National Aeronautics and Space Administration

A New Space Exploration Enterprise

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May 5, 2010

Human Space Exploration Themes Remain the Same

A Sustained Presence - Extending Human Frontiers

New Knowledge in Science and Technology

Economic Expansion

Global Partnerships

Inspiration and Education

The New Path for Human Space Exploration

- **The FY 2011 budget request challenges NASA to embark on a new human space exploration program that is sustainable and affordable**
- **The budget balances investments in future human spaceflight systems with obtaining key knowledge about future destinations and demonstrating critical enabling technologies for human spaceflight and exploration, including:**
  - Research & development of heavy-lift and propulsion engines and other key technologies
  - Technology development and demonstrations to reduce cost and prove required capabilities for future human exploration
  - Precursor robotic missions to multiple destinations to cost- effectively scout human exploration targets and identify hazards and resources for future human exploration
  - Increased investment in Human Research to prepare for long journeys beyond Earth
  - Expanded efforts to develop U.S. commercial human spaceflight capabilities, making space travel more accessible and affordable
- **The FY2011 budget will continue the development of the human crew capsule, an Orion-derived vehicle that will serve as an emergency return vehicle from ISS, and will be part of the technological foundation for advanced spacecraft to be used in future deep space missions**

What is the Destination?

- **The future human space flight program will build through a steady sequence of achievements, from a set of crewed flights to test and prove systems required for exploration beyond LEO orbit early in the next decade, to a near-Earth object mission in 2025, to missions to Mars' environs by mid-2030s, followed by landing on Mars**
- **This approach builds experience and capability through time, results in successive "firsts" (much like the Mercury and Gemini approach) and allows the human spaceflight systems to be developed serially rather than concurrently, making the endeavor affordable to the tax-payer**
- **Although we cannot provide a date with certainty for the first human landing on Mars, we can identify essential capabilities needed for such a mission. These are reflected in the programs within this budget request.**
  - They are capabilities that have been recommended consistently for over two decades in national level reports of committees and commissions addressing future human space exploration
  - They are the near-term steps NASA must take to create the new knowledge and capabilities required for humans to venture beyond low-Earth orbit (LEO) to stay

Phased Development Strategy

2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Phase I
Build the Foundation

