National Aeronautics and Space Administration

The Big Picture: Space Exploration & Operations Planning, Integration & Partnerships

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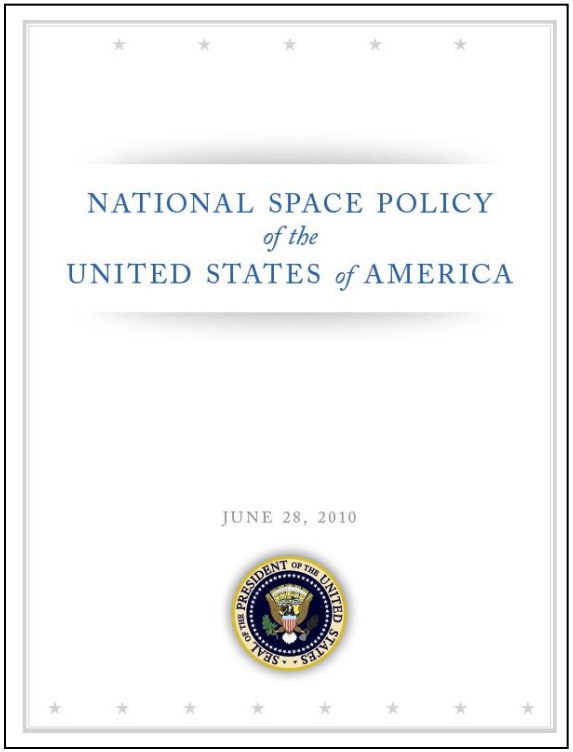
US & NASA are Committed to Human Spaceflight

International Partnerships are Essential for Exploration Success

U. S. National Space Policy Goals

- **Energize competitive domestic industries**
- **Expand international cooperation**
- **Strengthen stability in space**
- **Increase assurance and resilience of mission-essential functions**
- **Pursue human and robotic initiatives**
- **Improve space-based Earth and solar observation**



"NASA has a key role in achieving the goals defined in the new policy. We are committed to working with other agencies, industry, and international partners to achieve national goals in exploration - human and robotic - and technology development that will ensure a robust future for the U.S. and our friends around the world." NASA Administrator Charles Bolden, June 28, 2010

The NASA Vision

To reach for new heights and reveal the unknown, so that what we do and learn will benefit all humankind.

NASA Strategic Goals

1. **Extend and sustain human activities across the solar system.**
2. **Expand scientific understanding of the Earth and the universe in which we live.**
3. **Create the innovative new space technologies for our exploration, science, and economic future.**
4. **Advance aeronautics research for societal benefit.**
5. **Enable program and institutional capabilities to conduct NASA's aeronautics and space activities.**
6. **Share NASA with the public, educators, and students to provide opportunities to participate in our mission, foster innovation, and contribute to a strong national economy**

Budget Lays the Foundation for and Enables Significant Progress on Key Human Space Activities

- **Specific content of human spaceflight portfolio (in FY12 budget) validated by NASA framework studies and consistent with NASA Authorization Act of 2010**
  - **ISS utilized for key exploration research and demonstrations**
  - **Commercial cargo and crew access to ISS**
  - **SLS & MPCV: Initial essential capabilities required to lead multi-destination human exploration beyond LEO**
  - **Cutting-edge human research and development of needed life support, crew habitat and other future exploration capabilities**
  - **Leveraging NASA, industry, academia, and partner capabilities while planning innovative, cost-effective approaches to development and future operations**

Affordability is a major challenge: NASA must evolve its traditional approach to human space systems planning and development.

Planning Context: Policy, Process, and Law

- **2007: International Space Exploration Coordination Group (ISECG) Created**
- **2009: Review of U.S. HSF Plans Committee [Augustine Committee]**
- **2010: National Space Policy (28 June 2010) and ISS Assembly Complete**
- **2010: NASA Human Exploration Framework Team (HEFT) & ISECG Work**
  - Phase 1 (Apr-Aug 2010)/Phase 2 (Sep-Dec 2010)
  - ISECG Reference Architecture for Human Lunar Exploration completed
- **2010: NASA Authorization Act**
  - Long-term goal: "To expand permanent human presence beyond low Earth orbit and to do so, where practical, in a manner involving international partners."
- **2011: Human Space Exploration Architecture Planning (ongoing)**
  - Apr 2011: FY11 CR passed, Sep 2011: FY12 CR passed
  - Sep 2011: ISECG Global Exploration Roadmap First Iteration
  - Nov 2011: ISS Exploration Working Group, 1st Meeting in Italy

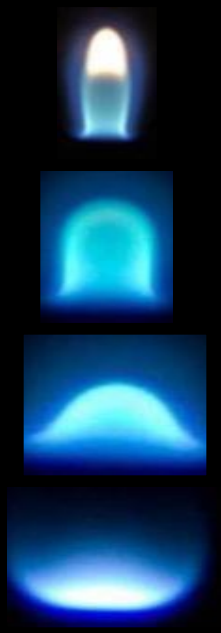
Evolving NASA Exploration Principles (DRAFT)

