

National Aeronautics and Space Administration



NASA/FAA Human Spaceflight

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Strategic Principles for Exploration Implementation

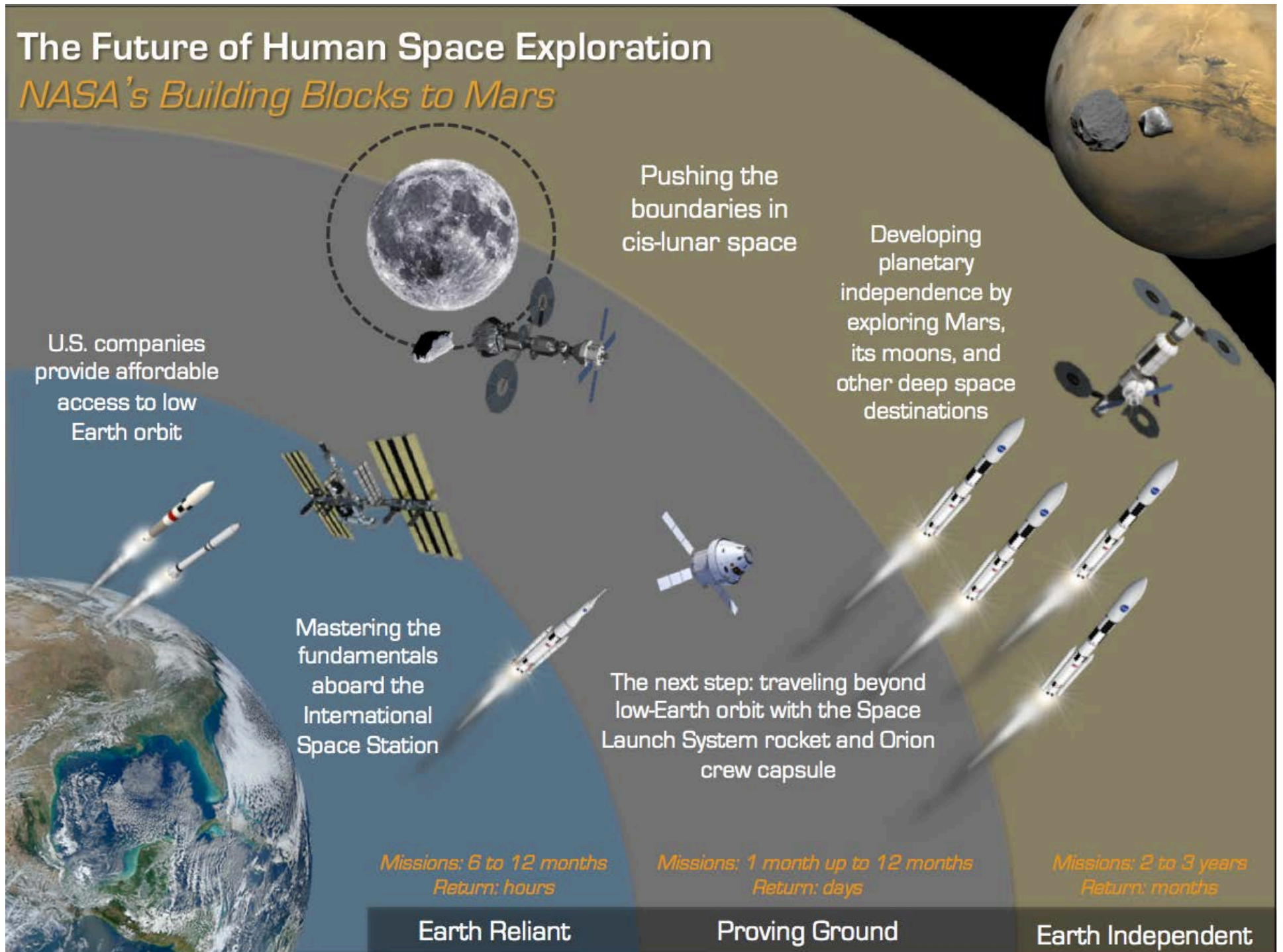


Six key strategic principles to provide a sustainable program:

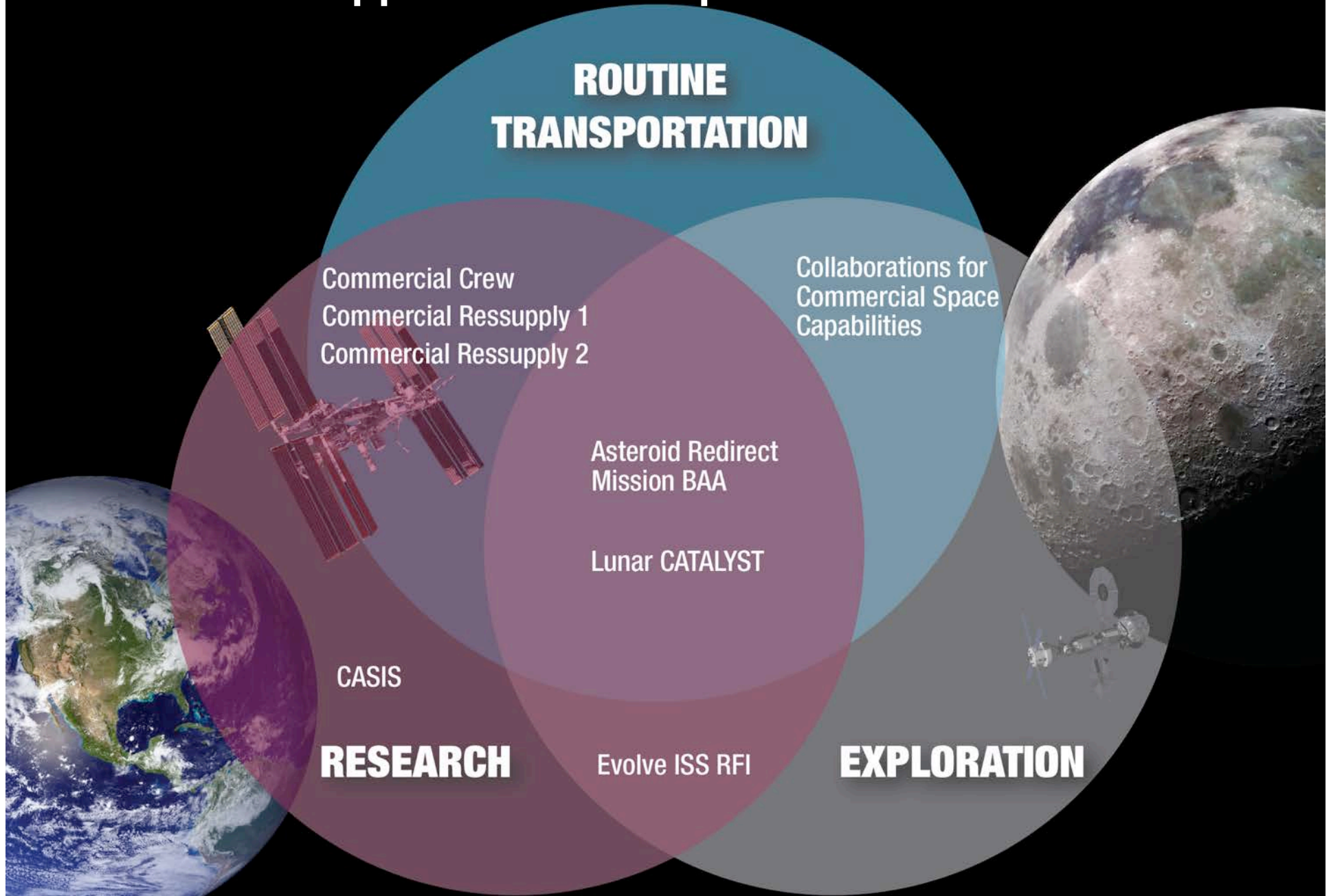
1. Implementable in the ***near-term with the buying power of current budgets*** and in the longer term with budgets commensurate with economic growth.
2. Application of ***high Technology Readiness Level*** (TRL) technologies for near term, while focusing research on technologies to address challenges of future missions
3. ***Near-term mission*** opportunities with a defined cadence of compelling missions providing for an incremental buildup of capabilities for more complex missions over time
4. Opportunities for ***US Commercial Business*** to further enhance the experience and business base learned from the ISS logistics and crew market
5. ***Multi-use, evolvable*** Space Infrastructure
6. Significant ***International and Commercial participation***, leveraging current International Space Station partnerships

