

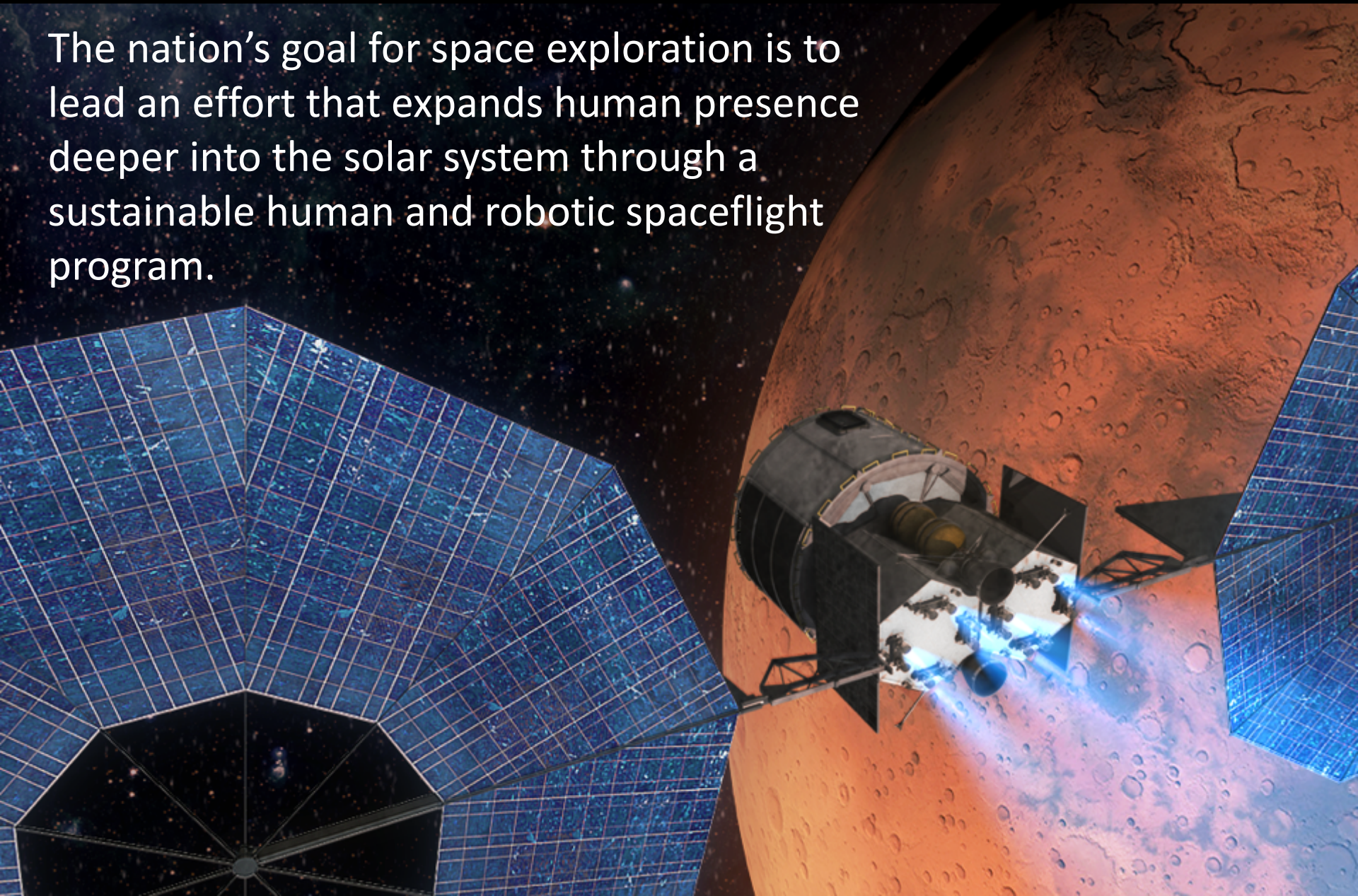
Progress in Defining the Deep Space Gateway and Transport Plan

