



Deep Space Gateway Study Overview

Global Exploration Roadmap Virtual Workshop

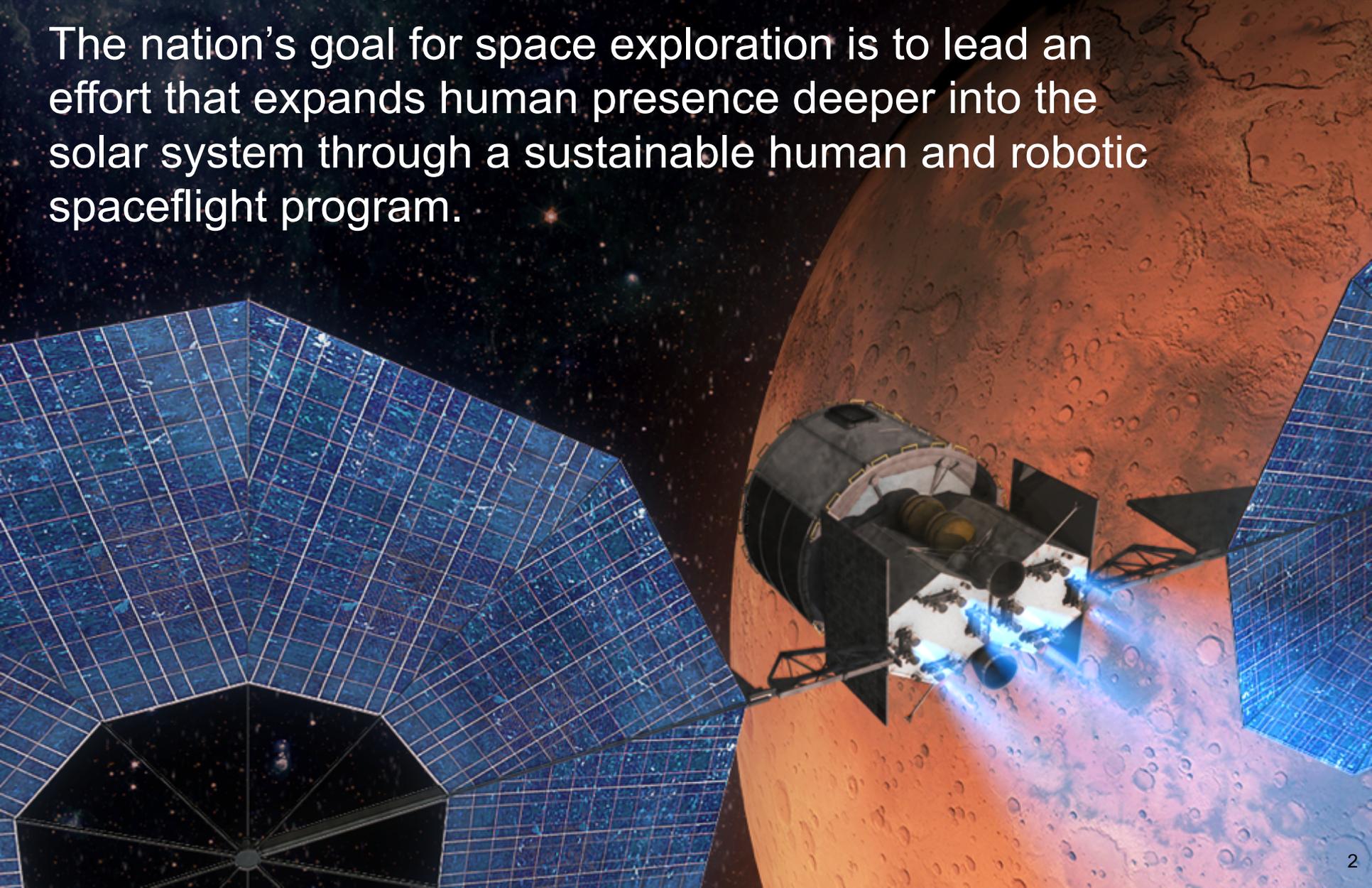
John Guidi AES/HEOMD

November 29, 2017

Why a Gateway? Our Goal



The nation's goal for space exploration is to lead an effort that expands human presence deeper into the solar system through a sustainable human and robotic spaceflight program.