The Future of Human Space Exploration

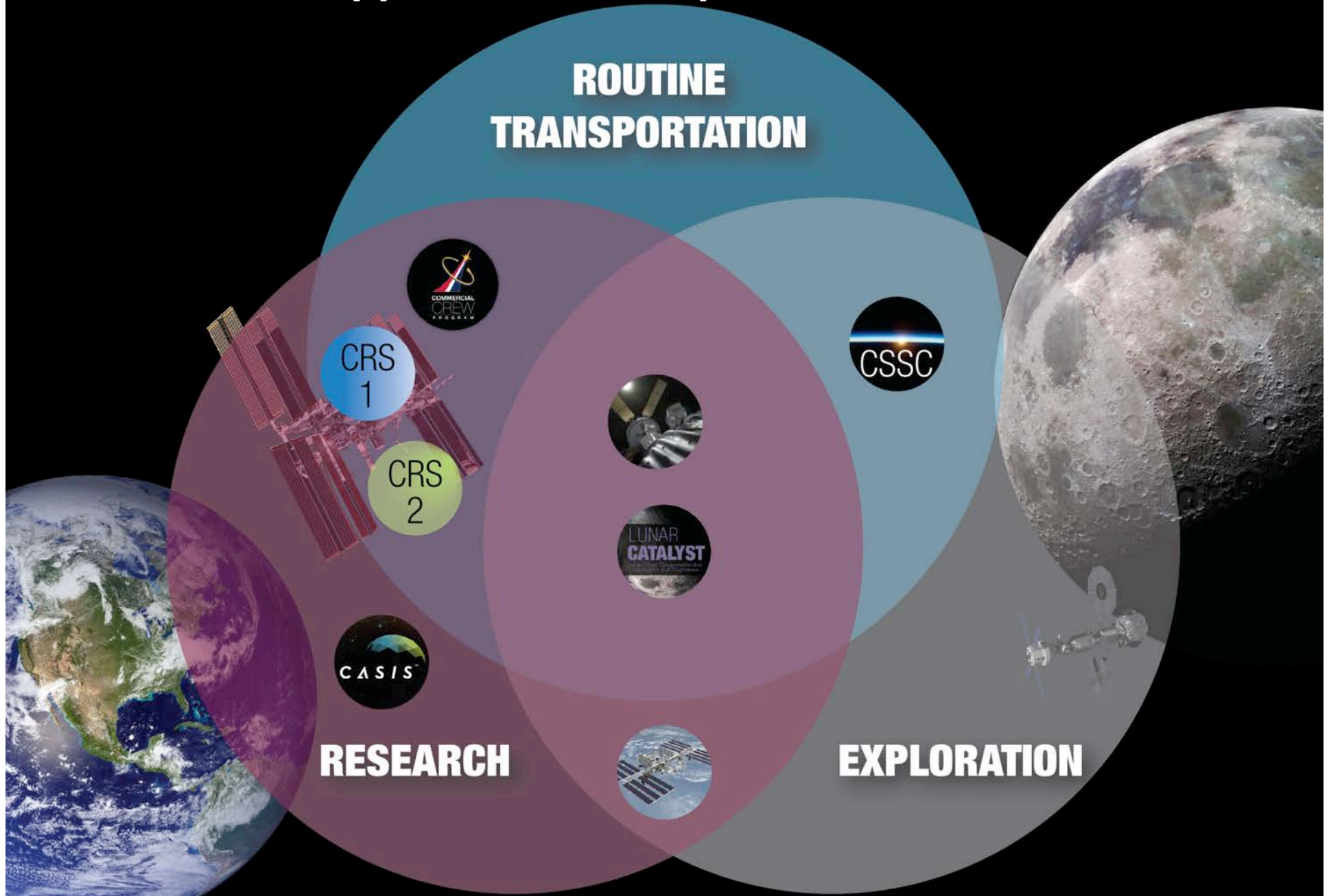
NASA's Building Blocks to Mars

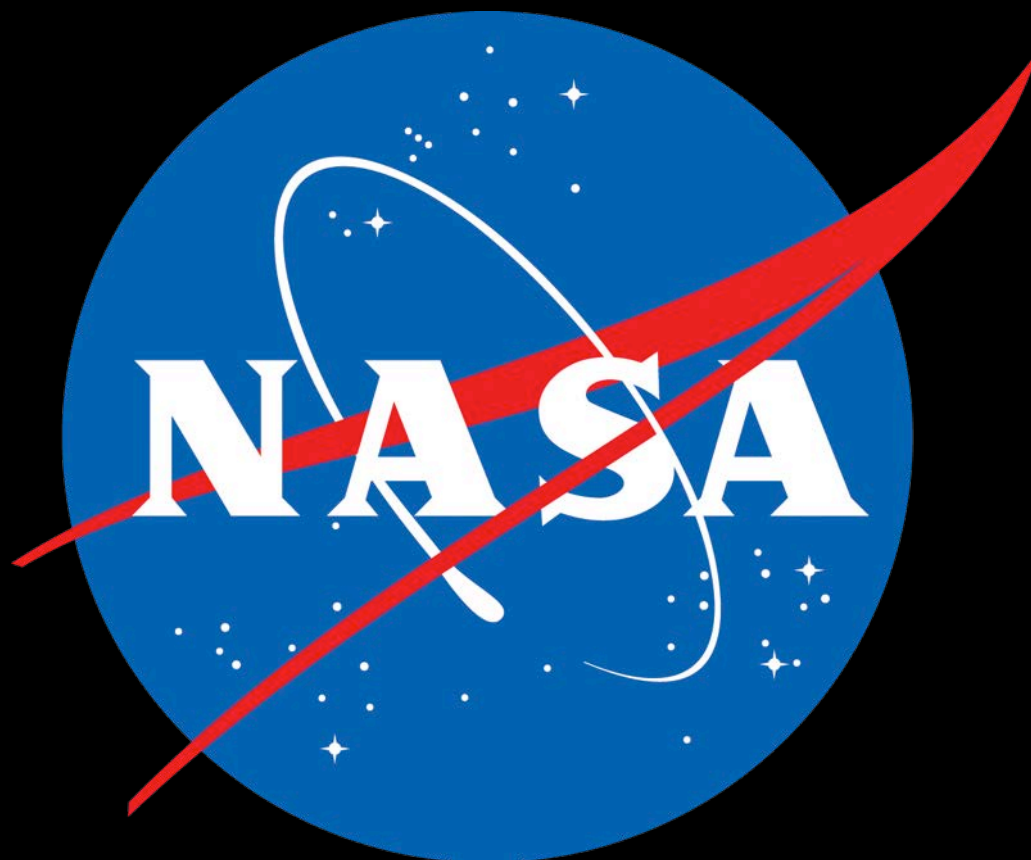


Commercial Opportunities in Space with NASA



Commercial Opportunities in Space with NASA







Advancing Exploration with Commercial Opportunities in Space

Jason Crusan

Director, Advanced Exploration Systems
NASA Human Exploration and Operations
Mission Directorate



Human Exploration and Operations

Advanced Exploration Systems



Advanced Exploration Systems (HEOMD)

- Advanced development of exploration systems to reduce risk, lower lifecycle cost, and validate operational concepts for future human missions beyond Earth orbit.
- Demonstrate prototype systems in ground test beds, field tests, underwater tests, and International Space Station flight experiments.
- Use and pioneer innovative approaches and public-private partnerships for affordable rapid systems development and provide hands-on experience for the NASA workforce.
- Maintain critical competencies at the NASA Centers and provide NASA personnel with opportunities to learn new and transform skills.
- Infuse new technologies developed by Space Technology Mission Directorate / Exploration Technology Development into exploration missions.
- Support robotic missions of opportunity to characterize potential destinations for human exploration.