William H. Gerstenmaier
to the NASA Advisory Council
March 28, 2017

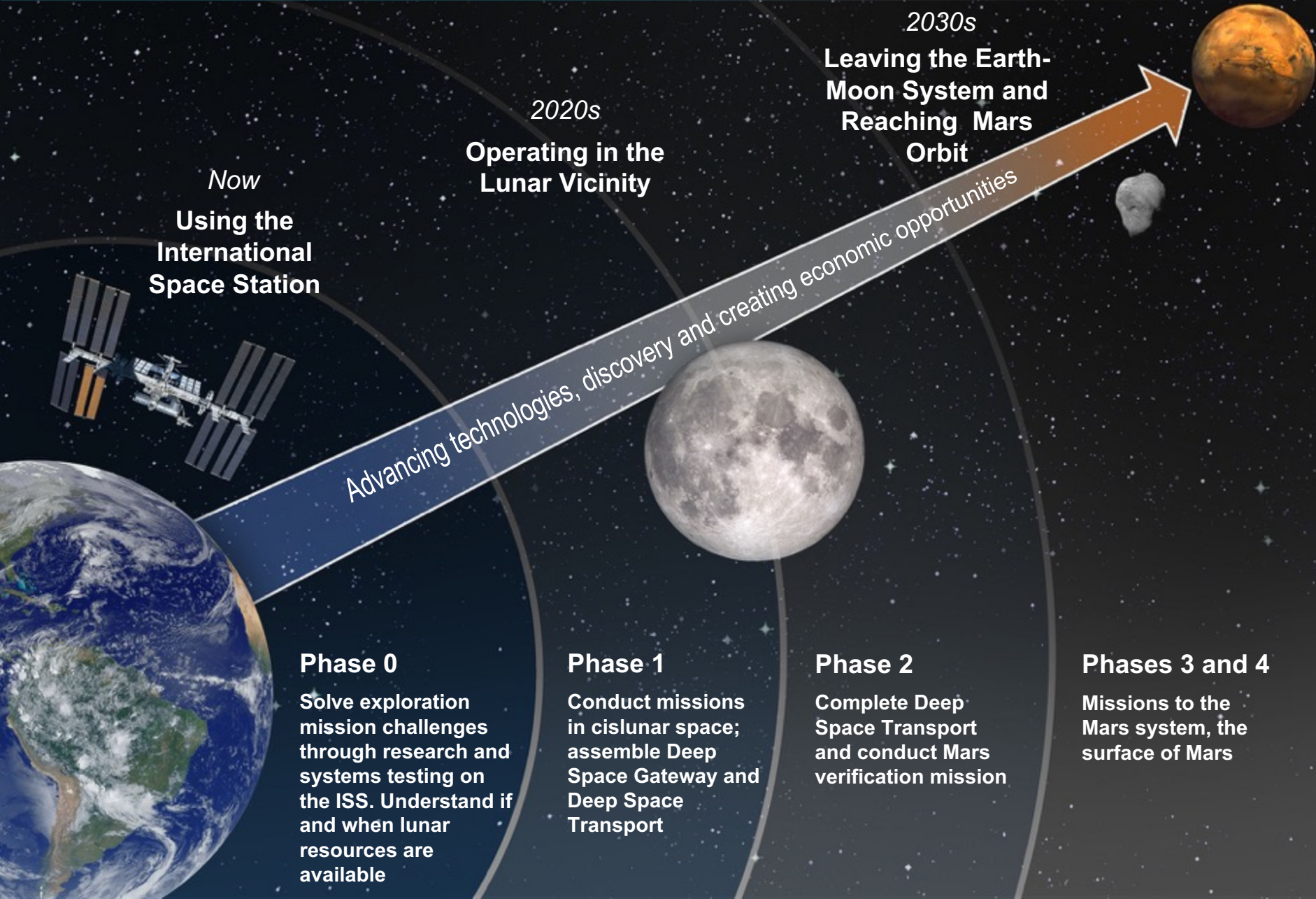
Our Goal



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.



Exploring Space In Partnership





SEC. 202. GOALS AND OBJECTIVES.