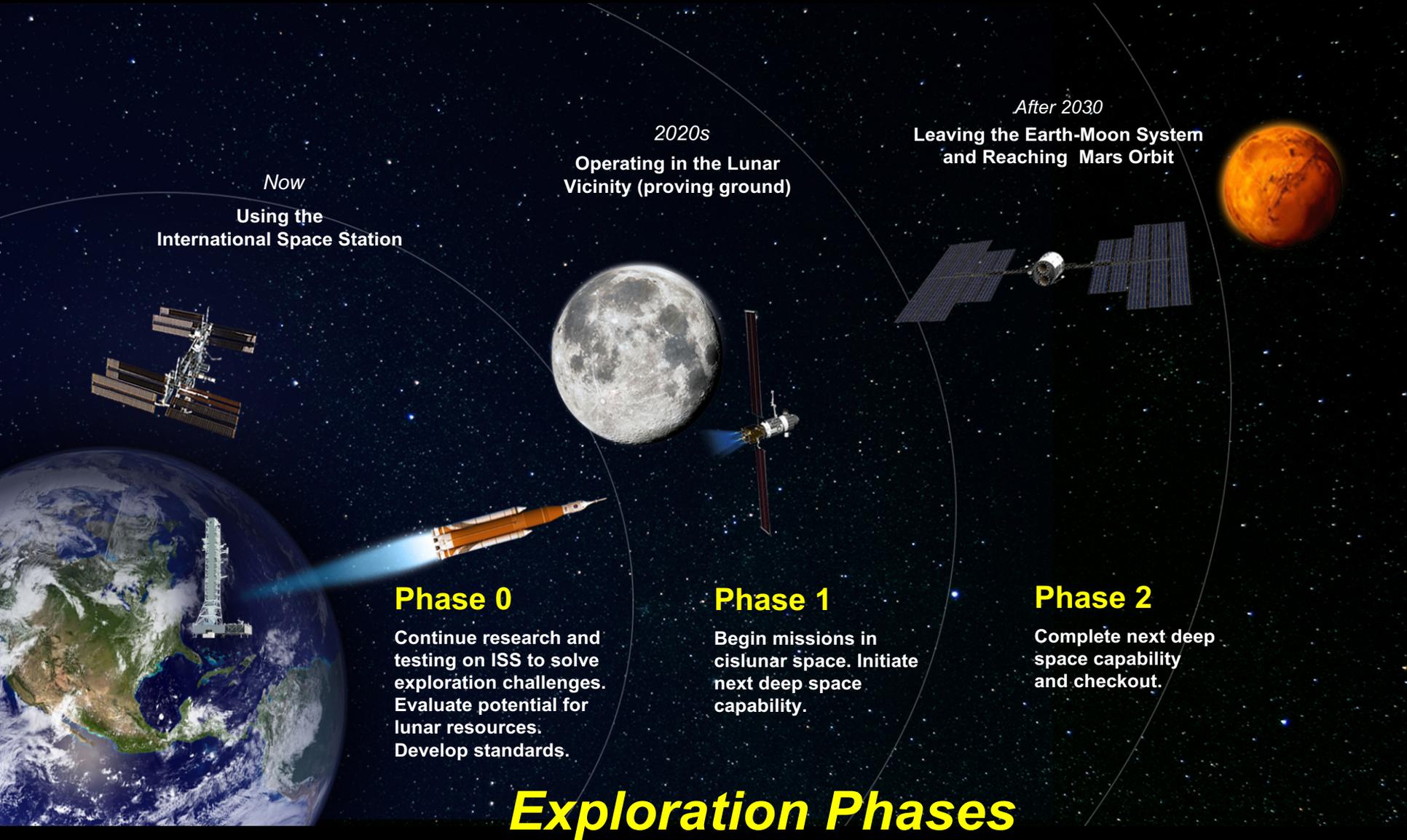
STRATEGIC PRINCIPLES FOR SUSTAINABLE EXPLORATION