Exploration Plan should have the following elements:

1. **Significant International Partner Involvement**
2. **Opportunities for Commercial Participation**
3. **Multi-Use Space Infrastructure: Sustainability and Re-usability**
4. **Pursue Focused R&D of New Technologies, Mature (High TRL) for Applications**
5. **Affordability**
6. **Steady Cadence of Progress: Timely & Compelling**

International Space Station (ISS)

ISS as a Research and Development Platform



HABITATION – LIFE SUPPORT – ROBOTICS – ENVIRONMENTAL MONITORING – CREW HEALTH - COMMUNICATIONS

Earth's Moon

- 382,500 km / 237,674 mi
- Witness to the birth of the Earth and inner planets
- Has critical resources to sustain humans
- Significant opportunities for commercial and international collaboration

Mars and its Moons

- 54,500,000 km / 33,900,00 mi
- A premier destination for discovery: Is there life beyond Earth? How did Mars evolve?
- True possibility for extended, even permanent, stays
- Significant opportunities for international collaboration
- Technological driver for space systems

HEO/GEO/Lagrange Points

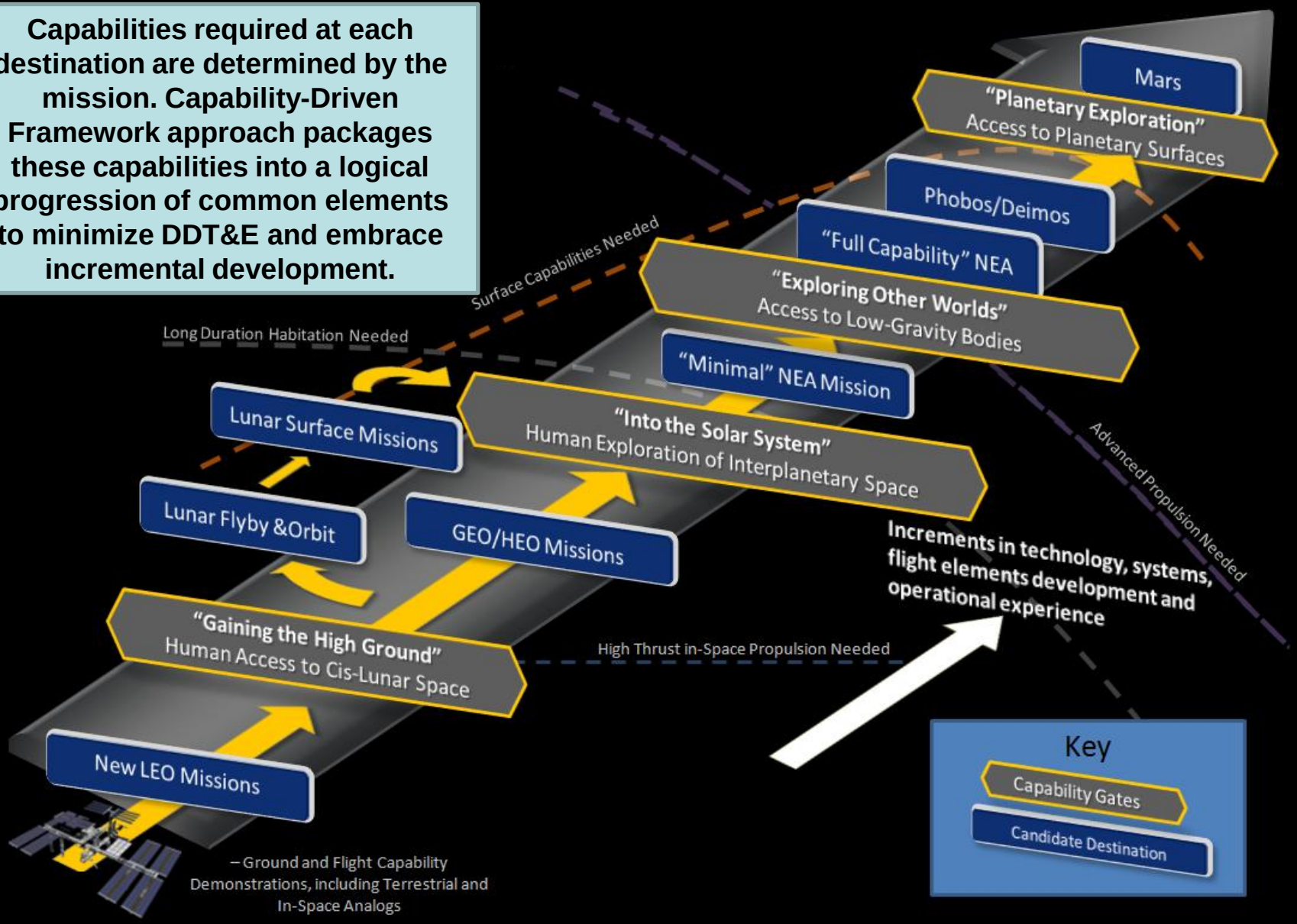
- Microgravity destinations beyond LEO
- Opportunities for construction, fueling and repair of complex in-space systems
- Excellent locations for advanced space telescopes and Earth