Human Exploration and Operations

Advanced Exploration Systems



Rapid development and testing of prototype systems and validation of operational concepts to reduce risk and cost of future exploration missions:

- **Crew Mobility Systems**
 - Systems to enable the crew to conduct “hands-on” surface exploration and in-space operations, including crew excursion vehicles, advanced space suits, and crew egress
- **Deep Space Habitation Systems**
 - Systems to enable the crew to live and work safely in deep space, including deep space habitats, reliable life support, radiation protection, and fire safety
- **Vehicle Systems**
 - Systems for in-space propulsion stages and small robotic landers, including nuclear propulsion, modular power systems, lander technology test beds, and autonomous precision landing
- **Operations**
 - Systems to enable more efficient mission and ground operations, including integrated testing, autonomous mission ops, integrated ground ops, and logistics reduction
- **Robotic Precursor Activities**
 - Acquire strategic knowledge on potential destinations for human exploration to inform systems development, including prospecting for lunar ice, characterizing the Mars surface radiation environment, radar imaging of NEAs, instrument development, and research and analysis

Summary for FY14

- AES has established 64 milestones for FY14
- Over 60% include flight demonstration elements
- Goal to achieve at least 80%
- AES includes 559 civil servants in FY14

EVOLVABLE MARS CAMPAIGN

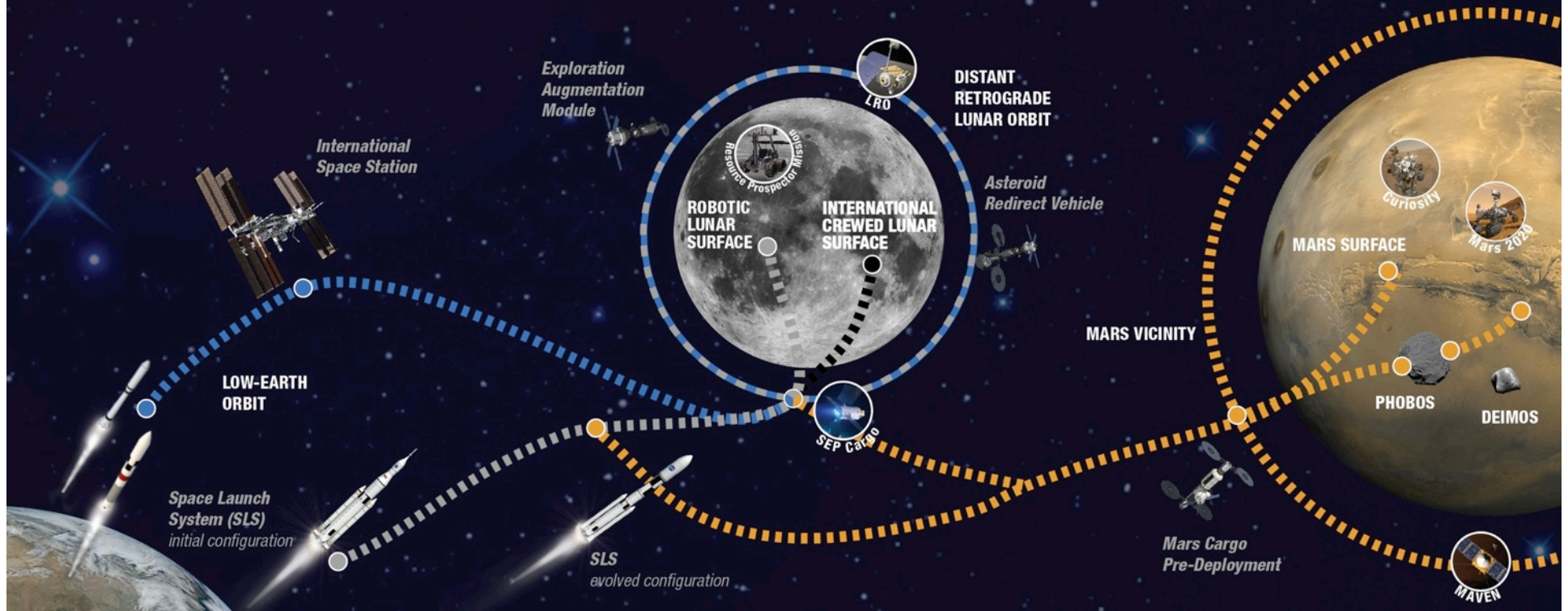
A Pathways Approach to Exploration



EARTH DEPENDENT

PROVING GROUND

EARTH INDEPENDENT



THE TRADE SPACE

Across the Board

Solar Electric Propulsion • In-Situ Resource Utilization (ISRU) • Robotic Precursors • Human/Robotic Interactions • Partnership Coordination • Exploration and Science Activities

Cis-lunar Trades

- Deep-space testing and autonomous operations
- Extensibility to Mars
- Mars system staging/refurbishment point and trajectory analyses

Mars Vicinity Trades

- Split versus monolithic habitat
- Cargo pre-deployment
- Mars Phobos/Deimos activities
- Entry descent and landing concepts
- Transportation technologies/trajectory analyses

