Mission Directorate: Space Technology

Overview

NASA's Space Technology Program builds upon the success of its Innovative Partnerships Program and responds to input from the NRC in establishing an advanced space systems concepts and enabling technology development activity. The Space Technology program will advance multi-purpose technology, in some cases to flight-ready status. The Space Technology Program will complement the mission-focused technology development activities in NASA's Mission Directorates, delivering solutions to NASA's needs for new technologies in support of future NASA missions in science and exploration, as well as the needs of other government agencies and the Nation's space industry in a manner similar to the way National Advisory Committee for Aeronautics aided the early aeronautics industry. The Space Technology Program will enable new approaches to NASA's current mission set and allow NASA to pursue entirely new missions.

In contrast to the mission-focused technology development activities in the NASA Mission Directorates, there shall be multiple customers for Space Technology program products. Potential customers include any of the NASA mission directorates, other government agencies, and the Nation's space industry. The Space Technology program will employ a portfolio approach to innovation that ensures opportunities for technology investment and maturation over the entire Technology Readiness Level (TRL) spectrum (see http://www.hq.nasa.gov/office/codeq/trl/trl.pdf for TRL definitions). The Space Technology program will sponsor research in academia, industry, and NASA Centers based on the quality of research proposed at those institutions and in a manner that supports competition and balance.

The FY 2011 budget request for Space Technology is $572.2 million, and $4,925.9 million is included in the five-year budget plan. While fostering and stimulating an innovative research and development culture at the NASA Centers, this initiative will expand NASA's technology and innovation portfolio through three major Program elements that span the TRL spectrum: open competitions that stimulate highly innovative early-stage space system concepts and ideas, development of game-changing technologies that can address NASA and national needs, and development of crosscutting capability demonstrations that permit infusion of new technological solutions into future spaceflight missions. While many visionary space systems concepts will be initiated by the Space Technology Program through early stage innovation awards and some of these concepts will progress through all three major program elements to achieve flight readiness status, it is important to note that the program also welcomes existing but immature technologies (TRL<6) from a wide range of sources for further development.

The Space Technology Program's space systems research and technology development activities leverage partnerships with the NASA field Centers, other Government agencies, academia, small businesses, and the emerging commercial space industry, while building the capabilities for tomorrow's space missions today. NASA's space technology investments are closely coordinated with the mission-focused technology investments of the NASA mission directorates, align with the Agency's Strategic Plan, and respond to both the President's space agenda and the Administration's research and development priorities.

The Space Technology Program is managed by NASA's new Office of the Chief Technologist, which reports directly to the NASA Administrator, outside the existing mission directorates. NASA will establish a deliberative panel of internal and external stakeholders - including stakeholders from industry and other government agencies - to review and advise on technology development priorities for the Space Technology Program through a transparent and balanced process. Beginning in FY 2011, activities associated with the Innovative Partnerships Program are integrated into Space Technology.

Mission Directorate: Space Technology

FY 2011 Budget Request

Budget Authority ($ millions)	FY 2009 Actual	FY 2010 Enacted	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
FY 2011 President's Budget Request	**0.0**	**0.0**	**572.2**	**1,012.2**	**1,059.7**	**1,063.9**	**1,217.9**
Space Technology	0.0	0.0	572.2	1,012.2	1,059.7	1,063.9	1,217.9
Total Change from FY 2010 President's Budget Request	**0.0**	**0.0**	**572.2**	**1,012.2**	**1,059.7**	**1,063.9**	**--**

Mission Directorate:	Space Technology
Theme:	Space Technology

Theme Overview

The Space Technology Program consists of three major program elements and an Agency partnership development and strategic integration function. Through the three major elements of this program (Early Stage Innovation, Game Changing Technology, and Crosscutting Capability Demonstrations), a broad array of participants including NASA Centers, other Government agencies, academia and industry are engaged through competitive awards. These three program elements have been established based on past successful approaches to technology development using the TRL scale to organize the program content and on a desire to balance the funding distribution against NASA's future mission needs. Strategic integration of NASA's technology portfolio - working with the Mission Directorates and NASA Centers to develop an Agency technology roadmap and measure the significance and performance of the Agency's technology investments is also performed within this Program. By enhancing the function of NASA's Innovative Partnerships Program, the Space Technology Program also provides a single Agency entry point for technology transfer and commercialization, interagency coordination and joint activities, intellectual property management and partnership opportunities, providing additional value to external innovators, including a wide range of small businesses and the commercial space industry.