- **FISCAL REALISM**
Implementable in the near-term with the buying power of current budgets and in the longer term with budgets commensurate with economic growth;
- **SCIENTIFIC EXPLORATION**
Exploration enables science and science enables exploration; leveraging scientific expertise for human exploration of the solar system.
- **TECHNOLOGY PULL AND PUSH**
Application of high TRL technologies for near term missions, while focusing sustained investments on technologies and capabilities to address the challenges of future missions;
- **GRADUAL BUILD UP OF CAPABILITY**
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;
- **ECONOMIC OPPORTUNITY**
Opportunities for U.S. commercial business to further enhance their experience and business base;
- **ARCHITECTURE OPENNESS AND RESILIENCE**
Resilient architecture featuring multi-use, evolvable space infrastructure, minimizing unique developments, with each mission leaving something behind to support subsequent missions;
- **GLOBAL COLLABORATION AND LEADERSHIP**
Substantial new international and commercial partnerships, leveraging current International Space Station partnerships and building new cooperative ventures for exploration; and
- **CONTINUITY OF HUMAN SPACEFLIGHT**
Uninterrupted expansion of human presence into the solar system by establishing a regular cadence of crewed missions to cis-lunar space during ISS lifetime.

EXPANDING HUMAN PRESENCE IN PARTNERSHIP

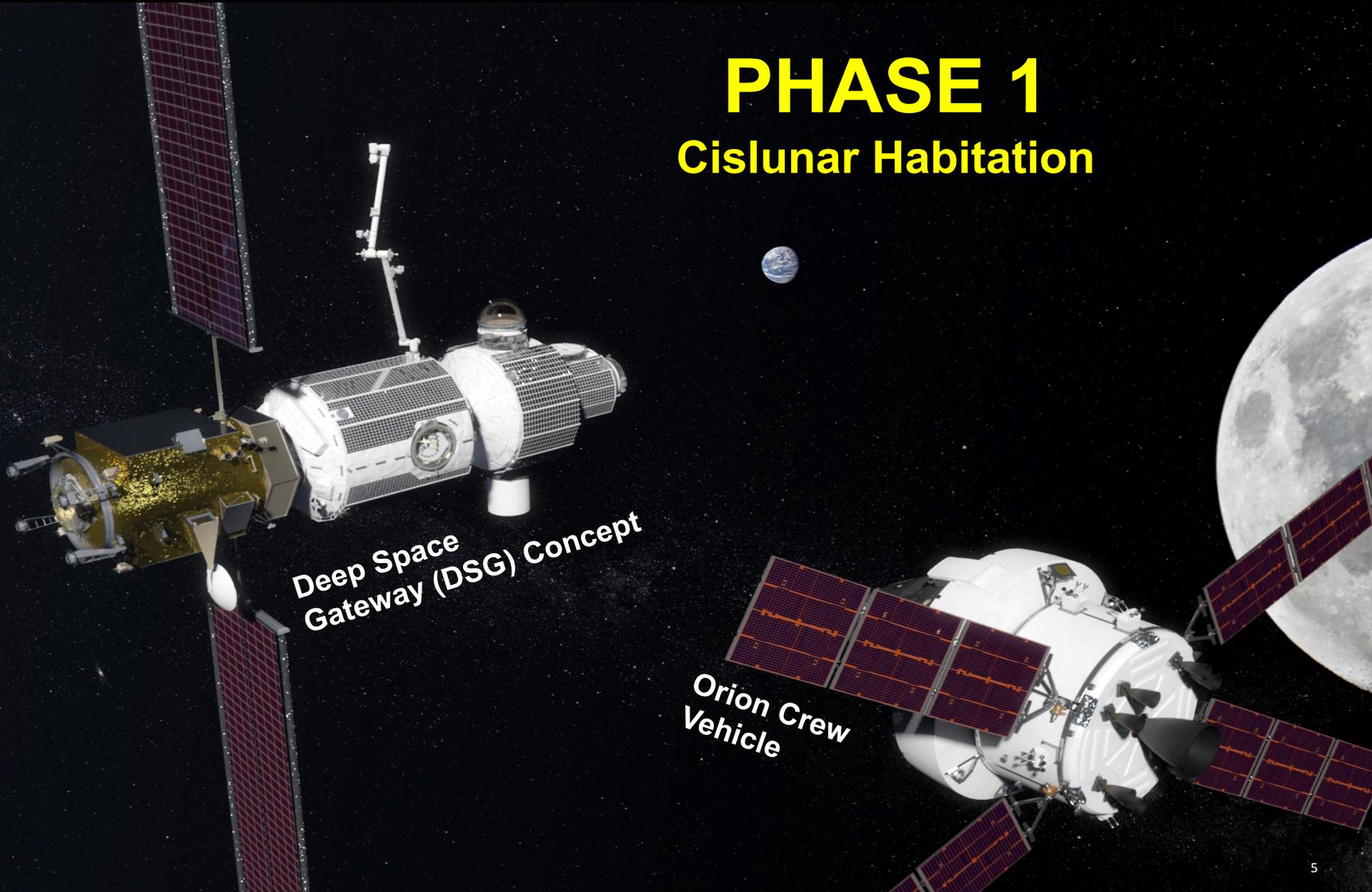
CREATING ECONOMIC OPPORTUNITIES, ADVANCING TECHNOLOGIES, AND ENABLING DISCOVERY



Exploration Phases



PHASE 1 Cislunar Habitation



Deep Space
Gateway (DSG) Concept

Orion Crew
Vehicle



● Study Assumptions

- Gateway provides ability to support multiple NASA, U.S. commercial, science and international partner objectives in Phase 1 and beyond
 - GER robotic and human missions – lunar and Mars
- Gateway outside of Earth's gravity well – supports long term reuse of DST