Small Business Innovative Research



National Aeronautics and Space Administration



SBIR/STTR Program Solicitation Nov. 14, 2013 - Jan. 29, 2014



www.nasa.gov

National Aeronautics and Space Administration



SBIR Select Program Solicitation Nov. 14, 2013 - Jan. 29, 2014

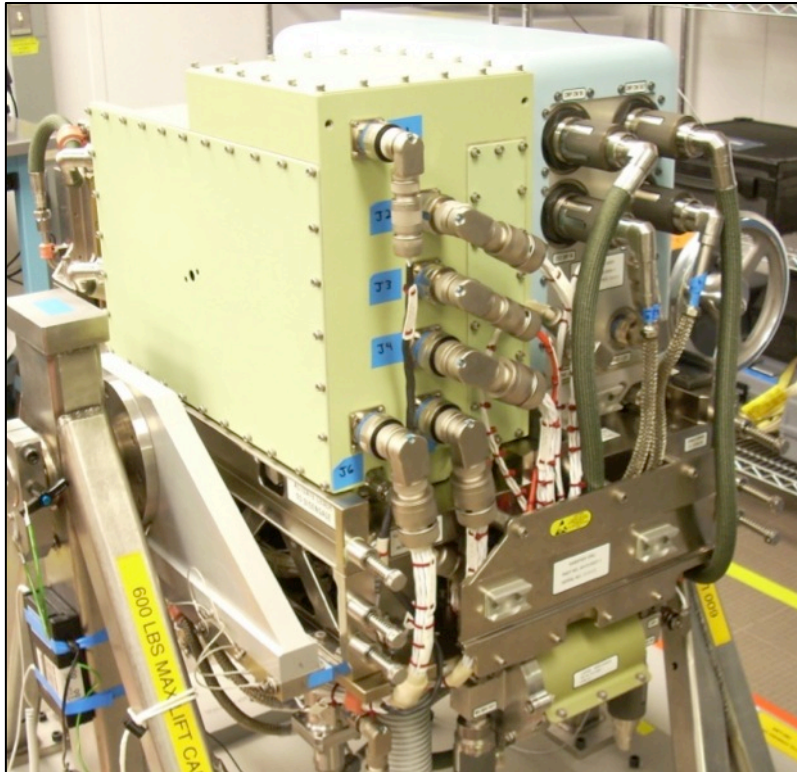


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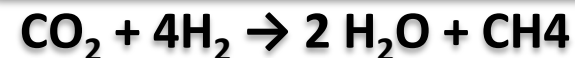
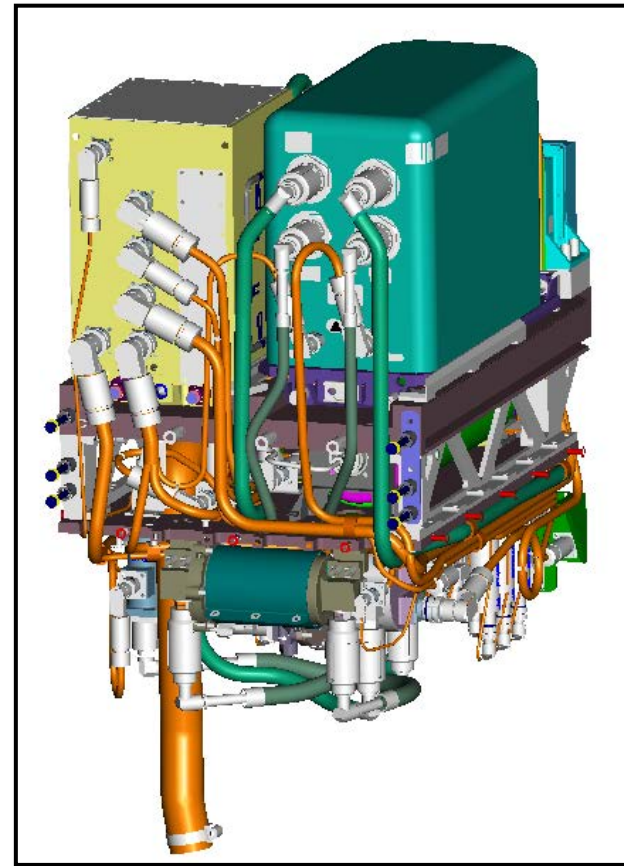
Sabatier: A New Kind of Service Contract



NASA only paid when fully operation service was online.
During operations NASA pays for **water production service on-orbit**, not for the hardware – more like a utility bill than a general contractor bill.



Sabatier Assembly Front View





Made In Space

Scheduled for a 2014 launch, the first 3D printer on the ISS will investigate the effects of consistent microgravity on melt deposition additive manufacturing and will print parts in space. Internal partnership between AES, ISS, and STMD and leverages SBIR prior award.