FY 2011 Budget Request

Budget Authority ($ millions)	FY 2009 Actual	FY 2010 Enacted	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
FY 2011 President's Budget Request	**0.0**	**0.0**	**572.2**	**1,012.2**	**1,059.7**	**1,063.9**	**1,217.9**
Early Stage Innovation	0.0	0.0	298.6	304.4	300.4	305.1	314.7
Game Changing Technology	0.0	0.0	129.6	359.3	349.1	349.1	424.2
Crosscutting Capability Demonstrations	0.0	0.0	102.0	302.0	362.0	362.0	424.0
Partnership Development and Strategic Integration	0.0	0.0	42.0	46.5	48.2	47.7	55.0
Total Change from FY 2010 Request	**0.0**	**0.0**	**572.2**	**1,012.2**	**1,059.7**	**1,063.9**	**--**

Mission Directorate:	Space Technology
Theme:	Space Technology

Relevance

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

The need for additional space capabilities is increasing as NASA leads our nation in envisioning missions of increasing complexity to explore and understand the Earth, our solar system, and the universe. Technology and innovation are critical to successfully accomplishing these missions. The Space Technology Program will improve the Nation's leadership in key research areas, enable far-term capabilities, and spawn game-changing innovations to make space travel more affordable and sustainable. Many positive outcomes are likely from a long-term, broad NASA advanced space concepts and technology development program. Chief among these are a more exciting space science and exploration future than our country has today, and a more robust national capability for space activities that will improve our competitive posture in the international marketplace, enable new industries and contribute to economic growth. Space Technology Program efforts will also serve as a spark to innovation that can be applied broadly in a more robust technology-based economy, an international symbol of our country's scientific innovation, engineering creativity and technological skill, and a component of the remedy to our nation's scientific and mathematics literacy challenges.

Major breakthroughs are needed to address our society's energy, health, transportation, and environment challenges. While NASA investments alone will not solve these grand challenges, NASA has proven to have a unique ability to attract and motivate many of the country's best young minds into educational programs and careers in science, technology, engineering and mathematics. A suite of game-changing space systems discoveries are within our nation's grasp. With a stronger focus on technology development, the intellectual capital at NASA's field centers will be utilized to deliver solutions to some of our nation's grand technological challenges.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Early Stage Innovation

FY 2011 Budget Request

Budget Authority ($ millions)	FY 2009 Actual	FY 2010 Enacted	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
FY 2011 President's Budget Request	0.0	0.0	298.6	304.4	300.4	305.1	314.7
Space Technology Research Grants	0.0	0.0	70.0	70.0	70.0	70.0	70.0
NIAC Phase I and Phase II	0.0	0.0	3.0	6.0	7.0	7.0	8.0
Center Innovations Fund	0.0	0.0	50.0	50.0	50.0	50.0	50.0
SBIR/STTR	0.0	0.0	165.6	168.4	163.4	168.1	176.7
Centennial Challenges	0.0	0.0	10.0	10.0	10.0	10.0	10.0
Changes from FY 2010 Request	0.0	0.0	298.6	304.4	300.4	305.1	--

Note: SBIR/STTR totals will change as amounts are calculated in accordance with current SBIR/STTR authorization.

Program Overview

The Early-Stage Innovation program element sponsors a wide range of low TRL advanced space system concept and initial technology development efforts across academia, industry and at the NASA field Centers. This program element includes: (a) the Space Technology Research Grant program (analogous to the Fundamental Aeronautics program within NASA's Aeronautics Research Mission Directorate) that focuses on foundational research in advanced space systems and space technology, (b) re-establishment of a NIAC-like Program to engage innovators within and external to the Agency in accordance with the recommendations of the NRC's Fostering Visions of the Future report, (c) enhancement of the Innovative Partnership Programs Seed Fund into a Center Innovations Fund to stimulate aerospace creativity and innovation at the NASA field Centers, (d) NASA's SBIR/STTR program to engage small businesses, and (e) the Centennial Challenges Prize Program to address key technology needs with new sources of innovation outside the traditional aerospace community. All selections within this low TRL program element are performed competitively. The FY 2011 budget request for the Early Stage Innovation program element within Space Technology is $298.6 million, and $1,523.2 million is included in the five-year budget plan. This program element incorporates two initiatives from NASA's Innovative Partnerships Program: $165.6 million in FY 2011 and $842.2 million in the five-year budget for the NASA SBIR/STTR program, and $10 million in FY 2011 and $50 million in the five-year budget for the NASA Centennial Challenges program.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Early Stage Innovation