- Gateway trades focus on the cislunar deep space environment:
 - Supports (with Orion docked) crew of 4 for a minimum of 30 days
 - Gateway utilization activities during crewed and uncrewed operations

● Current emphasis on identifying early Phase 1 elements

- Gateway Power Propulsion Element (PPE)
- Gateway habitat systems studies
 - Partnership capabilities in studies
- Utilization planning (science, technology, partnership goals)

● Future work to refine later elements; early feasibility trades complete

- Airlock and EVA capabilities, logistics strategy
- Deep space transport and habitation objectives/trades

Potential Phase 1 SLS Mission Sequence Under Trade



		Deep Space Gateway Buildup					
EM-1	Europa Clipper	EM-2	EM-3	EM-4	EM-5		
		2019 - 2025				2026	
SLS Block 1 Crew: 0	SLS Block 1B Cargo Europa Clipper (subject to approval)	SLS Block 1B Crew: 4 CMP Capability: 8-9T 40kW Power/Prop Bus	SLS Block 1B Crew: 4 CMP Capability: 10mT Habitation	SLS Block 1B Crew: 4 CMP Capability: 10mT Logistics	SLS Block 1B Crew: 4 CPL Capability: 10mT Airlock		
Distant Retrograde Orbit (DRO) 26-40 days	Jupiter Direct	Multi-TLI Lunar Free Return 8-21 days	Near Rectilinear Halo Orbit (NRHO) 16-26 days	NRHO, w/ ability to translate to/from other cislunar orbits 26-42 days	NRHO, w/ ability to translate to/from other cislunar orbits 26-42 days		
Gateway Concept (blue) Configuration (Orion in grey)			Cislunar Support Flight	Cislunar Support Flight			

Gateway concept could support multiple GER U.S. and international partner objectives in Phase 1 and beyond

- Parameters:**
- Gateway concept architecture supports GER vision
 - International and U.S. commercial development of elements and systems
 - Gateway could translate uncrewed between cislunar orbits
 - Ability to support science objectives in cislunar space

- Further Trades:**
- Order of logistics flights and logistics providers
 - Use of logistics modules for available volume
 - Ability to support lunar surface missions

