National Aeronautics and Space Administration

Broad Agency Announcement Virtual Industry Forum

November 6, 2014

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Director, Advanced Exploration Systems
Human Exploration and Operations Mission Directorate

www.nasa.gov/nextstep

Forum Purpose

- Provide an overview of the NextSTEP Broad Agency Announcement, released on October 28, 2014, which seeks proposals for concept studies and technology development efforts for key deep space exploration technologies

- Address questions from potential respondents

Agenda

- Review Ground Rules
- Introductions
- Pioneering Space Background
- BAA Overview
- Questions
  - Verbal questions during Q&A period of the forum
  - E-mail questions to: hq-nextstep-baa@mail.nasa.gov

Forum Ground Rules

- NASA will address questions during this teleconference to clarify the content of the Announcement
- Questions that require further assessment to address will be resolved as soon as possible after the forum, and the answers will be posted to the NextSTEP website: **http://www.nasa.gov/nextstep**
- Potential respondents may also submit questions in writing to the following email address: **hq-nextstep-baa@mail.nasa.gov**
- NASA will not provide evaluations, opinions, or recommendations regarding any suggested approaches or concepts
- The Announcement and written answers posted to the NextSTEP website take precedence over all verbal discussions, including this forum

NASA Representatives

- **Jason Crusan**, Director of Advanced Exploration Systems, Human Exploration and Operations Mission Directorate (HEOMD)
- **Kenneth Bollweg,** Advanced Propulsion Systems, HEOMD/AES
- **Doug Craig**, Human Spaceflight Architecture Team (HAT), HEOMD/AES
- **Valerie Chabot**, HEOMD (Teleconference Moderator)

HUMAN EXPLORATION

NASA's Path to Mars

EARTH RELIANT

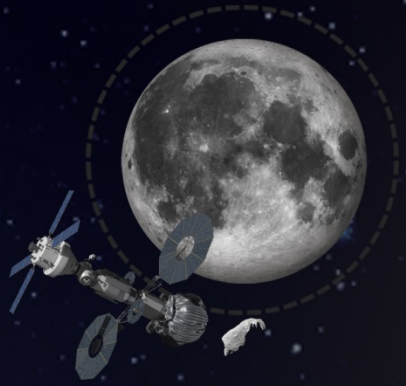
MISSION: 6 TO 12 MONTHS
RETURN TO EARTH: HOURS

Learning fundamentals aboard the International Space Station

U.S. companies provide access to low-Earth orbit

PROVING GROUND

MISSION: 1 TO 12 MONTHS
RETURN TO EARTH: DAYS

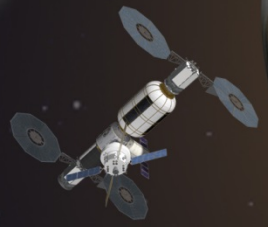


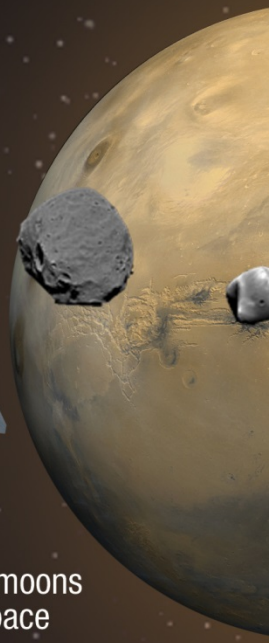
Expanding capabilities by visiting an asteroid in a lunar distant retrograde orbit

Traveling beyond low-Earth orbit with the Space Launch System rocket and Orion spacecraft