Project Descriptions and Explanation of Changes

Space Technology Research Grants

Space Technology Research Grant Projects will meet future space science and exploration needs of NASA, other government agencies, and the commercial space sector through technological innovation. This low TRL technology portfolio focuses on foundational research in advanced space systems and space technology performed primarily through collaborative efforts between academia and NASA field Centers, with the option of including small business and industry partners. Integration and assessment of emerging technologies and advances in related disciplines to change the state-of-the-art in space systems design, hardware and modeling will be conducted. This thrust will provide idea maturation at the discipline and subsystem level prior to major R&D investment. This project will also provide innovations in space systems to help make space exploration more affordable. Project competition guidelines include a maximum award of $400k/yr for one year, with at most a one-year extension following technical evaluation of a renewal proposal. Examples of the types of foundational space system research that may be performed through this project include:Computational Materials Design, Nanotube Based Structural Materials, High Bandwidth Communications, Lightweight Low Transit Volume Space Structures, Non-Chemical In-Space Propulsion, Coatings and Adhesives, Flexible Power Arrays, Microwave/Laser Power Transmission, Energy Storage Systems, Space Robotic Assembly and Fabrication, Formation Flying Spacecraft Systems (Swarm Operations), Orbital Debris Removal, Planetary Protection Techniques, Nonconventional Access to Space, Print Manufacturing and Rapid 3D Prototyping, Extreme Environment (Temperature/Radiation) Sensors and Mechanisms, Climate Sensors, Planetary Entry Decelerators, Reliable and Affordable Exploration Systems, Advanced Radiation Shielding Materials(Techniques and Systems), Safe Despin/Detumble Approaches for Large Non-operational Spacecraft, Material/Structural Concepts to Mitigate Impact of Small Debris, and Precision Timing and Navigation Using Only Celestial Objects.

A significant aspect of this project is the competitive selection of U.S. citizen graduate student research that shows significant promise for future application toward NASA missions and strategic goals. The Space Technology Grant Project will train the next generation of aerospace engineers and scientists by funding NASA-related graduate student research performed on campus during the academic year and research performed at a NASA Center during the summer months, gaining hands-on experience. Each student in this project will be matched to a technically relevant and engaged NASA researcher who will serve as the student's NASA advisor. Through this experience, students will advance their STEM education, gain NASA experience and learn the research process. Innovative projects with high risk/high payoff will be encouraged. This project thrust will provide the Nation a new pipeline of engineers and scientists to improve the nation's technological competitiveness and serve NASA by providing a steady stream of new talent for potential hiring opportunities. Project guidelines include selection of as many as 500 graduate students per year for a two-year fellowship during their graduate studies, with at most a one-time extension following technical evaluation of a renewal proposal for two additional years. Funding will include tuition remission, a research stipend, fringe, and summer travel expenses. A small amount of funding for both the student's university advisor and NASA advisor will also be provided. Students will be selected based on demonstrated performance (GPA and GRE scores) and recommendations letters. Selected students are required to spend at least one summer, preferably two, at the host NASA center. The host Center will be provided resources for laboratory work and mentoring workforce.

NIAC Phase I and Phase II

Responsive the NRC report, Fostering Visions for the Future: A Review of the NASA Institute for Advanced Concepts (2009), the NASA Institute of Advanced Concepts (NIAC) will be re-established as a project within the Early Stage Innovation Program. The project is formulated as a two-phase, low TRL activity, focused upon conceptual studies of visionary approaches addressing long-term NASA strategic goals. The first phase of NIAC will fund a competed set of conceptual studies and systems analyses that investigate how technology innovations will enable NASA's future missions and extend its goals. Second Phase NIAC proposals will further develop successful Phase I proposals and work to transition the key technical advances into projects within the Game Changing Technology Program.

NIAC will serve as an incubator for bringing new technologies into future aerospace endeavors. By supporting innovative and visionary concepts aimed a decade or more into the future, NIAC-funded research significantly impacts the Agency's future missions as well as its roadmaps for future science, discovery and exploration. As a low-TRL early phase activity, NIAC will serve as a visible and recognized entry point for innovators and researchers who will enable future NASA missions and goals.

While the NIAC seeks concepts that stretch the imagination, these concepts must be based on sound scientific principles. In the context of the NIAC requirements, successful proposals for advanced concepts or studies will be: (a) innovative, visionary and new; not incremental, evolutionary or duplicative of concepts previously studied by NASA, (b) an architecture, system, mission strategy or approach to meeting an aeronautics and/or space goal; not narrowly focused at the component or sub-system level, (c) described in an aeronautics and/or space mission context, (d) adequately substantiated with a description of the scientific principles that form the basis for the concept, and (e) focused on a technology that is either, newly emerging, a unique combination of emerging technologies, or a technology that is developed as an integral part of the proposal.