Near Earth Asteroids

- Compelling science questions: How did the Solar System form? Where did Earth's water and organics come from?
- Planetary defense: Understanding and mitigating the threat of impact resources
- Excellent stepping stone for Mars

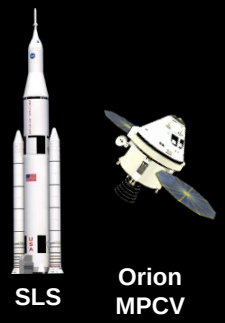
Capability Driven Exploration

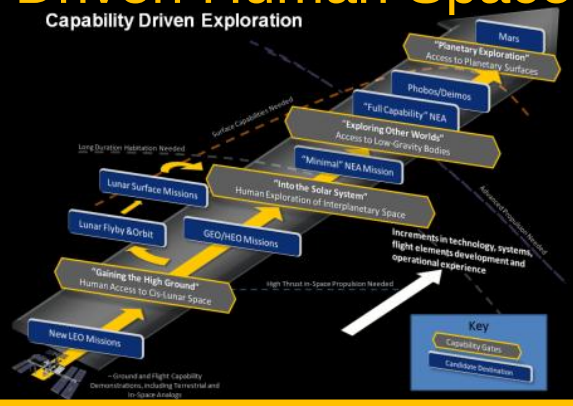
Capabilities required at each destination are determined by the mission. Capability-Driven Framework approach packages these capabilities into a logical progression of common elements to minimize DDT&E and embrace incremental development.



Common Capabilities Identified for Exploration

Capability Driven Human Space Exploration





Architecture Common Capabilities (Building Blocks)

- Low Earth Orbit Crew and Cargo Access
- Human -Robotic Mission Ops
- In-Space Propulsion
- Adv. In-Space Propulsion
- Deep Space Habitation
- Ground Operations
- Beyond Earth Orbit Crew and Cargo Access
- Robotic Precursor
- EVA
- Mobile EVA and Robotic Platform
- Destination Systems
- Autonomous Mission Operations

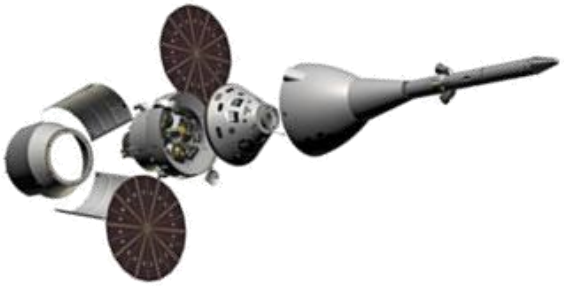
Technologies, Research, and Science

- OCT Technology Development Efforts
- AES Proposals
- HEO and SMD Cross Cutting Research & Science
- Human Exploration Specific Technologies

SLS and MPCV are the cornerstones of the Exploration Enterprise, but concurrent, innovative, and extremely lean Beyond-LEO incremental capability development is vital

SLS & MPCV: Key, Initial Enablers for Exploration Beyond LEO

- **NASA will develop the launch and spaceflight vehicles that will provide the initial capability for crewed exploration missions beyond LEO**
  - The **Space Launch System** (SLS) program will develop the heavy lift vehicle that will launch the crew vehicle, other modules, and cargo for these missions
  - The **Multi-Purpose Crew Vehicle** (MPCV) program develops the vehicle that will carry the crew to orbit, provide emergency abort capability, sustain the crew while in space, and provide safe re-entry from deep space return velocities



SLS and MPCV are the cornerstones of the Exploration Enterprise, but Concurrent Beyond-LEO Capability Development is vital