EARTH INDEPENDENT

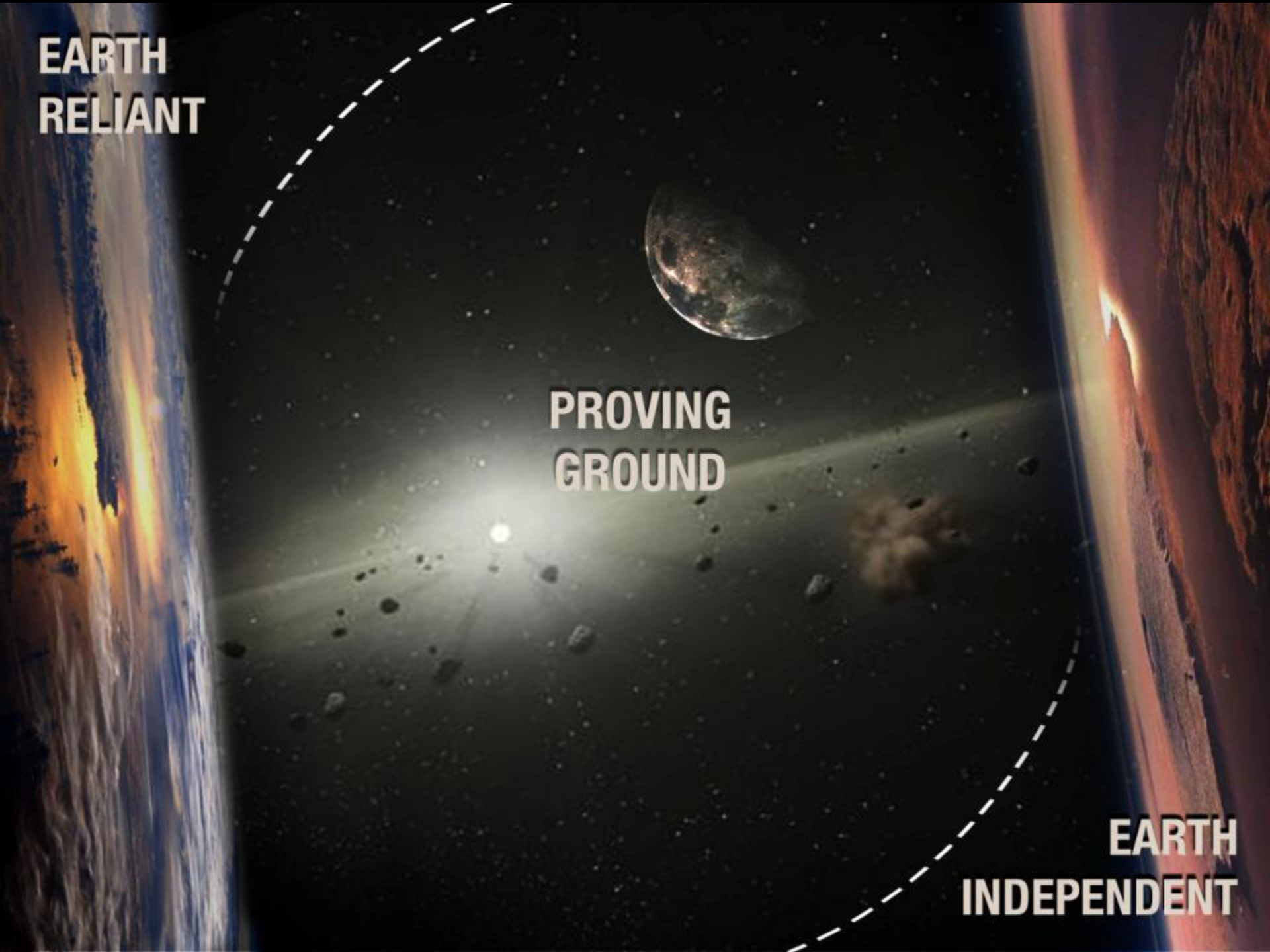
MISSION: 2 TO 3 YEARS
RETURN TO EARTH: MONTHS