(a) LONG TERM GOALS - The long-term goals of the human space flight and exploration efforts of NASA shall be -

(1) to expand permanent human presence beyond low-Earth orbit and to do so, where practical, in a manner involving international, academic, and industry partners;

(2) crewed missions and progress toward achieving the goal in paragraph (1) to enable the potential for subsequent human exploration and the extension of human presence throughout the solar system; and

(3) to enable a capability to extend human presence, including potential human habitation on another celestial body and a thriving space economy in the 21st Century.

NASA Transition Authorization Act of 2017 (cont'd)



(b) KEY OBJECTIVES - The key objectives of the United States for human expansion into space shall be -

(1) to sustain the capability for long-duration presence in low-Earth orbit, initially through continuation of the ISS and full utilization of the United States segment of the ISS as a National Laboratory, and through assisting and enabling an expanded commercial presence in, and access to, low-Earth orbit, as elements of a low-Earth orbit infrastructure;

(2) to determine if humans can live in an extended manner in space with decreasing reliance on Earth, starting with utilization of low-Earth orbit infrastructure, to identify potential roles that space resources such as energy and materials may play, to meet national and global needs and challenges, such as potential cataclysmic threats, and to explore the viability of and lay the foundation for sustainable economic activities in space;

(3) to maximize the role that human exploration of space can play in advancing overall knowledge of the universe, supporting United States national and economic security and the United States global competitive posture, and inspiring young people in their educational pursuits;

(4) to build upon the cooperative and mutually beneficial framework established by the ISS partnership agreements and experience in developing and undertaking programs and meeting objectives designed to realize the goal of human space flight set forth in subsection (a); and

(5) to achieve human exploration of Mars and beyond through the prioritization of those technologies and capabilities best suited for such a mission in accordance with the stepping stone approach to exploration under section 70504 of title 51, United States Code.

Human Space Exploration Phases From ISS to the Surface of Mars as of November 2016



Today
Phase 0: Exploration Systems **Testing on ISS**

Ends with testing, research and demos complete*

Asteroid Redirect-Crewed Mission Marks Move from Phase 1 to Phase 2

Phase 1: **Cislunar Flight Testing** of Exploration Systems

Ends with one year crewed Mars-class shakedown cruise

Phase 2: **Cislunar Validation** of Exploration Capability

Phase 3: Crewed Missions Beyond Earth-Moon System

▲ Planning for the details and specific objectives will be needed in ~2020

Phase 4a: Development and robotic preparatory missions

Phase 4b: Mars Human Landing Missions

Mid-2020s

2030

* [There are several other considerations for ISS end-of-life](#)

HEO Exploration Objectives Baselined for Phase 0/1/2

Planned update in work to reflect evolving exploration strategy



National Aeronautics and
Space Administration

HEOMD-001
INITIAL RELEASE

RELEASE DATE: 09/07/2016

HUMAN EXPLORATION AND OPERATIONS EXPLORATION OBJECTIVES

*Publicly available: Release to Public Websites Requires Approval of
Chief, Office of Primary Responsibility*

Phase 0: Exploration Systems Testing on ISS and in LEO (17 objectives)

“Leverage the ISS as a test bed to demonstrate key exploration capabilities and operations, and foster an emerging commercial space industry in LEO.”

Phase 1: Cislunar Demonstration of Exploration Systems (28 objectives)

Update will reflect buildup of the Deep Space Gateway

Phase 2: Cislunar Validation of Exploration Systems (18 objectives)