Near-Term Implementation Approach: Take Small Steps For Giant Progress

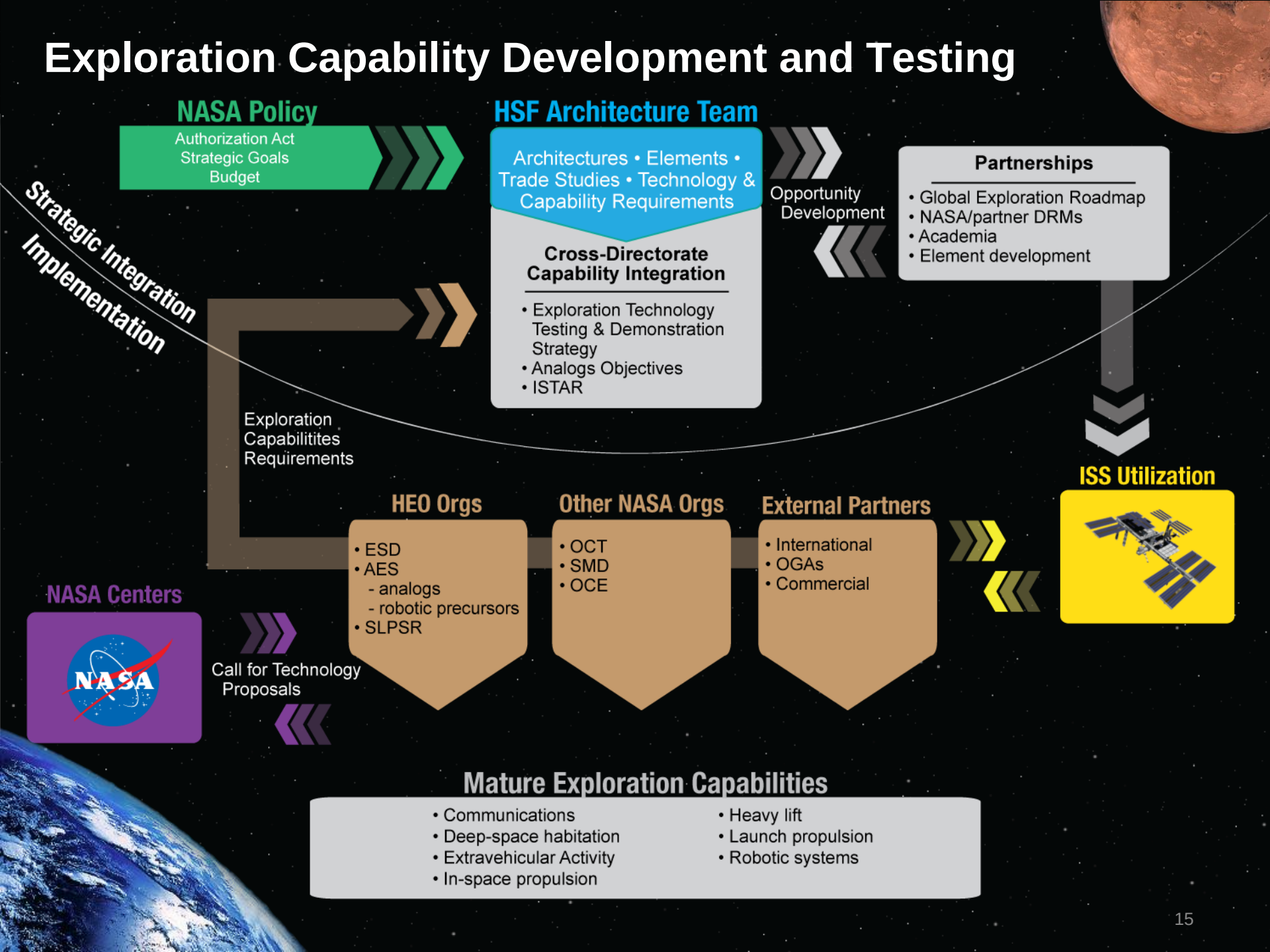
- **Strategy: Make/Show progress with small, incremental steps**
  - Set compelling/visible near-term milestones for capability development
  - Develop deep space elements so they are for SLS /Orion deployment

- **Requires innovative ways to produce 'Beyond-LEO' capabilities:**
  - Expand partnerships (international, interagency, industry, academia)
  - Acceptable cost and risk with tangible progress & stakeholder value
  - Leverage commonality and interoperability
  - Utilize existing assets (multi-use, reuse, re-purpose)
  - Integrate with other current or planned flight projects
  - Use ISS as an Exploration Development and Flight Test Center
  - Use Robotic missions to qualify systems & sustain public interest