Exploring Mars, its moons and other deep space destinations

6

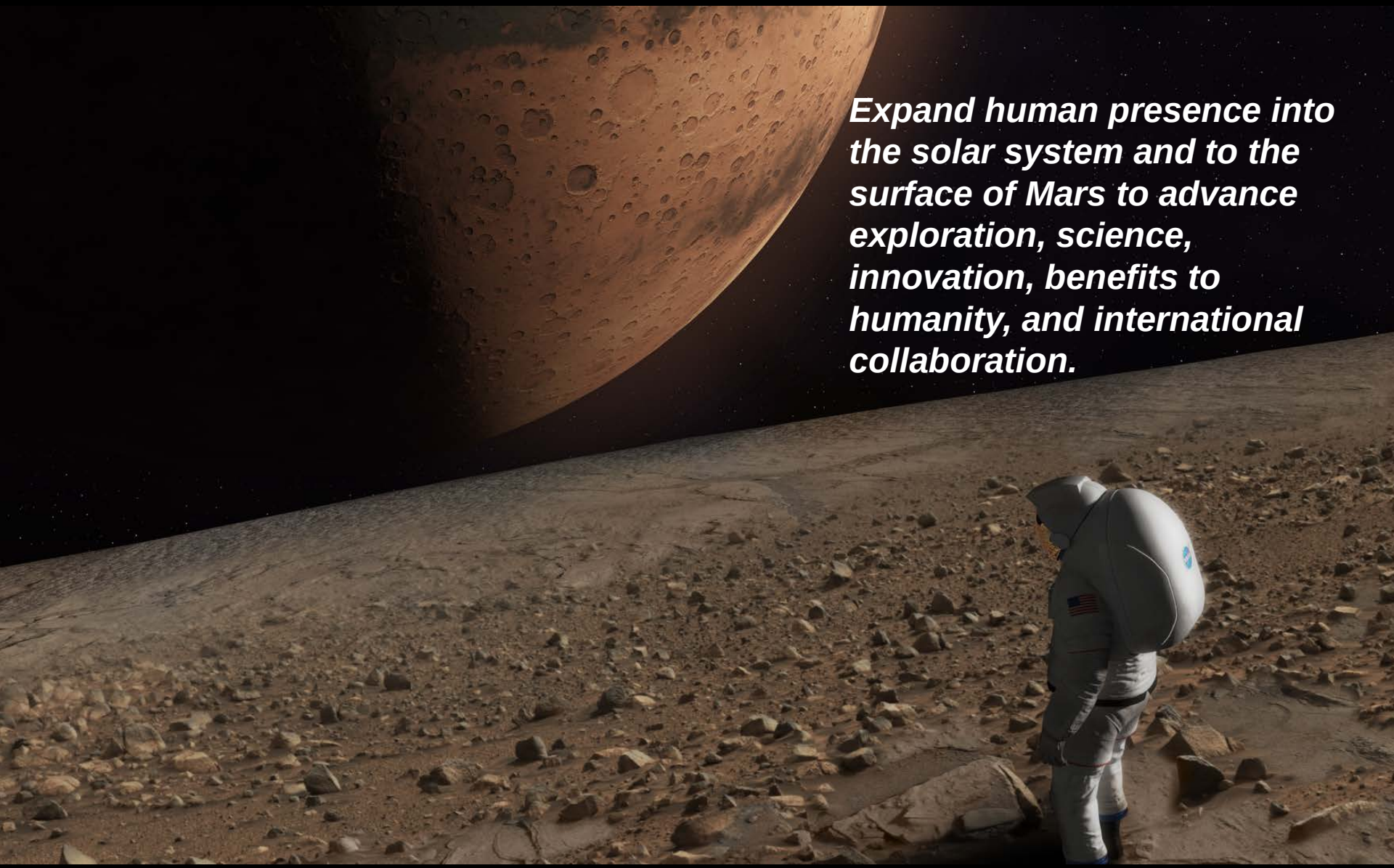

EARTH
RELIANT
PROVING
GROUND
EARTH
INDEPENDENT

Pioneering Space - Goals

"Fifty years after the creation of NASA, our goal is no longer just a destination to reach. Our goal is the capacity for people to work and learn and operate and live safely beyond the Earth for extended periods of time, ultimately in ways that are more sustainable and even indefinite. And in fulfilling this task, we will not only extend humanity's reach in space -- we will strengthen America's leadership here on Earth."

- President Obama, April 2010

NASA Strategic Plan Objective 1.1



Expand human presence into the solar system and to the surface of Mars to advance exploration, science, innovation, benefits to humanity, and international collaboration.

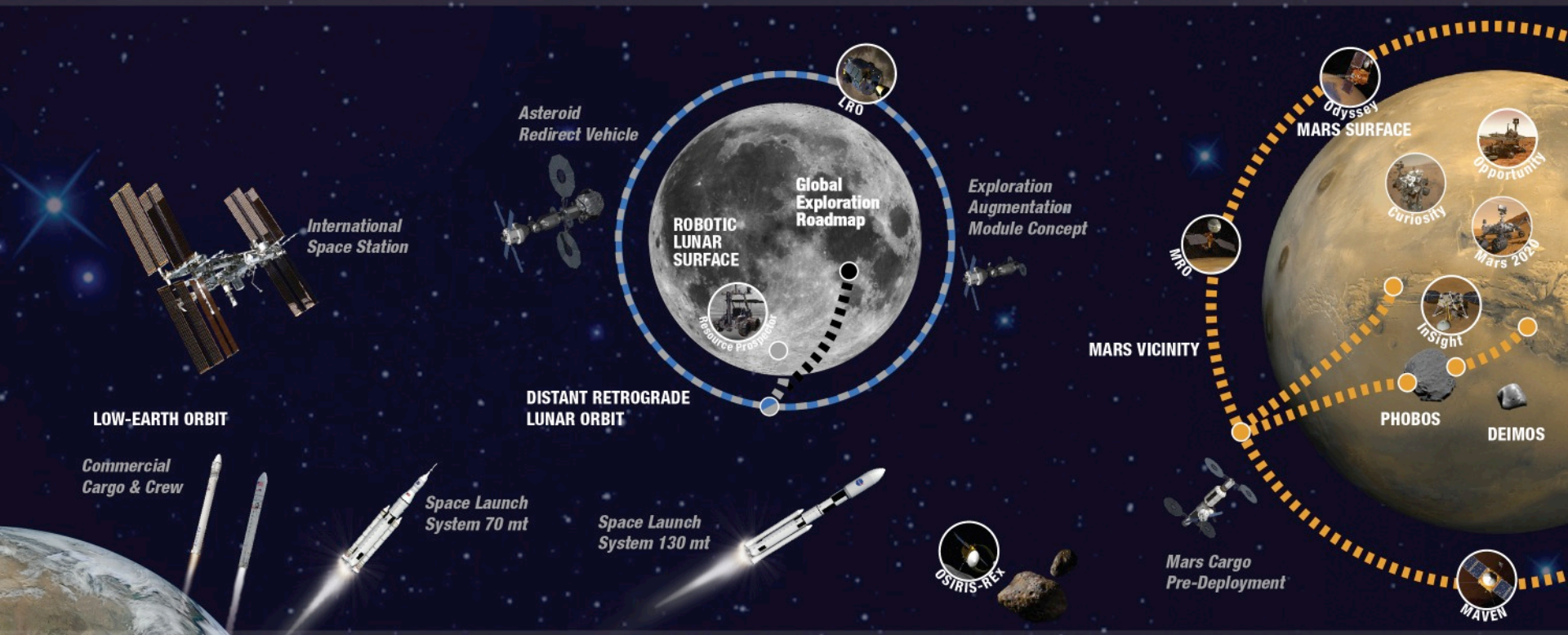
Strategic Principles for Sustainable Exploration

- Implementable in the ***near-term with the buying power of current budgets*** and in the longer term with budgets commensurate with economic growth*;*
- ***Exploration enables science*** **and science enables exploration***;*
- Application of ***high Technology Readiness Level*** (TRL) technologies for near term missions, while focusing sustained investments on ***technologies and capabilities*** to address challenges of future missions;
- ***Near-term mission opportunities*** with a defined cadence of compelling and integrated human and robotic missions providing for an incremental buildup of capabilities for more complex missions over time;
- Opportunities for ***U.S. commercial business*** to further enhance the experience and business base;
- ***Multi-use, evolvable*** space infrastructure, minimizing unique major developments;
- Substantial ***international and commercial participation***, leveraging current International Space Station and other partnerships.

