



# Investments in the Future: NASA's Technology Programs

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# 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, 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. The resulting program should be organizationally independent of major development programs, serve all civil space customers, including the commercial sector, conduct an extensive assessment of the current state and potential of civil space technology; and conduct cutting-edge fundamental research in support of the nation’s space technology base.”*
- **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.”*

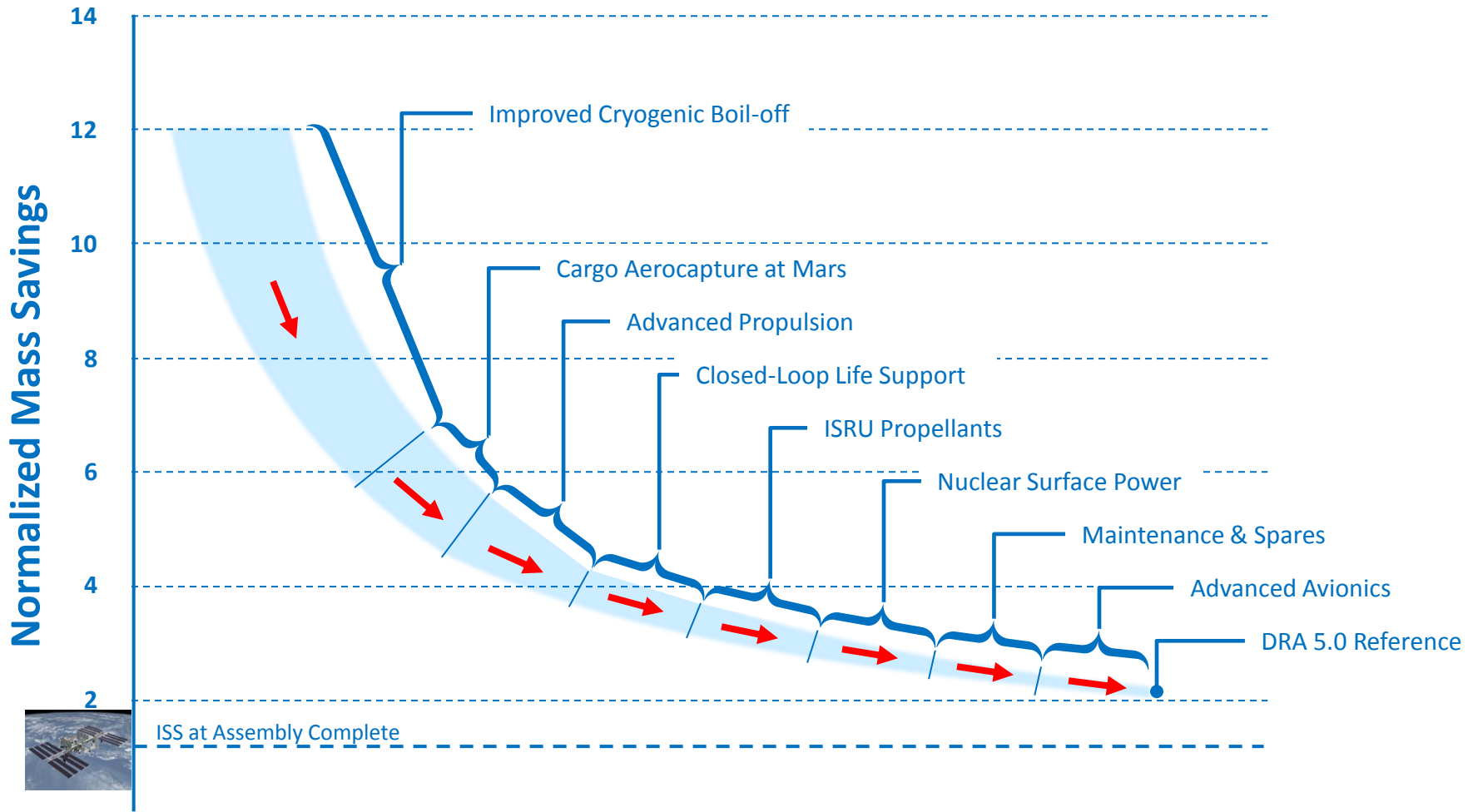


# Consistent Set of Exploration Capability Investments

	1969	1986	1987	1988	1989	1990	1991	1997	2004	2009
	Post-Apollo Space Program (NASA STG)	Pioneering the Space Frontier (Paine)	America's Future in Space (Ride)	Beyond Earth's Boundaries (NASA)	90-Day Study (NASA)	Future of U.S Space Program (Augustine)	America at the Threshold, SEI (Stafford)	Human Exploration of Mars DRM (NASA)	President's Commission on U.S. Space Exploration Policy (Aldridge)	Report of U.S. Spaceflight Committee (Augustine)
Advanced/Closed Loop Life Support		X	X	X	X	X	X	X	X	X
Advanced Power Generation & Storage (in-space and surface, Solar and nuclear)	X	X	X	X	X	X	X	X	X	X
Advanced In-Space Propulsion (chemical, solar electric, nuclear thermal, nuclear electric)	X	X	X	X	X	X	X	X	X	X
In-Space Cryo/Propellant Transfer and Storage		X	X	X	X		X	X	X	X
Heavy Lift Launch Vehicle			X	X	X	X	X	X	X	
Autonomous/Expert Systems		X	X			X		X	X	X
Robotics (tele-robotic & autonomous operation)		X	X		X	X	X	X	X	X
EDL (includes aerocapture, aerobraking, aeroentry)		X	X	X	X	X	X	X	X	X
Human Health and Performance (Radiation, gravity, psychological effects and mitigation, medical technologies)	X	X	X		X	X	X	X	X	X
Autonomous Rendezvous and Docking				X	X		X		X	X
In-Situ Resource Utilization (Lunar, NEO, and Mars based)		X	X	X	X	X	X	X	X	X
Lightweight Structures and Materials		X					X	X	X	X
Advanced In-Space Engine					X	X	X		X	X
Advanced EVA Systems		X		X	X	X	X	X	X	
Communication Technology	X				X	X	X		X	
Reliable Efficient Low Cost Advanced Access to Space	X		X							X
Reusable In-Space Transfer	X	X	X		X	X				
Surface Rovers				X			X	X		



