National Aeronautics and Space Administration

Progress in Defining the Deep Space Gateway and Transport Plan

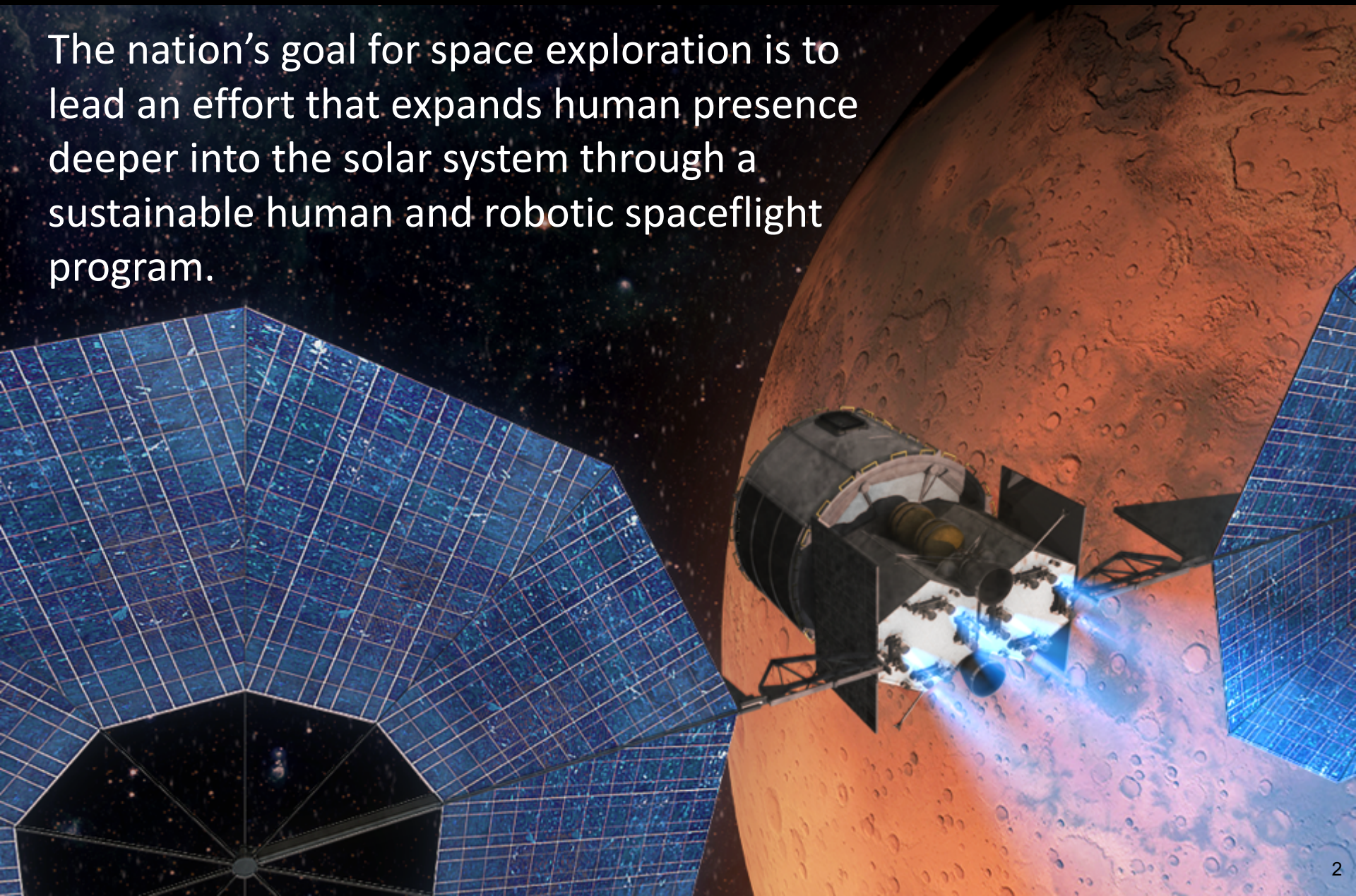
William H. Gerstenmaier

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

Now

Using the International Space Station

2020s

Operating in the Lunar Vicinity

2030s

Leaving the Earth-Moon System and Reaching Mars Orbit

Advancing technologies, discovery and creating economic opportunities

Phase 0

Solve exploration mission challenges through research and systems testing on the ISS. Understand if and when lunar resources are available