The NIAC Phase I Program will competitively select low TRL (1-2) conceptual studies and systems analyses that examine the impacts of visionary changes. Phase I studies will examine the overall technical viability of the technology or concept, as well as how the change will impact or enable future architectures, missions or goals. Successful Phase I study proposals will examine changes in technologies that will occur 10 or more years into the future, have a maximum duration of 1 year, and a maximum budget of $100K. Proposals will be accepted from NASA researchers, academia, other Government Agencies, industry and partnerships. Phase II NIAC proposals will be competitively selected from the set of highly successful Phase I awards and will have a maximum duration of two years and a maximum budget of $500K. Phase II awards will study the major feasibility issues associated with cost, performance, development time and key issues with the technology, concept or approach. The Phase NIAC II study will also examine the transition path for potentially infusing the concept, technology or approach into a future Game Changing Technology project. Both Phase I and Phase II awards will be competitively selected based upon independent peer reviews. Participation in these studies is open to all categories of U.S. individuals and organizations. To encourage external innovators, NASA organizations, including the Jet Propulsion Laboratory, would be limited to receiving no more than 30% of the total NIAC project budget line in any given year.

Center Innovations Fund

The Center Innovations Fund will be distributed among the ten NASA centers to provide seed funding for new ideas and idea generation activities. These funds will allow Centers to support low TRL innovative technology initiatives that leverage Center talent and capability. It is envisioned that the most promising ideas that emerge from the Center Innovation Funds will compete subsequently for funding from other parts of the Space Technology Program or other NASA technology development programs. By placing the competition for these funds at the Center level, the Space Technology Program aims to stimulate and encourage creativity and innovation from within the NASA Centers. Activities supported with these funds must fall within the scope of space technology, dual-use technology, or be a technology that addresses a significant national need. All Center Innovations Fund awards must demonstrate scientific/technical merit and feasibility, relevance and value to NASA, capability and strength of the team, and the potential for leveraging of resources.

Through the Center Chief Technologist, Centers will conduct competitions on 6-month cycles to select ideas and provide appropriate oversight. Detailed feedback on these activities will be required before the end of each FY. Feedback describing the innovation pursued, criteria for selection, its relevance to the stated goals of the Center Innovation Funds, and the final results of the effort will be collected and measured. Centers may choose to highlight some projects by having the individual or team present their results directly to the Office of the Chief Technologist. An end-of-year report will be generated at each Center describing the successes and failures of the funded ideas, with an emphasis on the creativity involved. Proposals that would have been selected if more funds had been available to that Center may also be described in an Appendix of the report. These annual Center Innovation and Creativity Reports will be reviewed and scored by the Space Technology Program for creativity of the investment portfolio (independent of their success or failure) and on the future promise of any individual project successes. This scoring will feed directly into the process of allocating funds for the following year's Innovation Funds so that both creativity and success are rewarded.

Building on the demonstrated success of the Innovative Partnerships Program Seed Fund, a significant portion of the Center Innovations Fund will be used to leverage technology development partnerships. Partners will be sought out by the Centers for the pursuit of innovation that is of common interest, as demonstrated by the willingness of partners to contribute with technologies, resources, and expertise. Partners will include private sector firms both large and small, universities, other government agencies and FFRDCs.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Early Stage Innovation

SBIR/STTR

The Small Business Innovation Research (SBIR) Program was established by Congress in 1982 to increase research and development opportunities for small businesses with 500 or fewer employees, to increase employment, and to 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. NASA will implement the SBIR program consistent with pending reauthorization. Current authorization provides for SBIR funding at 2.5 percent of NASA's extramural research and development expenditures.

The Small Business Technology Transfer Research (STTR) Program 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 extramural research and development budget, approximately one-eighth of the amount for SBIR.

Beginning in FY 2011, SBIR and STTR activities associated with the Innovative Partnerships Program are transferred to Space Technology. The Space Technology Program implements NASA's SBIR and STTR programs 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. NASA tracks the maturity of technologies funded by SBIR/STTR through use of Technology Readiness Levels (TRLs)(see http://www.hq.nasa.gov/office/codeq/trl/trl.pdf for TRL definitions). This is important for understanding when technologies will be ready for infusion into NASA's programs and projects as well as their readiness for commercial use. Tracking TRLs also provides insight into the progress that technologies are making, and over time, the performance of different firms for successful maturing technologies. Included in this request, in addition to the 2.8% of extramural R&D for contract awards, are funds for SBIR/STTR Program Support to cover the administrative costs of running the program with operations at all ten NASA field centers, as well as the outreach efforts needed to increase participation in SBIR/STTR by the small business community. The percentage of new firms participating in NASA's SBIR/STTR programs each year has been in the 30-50% range, yielding new applicants each year. New participants have submitted between 20-35% of the total number of proposals in any given year.

Technologies funded by SBIR/STTR have made important contributions to numerous NASA programs and projects and have also been commercial successes that are bringing important benefits to society. The Agency is actively working to increase the number of NASA-funded SBIR/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.