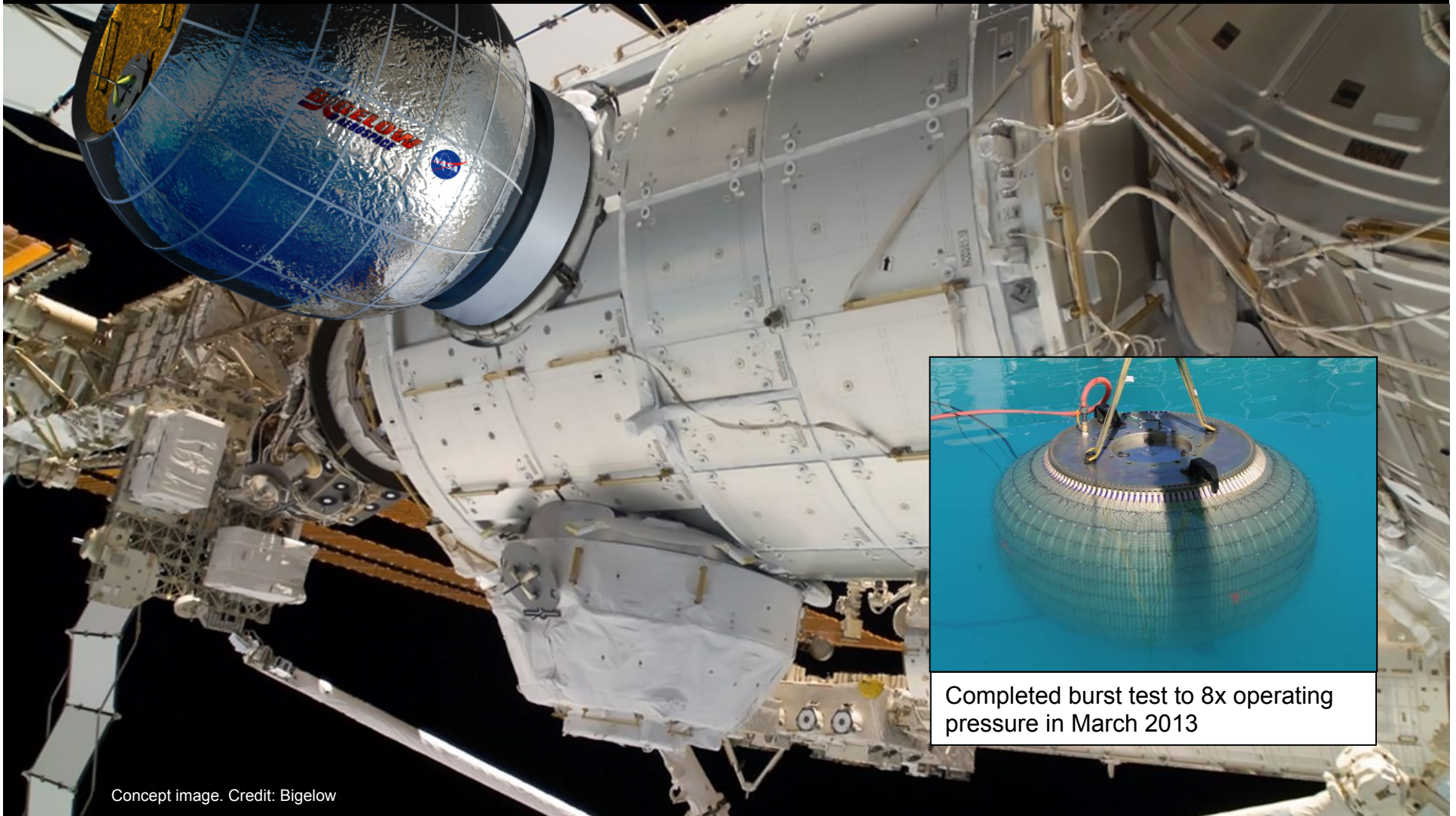


The First 3D Printer in Space

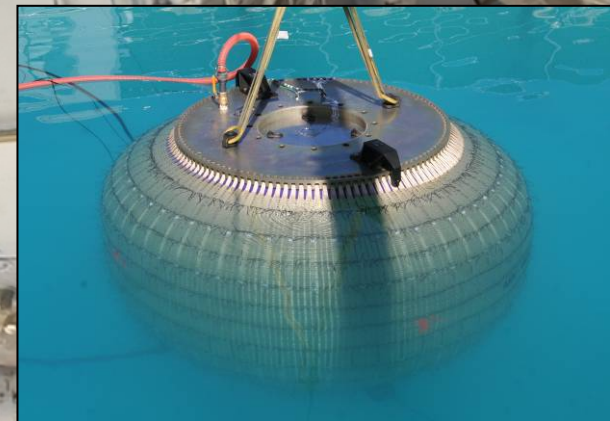
Image Credit: Made In Space

Builds 3D objects, layer-by-layer, with Acrylonitrile Butadiene Styrene (ABS) plastic (same material as Legos).

Cost Sharing Contract – Bigelow Expandable Activity Model



Concept image. Credit: Bigelow



Completed burst test to 8x operating pressure in March 2013

- BEAM was initiated in January 2013
- BEAM will be berthed to Node 3 Aft

- BEAM planned launch date is May 2015 in SpaceX8 mission
- Total Internal Inflated Volume ~565 ft³



April 30, 2014 – NASA Selects three Lunar CATALYST Partners:

Astrobotic Technology, Inc.



Astrobotic Technology's Griffin lander.
Credit: Astrobotic Technology, Inc.

Masten Space Systems, Inc



Masten's XEUS lander.
Credit: NASA/Masten Space Systems, Inc

Moon Express, Inc.



Moon Express's MX-1 Lander.
Credit: Moon Express, Inc.

Asteroid Redirect Mission Broad Agency Announcement - \$6 Million in Potential Awards



Five BAA Topics

- Asteroid Capture Systems
- Rendezvous Sensors
- Adapting Commercial Spacecraft for the Asteroid Vehicle
- Studies of Potential Future Partnership Opportunities for Secondary Payloads
- Studies of Potential Future Partnership Opportunities for the Asteroid Redirect Crewed Mission

Schedule

- March 21: BAA released
- March 26: Asteroid Initiative Opportunities Forum
- April 4: Notices of Intent Due (~100 received)
- May 5: Proposals Due
- June 6: Selections Announced
- July 1: Contracts Begin
- December 31: Contracts End