EVOLVABLE MARS CAMPAIGN

A Pioneering Approach to Exploration

EARTH RELIANT — 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

EARTH RELIANT

NEAR-TERM OBJECTIVES

DEVELOP AND VALIDATE EXPLORATION CAPABILITIES IN AN IN-SPACE ENVIRONMENT

- Long duration, deep space habitation systems
- Next generation space suit
- Autonomous operations
- Communications with increased delay
- Human and robotic mission operations
- Operations with reduced logistics capability
- Integrated exploration hardware testing

LONG-DURATION HUMAN HEALTH EVALUATION

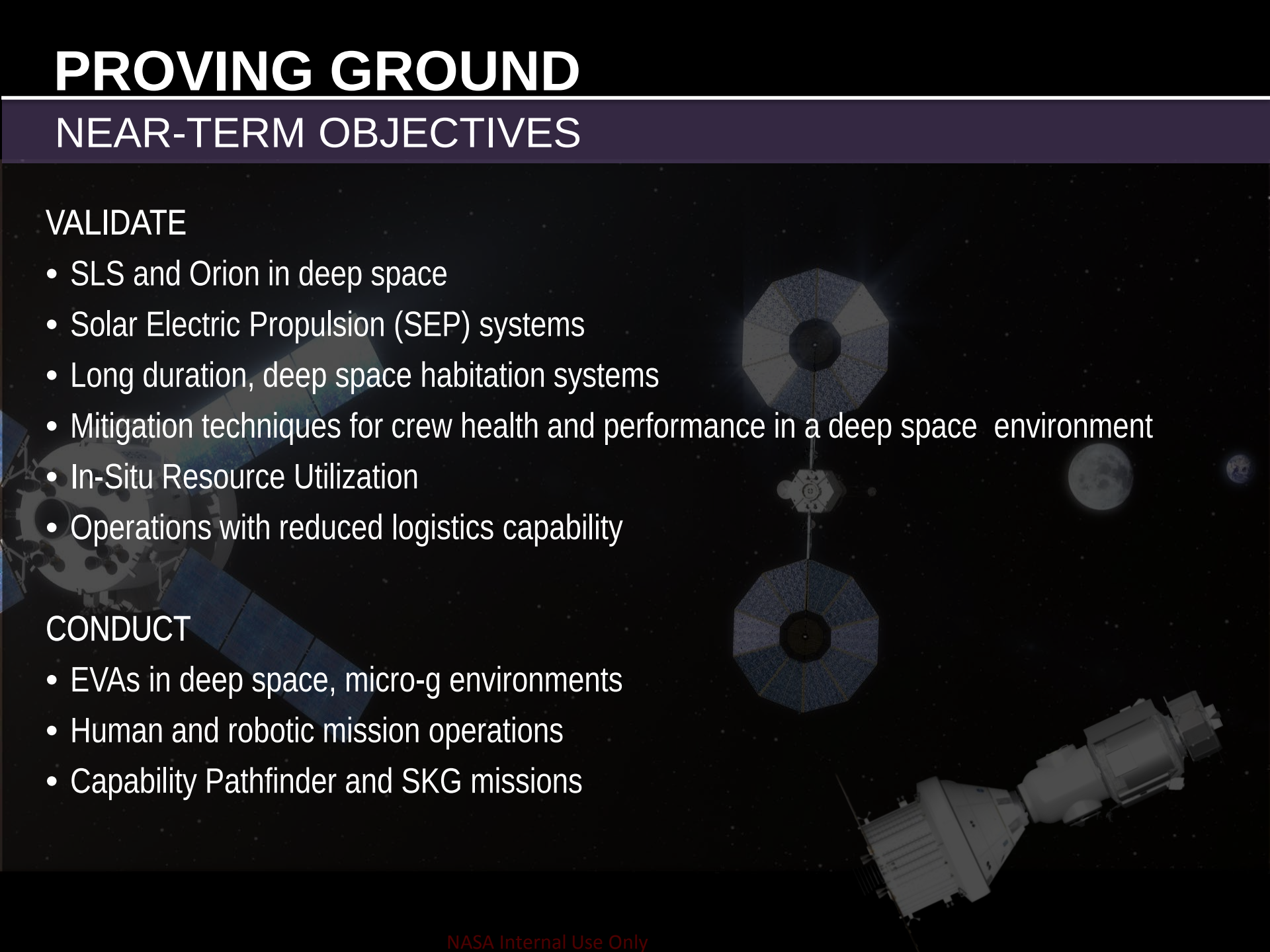
- Evaluate mitigation techniques for crew health and performance in micro-g space environment
- Acclimation from zero-g to low-g