# The Value of Technology Investments Mars Mission Example

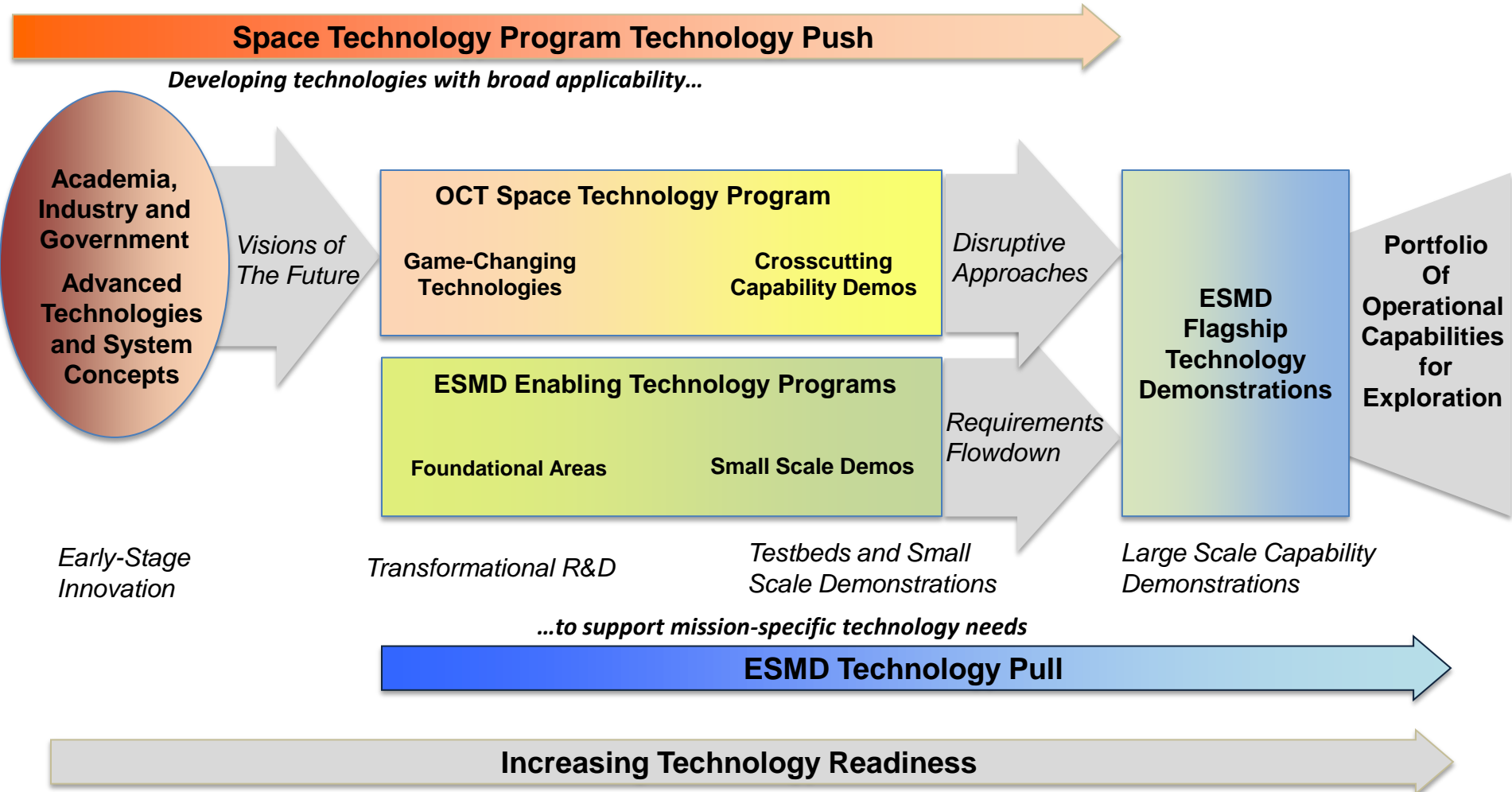


- Without technology investments, the mass required to initiate a human Mars mission in LEO is approximately twelve times the mass of the International Space Station
- Technology investments of the type proposed in the FY 2011 budget are required to put such a mission within reach



# NASA's Integrated Technology Programs

- A portfolio of technology investments which will enable new approaches to NASA's current mission set and allow the Agency to pursue entirely new missions of exploration and discovery.





# A Technology-Enabled Exploration Strategy

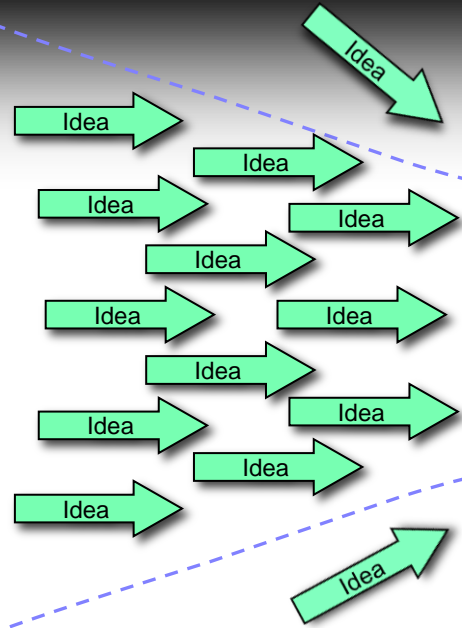
- Early stage innovation and foundational research efforts feed NASA's technology development programs.
- A steady cadence of technology demonstrations will prove the requisite flexible path capabilities, enabling a stepping-stone set of human exploration achievements.
  - This sequence of missions will begin with a set of crewed flights to prove the capabilities required for exploration beyond low Earth orbit.
  - After these initial missions, the long-duration human spaceflight capabilities matured through our technology development programs will enable human explorers to conduct the first-ever deep space human exploration missions.
- NASA's technology development programs include early investment in the long-lead capabilities needed for future deep space and surface exploration missions.
  - Needed capabilities are identified, multiple competing technologies to provide that capability are funded, and the most viable of these are demonstrated in flight so that exploration architectures can then reliably depend upon them.
  - For example, NASA's parallel path investments in heavy-lift propulsion, in-space propellant storage and transfer, and in-space propulsion technologies provide robustness and improve the viability of a future deep space human exploration capability.