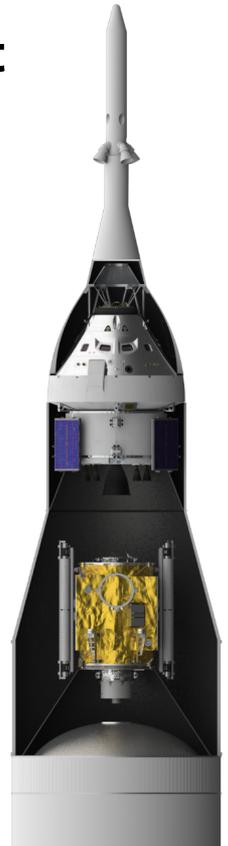
DSG: Power Propulsion Element

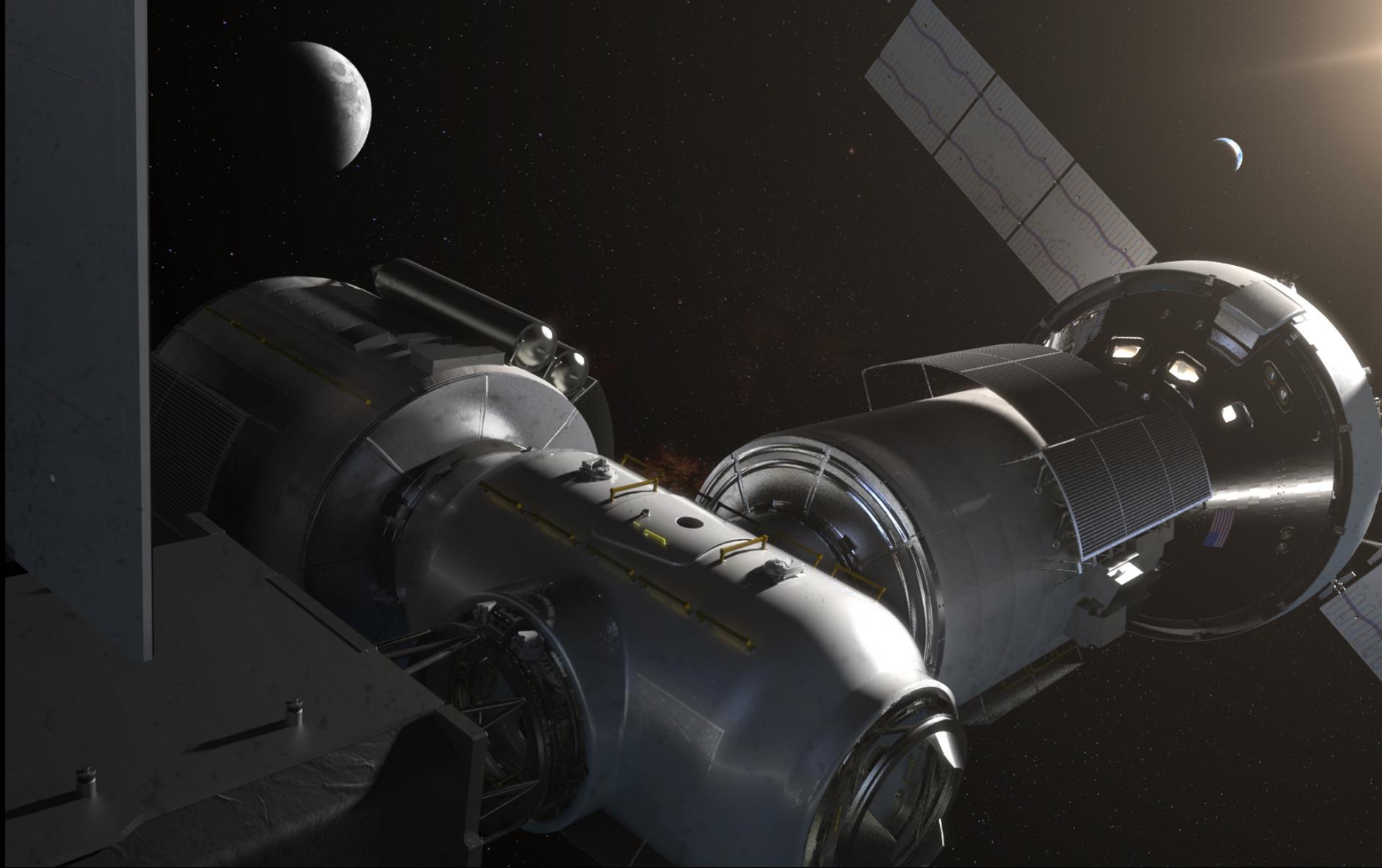


Power Propulsion Element Functionality



- **PPE studies for a gateway approach leverage advanced solar electric propulsion (SEP) technologies developed and matured during Asteroid Redirect Mission activities**
- **The PPE could provide key functionality for the DSG concept including**
 - SEP system ~ 40Kw
 - Power to DSG and externally accommodated elements
 - Orbital maintenance, attitude control as needed
 - Transportation for the DSG between cislunar orbits
 - Communications with Earth, space to space communications, and radio relay capability in support of extra-vehicular activity communications.
- **PPE could launch co-manifested with Orion crew vehicle on the Space Launch System for the EM-2 flight**





DSG: Habitation Capability Studies

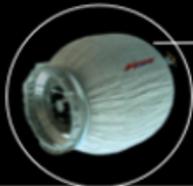


Habitation Development Strategy

Phase 0:

SYSTEMS DEVELOPMENT AND TESTING ON ISS / LEO

LEO COMMERCIALIZATION



Bigelow Expandable Activity Module



Spacecraft Fire Safety



Human Research and Performance

Habitation System Projects



Life Support Systems



Exercise Systems



