



# NASA Innovation and Technology Preliminary Planning

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# Outline

- NASA Innovation and Technology Initiative
- NASA Office of the Chief Technologist
- Space Technology Program



# Augustine Committee Input

- In 2009, the Augustine Committee strongly endorsed increased investment in innovative technologies and approaches to achieving broadly defined NASA and national goals
- This technology and innovation investment was included in *all* new Program Options suggested by the Augustine Committee

*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. NASA now has an opportunity to develop a technology roadmap that is aligned with an exploration mission that will last for decades. If appropriately funded, a technology development program would re-engage the minds at American universities, in industry and within NASA. The investments should be designed to increase the capabilities and reduce the costs of future exploration. This will benefit human and robotic exploration, the commercial space community, and other U.S. government users.*



# Recent NRC Recommendations (1 of 2)

- In 2009, the NRC report “America’s Future in Space” specifically speaks to this issue in one of its six key recommendations:

*4. **Advanced space technology.** 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. The resulting program should:*

- a. Be organizationally independent of major development programs;*
- b. Serve all civil space customers, including the commercial sector;*
- c. Conduct an extensive assessment of the current state and potential of civil space technology; and*
- d. Conduct cutting-edge fundamental research in support of the nation’s space technology base.*



# Recent NRC Recommendations (2 of 2)

- In 2009, the Congressionally mandated NRC report “Fostering Visions for the Future: A Review of the NASA Institute for Advanced Concepts” also speaks to this issue:

## Key Recommendations:

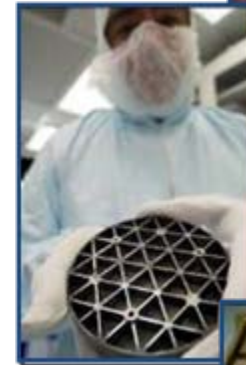
- *NASA should reestablish a NIAC-like entity (“NIAC2”)...to seek out visionary, far-reaching, advanced concepts with the potential of significant benefit to accomplishing NASA’s charter and to begin the process of maturing these advanced concepts for infusion into NASA’s missions*
- *NIAC2 should report to the Office of the Administrator, be outside mission directorates, and be chartered to address NASA-wide mission and technology needs. To increase NIAC2’s relevance, NASA mission directorates should contribute thematic areas for consideration. The committee also recommends that a NIAC2 organization should be funded and administered separately from NASA development programs, mission directorates, and institutional constraints.*
- *Future NIAC2 proposal opportunities be open to principal investigators or teams both internal and external to NASA*