Commercial Sector, Robotic Precursors, and Game-Changing Technology Development

Phase II
Systems Development

Design and Development of Heavy-Lift and In-space capabilities

Phase III
Sustainable Exploration of the Solar System

Human Exploration Missions to Solar System Destinations

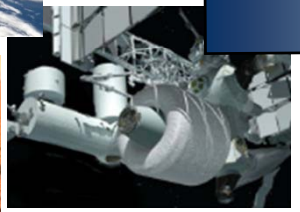
Strategy for Future Human Missions

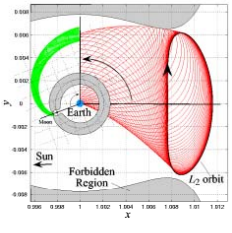
Potential Destinations

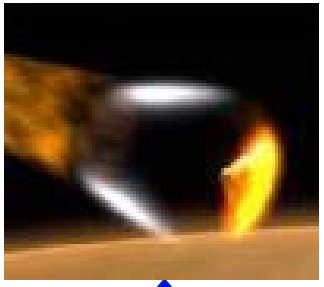
Mission Analyses

Common Capabilities

Systems Design







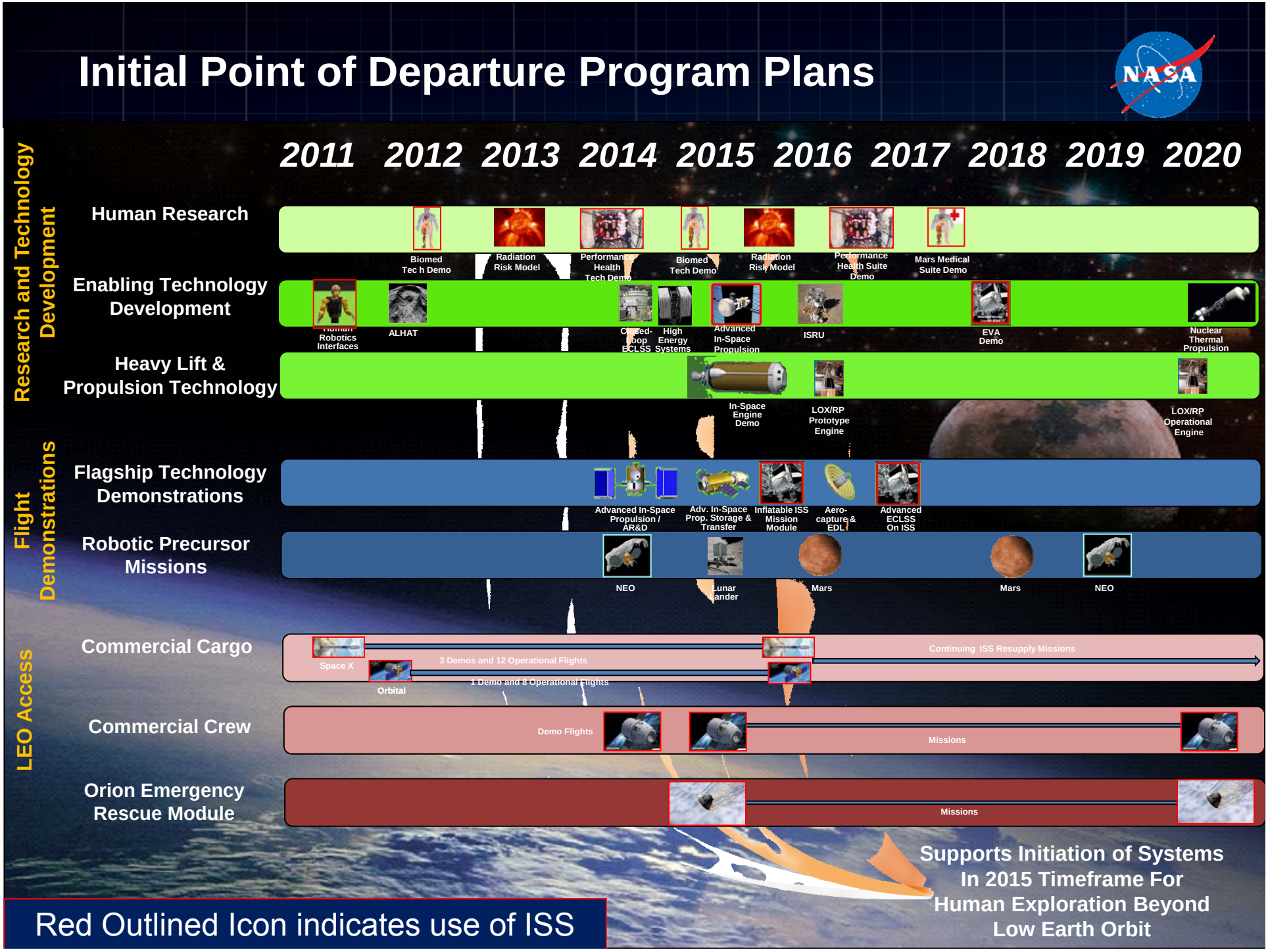
Technology Building Blocks

- Efficient In-Space P
- Aerocapture
- Low-cost Engines
- Cryo Fluid M
- Robust/Efficient P
- Lightweight S
- Radiation Research
- Zero/Low-g Research
- Regenerable Life S
- Advanced Lightweight EVA

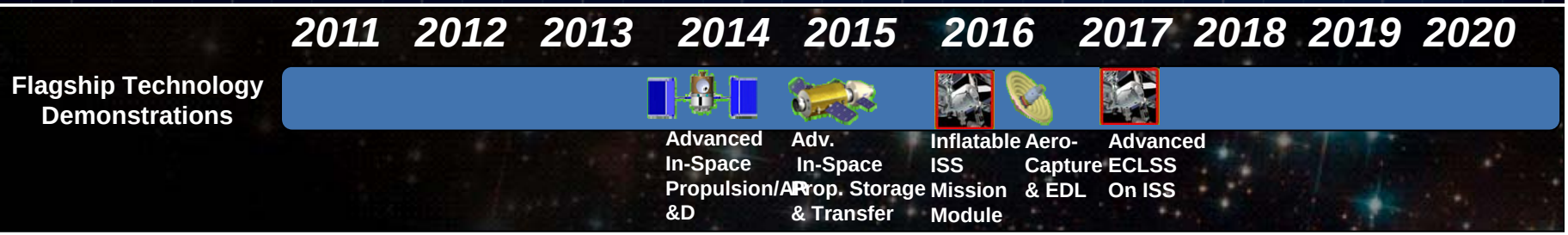
"Breakthrough" Technologies

- Hypersonic Inflatable a
- Regenerative A
- Revolutionary ETO P
- Innovative Mission Concepts