Centennial Challenges

The Centennial Challenges program seeks innovative solutions to technical problems that can drive progress in aerospace technology of value to NASA's missions in space operations, science, exploration and aeronautics. Beginning in FY 2011, Centennial Challenge activities associated with the Innovative Partnerships Program are transferred to the Space Technology Program. Centennial Challenges encourage the participation of independent teams, individual inventors, student groups and private companies of all sizes in aerospace research and development, and seek to find the most innovative solutions to technical challenges through competition and cooperation. NASA's original seven prize challenges have been successful in encouraging broad participation by innovators across our nation and across generations. Many of these technical challenges also have direct relevance to national and global needs such as energy and transportation.

Prize programs encourage diverse participation and multiple solution paths. A measure of diversity is seen in the geographic distribution of participants (from Hawaii to Maine) that reaches far beyond the locales of the NASA Centers and major aerospace industries. The participating teams have included individual inventors, small startup companies, and university students and professors. An example of multiple solution paths was seen in the 2009 Regolith Excavation Challenge. NASA can typically afford one or two working prototypes in a development program but at this Challenge event, over twenty different working prototypes were demonstrated for the NASA technologists. All of these prototypes were developed at no cost to the government. For three years of competitions with dozens of teams investing tens of thousands of hours, NASA spent only $750,000 in prize money.

The return on investment with prizes is exceptionally high as NASA expends no funds unless the accomplishment is demonstrated. NASA provides only the prize money and the administration of the competitions is done at no cost to NASA by non-profit allied organizations. For the Lunar Lander Challenge, twelve private teams spent nearly 70,000 hours and the equivalent of $12 million trying to win $2 million in prize money. Prizes also focus public attention on NASA programs and generate interest in science and engineering. Live webcasts of Centennial Challenge competitions attract thousands of viewers across the nation and around the world. The 2009 Power Beaming completion resulted in over 100 news articles and web features. Prizes also create new businesses and new partners for NASA. The winner of the 2007 Astronaut Glove Challenge started a new business to manufacture pressure suit gloves. Armadillo Aerospace began a partnership with NASA related to the reusable rocket engine that they developed for the Lunar Lander Challenge, and they also sell the engine commercially.

In selecting topics for prize competitions, NASA consults widely within and outside of the Federal Government. The $10 million per year FY 2011 request for Centennial Challenges will allow NASA to pursue new and more ambitious prize competitions. Topics for future challenges that are under consideration include revolutionary energy storage systems, solar and other renewable energy technologies, laser communications, demonstrating near-Earth object survey and deflection strategies, innovative approaches to improving the safety and efficiency of aviation systems including Next Generation Aeronautics efforts, closed-loop life support and other resource recycling techniques, and low-cost access to space. Annual funding for Centennial Challenges allows new prizes to be announced, addressing additional technology challenges that can benefit from the innovation of the Citizen inventor.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Game Changing Technology

FY 2011 Budget Request

Budget Authority ($ millions)	FY 2009 Actual	FY 2010 Enacted	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
FY 2011 President's Budget Request	**0.0**	**0.0**	**129.6**	**359.3**	**349.1**	**349.1**	**424.2**
Game-Changing Developments	**0.0**	**0.0**	**123.6**	**329.3**	**319.1**	**319.1**	**394.2**
Small Satellite Subsystem Technologies	**0.0**	**0.0**	**6.0**	**30.0**	**30.0**	**30.0**	**30.0**
Changes from FY 2010 Request	**0.0**	**0.0**	**129.6**	**359.3**	**349.1**	**349.1**	**--**

Program Overview

The Game Changing Technology Program element 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. Responsive to the NRC report: America's Future in Space: Aligning the Civil Space Program with National Needs (2009), this program element demonstrates the feasibility of novel, early-stage ideas that have the potential to revolutionize future space missions through a significant ground-based test and/or laboratory experimentation program. Fixed duration awards are made to PI-led teams comprised of government, academia and industry partners. These high-risk awards are evaluated annually for progress against baseline milestones with the objective of maturing technologies to a TRL of 4, and in some cases TRL 5/6, through ground-based testing and laboratory experimentation (see http://www.hq.nasa.gov/office/codeq/trl/trl.pdf for TRL definitions). NASA intends to collaborate with DARPA and other government agencies in this program element to create and implement collaborative game-changing space technology initiatives, and share program management lessons learned. In this program element, more than 70% of the funds are competitively awarded.