Docking / berthing Systems



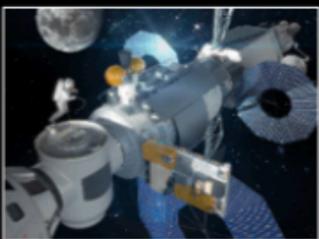
Advanced Avionics



EVA

Phase 1:

DEEP SPACE TESTING



Gateway

NextSTEP Habitation / Int. Partners

Phase 2:

DEEP SPACE VALIDATION



Deep Space Transport

Shakedown Cruise

NextSTEP Habitation Overview – Hab Studies

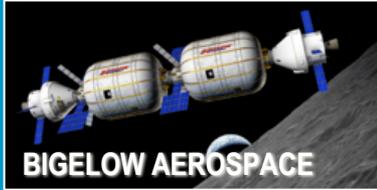


NextSTEP: 2015-2016

Cislunar habitation concepts that leverage commercialization plans for LEO



LOCKHEED MARTIN



BIGELOW AEROSPACE



ORBITAL ATK



BOEING

FOUR SIGNIFICANTLY DIFFERENT CONCEPTS RECEIVED

Partners develop required deliverables, including concept descriptions with concept of operations, NextSTEP Phase 2 proposals, and statements of work.

NextSTEP: 2016-2018



BIGELOW AEROSPACE
FIRST DRSB ASSEMBLED IN LEO

FIVE GROUND PROTOTYPES BY 2018



SIERRA NEVADA CORPORATION



ORBITAL ATK



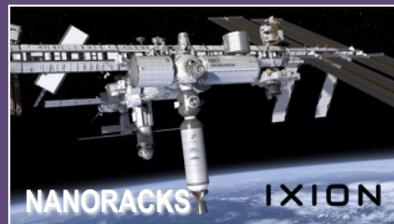
LOCKHEED MARTIN



BOEING

- Partners refine concepts and develop ground prototypes.
- NASA leads standards and common interfaces development.

ONE CONCEPT STUDY



NANORACKS IXION

IECST study discussions with international partners



Define reference habitat architecture in preparation for Phase 3.