Phase 1

Conduct missions in cislunar space; assemble Deep Space Gateway and Deep Space Transport

Phase 2

Complete Deep Space Transport and conduct Mars verification mission

Phases 3 and 4

Missions to the Mars system, the surface of Mars

NASA Transition Authorization Act of 2017

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;

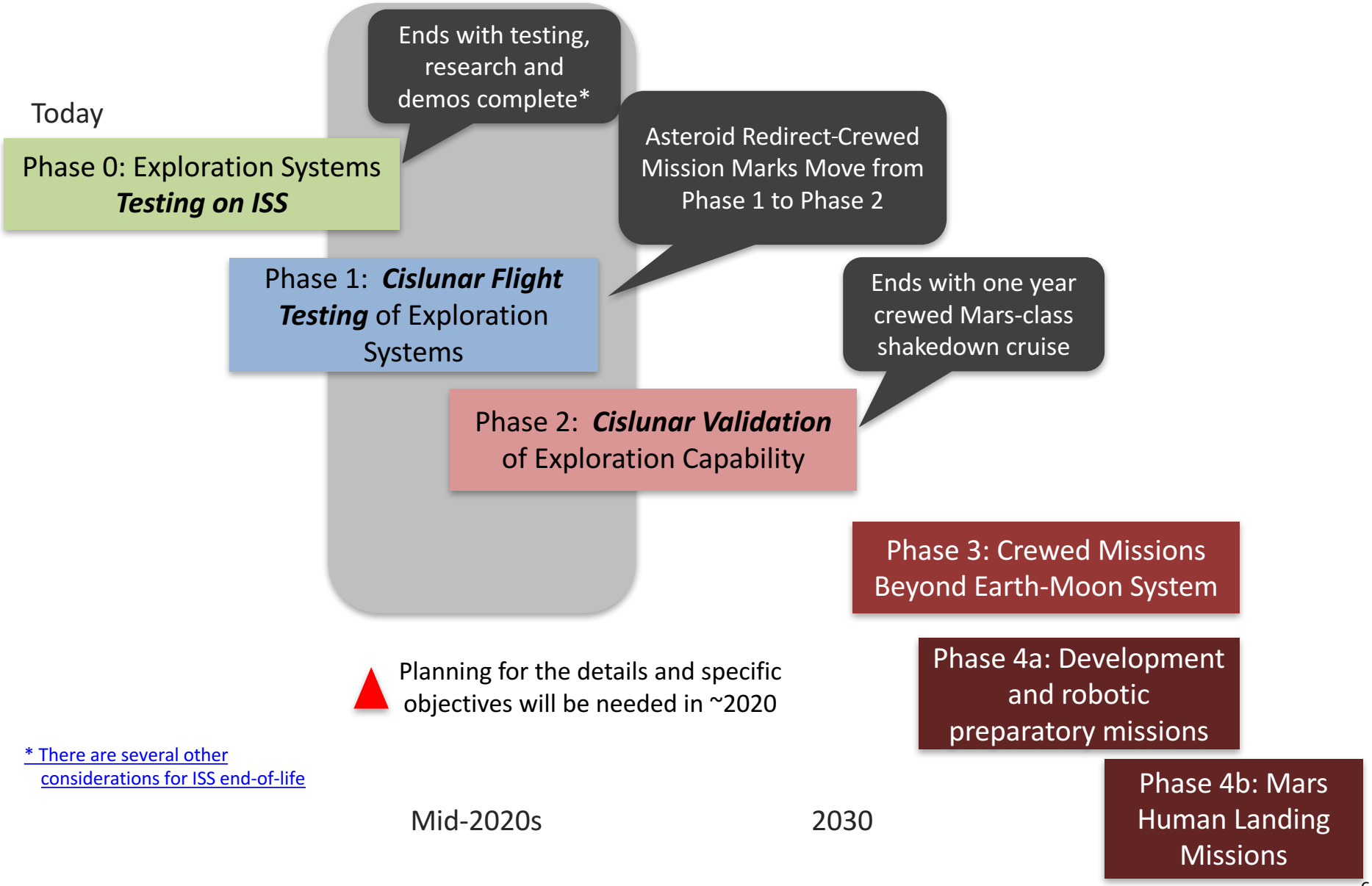
(2) to determine if humans can live in an extended manner in space with decreasing reliance on Earth, starting with utilization of low-Earth orbit infrastructure, to identify potential roles that space resources such as energy and materials may play, to meet national and global needs and challenges, 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