Initial Point of Departure Program Plans



Flagship Technology Demonstration Program



- **Objectives**
  - Conduct large scale, in space demonstrations of technologies that advance capability for human space exploration
  - Improve the capability and reduce the cost of future exploration missions
  - Life cycle cost should range from $400M to $1B each including launch cost
  - Point of departure missions:
    - 2014: Advanced in-space propulsion
    - 2015: Advanced in-space propellant transfer and storage
    - 2016: Lightweight/inflatable modules and closed loop life support
    - 2017: Aero-assist/entry, descent and landing

- **Development Strategy**
  - Complete studies, analysis and trades and then finalize development plans in FY10
  - Industry, academia and other partner participation will be sought via RFI in May and BAA in July
  - Initiate missions in 2011 to support annual launches starting in 2014
  - Acquisition strategy will be fast paced to accomplish the 5-year life cycle for each demonstration with high confidence of success

Enabling Technology Development and Demonstration

- **Objectives**
  - Mature exploration technologies through laboratory, small ground and flight experiments
  - Successful prototype handed off to Flagship, robotic precursor, other missions for validation of key capabilities
  - Investing in ten technology domains
- **Development Strategy**
  - Similar to current Exploration Technology Development Program (ETDP) but with more emphasis on ground demonstrations and flight experiments
  - Invest in all ten technology domains and fund short duration projects/demos of $100M or less
- **Status**
  - Complete studies, analysis and trades and then finalize development plans in FY10
  - Industry, academia and other partner input on potential demonstrations will be sought via RFI to be released in May and BAA to be released in July

Exploration Robotic Precursor Missions

- **Objectives**
  - Conduct precursor investigations at sites of future human exploration
    - Provide knowledge to inform the selection of Human Exploration destinations
    - Identify the conditions, environments and hazards for human exploration beyond LEO and Identify resources to facilitate sustainability, lower launch mass, and “living off the land”
  - Provide a platform for flight demonstrations of technologies
- **Development Strategy**
  - Medium Class Exploration Missions
    - Destinations selected according to priority data needs of human exploration
    - Generally capped at $800 million or less (life cycle cost)
  - Small Scout Class Exploration Missions
    - Small, competed, rapid turnaround, risk tolerant missions ($100 million to $200 million life cycle cost)
    - Demonstrate new, innovative ways of conducting robotic exploration while providing highly relevant measurements and operational experiences
    - Goal is one launch per 1-2 years starting in 2013
- **Status**
  - Complete studies, analysis and trades and then finalize development plans in FY10
  - Industry, academia and other partner input on mission concepts will be sought via RFI in May

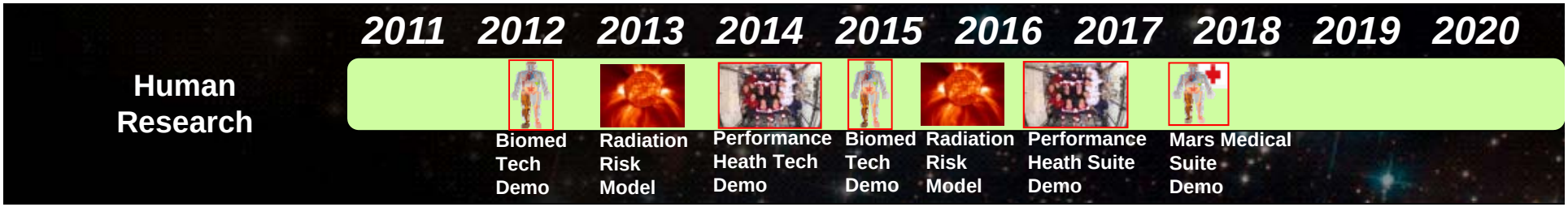
Heavy Lift & Propulsion Technology Program