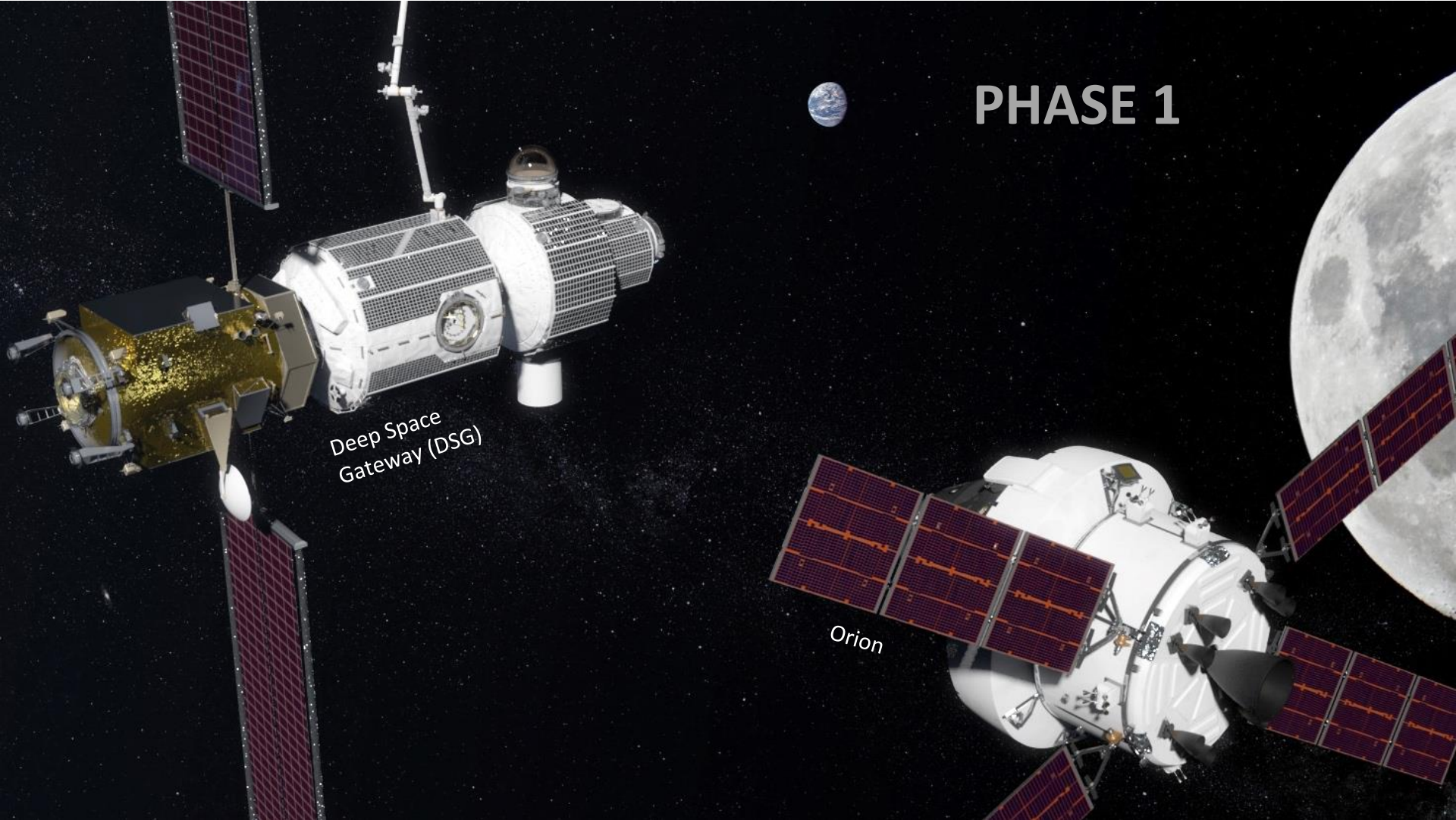
Updated will reflect buildup of the Deep Space Transport



PHASE 1

Deep Space Gateway (DSG)

Orion



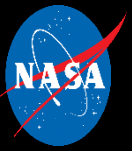
Deep Space Gateway Functionality



- **Assumptions**
 - Deep Space Gateway provides ability to support multiple NASA, U.S. commercial, and international partner objectives in Phase 1 and beyond
 - The Gateway is designed for deep space environments
 - Supports (with Orion docked) crew of 4 for total mission up to 42 days
 - Supports buildup of the Deep Space Transport
 - Open trade for compatibility for operations in Low Lunar Orbit
- **Emphasis on defining early Phase 1 elements**
 - Gateway Power Propulsion Bus
 - Gateway Habitat
 - Logistics Strategy
- **Future work to refine later elements; early feasibility trades complete**
 - Airlock
 - Deep Space Transport

Phase 1 Plan

Establishing deep-space leadership and preparing for Deep Space Transport development