*\*Underline highlight added.*



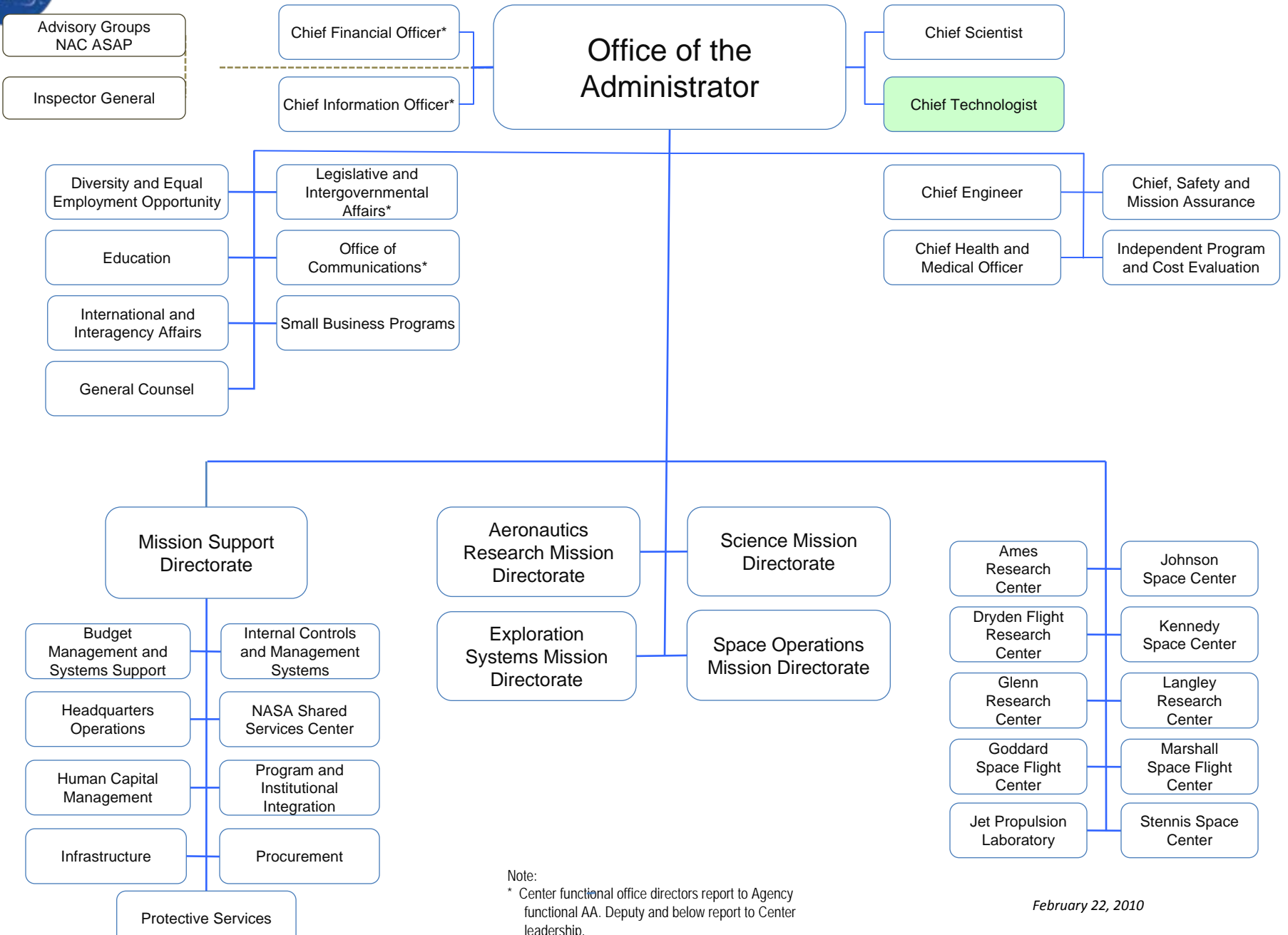
# NASA Innovation Initiative Goals\*

- Revitalize NASA as a preeminent R&D organization through significant investment in longer term technical or process innovations
- Encourage innovative application of NASA capabilities to address broader national needs such as energy, weather and climate, Earth science, health and wellness, national security, and STEM education
- Stimulate a vibrant commercial space sector through helping to create new types of engagement, creation of new markets, and investments in future technologies
- Generate excitement about NASA's work by investing in a large number of highly creative activities with potential for disruptive breakthroughs
- Provide exciting hands-on work for students and new employees





# National Aeronautics and Space Administration



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



# Office of Chief Technologist

## Roles/Responsibilities

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 program.
- 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 continue to manage mission-focused technology 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



# NASA Office of the Chief Technologist

HQ – Overall Program Management

**Chief Technologist (CT)**

**Deputy CT**

**Financial Management**

**Partnership Development**

**Communications**

**Strategic Integration**

**Early-Stage Innovation**

**Game Changing Technology**

**Crosscutting Capability Demonstrations**

**Space Tech Research  
Grants  
NIAC2  
SBIR/STTR  
Centennial Challenges  
Center Innovation Fund  
Management & Implementation**

**Game-Changing Development  
Small Sat Technologies**

**Technology Demonstrations  
Edison Small Sat Missions  
Flight Opportunities**

**Management & Implementation**

**Management & Implementation**

**Projects / Activities**

**Projects / Activities**

**Flight Demos,  
Projects / Activities**

Centers - Project Implementation



# Partnership Development

- Partnerships are an integral part of NASA's strategy for reinvigorating technology and innovation.
- The Office of the Chief Technologist provides a visible Agency entry point for technology transfer and commercialization, interagency coordination and joint activities, intellectual property management and partnership opportunities.
- Activities within and coordinated by the Office of the Chief Technologist leverage partnerships with the NASA field Centers, other Government agencies, academia, small businesses, industry and international partners to build the capabilities for tomorrow's space missions today.
- The Office of the Chief Technologist proactively cultivates partnerships and facilitates transfer of NASA technologies for public benefit through a network of offices at each of NASA's field centers.