COMMERCIAL CREW TRANSPORTATION

- Acquire routine U.S. crew transportation to LEO

PROVING GROUND

NEAR-TERM OBJECTIVES



VALIDATE

- SLS and Orion in deep space
- Solar Electric Propulsion (SEP) systems
- Long duration, deep space habitation systems
- Mitigation techniques for crew health and performance in a deep space environment
- In-Situ Resource Utilization
- Operations with reduced logistics capability

CONDUCT

- EVAs in deep space, micro-g environments
- Human and robotic mission operations
- Capability Pathfinder and SKG missions

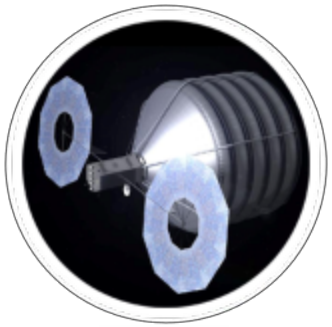
Proving Ground

Exploration Transportation Systems BEO

- SLS provides heavy lift transportation of crew and cargo to deep space
- Orion provides early crew transportation and life support along with navigation and operations for deep space crew missions

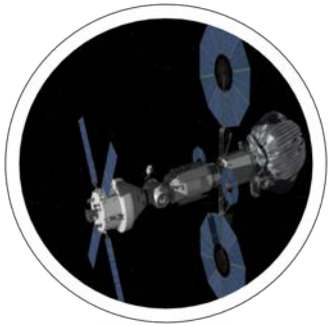
Capability Pathfinders / SKG Missions

- Resource Prospector
- Mars 2020 payload
- Potential Phobos precursor mission
- EDL /Lander / ISRU / Surface Power
- Pathfinder of deep space chemical stage



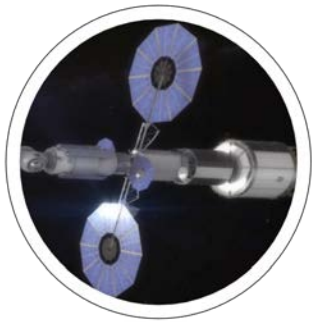
Asteroid Redirect Mission

- Advanced solar electric propulsion (SEP) demonstration
- Maneuvering large objects in interplanetary trajectories w/SEP
- Integrated robotic/Orion vehicle stack operations in deep space orbits
- Deep space navigation and common rendezvous
- International docking system
- Deep space advanced EVA capability
- Sample handling and return
- Operations at low gravity bodies



Exploration Augmentation Module

- Deep space system and operational testing including long duration robotic tended spacecraft
- Deep space testing on radiation mitigation and general strategic knowledge gap closure for long duration human missions
- Deep space testing of advanced EVA and other systems and operations
- Tele-operations in space and on lunar surface
- Sample handling and return



Mars Habitat Prototype

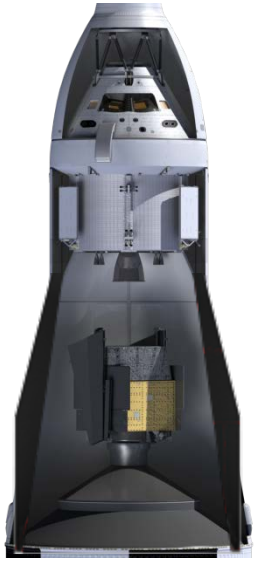
- Spacecraft life testing in deep space
- 500-900 day Deep Space Habitat including long duration dormancy time periods
- Advanced maintenance & logistics packaging

Notional Proving Ground Vehicle Capability

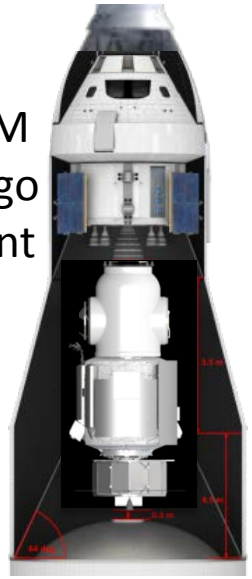
Concept trade for co-Manifest large payloads with Orion on early Exploration Missions

- Co-manifesting large payloads enables significant opportunities
- Proving ground vehicle is SLS with Exploration Upper Stage (EUS) – Block 1B
  - Volume between EUS and Orion for large payloads
  - Approximately 10mt capability, subject to analysis
  - Flight rate is one/year beginning with EM-2
- Supports development of Mars capabilities and enhances value of Proving Ground missions

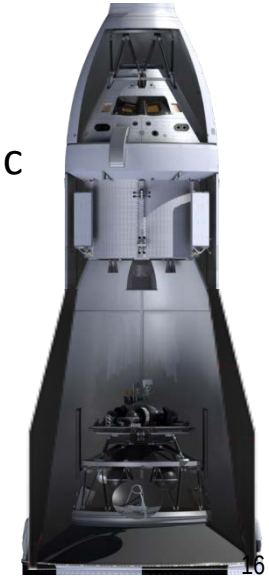
Orion w/ARV or Science Payload



Orion w/ EAM or Cargo Element



Orion w/Robotic Landers



NextSTEP BAA Overview

- Enter into **Fixed Price Contracts** with technical/payment milestones with private-sector partners
  - The number of contracts varies subject to funds availability based on appropriation levels and upon the allocation available within each thrust area
  - Emphasis for eligibility and execution placed on contribution of private corporate resources to the private-public partnership to achieve goals and objectives
- Facilitate development of deep space human exploration capabilities in the cislunar proving ground and beyond
- Select partners with the technical capability to mature key technologies and, demonstrate commitment toward potential commercial application
- Three critical areas for technology maturation:
  - Advanced Propulsion Systems
  - Habitation Systems
  - Small Satellite Missions (EM-1 secondary payloads)