***The renewed emphasis on technology in the President's FY11 budget request balances the long-standing NASA core competencies of R&T, spaceflight hardware development, and mission operations, is essential for the success and sustainability of any enduring initiative of human and robotic exploration of the solar system, and recognizes the Agency as an important catalyst for innovation and economic expansion in our Nation.***

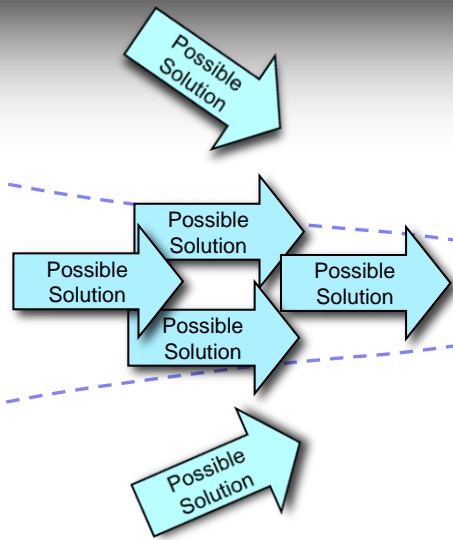


# NASA Space Technology

Visions of the Future



Does it WORK?



Is it Flight Ready?

Infusion Opportunities for NASA Mission Directorates, Other Govt. Agencies, and Industry



Creative ideas regarding future NASA systems or solutions to national needs.



Prove ideas with the potential to revolutionize future NASA missions or fulfill national needs.



Mature crosscutting capabilities that advance multiple future space missions to flight readiness status





# NASA Space Technology Program Foundational Principles

- The Space Technology Program shall
  - Advance non-mission-focused technology.
  - Produce technology products for which there are multiple customers.
  - 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.
  - Employ a portfolio approach over the entire technology readiness level spectrum.
  - Competitively sponsor research in academia, industry, and the NASA Centers based on the quality of the research proposed.
  - Leverage the technology investments of our international, other government agency, academic and industrial partners.
  - Result in new inventions, new capabilities and the creation of a pipeline of innovators trained to serve future National needs
- Crosscutting technologies\* that may be solicited by this program include lightweight structures and materials, advanced in-space propulsion, nano-propellants, lightweight large aperture space systems, power generation/transmission systems, energy storage systems, in-space robotic assembly and fabrication systems, high bandwidth communications, and inflatable aerodynamic decelerators.