# Strategic Integration

- The Office of the Chief Technologist is responsible for strategic integration of NASA's technology portfolio.
- This requires tight coordination with the Mission Directorates (MD) and NASA Centers in which OCT personnel:
  - Participate in all Agency technology program formulation activities
  - Develop and manage the Agency level technology portfolio
    - Agency technology gap/overlap assessments
    - Agency assessment of balance and prioritization
  - Develop an Agency level technology roadmap
    - Driven by the Agency's strategic goals, consistent with the NASA Strategic Plan, and coordinated with our partners in industry, academia and other government agencies
- Integrated assessment of the Agency's technology portfolio is performed by the NASA Technology Executive Council (NTEC), chaired by the Agency's Chief Technologist with participation from the Mission Directorates and Office of the Chief Engineer.



# Strategic Integration

Within NASA, OCT develops and coordinates an integrated technology investment strategy through:

- 1) **NASA Technology Executive Council (NTEC)** – Representatives from OCT, OCE and of each MD. Technology coordination strategic planning across Agency.
- 2) **Center Research and Technology Council (CRTC)** – Top researchers from NASA Centers, innovative and engaged in external community and knowledgeable of research and technology efforts across Centers.
- 3) **NAC Technology and Innovation Committee** – guidance and feedback from external community
- 4) **NAC Commercial Space Committee** – guidance and feedback from external community

OCT expects to partner with the following external customers/stakeholders:

- 1) Academia
- 2) DARPA, AFOSR
- 3) ARPA-E
- 4) Other government agencies
- 5) Commercial
- 6) International partners



# NASA Space Technology Foundational Principles

- The Space Technology Program shall advance non-mission-focused technology currently at low-to-mid Technology Readiness Levels (TRLs), in some cases to flight-ready status.
- The Space Technology Program shall meet the Nation's needs for new technologies to support 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 NACA aided the early aeronautics industry. There shall be multiple customers for Space Technology program products.
- The Space Technology Program shall employ a portfolio approach to innovation that ensures opportunities for technology investment and maturation over the entire TRL spectrum.
- The Space Technology Program shall sponsor research in academia, industry, and NASA field Centers based on the quality of research proposed at those institutions and in a manner that supports competition and balance.



# Space Technology Program Element Proposed Budget

<b>Major Space Technology Program Elements</b>	<b>FY11</b>	<b>FY12</b>	<b>FY13</b>	<b>FY14</b>	<b>FY15</b>
Early Stage Innovation	298.6	304.4	300.4	305.1	314.7
Game Changing Technology	129.6	359.3	349.1	349.1	424.2
Crosscutting Capability Demonstrations	102.0	302.0	362.0	362.0	424.0
Partnership Development and Strategic Integration	42.0	46.5	48.2	47.7	55.0
	572.2	1012.2	1059.7	1063.9	1217.9

<b>Space Technology Program</b>	<b>FY11</b>	<b>FY12</b>	<b>FY13</b>	<b>FY14</b>	<b>FY15</b>
Partnership Development and Strategic Integration	42	46.5	48.2	47.7	55
Early Stage Innovation					
a) Space Technology Research Grants	70	70	70	70	70
b) NIAC Phase I and Phase II	3	6	7	7	8
c) Center Innovations Fund	50	50	50	50	50
d) SBIR/STTR	165.6	168.4	163.4	168.1	176.7
e) Centennial Challenges	10	10	10	10	10
Game Changing Technology					
a) Game-changing developments	123.6	329.3	319.1	319.1	394.2
b) Small satellite subsystem technologies	6	30	30	30	30
Crosscutting Demonstrations					
a) Technology demonstration missions	75	265	325	325	387
b) Small satellite demonstration missions	10	20	20	20	20
c) CRuSR/FAST	17	17	17	17	17
Subtotal	572.2	1012.2	1059.7	1063.9	1217.9



# NASA Space Technology Program Elements

**1)Early-Stage Innovation:** Creative ideas regarding future NASA systems and/or solutions to national needs.

**2)Game Changing Technology:** Prove feasibility of novel, early-stage idea that has potential to revolutionize a future NASA mission and/or fulfill national need.