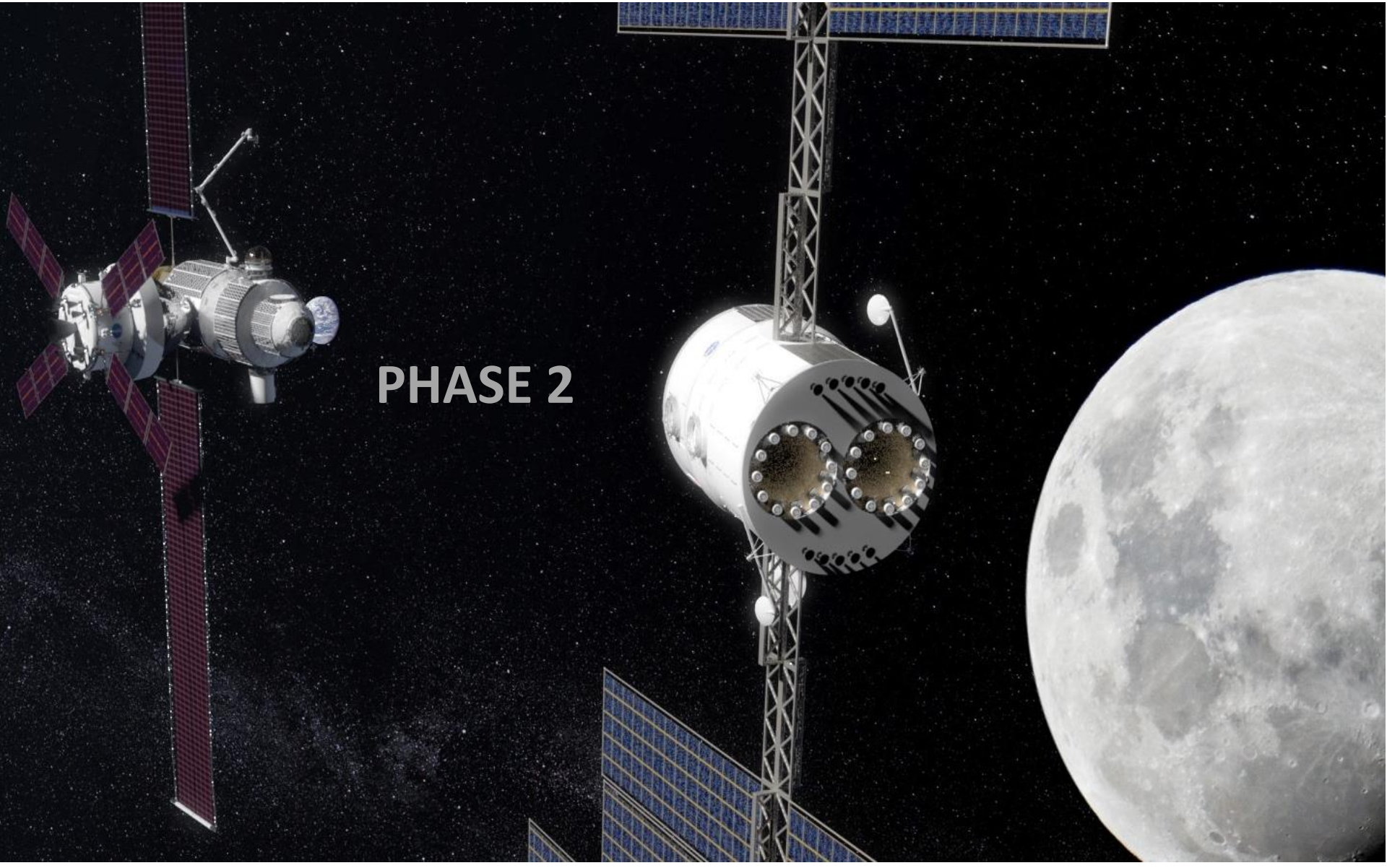
Deep Space Gateway Buildup					
EM-1	Europa Clipper	EM-2	EM-3	EM-4	EM-5
2019 - 2025					2026
<p>SLS Block 1 Crew: 0</p>	<p>SLS Block 1B Cargo Europa Clipper (subject to approval)</p>	<p>SLS Block 1B Crew: 4 CMP Capability: 8-9t 40kW Power/Prop Element</p>	<p>SLS Block 1B Crew: 4 CMP Capability: 10t Habitation</p>	<p>SLS Block 1B Crew: 4 CMP Capability: 10t Logistics</p>	<p>SLS Block 1B Crew: 4 CPL Capability: 10t Airlock</p>
<p>Distant Retrograde Orbit (DRO) 26-40 days</p>	<p>Jupiter Direct</p>	<p>Multi-TLI Lunar Free Return 8-21 days</p>	<p>Linear Rectilinear Halo Orbit (NRHO) 16-26 days</p>	<p>NRHO, w/ ability to translate to/from other cislunar orbits 26-41 days</p>	<p>NRHO, w/ ability to translate to/from other cislunar orbits 26-41 days</p>
<p>Gateway (blue) Configuration (Orion in grey)</p>			<p>Cislunar Support Flight</p>	<p>Cislunar Support Flight</p>	

