Investments in the Future: NASA's Technology Programs

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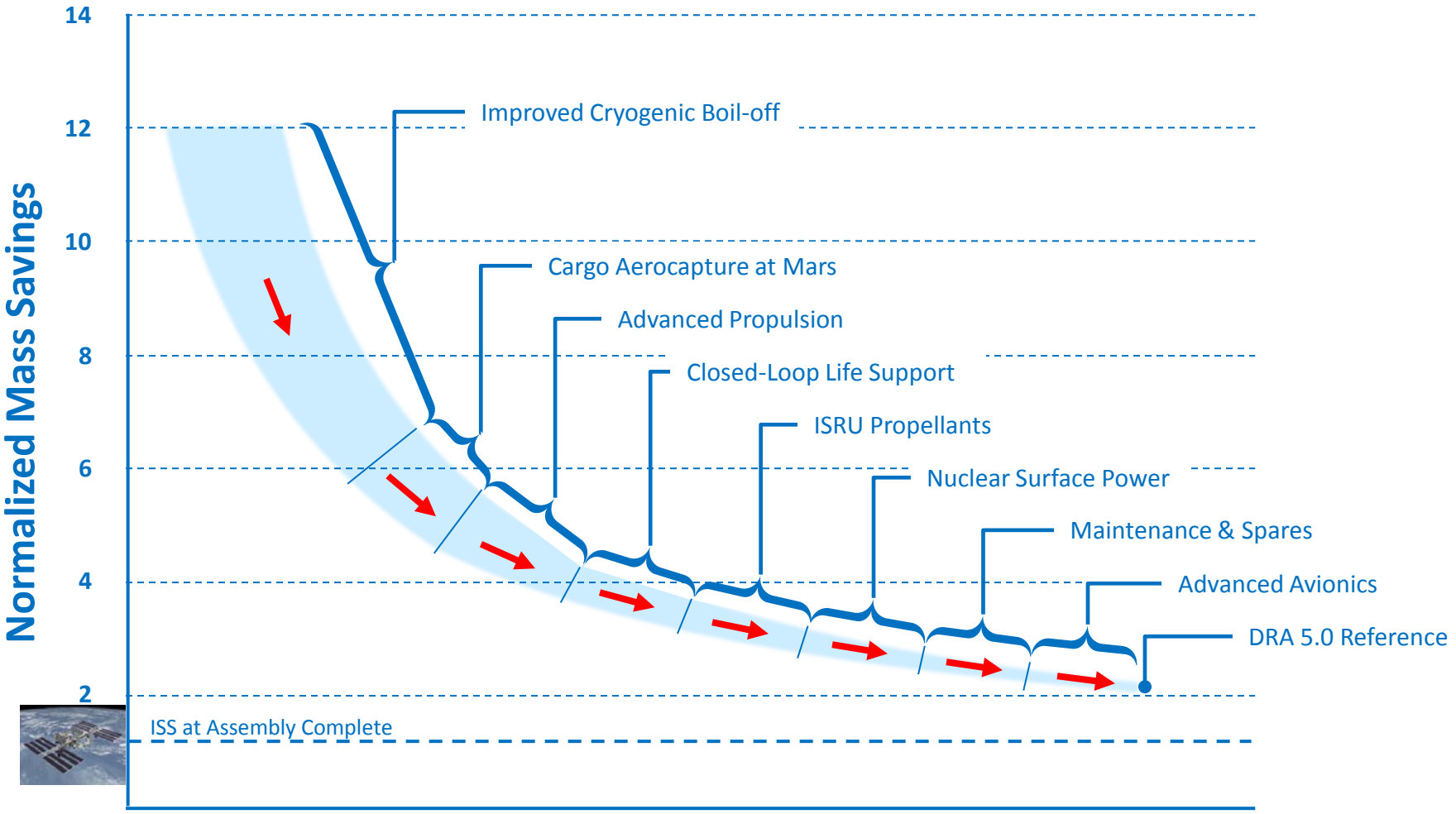
External Input Has Driven Development of NASA's Technology-Enabled Approach