New technologies considered may include advanced lightweight structures and materials, advanced in-space propulsion, nano-propellants, large aperture antennas and telescopes, power generation/transmission, surface robotic construction, energy storage, high bandwidth communications, and small satellite subsystem technology. With a focus on game-changing technologies, success is not expected with each investment; however, on the whole, and over time, dramatic advances in space technology that enable entirely new NASA missions and potential solutions for a wide variety of our society's grand technological challenges are expected and will be measured. The FY 2011 budget request for the Game Changing Technology program element within Space Technology is $129.6 million, and $1,611.3 million is included in the five-year budget plan.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Game Changing Technology

Project Descriptions and Explanation of Changes

Game Changing Developments

The Game Changing Developments element will use a DARPA-like "end-game" approach. Research teams will be provided a list of challenge goals with top level requirements for the desired capability. The PI team then defines solution approaches and the anticipated technology needs. The PI is held accountable for ensuring that discoveries will move rapidly from the laboratory to application. Game Changing Development projects are intended to be capability-oriented and differ from traditional R&D methods that advance discipline or core knowledge. Instead of lengthy proposals, Heilmeier's Catechism is employed whereby seven key questions must be answered by the PI for each proposed effort:

- What are you trying to do? Articulate your objectives using absolutely no jargon.
- How is it done today, and what are the limits of current practice?
- What's new in your approach and why do you think it will be successful?
- Who cares? If you're successful, what difference will it make?
- What are the risks and the payoffs?
- How much will it cost? How long will it take?
- What are the midterm and final "exams" to check for success?

New capabilities considered may include advanced in-space propulsion, large aperture antennas and telescopes, power generation/transmission, robotic construction systems, energy storage and high bandwidth communications.

An annual call for proposals will be made for game changing, "push" technologies that will be demonstrated at the subsystem or system level. In some cases, multiple technology advances may be required to achieve the stated capability. Awards will be made to PI-led teams comprised of government, academia and industry partners for high risk/ high payoff capabilities. Failure to achieve the stated capability goals within the schedule will necessarily result in termination. Review gates may also determine early cessation of an activity. Each high-risk activity will be made for a two-year duration to mature from TRL 3 to TRL of 4 or greater. These efforts will generally include the design, build and test of technology development units. Project success is measured both through technology advancement and demonstration of clear advantages enabling new NASA missions or dramatic improvements in their viability. A third optional year may be awarded to achieve TRL 5/6 if technically possible without the cost of orbital flight testing. Flight experiments will be conducted in the Crosscutting Capability Demonstration Program element; however, in some cases, ground testing or low cost (e.g. sub-orbital) flight testing may be used to raise the TRL (5/6) during the third year under the Game Changing Program element. Two year awards must be less than $45M. If an optional third year is awarded to achieve TRL 5/6, the total 3 year award cannot exceed $75M. Project selection guidelines include the establishment of PI-led teams willing to serve as communities of change-state advocates. Non-NASA PI's selected for participation may be offered an assignment to NASA for no more than three years, through an Intergovernmental Personnel Act (IPA) or NEX position.

Small Satellite Subsystem Technologies

Technologies that enable small satellites to provide game changing capabilities for the government and commercial sectors will be supported under a competed Small Satellite Subsystem Technologies project. These "push" technologies may include formation flying, long life power systems, miniaturized remote sensors, deployable apertures, autonomous swarm operations, and other technology enablers. Architectures, proximity operations, robotics, space-to-space power transmission and other system interoperability such as that being developed for standardization in the cubesat class of spacecraft will also be considered for TRL advancement from 3 to 4. In this project, ground testing of promising transformational small satellite capabilities are sought. Activities will have a two-year timeframe to mature to TRL 4. In some cases, based on performance and technology objectives, a third optional year may be granted to achieve TRL 5/6. However, technologies and capabilities that require flight testing must be submitted to the Crosscutting Capability Demonstration Program element. Annual review gates may determine early cessation of an activity. Two year funding must be less than $12M. If an optional third year is granted to achieve TRL 5/6, the total 3 year amount cannot exceed $18M. This small satellite subsystem technology development project will provide subsystem advances for the Edison Small Satellite Demonstration Missions and other small satellite missions.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Crosscutting Capability Demonstrations

FY 2011 Budget Request

Budget Authority ($ millions)	FY 2009 Actual	FY 2010 Enacted	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
FY 2011 President's Budget Request	**0.0**	**0.0**	**102.0**	**302.0**	**362.0**	**362.0**	**424.0**
Technology Demonstration Missions	**0.0**	**0.0**	**75.0**	**265.0**	**325.0**	**325.0**	**387.0**
Edison Small Satellite Demonstration Missions	**0.0**	**0.0**	**10.0**	**20.0**	**20.0**	**20.0**	**20.0**
Flight Opportunities	**0.0**	**0.0**	**17.0**	**17.0**	**17.0**	**17.0**	**17.0**
Changes from FY 2010 Request	**0.0**	**0.0**	**102.0**	**302.0**	**362.0**	**362.0**	**--**

Program Overview

One of the greatest challenges that NASA faces in incorporating advanced technologies into future missions is bridging the mid-TRL (3-6) gap between early conceptual studies and infusion of a new technology onto the critical path of a science or exploration mission. While the Game Changing Technology Program element will address an aspect of this gap, maturing a space technology to flight readiness status through relevant environment testing is a significant challenge from both a cost and risk perspective. Flight demonstration of a technology that has the potential for enormous economic savings in the long run is often considered too risky for a mission program or too costly for a technology program.