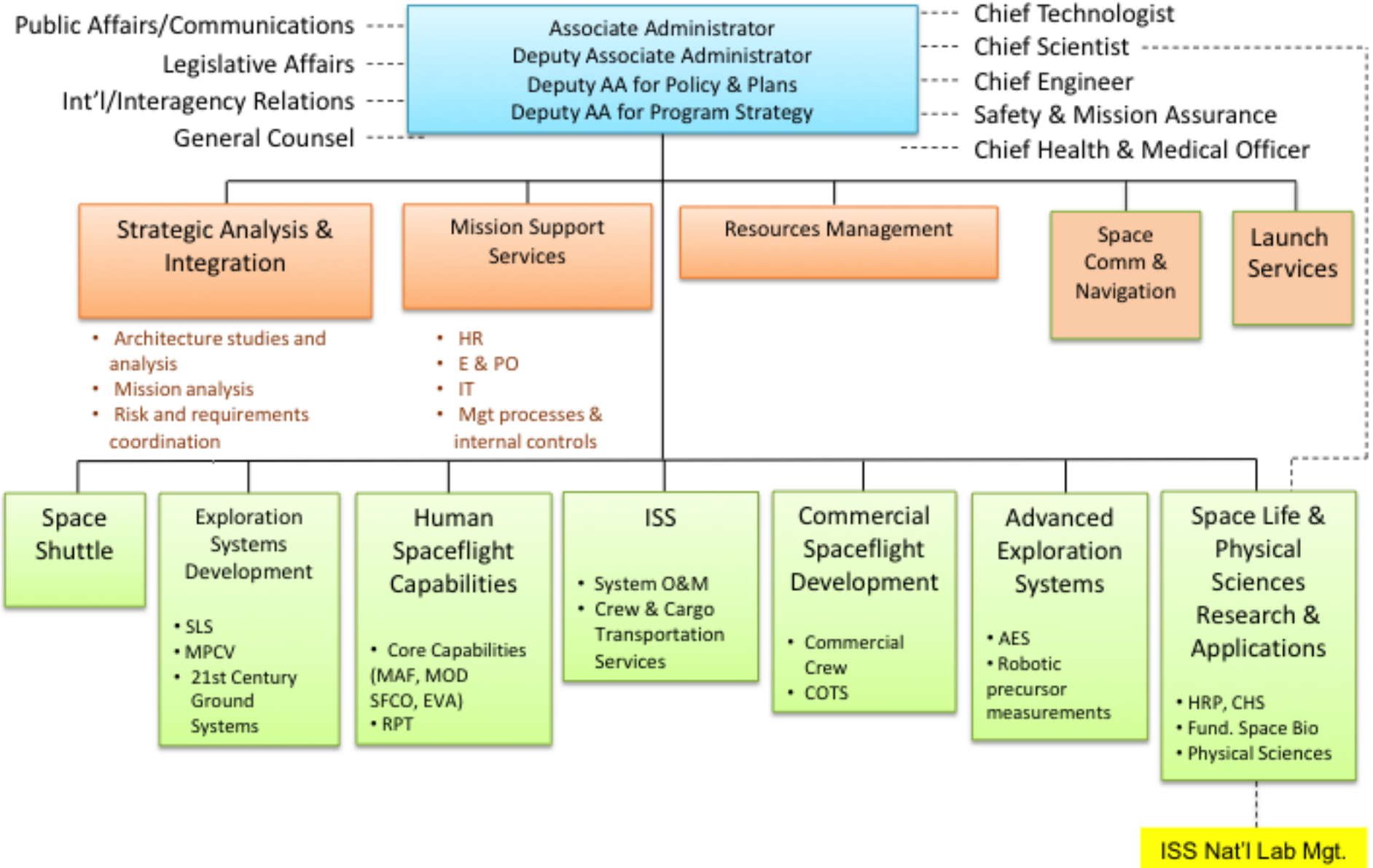
- **Maximize Flight, Ground, Analog &System Test Events**

Set a cadence of small incremental steps to steadily build, test, refine, and qualify capabilities that lead to affordable flight elements and a deep space capability