- **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		

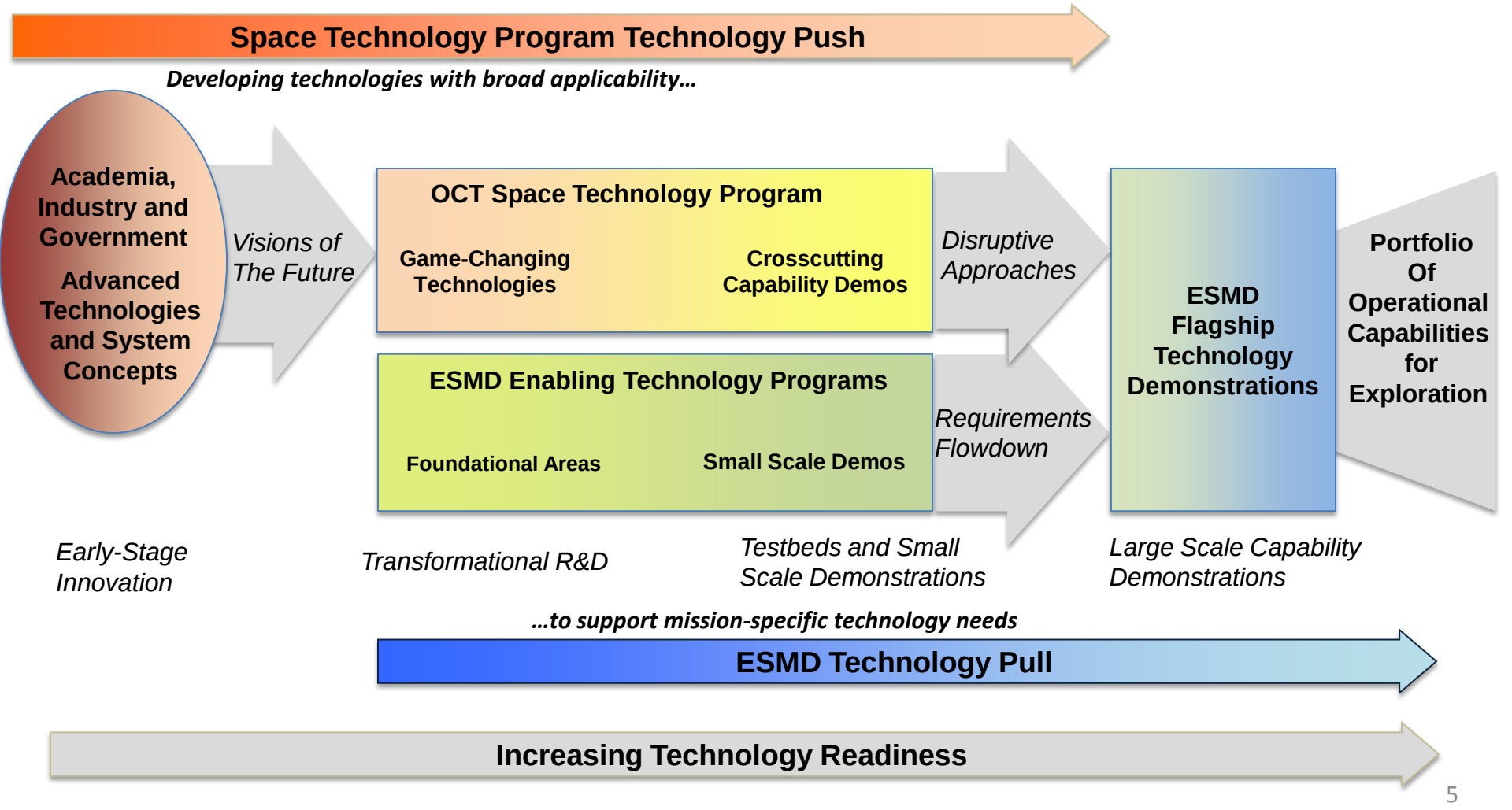
The Value of Technology Investments
Mars Mission Example



- 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.