The Crosscutting Capability Demonstration program element matures a small number of technologies that are of benefit to multiple customers to flight readiness status, TRL 6. In this program element, more than 70% of the funds are competitively awarded. Technical risk, technology maturity, mission risk, customer interest, and proposed cost are discriminators used in the selection process. For infusion purposes, NASA-industry teams are required to have a sponsor (or sponsors) willing to cost share a minimum of 25% of the proposed development effort. With objectives analogous to the former New Millennium program, NASA will pursue flight demonstrations not only as standalone missions, but also as missions of opportunity using planned NASA missions as well as international and commercial partner space platforms through this program element. Examples of type of technologies that may be considered for this flight test program component include optical communications, and supersonic and hypersonic inflatable aerodynamic decelerators.

The Crosscutting Capability Demonstration Program element also includes the Commercial Reuseable Suborbital Research Program (which provides suborbital flight opportunities for technology demonstrations, scientific research and education), the Facilitated Access to the Space environment for Technology (FAST) project (which focuses on testing technologies on parabolic aircraft flights that can simulate microgravity and reduced gravity environments) and the the Edison Small Satellite Demonstration project (which develops and operates small satellite missions in partnership with academia). The FY 2011 budget request for the Crosscutting Capability Demonstration program element within Space Technology is $102 million, and $1552 million is included in the five-year budget plan.

Project Descriptions and Explanation of Changes

Technology Demonstration Missions

The most significant portion of the Crosscutting Capability Demonstration program element is the Technology Demonstration project. A key requirement for eligibility in this project is that the technology under consideration must be crosscutting (defined as a technology with potential to benefit to multiple NASA mission directorates, other government agencies or the space industry). Performing these flight demonstrations will advance the technology readiness of the selected systems, provide tangible products from the NASA innovation and technology program and capture significant public interest and awareness. Furthermore, executing these engaging and technically challenging space flight demonstrations, including designing the flight test program, building the flight hardware and performing/operating the mission is an outstanding means for developing the current NASA and industry workforce to handle more challenging space missions in the future.

This project will perform yearly calls for proposed flight test demonstrators. It is anticipated that between 3 and 8 openly competed proposals will be selected each year. Flight test projects that can be completed within a maximum of three years are sought. The Space Technology Program funding contribution to a given flight test demonstration is limited to a total of $150 M. The funding cap includes all elements of the flight test demonstration including test planning, flight hardware, launch costs, ground ops and post testing assessment/reporting.

In addition to the above criteria, for selection as a Crosscutting Capability Demonstration project, the candidate technology must be relatively mature (TRL of 4 or above), and if successful must raise the TRL of the candidate technology to a TRL of 6 or higher, such that it may be infused into the critical path for future NASA missions. Competed flight test demonstration opportunities are open to teams involving NASA centers, industry, other Government agencies and academia. All participants must be U.S. entities.

Edison Small Satellite Demonstration Missions

The Edison Small Satellite Demonstration project will develop and operate a series of NASA-focused small satellite demonstration missions. Science objectives for these missions will focus on the life and physical sciences, including fundamental biology. Technology objectives could include formation flying, autonomous operations, collaborative observations, and approaches enabling payload recovery. NASA will pursue these missions in collaboration with academia and small business in close coordination with relevant successful programs under development at AFRL and the Operationally Responsive Space Office. NASA-university collaborative efforts will be explored to enable university students to gain hands-on experience within these project activities. In addition, this project seeks to serve the small satellite community by improving the affordability of small payload launch through secondary payload process improvements and other development efforts.

Flight Opportunities

Through the Commercial Reusable Suborbital Research (CRuSR) project and the Facilitated Access to the Space environment for Technology (FAST) project, NASA provides flight opportunities for science, technology development and education efforts to reduced-gravity environments, brief periods of weightlessness, and high-altitude atmospheric research. Beginning in FY 2011, these two activities associated with the Innovative Partnerships Program are transferred to the Space Technology Program.

CRuSR will also help foster the development of the commercial reusable suborbital transportation industry, an important step in the longer-term path that envisions suborbital RLVs evolving to provide the Nation with much lower-cost and much more reliable access to orbital space. CRuSR establishes a series of suborbital flights that will yield many benefits to NASA by providing access to 3-4 minutes of microgravity for experimentation, discovery and testing. Results are expected to reduce the risk for use of new technologies in future missions by demonstrating application in the space environment, providing for routine recovery of payloads and frequent flights. As commercial suborbital capabilities become available, the CRuSR program will competitively secure flight services for experiment payloads supporting NASA's objectives in science, technology and education.