**3)Crosscutting Capability Demonstration:** 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.

\*Both competitive and guided program approaches will be used in the Game Changing Technology and Crosscutting Capability Demonstration program elements. The Early-Stage Innovation program element will be entirely competed.



# NASA Space Technology Program Elements

**TRL**

**1**

**2**

**3**

**4**

**5**

**6**

**7**

## Early-Stage Innovation

- System Concepts and Analyses
- Foundational Disciplinary Advances
- Technology Enablers
- Benefits/Feasibility Assessments

## Game-Changing Technology

- New Capabilities  
(Systems & Subsystems, Not Components)
- Large Scale
- Quantitative Performance
- Hardware Validation
- Risk Results in Moderate Failure Rate

## Crosscutting Capability Demo.

- Relevant Environment Testing
- 7120 Flight Processes
- Not Mission Specific Technology
- 25% Cost Share Req. for Flight Tests



# Potential Topics

- **Early Stage Innovation**

- 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), 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

- **Game Changing Technology**

- Advanced lightweight structures and materials, advanced in-space propulsion, nano-propellants, lightweight large aperture antennas and telescopes, power generation/transmission, surface robotic construction, energy storage, high bandwidth communications, and small satellite subsystem technology

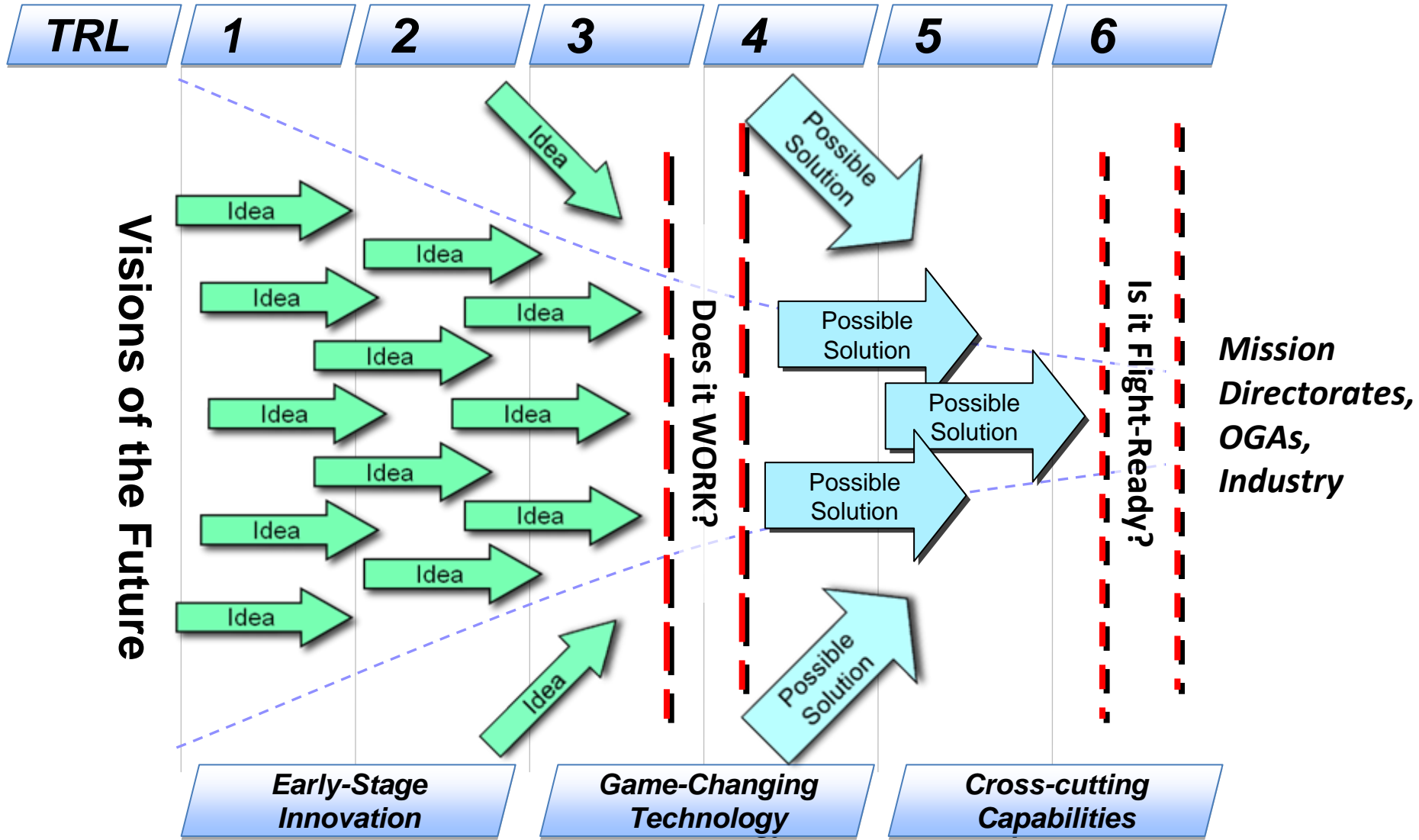
- **Crosscutting Capability Demonstrations**