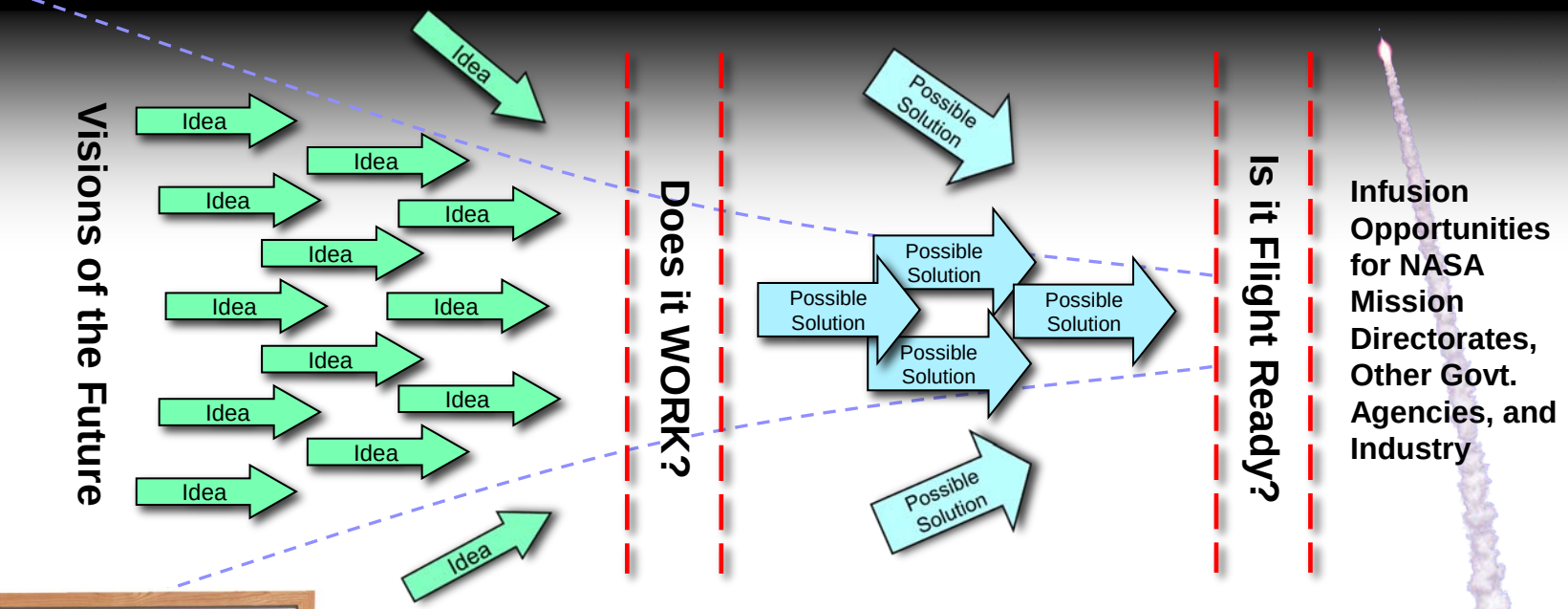


A Technology-Enabled Exploration Strategy

- 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 Program



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

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

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

NASA Space Technology Program Foundational Principles

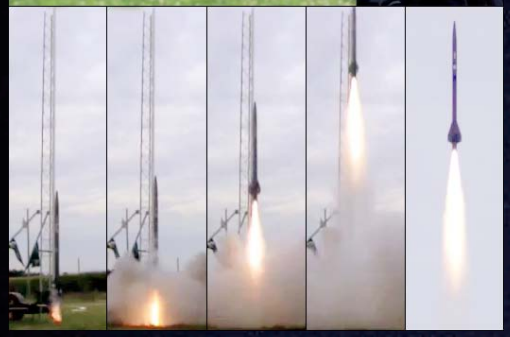
- The Space Technology Program shall
  - Advance non-mission-focused technology.
  - Produce technology products for which there are multiple customers.
  - Meet the Nation's needs for new technologies to support future NASA missions in science and exploration, as well as the needs of other government 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

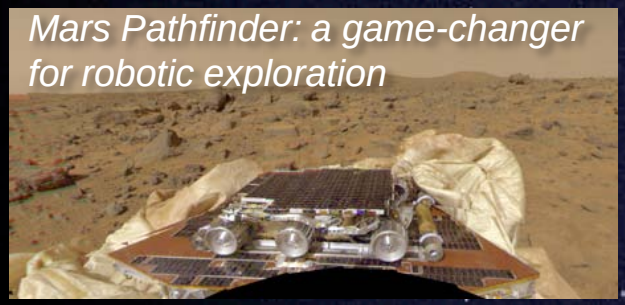
- Crosscutting technologies* that may be solicited by this program include lightweight structures and materials, advanced in-space propulsion, nano-propellants, lightweight large aperture space systems, power generation/transmission systems, energy storage systems, in-space robotic assembly and fabrication systems, high bandwidth communications, and inflatable aerodynamic decelerators.

*This list is exemplary, not inclusive.

Summary

- 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.





- 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.