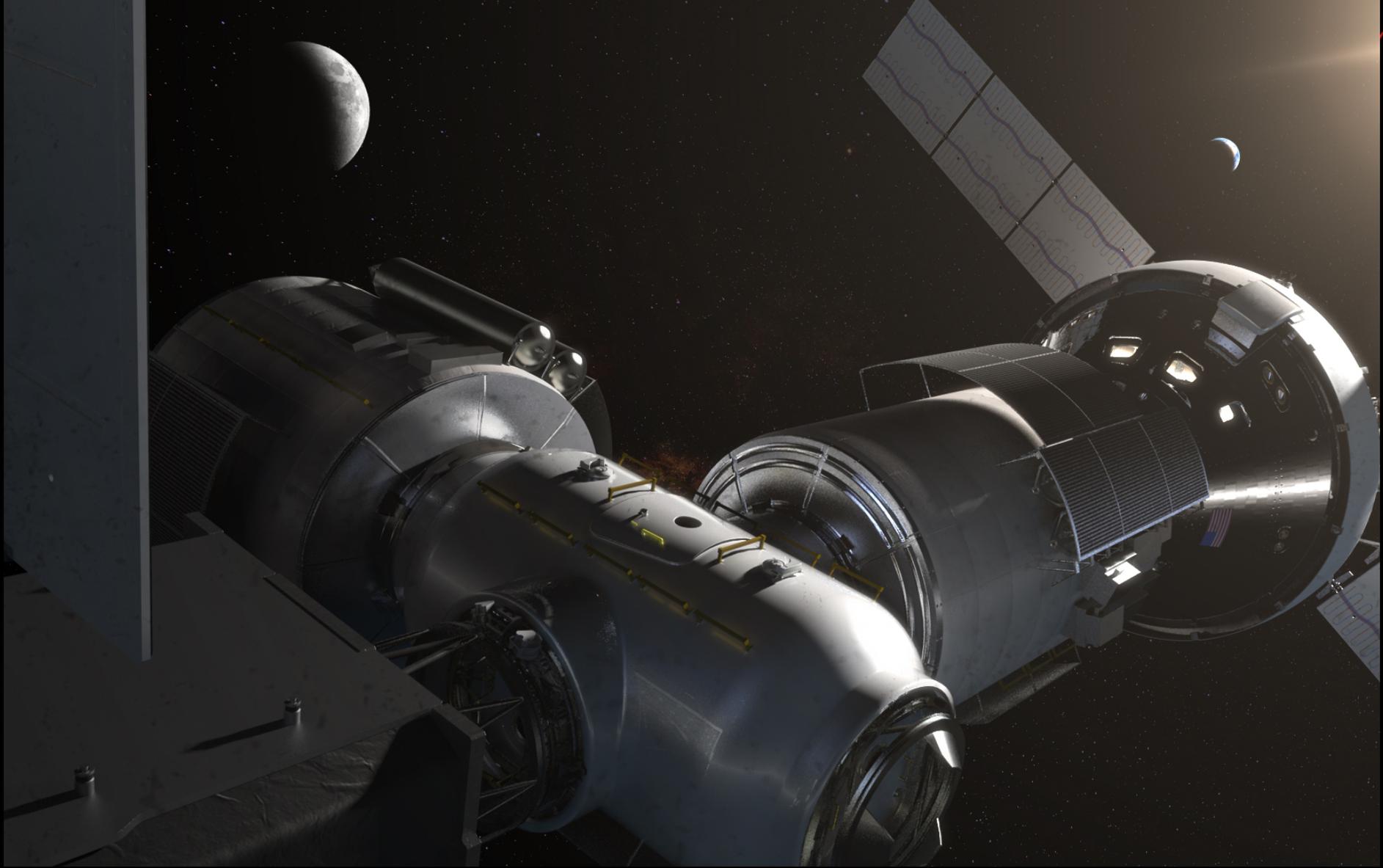
NextSTEP: 2018+

- Partnership approach, leveraging domestic and international capabilities
- Development of deep space habitation capabilities
- Deliverables: flight unit(s)

DSG Concept Studies – What's Next ?



- **HQ and Center Deep Space Gateway & Transport Concept Team**
 - Established Internal Team - June 2017
 - Concept Planning, Utilization, Systems Engineering teams
 - Incorporates long standing ISS partners analysis on gateway concepts
- **Integrated with Exploration Systems Development (Orion/SLS/GO)**
 - Leverages ESD programmatics, document structure, control boards
 - Engineering & Analysis Teams – resources for trade studies
- **ISS Program supporting concept development**
- **DSG&T Systems Engineering and Integration analysis**
 - First integrated analysis cycle starts April, 2018
 - Infusion of science, technology, partnership utilization requirements
 - Integration with deep space transport concept and objectives
- **Utilization and partnership opportunities – objectives definition**
 - Opportunities for DSG planning involvement - workshops



Questions?