- **Objectives**
  - Develop a First Stage Launch Propulsion System
  - Demonstrate an In-Space Engine
  - Conduct Foundational Propulsion Research
  - Enable Future Development of a Heavy Lift Launch Vehicle
  - Establish launch vehicle requirements and architecture by 2015

- **Strategy**
  - First Stage Focus is U.S. hydrocarbon (LOX/RP)
    - Thrust ≥ 1 million lbs
    - Improved robustness, efficiencies, affordability, operability
    - Explore partnerships with DOD and commercial industry on common engine for national security and civil space missions
  - Demonstrate LOX/Methane and/or LOX/H2 in-space advanced engine
  - Perform foundational propulsion research on maturing the critical and high impact technology areas such as New Propellants, Advanced Propulsion Materials and Manufacturing Techniques, Combustion Processes, Propellant Storage and Control, Engine Health Monitoring

- **Status**
  - Complete studies and analysis on all fuel types, performance requirements, and launch vehicle architectures
  - Industry, academia and other partner participation will be sought via RFI and BAA to be released in May

Human Research Program



- **Objectives**
  - Reduce the highest risks to crew health and performance for space exploration missions
  - Conduct space biomedical research and technology development to provide risk mitigation
  - Enable development of human spaceflight medical standards for risks that are poorly understood
  - Develop and validate countermeasures or technologies that reduce spaceflight medical risks
  - Support the transition of mitigation or treatment strategies to spaceflight medical practice

- **Strategy**
  - Address human health and performance risks endorsed by the National Research Council and Institute of Medicine
  - Evidence/Risk-based Program Architecture: Evidence → Risks → Gaps → Tasks → Deliverables
  - Leverage & Collaborate with US Agencies, International Partners, and National Space Biomedical Research Institute
  - Use a competitive solicitation process and peer review to acquire high quality research activities

Commercial Crew and Cargo Program

- **Objectives**
  - For commercial cargo, accelerate the achievement of already-planed milestones or introduce new milestones that would ultimately improve mission success
  - Support the development of commercial crew transportation providers to whom NASA could competitively award a crew transportation services contract
  - Reduce the gap in human space flight capability and lower costs
  - Draft human rating requirements document with Agency and Industry coordination
- **Strategy**
  - Build off successful progress in the development of commercial cargo capabilities; spurring the development of American commercial human spaceflight vehicles
  - Use competitive solicitations that support a range of higher and lower programmatic risk systems
  - Ensure all systems developed meet the agency's stringent human-rating requirements
- **Status**
  - NASA completing plans for the Commercial Crew Program
  - Finalizing acquisition strategy and approach to human rating, vendor oversight

Orion Emergency Rescue Module

- **Objectives**
  - Restructure the Orion Emergency Rescue Module project to design a simpler and more efficient capsule that will be focused on crew emergency escape from the International Space Station
  - Create an American crew escape capability that will increase the safety of our crews on the Space Station, reduce our dependence on foreign providers, and simplify requirements for commercial crew providers
  - Establish a technological foundation for future exploration spacecraft needed for human missions beyond low Earth orbit

- **Strategy**
  - Leverage work already performed on Orion to meet the important safety requirement of providing stand-by emergency escape capabilities for astronauts on the Space Station
  - Build an affordable solution by removing capabilities not required for a rescue vehicle: launch abort system, human rated launch vehicle, simplified life support, suits, etc. while still providing a technical foundation that can grow into a future exploration vehicle

- **Status**
  - Budget details and offsets to be released via a revised request
  - NASA working technical details including likely launch date and and how vehicle will contribute to technological foundation for future exploration spacecraft

ESMD: Blazing a Trail Into the Solar System

- NASA's human spaceflight program seeks to extend human presence throughout the solar system
- The President's FY2011 Budget Request takes a new approach to this goal, focusing on capabilities that will allow us to reach multiple destinations, including the Moon, Asteroids, Lagrange points, and Mars and its moons
- The investments seek to create the new *knowledge* and *capabilities* required for humans to venture beyond low Earth orbit while building initial next generation human flight systems
- The approach will result in many human firsts, affordable human system development over time, and a sustained human presence beyond low Earth orbit