Advanced Propulsion Systems

- Objectives: Advance the TRL of high power Electric Propulsion systems
  - 50 kW to 300 kW per thruster range
  - Test at a minimum system input power of 100 kW for 100 hours
  - Operate over broad power and specific impulse range
  - Scalable to MW
  - Extended lifetime and operational (thrusting) time
  - Manageable specific mass of total propulsion system

- Anticipated Deliverables:
  - Periodic technical interchange and status meetings
  - EP Engine system design and test data demonstrating TRL 5

- General Information:
  - Anticipate nominal 36 month effort. Potential follow-on efforts for further technology maturation
  - Awards may vary from $500K - $4M per year

Habitat Systems (1 of 2)

- Objectives: Develop concepts, investigate technologies, and develop concepts of operations
  - Define the architecture and/or subsystems of the Exploration Augmentation Module OR
  - Other capabilities enabling extended habitation in deep space in a modular way that gradually builds capabilities for deep space transit
  - May address concepts and technologies in:
    - Transportation: ISS docking flexibility, lunar DRO operation, sub-systems management, remote or crewed, ARV compatibility, potential use for Mars transit
    - Habitation: habitable volume for crew/logistics, Orion compatibility and mission extension, Enhancements/testing of ECLSS and associated sub-systems
    - Operations & Environment: extended lifetime, airlock capabilities, independent operations, support EVA, support vehicle docking

Habitat Systems (2 of 2)

- Anticipated Deliverables:
  - Periodic technical interchange and status meetings
  - Final Concept study, Concept of Operation, or Technology investigation report
  - SOW, schedule, cost estimate for optional further development

- General Information:
  - Anticipate nominal initial phases to be 12 month effort. Potential phased follow-on efforts for technology/capability development
  - Awards may vary from $500K - $1M per phase, with 6-12 month phases

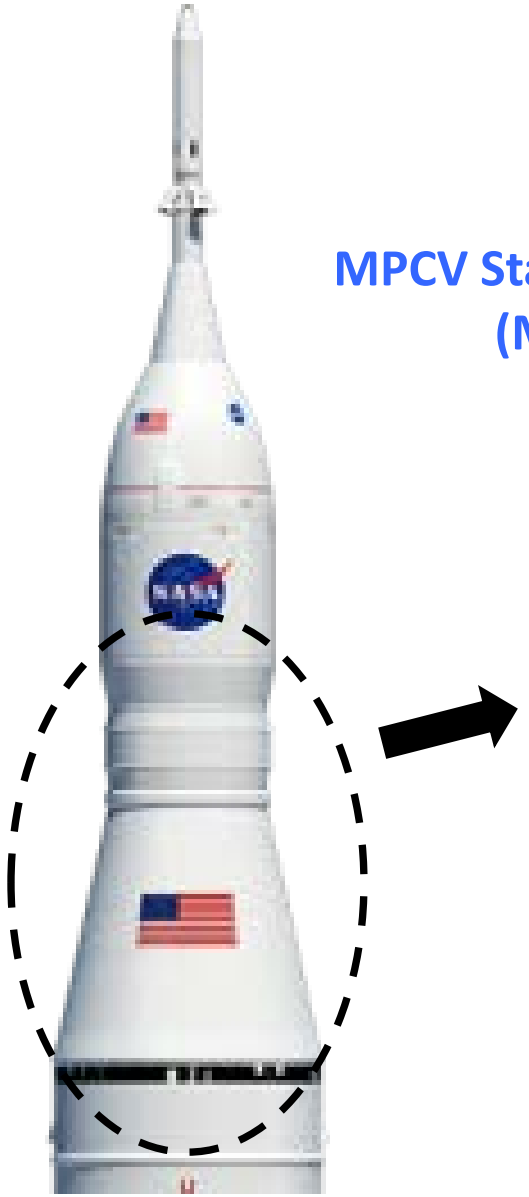
Small Satellites

- Objectives: Develop CubeSat missions to fly as secondary payloads on EM-1
  - Must address Strategic Knowledge gaps in some way
  - May have commercial application

