>Performer Selection</b>	100% Competed	> 70% Competed	> 70% Competed
<b>Typical Performers</b>	Academia, NASA, Industry	NASA, Fed Labs, Industry, Academia	Industry, NASA
<b>Acquisition Strategy</b>	Grants, Contracts, Cooperative Agreements, Prize Competitions	BAAs, Contracts	Contracts, Space Act Agreements
<b>Cost-Sharing</b>	Encouraged	Preferred	Required, 25% min for TDM
<b>Partners</b>	Academia Federal: NASA MDs, DARPA, DOD, DOE, NOAA, NSF, Other Industry: Aerospace, Non-Aerospace International Partners		

# President's Budget Request for NASA Space Technology Program



Space Technology (Major Elements)	FY 2011 PBR	FY 2012	FY 2013	FY 2014	FY 2015	FY11-15 Total
Partnership Development & Strategic Integration	42.0	46.5	48.2	47.7	55.0	239.4
Early Stage Innovation	298.6	304.4	300.4	305.1	314.7	1523.2
Game Changing Technology	129.6	359.3	349.1	349.1	424.2	1611.3
Crosscutting Capability Demonstrations	102.0	302.0	362.0	362.0	424.0	1552.0
<b>TOTAL</b>	<b>572.2</b>	<b>1012.2</b>	<b>1059.7</b>	<b>1063.9</b>	<b>1217.9</b>	<b>4925.9</b>

Space Technology	FY 2011 PBR	FY 2012	FY 2013	FY 2014	FY 2015	FY11-15 Total
Partnership Development & Strategic Integration						
Partnership Development & Strategic Integration	42.0	46.5	48.2	47.7	55.0	239.4
Early Stage Innovation						
(1) Space Tech Res Grants	70.0	70.0	70.0	70.0	70.0	350.0
(2) NIAC	3.0	6.0	7.0	7.0	8.0	31.0
(3) Center Innovation Fund	50.0	50.0	50.0	50.0	50.0	250.0
(4) SBIR/STTR	165.6	168.4	163.4	168.1	176.7	842.2
(5) Centennial Challenges	10.0	10.0	10.0	10.0	10.0	50.0
Game Changing Technology						
(6) Game Changing Developments	123.6	329.3	319.1	319.1	394.2	1485.3
(7) Small Satellite Subsystems Tech	6.0	30.0	30.0	30.0	30.0	126.0
Crosscutting Capability Demonstrations						
(8) Technology Demonstration	75.0	265.0	325.0	325.0	387.0	1377.0
(9) Edison Small Satellite Demo	10.0	20.0	20.0	20.0	20.0	90.0
(10) Flight Opportunities	17.0	17.0	17.0	17.0	17.0	85.0
<b>TOTAL</b>	<b>572.2</b>	<b>1012.2</b>	<b>1059.7</b>	<b>1063.9</b>	<b>1217.9</b>	<b>4925.9</b>