- Optical communications, aerocapture, supersonic and hypersonic inflatable aerodynamic decelerators, formation flying, advanced in-space propulsion

\*This list is exemplary, not inclusive.



# NASA Space Technology Program

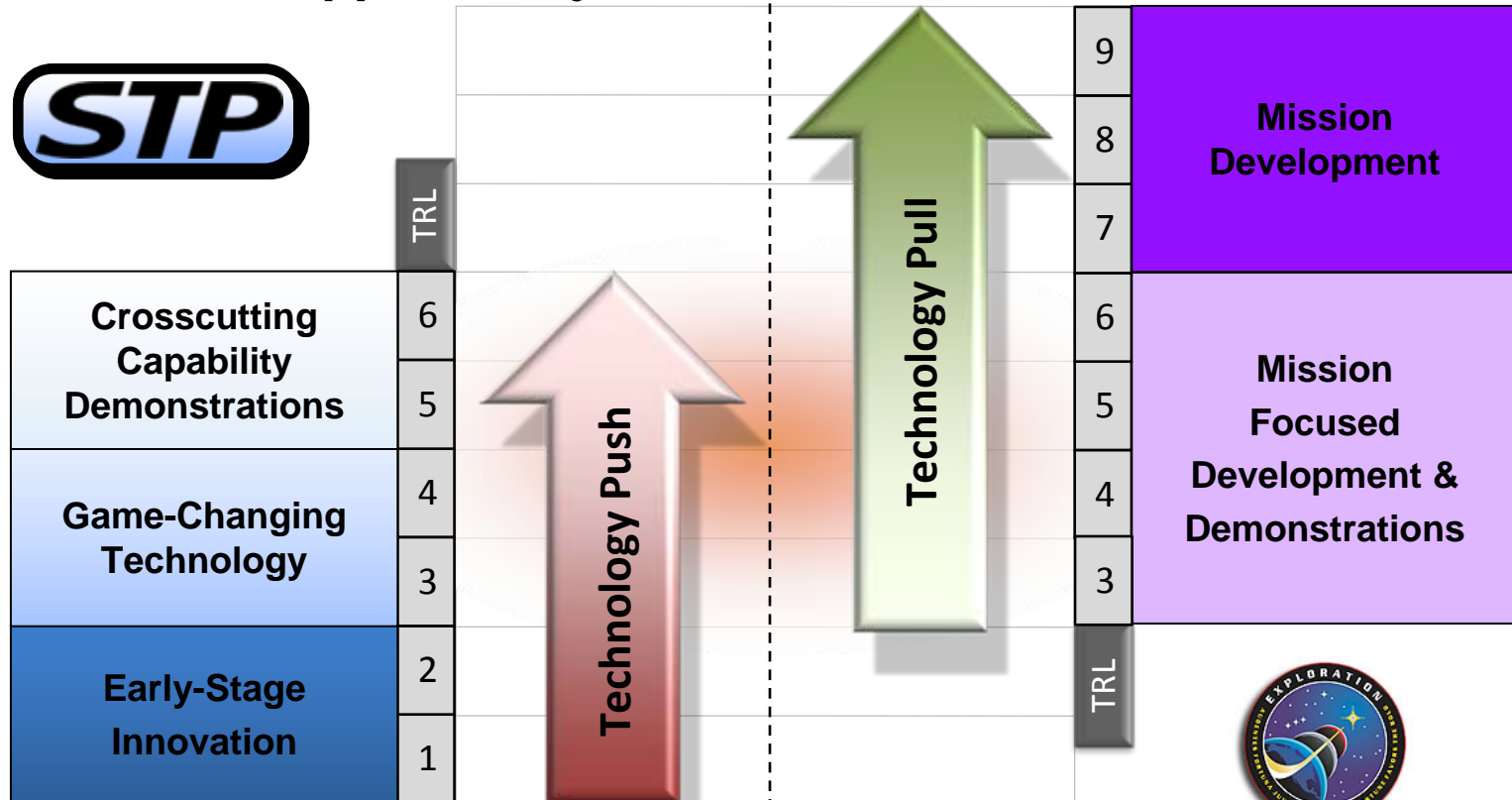




# Relationship with Mission Directorate Technology Programs (e.g., ESMD)

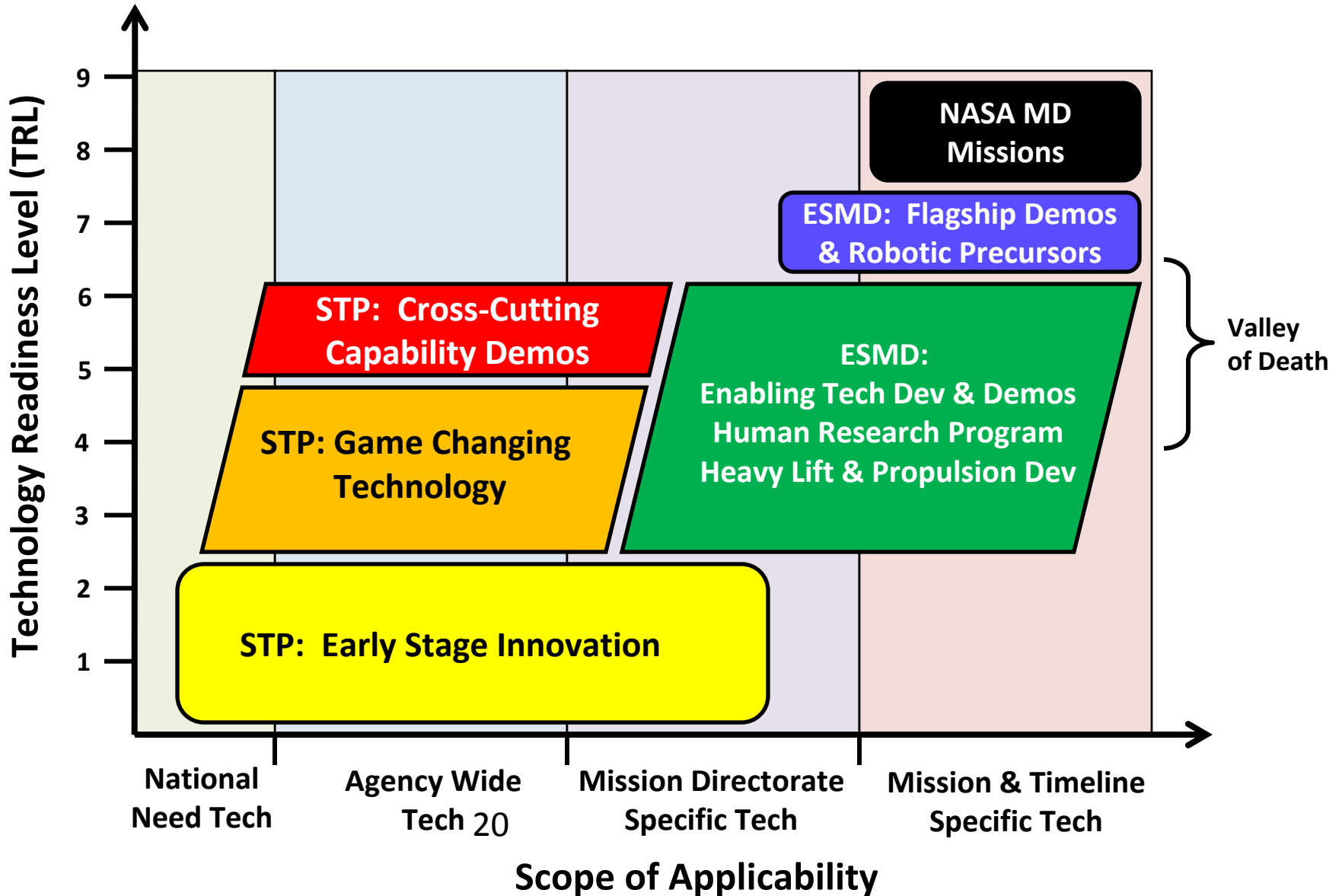
***Developing Technologies  
with Broad Applicability...***