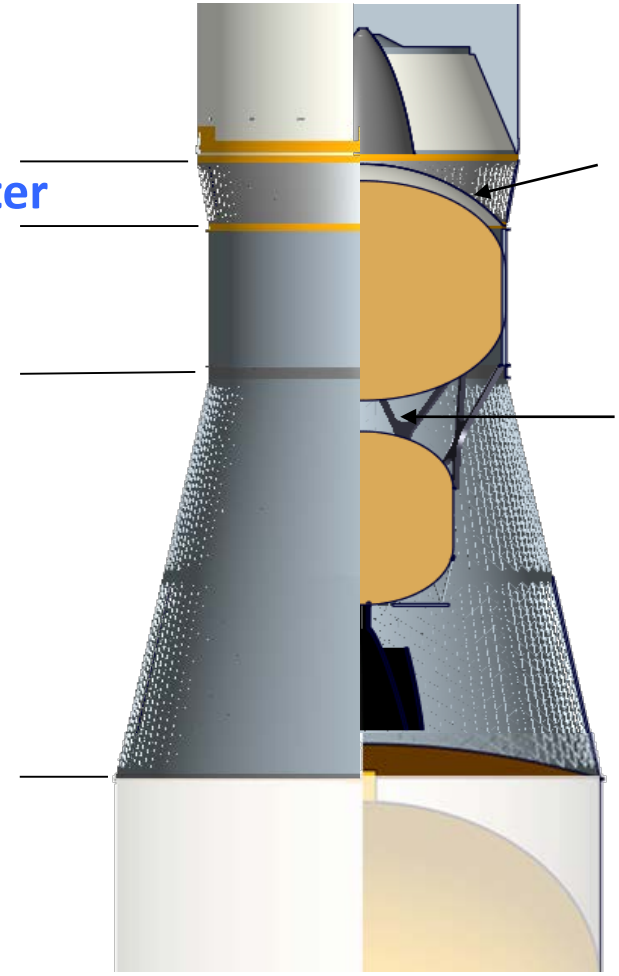
- Anticipated Deliverables:
  - Periodic technical interchange and status meetings
  - CubeSats to fly as secondary payloads on EM-1

- General Information:
  - Level of corporate contribution included in Proposal Evaluation Criteria
  - Nominal schedule tied to EM-1 mission: current notional schedule:
    - Phase III safety review; L-24M
    - CubeSat Delivery to KSC; L-4M
  - CubeSats subject to EM-1 requirements
  - Additional information available at: www.nasa.gov/nextstep

SLS Configuration



MPCV Stage Adapter (MSA)



MSA Diaphragm

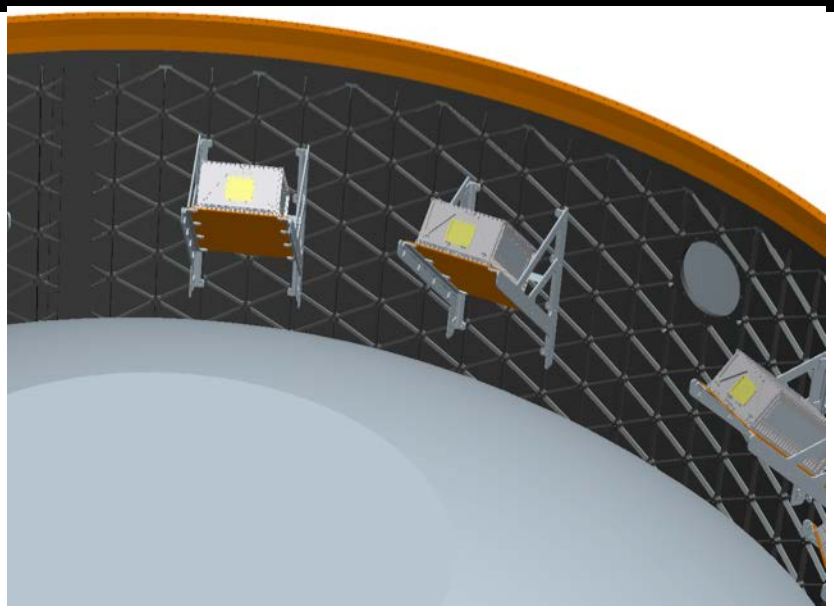
SLS Secondary Payload Accommodations

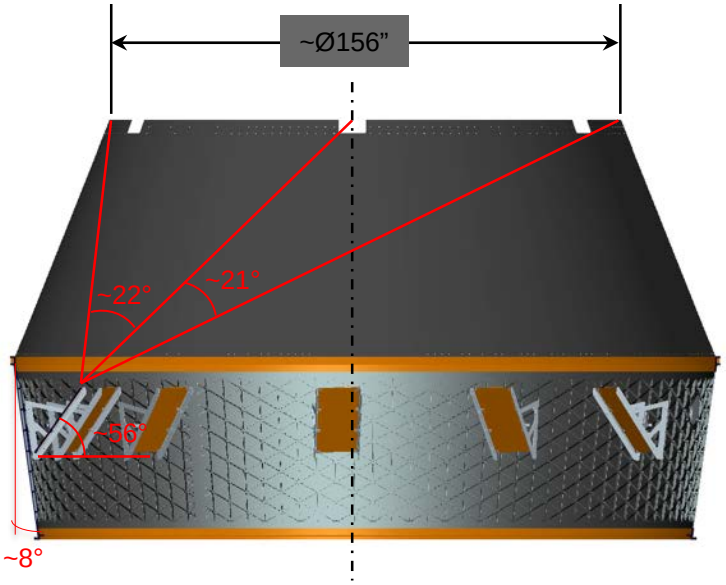
Eleven 6U/12U payload locations
6U volume/mass is the current standard (14 kg payload mass)

Payloads will be “powered off” from turnover through Orion separation and payload deployment

Payload Deployment System Sequencer; payload deployment will begin with pre-loaded sequence following MPCV separation and ICPS disposal burn

Payload requirements captured in Interface Definition and Requirements Document





General Information

- **Key Dates**
  - Nov 10 Notice of Intent. Not mandatory but highly encouraged
  - Dec 12 Proposals due

- NASA's intent is to announce selected proposals by Feb 2015 and begin contract negotiations based upon availability of funding. NASA intends to award contracts by Mar 2015.