The FAST project also provides opportunities for emerging technologies to be tested in the space environment thereby increasing their maturity and the potential for their use in NASA programs and in commercial applications. FAST focuses on testing technologies on parabolic aircraft flights that can simulate microgravity and the reduced gravity environments of the Moon or Mars. The FAST project promotes the growth of emerging commercial space services by employing competitively selected private reduced gravity flight services. In 2008, an initial set of FAST reduced gravity flights were accomplished with five SBIR companies. In 2009, 19 FAST-sponsored technology projects were flown during a flight week with two days of microgravity and two days of lunar gravity. The projects came from private companies, universities, government laboratories and partnerships among those entities. In 2011, NASA expects to fund up to four flight weeks for technology demonstration and research, allowing many more projects to benefit from the use of reduced gravity aircraft flights. A measure of FAST program success will be the extent to which it can infuse new technologies into NASA programs while encouraging the development of commercial space services by enlarging the customer base for this emerging industry.

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Partnership Development and Strategic Integration

FY 2011 Budget Request

Budget Authority ($ millions)	FY 2009 Actual	FY 2010 Enacted	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015
FY 2011 President's Budget Request	**0.0**	**0.0**	**42.0**	**46.5**	**48.2**	**47.7**	**55.0**
Partnership Development and Strategic Integration	**0.0**	**0.0**	**42.0**	**46.5**	**48.2**	**47.7**	**55.0**
Changes from FY 2010 Request	**0.0**	**0.0**	**42.0**	**46.5**	**48.2**	**47.7**	**--**

Mission Directorate:	Space Technology
Theme:	Space Technology
Program:	Partnership Development and Strategic Integration

Program Overview

Partnerships are an integral part of NASA's strategy for reinvigorating technology and innovation. Building upon the success of the Innovative Partnerships Program, we will pursue partnerships with U.S. industry, academia, other Government agencies, and international partners. Partnerships provide rich sources of innovation to help address NASA's technical challenges, and also yield other applications of NASA-developed technologies that will benefit the public and contribute to economic growth. In addition, this program element will continue to build partnerships that facilitate the transfer of the NASA's Aeronautics research to American industry and government users. The Space Technology Program will work with entrepreneurs across the aerospace industry to enable new capabilities that will spur growth in commercial space activities in a manner similar to the way NACA aided the early aeronautics industry. NASA will also leverage the technology investments of other government agencies, engage universities, especially in early stage innovation and work with its partners to create inspiration in STEM education.

One of the key partnership development functions is managing NASA's intellectual property and facilitating the transfer of NASA-derived technology for commercial application and other national benefit. In FY 2009, NASA documented more than 1,400 New Technology Reports on NASA-funded technology that could lead to patenting and transfer. 90 patent applications were filed and 188 patents were awarded in FY 2009. NASA has continued its initiative to generate licenses for NASA technologies through an auctioning intermediary at no cost to NASA - a groundbreaking innovation previously unprecedented in government. NASA continues to document the top 40-50 recent successes in its "Spinoff" publication with over 1,600 examples of successful technology transfer having been documented. One of the ways NASA communicates these benefits is through NASA@Home/City, which helps the public identify how space technology is making positive contributions to their daily lives (http://www.nasa.gov/city).

Strategic integration of NASA's technology portfolio is a significant responsibility within the Space Technology Program. This function centers on working with the Mission Directorates and NASA Centers to develop an Agency technology roadmap and measure the significance and performance of the Agency's technology investments. Technology roadmapping activities are driven by the Agency's strategic goals, are consistent with the NASA Strategic Plan and coordinated with the technology development activities of our partners in industry, academia and other government agencies. An integrated assessment of the Agency's technology portfolio is developed through the Mission Directorate Technology Council, chaired by the Agency's Chief Technologist with participation from the Mission Directorates and Office of the Chief Engineer. This council meets biweekly to track the status of technology plans within the Mission Directorates and the Space Technology Program. The Agency's overall technology investment content is reviewed quarterly and identified content gaps or redundancies are managed. In addition, annual assessments of the Agency's technology investment portfolio, program performance, and technology plans are performed. Space Technology Program managers gain insight into the Mission Directorate technology programs through these council meetings, daily interactions with their colleagues in the Mission Directorates, and at senior leadership team decision meetings where the Chief Technologist is present.

The FY 2011 budget request for Space Technology Program Partnership Development and Strategic Integration functions is $42 million, and $239.4 million is included in the five-year budget plan.