Exploration Capability Development and Testing



Organization Structure: Human Exploration and Operations



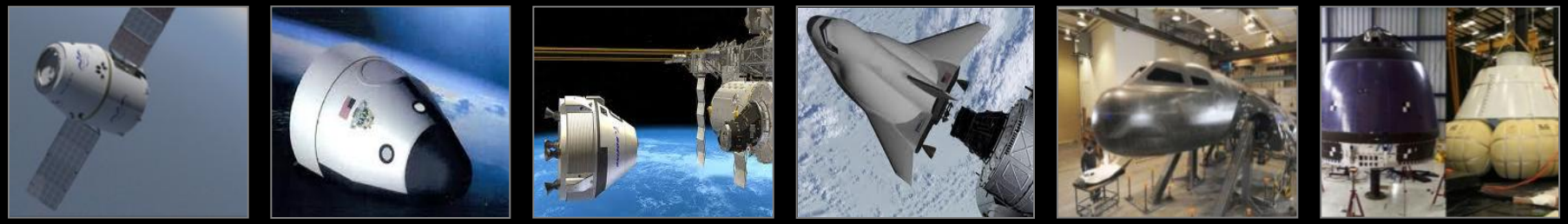
International Cooperation: Vital

Orion Multi-Purpose Crew Vehicle and Space Launch System

U.S. Commercial Space Development

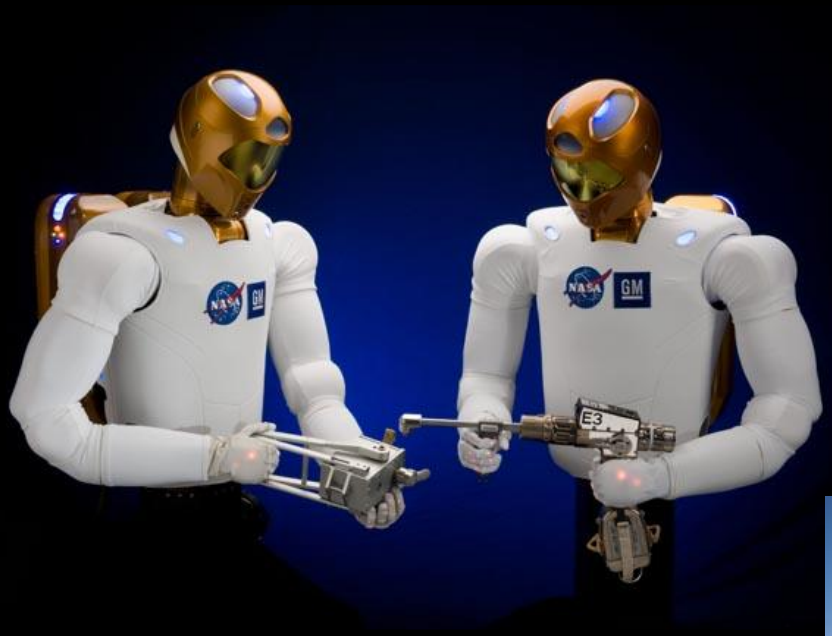
Cargo Transportation

Future Crew Transportation

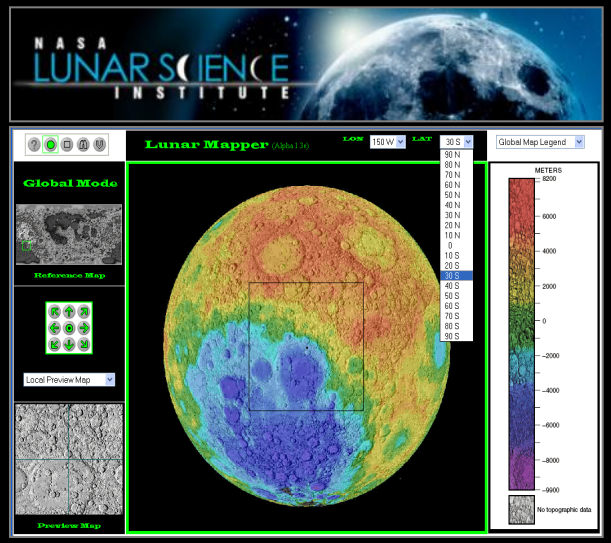


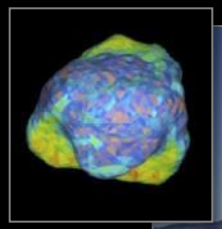
Space Communication and Navigation Networks
Interoperability Allows Flexibility and Collaboration