- A "blackout" period of communication is in effect until the contracts are awarded. All questions shall be directed to the e-mail box: hq-nextstep-baa@mail.nasa.gov
- Proposals submitted electronically to: hq-nextstep-baa@mail.nasa.gov

Eligible Participants

- **U.S. private-sector** entities including companies, universities, and non-profit organizations are eligible to submit proposals. Foreign institutions may submit proposals and will be subject to the NASA guidelines for foreign participation
- U.S. federal, state, and local government entities, including National Laboratories, Jet Propulsion Laboratory (JPL) employees, NASA Civil Servants and Federally Funded Research and Development Centers are not eligible to participate in proposals
- **Proposers must show a minimum of 50% corporate contribution or matching** to the overall effort
  - Corporate contribution may be in the form of direct labor, travel, consumables or other in-kind contributions
  - Other forms of corporate contribution such as investment in special facilities or equipment, tooling or other prior **private** investment, including Independent Research and Development (IRAD) are deemed acceptable for this effort.

Proposal Content (1 of 2)

- **Cover Page, Title Page**
- **Section I: Executive Summary**
- **Section II: Proof of Eligibility**
  - Private sector status
  - Corporate contribution
- **Section III: System Concept**
  - Concept description and how it functions
  - How concept addresses objectives/requirements
  - Anticipated improvements in Technology Readiness Level (TRL)
- **Section IV: Technical Approach**
  - Approach and schedule for designing, analyzing, and testing
  - Plans to mature key technologies, critical risks/mitigation plans
- **Section V: Capabilities**
  - Evidence of existing capabilities for designing and developing space-qualified systems applicable to the BAA objectives

Proposal Content (2 of 2)

- **Section VI: Intellectual Property**
  - Approach for data rights and inventions
  - Describe how approaches meet the objectives outlined under Section 2.3, Intellectual Property
- **Section VII: Price Proposal**
  - Overall Firm fixed price
  - Content and format contained in Appendix D of BAA
  - Relationship of corporate resources to the price
- **Attachments:**
  - Quad chart showing an overview of the proposal (template enclosed)
  - Resumes
  - Draft Statement of Work
  - Proposed Technical and Payment Milestones
  - Corporate Resources Documentation

*Project Title**

Objectives & Technical Approach:

- Major project objectives
- Description of technical approach

Image:

- Image depicting the concept to be developed.

Team:

- Key team members, organization, and role

Schedule

- List of major milestones for project lifecycle

Cost

- Total cost to NASA
- Total cost sharing from commercial partner

Proposal Evaluation and Selection Process

- **NASA reserves the right to select for negotiations all, some, or none of the proposals it receives in response to this BAA**
- **Compliance Check**
  - Proposals will be screened to evaluate whether they comply with the eligibility criteria and proposal requirements. Proposals that do not comply may be declared noncompliant and rejected without further review
- **Evaluation**
  - A Source Selection Panel will evaluate proposals according to pre-defined evaluation criteria. NASA may request additional information of a specific point or points in a proposal. The proposer will be instructed on the form of response (writing, verbal, etc.)
  - After evaluating each proposal, NASA will compare the results as part of a tradeoff analysis. The purpose of this tradeoff analysis is to select the proposal(s) that best meet the BAA objectives.
  - NASA may select a partner(s) based on initial proposal submissions. At its discretion, NASA may enter into due diligence with respondents. Due diligence may involve questions about the business, technical, and financial aspects of the proposals. If due diligence is conducted, proposers may be provided the opportunity to submit proposal updates.
- **Selection and Award**
  - Upon selection, final contract terms and conditions will be negotiated. Activities will commence after both parties have signed the contract.

Proposal Evaluation Criteria

- **Factor 1: Relevance**
  The Government will evaluate the ability of the proposal to meet the objectives stated in the appendix of this BAA for which the proposal was submitted.

- **Factor 2: Technical Merit**
  The Government will evaluate the quality, depth, and thoroughness of the proposed technical approach and the organization's capabilities and the qualifications of key personnel.

- **Factor 3: Price**
  The Government will evaluate the overall price reasonableness of the firm fixed price to the Government. Also an analysis will be done on the corporate contribution to ensure that it properly aligned with the proposed effort.

In addition, NASA reserves the right to assess information outside the proposal as it relates to the evaluation criteria stated above.

Questions

- Questions in this forum may be submitted in two ways:
  - Verbal questions during Q&A period of the forum
  - E-mail questions to: hq-nextstep-baa@mail.nasa.gov
- Please limit questions to clarifications of this BAA
- Questions that require further assessment to address will be resolved as soon as possible after the forum, and the answers will be posted to the NextSTEP website: **http://www.nasa.gov/nextstep**
- Any published responses to questions posted at the NextSTEP website will supersede verbal discussions during this forum

Conclusion

Thank you for your participation today

This presentation will be posted to the NextSTEP website:

http://www.nasa.gov/nextstep

Please submit questions about this Announcement to:

hq-nextstep-baa@mail.nasa.gov