These essential Gateway elements can support multiple U.S. and international partner objectives in Phase 1 and beyond

- Known Parameters:**
- Gateway to architecture supports Phase 2 and beyond activities
 - International and U.S. commercial development of elements and systems
 - Gateway will translate uncrewed between cislunar orbits
 - Ability to support science objectives in cislunar space
- Open Opportunities:**
- Order of logistics flights and logistics providers
 - Use of logistics modules for available volume
 - Ability to support lunar surface missions



PHASE 2



(PLANNING REFERENCE) Phase 2 and Phase 3

Looking ahead to the shakedown cruise and the first crewed missions to Mars



Transport Delivery		Transport Shakedown		Mars Transit	
EM-6	EM-7	EM-8	EM-9	EM-10	EM-11
2027		2028 / 2029		2030+	
<p>SLS Block 1B Cargo P/L Capability: 41t TLI</p> <p>Deep Space Transport</p>	<p>SLS Block 1B Crew: 4 CMP Capability: 10t</p> <p>Logistics</p>	<p>SLS Block 1B Cargo P/L Capability: 41t TLI</p> <p>DST Logistics & Refueling</p>	<p>SLS Block 2 Crew: 4 CMP Capability: 13+</p> <p>Logistics</p>	<p>SLS Block 2 Cargo P/L Capability: 45t TLI</p> <p>DST Logistics & Refueling</p>	<p>SLS Block 2 Crew: 4 CMP Capability: 13+</p> <p>Logistics</p>
<p>DST checkout in NRHO 191-221 days</p> <p>Cislunar Support Flight</p>		<p>DSG: continued operations in cislunar space</p> <p>DST: shakedown in cislunar space with return to DSG in NRHO 300-400 days</p> <p>Cislunar Support Flight</p>		<p>DSG: continued operations in cislunar space</p> <p>DST: Mars transit and return to DSG in NRHO</p> <p>Support Flight</p>	

Reusable Deep Space Transport supports repeated crewed missions to the Mars vicinity

Known Parameters:

- DST launch on one SLS cargo flight
- DST shakedown cruise by 2029
- DST supported by a mix of logistics flights for both shakedown and transit
- Ability to support science objectives in cislunar space

Open Opportunities:


- Order of logistics flights and logistics providers
- Shakedown cruise vehicle configuration and destination/s
- Ability to support lunar surface missions

Deep Space Transport Functionality



- **Assumptions**
 - Deep Space Transport provides habitation and transportation needs for transporting crew into deep space including supporting human Mars-class missions
 - The Transport system life will be designed for:
 - Reused for 3 Mars-class missions with resupply and minimal maintenance
 - Crew of 4 for 1,000 day-class missions in deep space
 - Launched on one SLS 1B cargo vehicle - resupply and minimal outfitting to be performed in cislunar space
- **Emphasis on supporting shakedown cruise by 2029**
 - Shakedown cruise to be performed in lunar vicinity
 - Utilizes deep space interfaces and common design standards
- **Future work trades**
 - Shakedown cruise objectives
 - Mars reference mission functional requirements

How are we leading future human exploration?

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- Maximizing utilization of the International Space Station
 - Actively promoting LEO commercialization
 - Resolving the human health and performance challenges
 - Expanding partnerships with commercial industry
 - Growing international partnerships
 - Building the critical *Deep Space Infrastructure*
 - Enabling the capabilities to explore multiple destinations