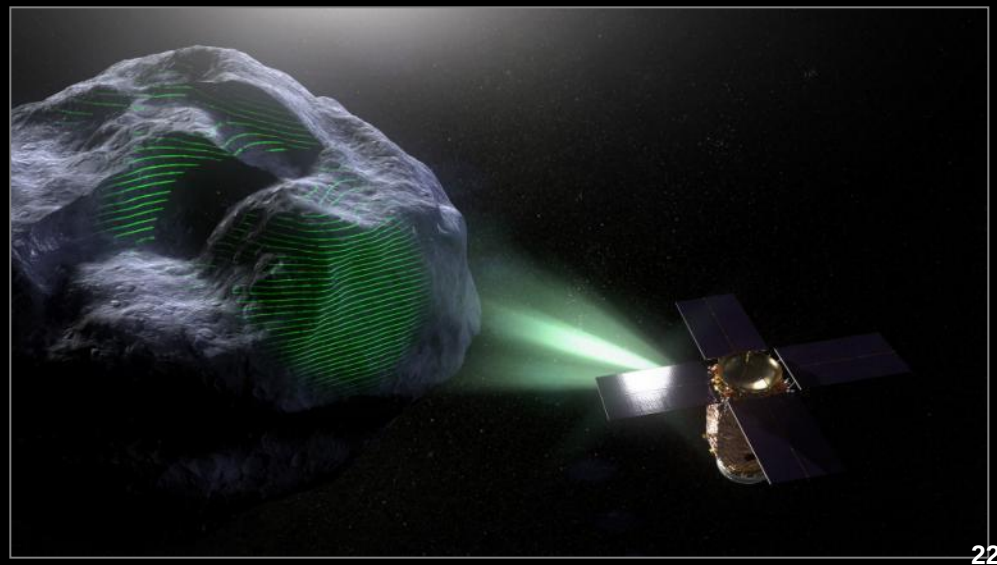
Technology Developments



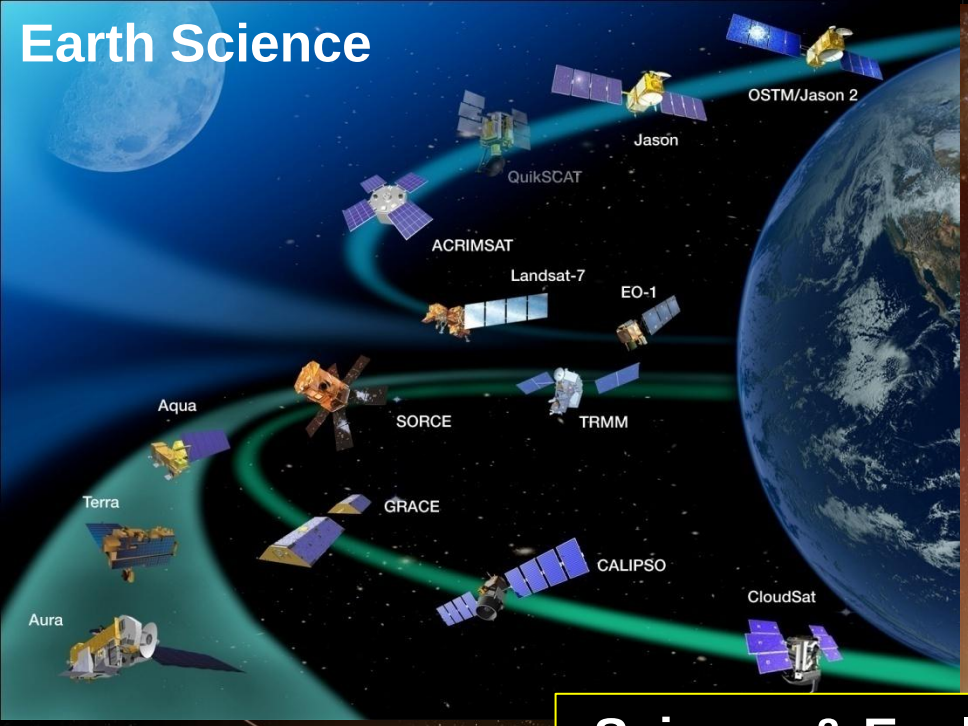
Robotic Precursor Missions Pave the Way for Future Human Exploration Missions