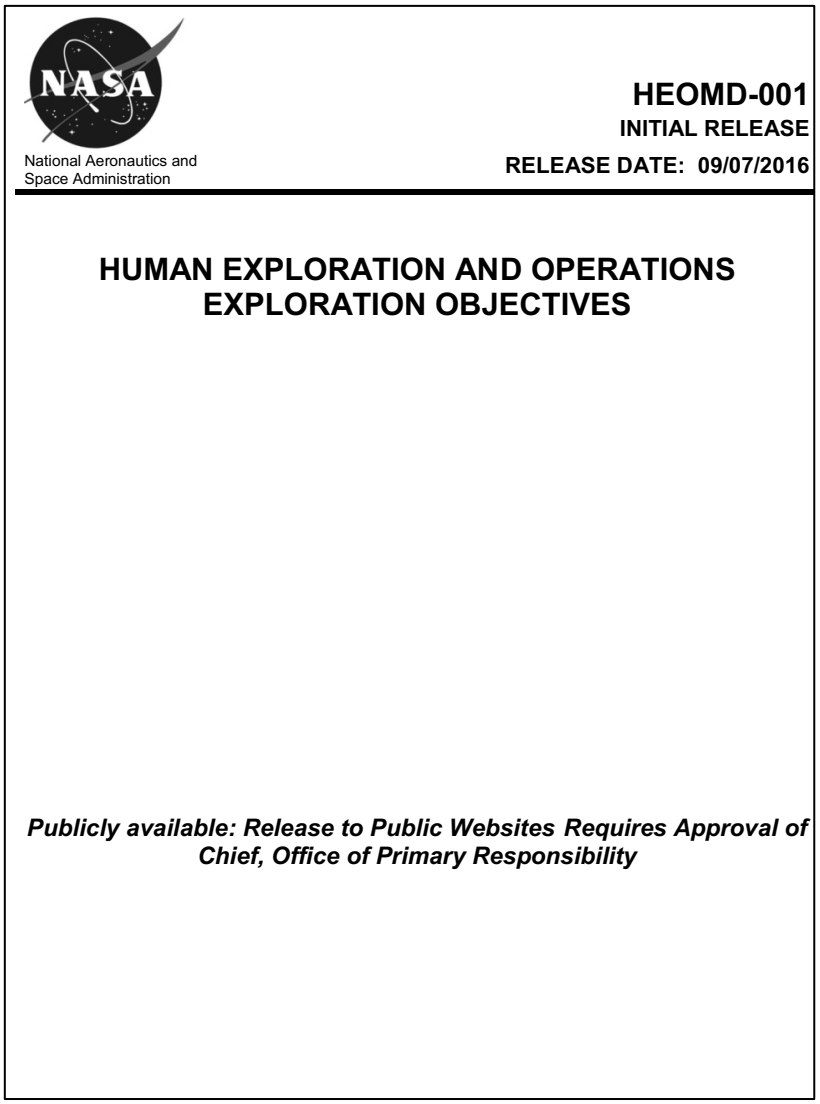
(5) to achieve human exploration of Mars and beyond through the prioritization of those technologies and capabilities best suited for such a mission in accordance with the stepping stone approach to exploration under section 70504 of title 51, United States Code.