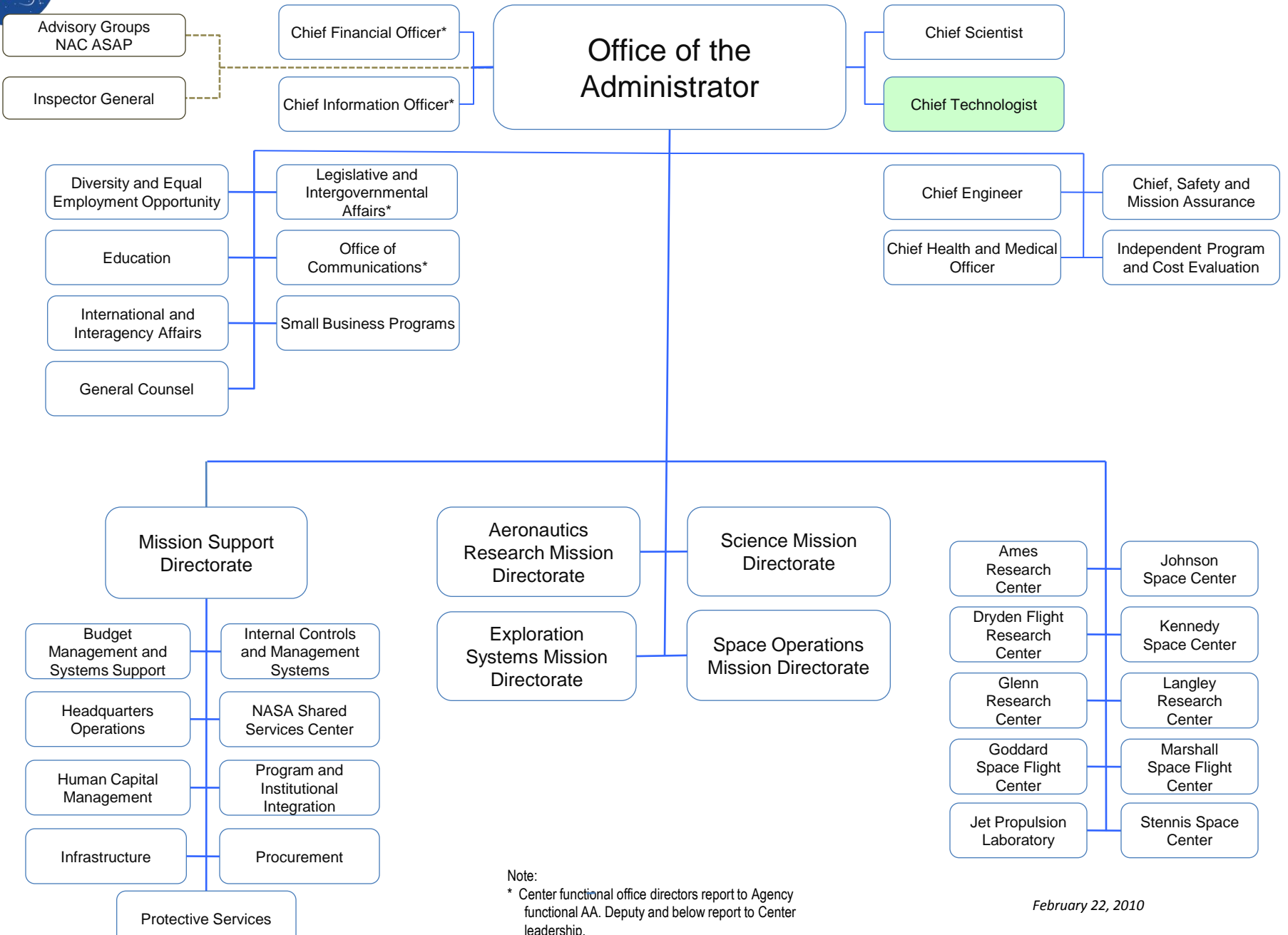
# NASA Space Technology Program Elements

- 1) **Early-Stage Innovation:** Creative ideas regarding future NASA systems and/or solutions to national needs.
  - NIAC2
  - Space Technology Research Grants (includes Fellowship program)
  - SBIR/STTR
  - Centennial Challenges
  - Center Innovation Fund
  
- 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.
  - Game Changing Development
  - Small Satellite Subsystem Technology
  
- 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.
  - Crosscutting Technology Demonstrations
  - Edison Small Satellite Demonstration Missions
  - Flight Opportunities

\*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.