***...to Support Mission-Specific  
Technology Needs.***





# Relationship Between ESMD and STP Technology Program Elements





# Near-Term Actions

- An Agency-wide team is in place developing detailed plans for the execution of the three major program elements and an Agency partnership development and strategic integration function
- Major milestones include:
  - Technology Roadmap and Prioritization Process: April 12, 2010
  - Space Technology Investment Coordination: April 12, 2010
  - Centennial Challenges Lunar Exploration Prize: April 26, 2010
  - Space Technology Program Plan (includes IPP): June 28, 2010
  - ISS as a Platform for Technology Development (SOMD lead): August 9, 2010
- Center program leadership assignments completed in March
- Solicitations/planning for new programs (Space Technology Research Grants, NIAC2, Center Innovation Fund, Game Changing Development, Small Satellite Technologies, Edison Small Satellite Missions, Technology Demonstrations) completed in May/June
- Solicitation/planning for ongoing programs (SBIR/STTR, Centennial Challenges, Flight Opportunities) proceeding on schedule

The Space Technology Program will be ready to make awards on October 1, 2010



# Approximate Number of Planned FY11 Space Technology Products

- 200 Space Technology Research Grants
- 500 Space Technology Graduate Fellowships
- 20 NIAC2 Phase I Awards
- 125 Center Innovation Fund Awards
- 400 SBIR/STTR Phase I Awards
- 50 SBIR/STTR Phase II Awards
- 5 New Centennial Challenges
- 6 Game Changing Development Awards
- 2 Small Satellite Technologies
- 3 Technology Demonstration Missions
- 1 Edison Small Satellite Missions
- 40 FAST Awards
- 2 CRuSR Awards

Over 1300 activities to be initiated in FY11



# Summary

## **NASA as a Major Component of our Nation's Innovation Engine:**

- America's economic competitiveness and high standard of living are based on decades of investment in innovation
- Investment in innovation in NASA communities will drive a sustainable, yet aggressive, future mission portfolio
- Innovative research and technology, tied to exciting missions with national importance, is a strong motivator for students in STEM disciplines, and a strong attraction for new hires
- This investment will also allow NASA to participate in the development of technological solutions addressing broader National needs in energy, weather & climate, Earth science, health & wellness, and National security
- NASA's focus on innovation and technology will:
  - Be responsive to Augustine and NRC input
  - Position NASA for human exploration beyond low earth orbit
  - Be highly engaging of our academic and industrial partners, and the emerging commercial space sector
  - Leverage efforts of other government agencies and international partners
  - Result in new inventions, new capabilities and creation of a pipeline of innovators trained to serve future national needs