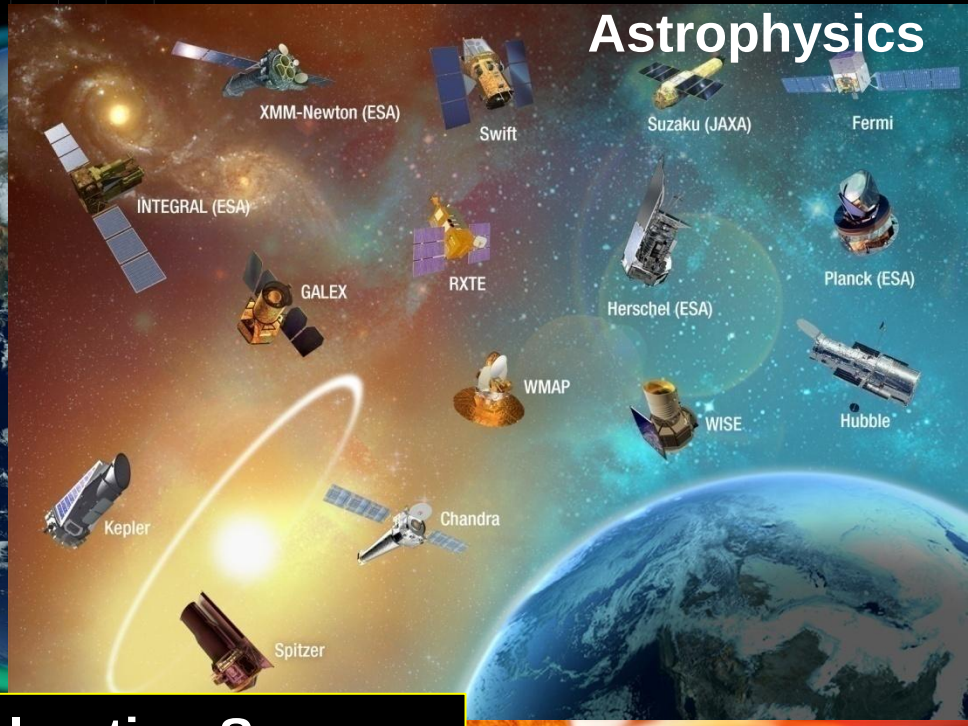


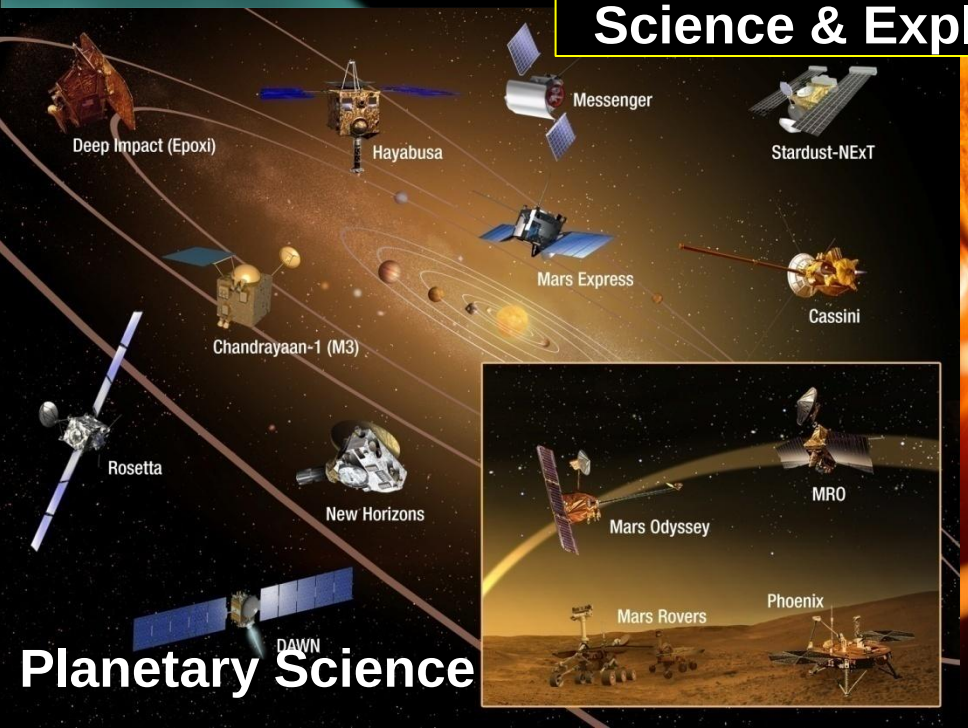


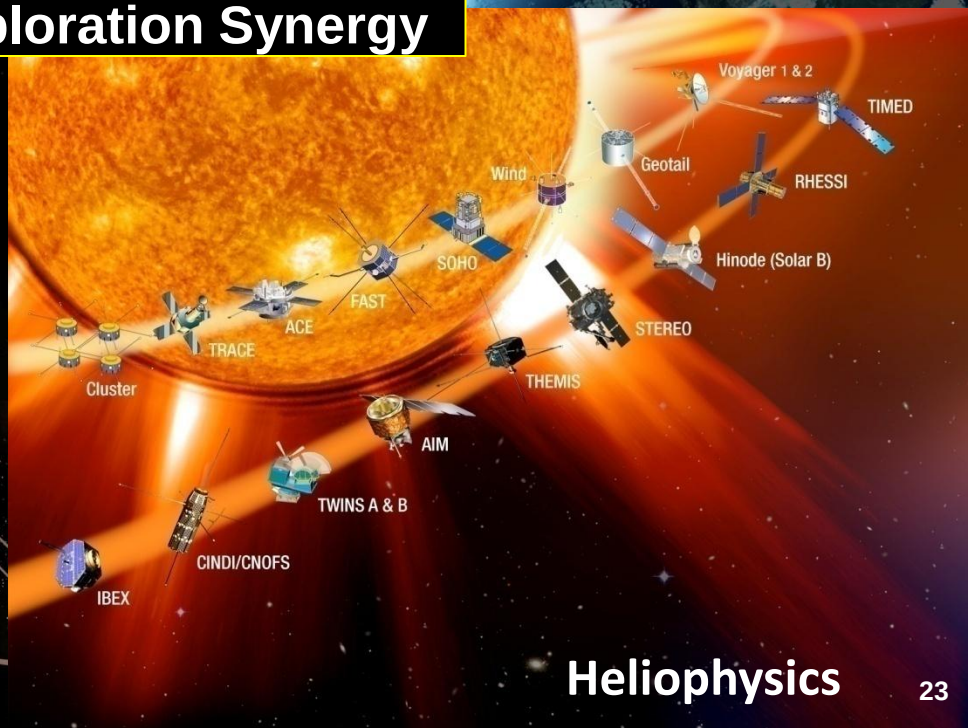


Science & Exploration Synergy









NASA Exploration Plans: Boldly Going Beyond

- **NASA's human spaceflight program is building and executing plans to <u>extend human presence throughout the solar system</u>**
- **Significant NASA Architecture Analysis and Planning On-going**
- **The FY 2012 Budget Request supports all critical aspects of a vibrant human spaceflight program, and all components of the NASA Authorization Act of 2010:**
  - **Affordability, Sustainability, and Flexibility are Key**
- **Partnerships, joint planning, and communication are essential elements**
  - **International Partnerships = Exploration**
- **Integration across the architecture and planning elements is vital to an affordable, executable, and sustainable Exploration enterprise**

Looking Towards the Future

- ISS will be the centerpiece of human spaceflight activities until at least 2020
- Research and technology breakthroughs aboard ISS will facilitate travel to destinations beyond low Earth orbit
- Destinations for human exploration remain ambitious: the Moon, asteroids and Mars
- Continue to undertake world-class science missions to observe our planet, reach destinations throughout the solar system and peer even deeper into the universe
- Advance aeronautics research to create a safer, more environmentally friendly and efficient air travel network for the Next Generation Air Transportation System
- Continue to inspire the next generation of scientists, engineers and astronauts by focusing on STEM education initiatives

Questions?