# 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 Technology Executive Council

- OCT will ensure close collaboration between the broadly applicable Space Technology Program and the mission-focused technology programs within the Mission Directorates through establishment of the NTEC
  - Strategic integration of NASA's technology investments
  - Minimize duplication, perform gap analysis and seek synergy
- Chaired by the NASA Chief Technologist, the NTEC will include the Mission Directorate AAs (or their designees) and the NASA Chief Engineer
- Through NTEC, the OCT will make quarterly and yearly decisional recommendations. Decisional recommendations may include adjustments in the scope, budget or schedule of any NASA technology program activity or any NASA technology development partnership through an approved decision process
- Through the NTEC and with inputs from the Mission Directorate technology programs, OCT will produce and communicate:
  - NASA strategic technology roadmap and prioritization documentation
  - NASA technology investment portfolio
  - NASA technology guidance and policy documentation.
  - Decisional recommendations regarding the scope, budget and schedule of NASA technology plans

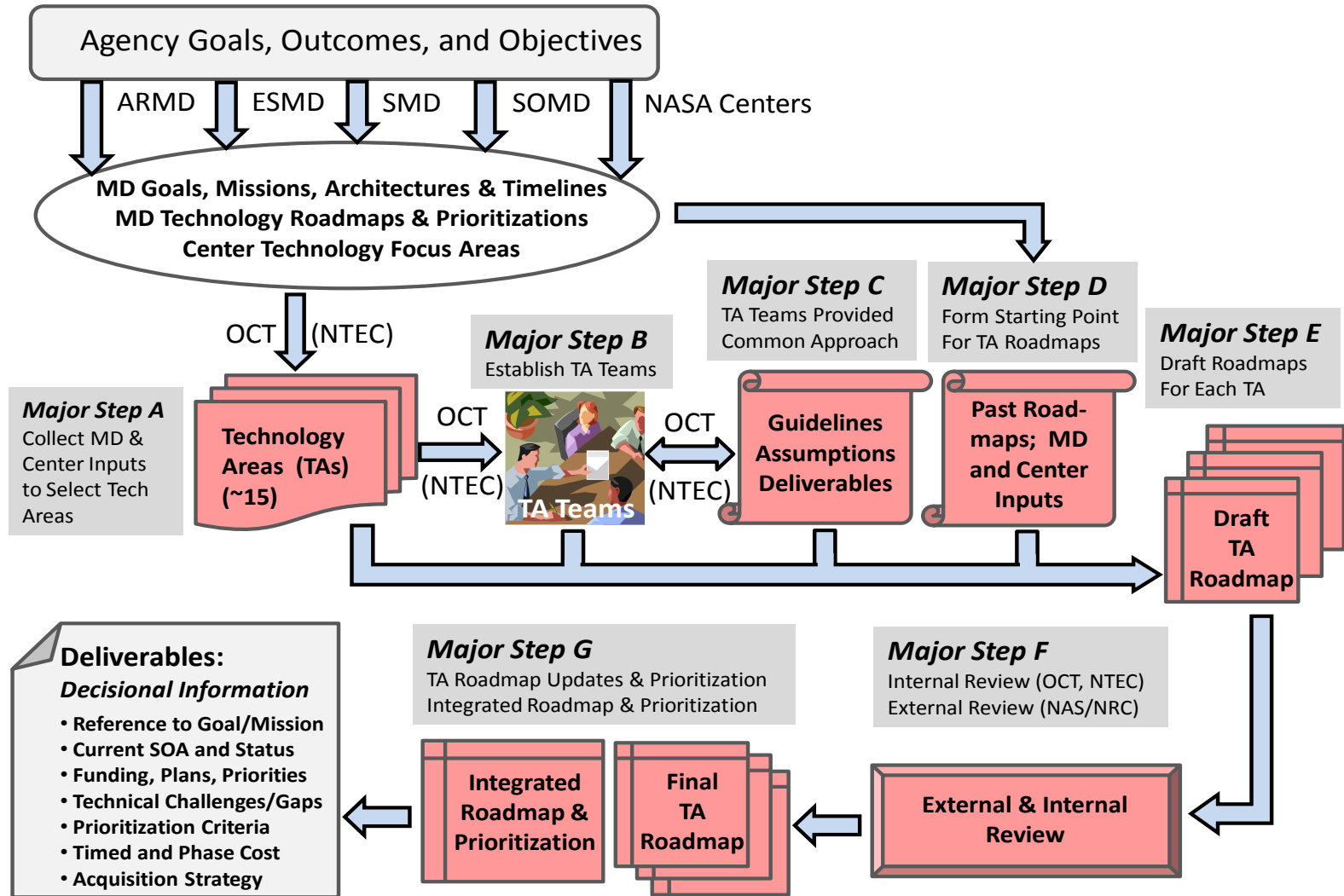


# Technology Roadmapping

- The Aero-Space Technology Area Roadmap (A-STAR) 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.
- These documents provide recommendations regarding the identity and prioritization of technology pathways needed to meet NASA Strategic Goals, Outcomes and Objectives, as well as National needs.
  - The A-STAR scope will not cover all technology work within the NASA. The approximately 15 chosen A-STAR technology areas will focus upon capability areas where significant technology investments are anticipated, and where substantial enhancements in NASA mission capabilities are needed.