# Backup



# NASA Space Technology Program

Space Technology Program Element	Early-Stage Innovation	Game-Changing Technology	Crosscutting Capability Demonstrations
Development Stage	Concept Validation (TRL 1-2)	Tech Demonstration (TRL 3-4/5)	System Qualification (TRL 6)
Number of Projects	100+	10-20	3-8
Typical Project Cost	\$50K-\$800K	\$45M (2 years) \$75M (3 years)	\$150M from STP
Project Duration	6 months – 2 years	2 yrs w/potential 1 yr extension	< 3 years
Programs	Space Tech Research Grants	Game Changing Development Small Satellite Technology	Technology Demonstrations Edison Small Sat Missions Flight Opportunities
	NIAC2		
	Center Innovation Fund		
	SBIR/STTR		
	Centennial Challenges		
Performer Selection	Competed	> 70% Competed	> 70% Competed
Typical Performers	Academia, NASA, Industry	NASA, Federal Labs, Industry, Academia	Industry, NASA
Funding/Partnership Mechanisms	Grants, Contracts, Cooperative Agreements, Prize Competitions	Grants, Contracts, Cooperative Agreements, Space Act Agreements	Contracts, Space Act Agreements
Cost-Sharing	Encouraged	Preferred	Required, 25% minimum
Partners	Academia Federal: NASA MDs, DARPA, DOD, DOE, NOAA, NSF, Other Industry: Aerospace, Non-Aerospace International Partners		



# Early Stage Innovation Program Element

## a)Space Technology Research Grants

- Analogous to the Fundamental Aeronautics program within NASA ARMD
- Focuses on foundational research in advanced space systems and space technology
- Includes new graduate fellowship program

## b)NIAC Phase I and Phase II

- Engages innovators internal and external to the Agency in accordance with the recommendations of the NRC's *Fostering Visions of the Future* report

## c)Center Innovations Fund

- Enhances the Innovative Partnership Programs Seed Fund to stimulate aerospace creativity and innovation at the NASA field Centers

## d)SBIR/STTR

- Engages small businesses and research institutions in aerospace innovation

## e)Centennial Challenges Prize Program

- Addresses key technology needs with new sources of innovation outside the traditional aerospace community

**All selections within this program element are performed competitively**



# Game Changing Technology Program Element

## a) Game Changing Development

- Maturation of advanced space technologies that may lead to entirely new approaches for the Agency's future space missions and solutions to significant national needs in accordance with the recommendations of the NRC's *America's Future in Space: Aligning the Civil Space Program with National Needs (2009)* report
- Demonstrates the feasibility of novel, early-stage ideas through a significant ground-based test and/or laboratory experimentation program
- Fixed duration awards made to PI-led teams comprised of government, academia and industry partners
- Collaboration with DARPA and other government agencies

## b) Small Satellite Subsystem Technology

- Technologies that enable small satellites to provide game changing capabilities for government and commercial sectors

**Greater than 70% of selections within this program element are performed competitively**



# Crosscutting Capability Demonstration Program Element

## a) Technology Demonstrations

- Crosscutting (defined as a technology with potential to benefit to multiple NASA mission directorates, other government agencies or the space industry)
- Demonstration in relevant environment (TRL 6)
- Maximum three years development
- Minimum 25% customer contribution to demonstrate infusion interest

## b) Edison Small Satellite Demonstration Missions

- Develop and operate a series of NASA-focused small satellite demonstration missions
- 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.

## c) Flight Opportunities

- NASA-provided flight opportunities for science, technology development and education efforts to reduced-gravity environments, brief periods of weightlessness, and high-altitude atmospheric research
- CRuSR program will competitively secure commercial suborbital flight services for experiment payloads supporting NASA's objectives in science, technology and education
- FAST focuses on testing technologies on parabolic aircraft flights that can simulate microgravity and the reduced gravity environments of the Moon or Mars

**Greater than 70% of selections within this program element are performed competitively**



# Technology Readiness Level Definitions