- NASA will establish the TA teams by including, as appropriate, members from NASA, other Agencies, academia and industry.
- OCT will organize a thorough peer review of the A-STAR technology roadmaps through an open and transparent process. This process will include internal and external review teams.



# Roadmap Process





# Summary

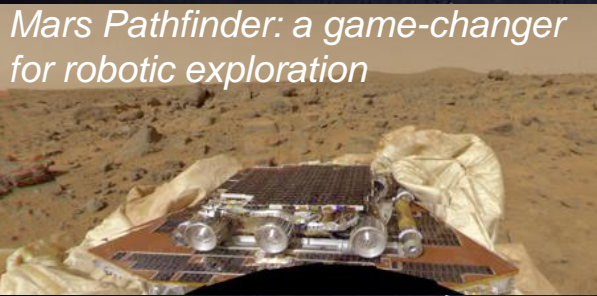


*NASA-Industry  
Inflatable Structures  
Collaboration*

- A consistent set of external recommendations have driven the Agency's technology-enabled approach to exploration.
- NASA's planning process has produced an integrated set of technology programs that will deliver the requisite capabilities for a flexible-path exploration timeline.
  - This process is ongoing and paced for an Oct 1 program start.

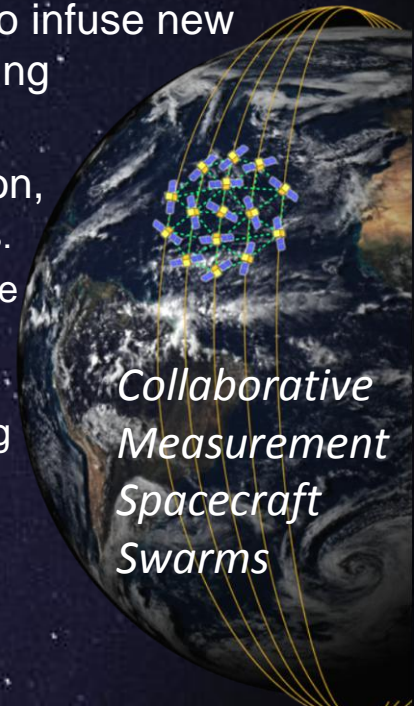


*University Students  
Build and Fly  
Aluminum-ice  
Nanopropellant  
Rocket*



*Mars Pathfinder: a game-changer  
for robotic exploration*

- NASA's approach matures these technologies by moving from the technology concept and analysis phase of the past decade to a steady cadence of laboratory, flight-test and in-space demonstrations.
- These technology investments are required to infuse new capabilities into our future mission set, enabling sustainable exploration approaches.
- A NASA focused on technology and innovation,
  - Drives our Nation's economic competitiveness.
  - Serves as a strong motivation 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, Earth science, health & wellness, and National security.



*Collaborative  
Measurement  
Spacecraft  
Swarms*