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



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

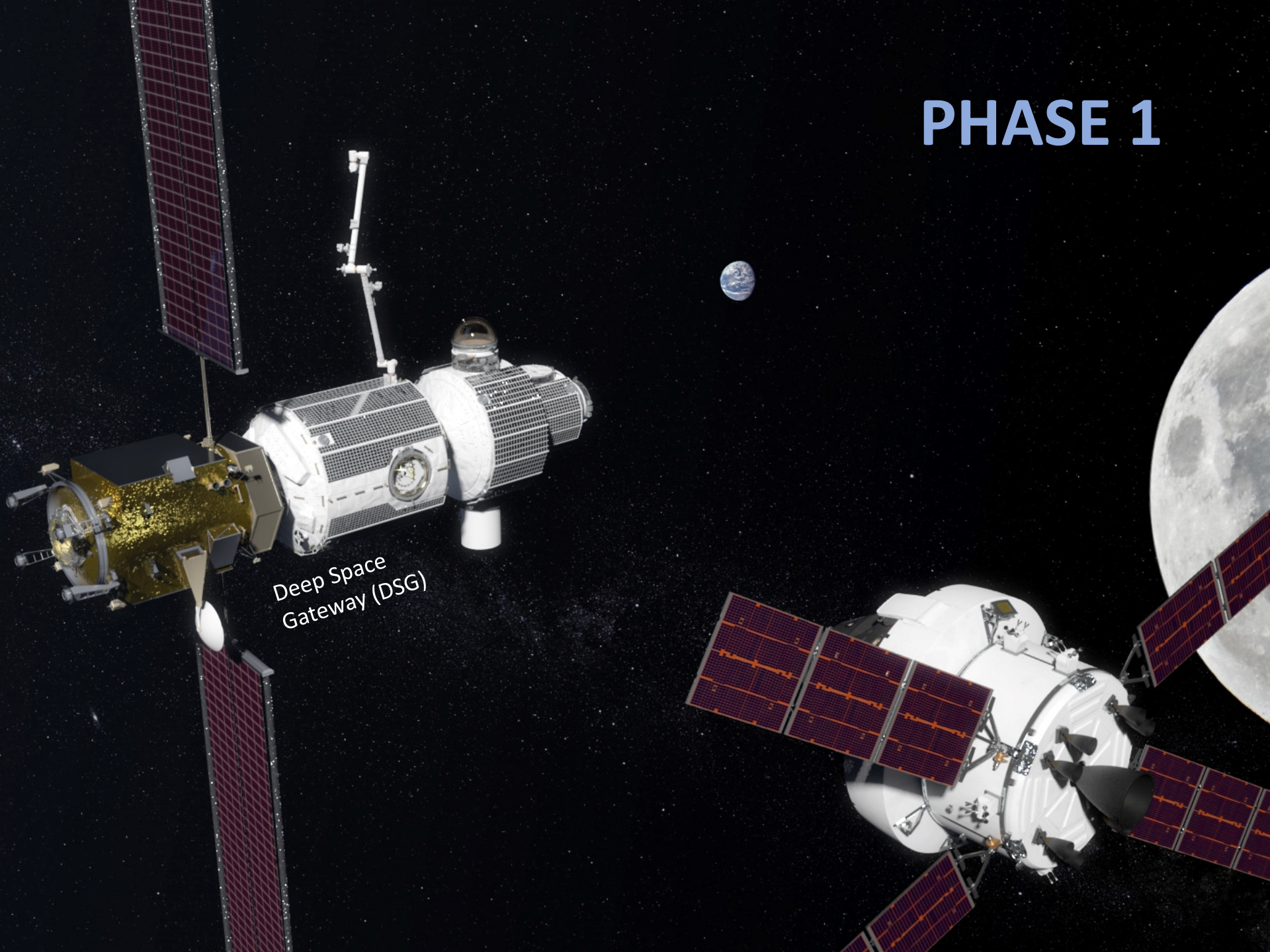
HUMAN EXPLORATION AND OPERATIONS
EXPLORATION OBJECTIVES

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)

Deep Space Gateway Functionality

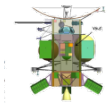
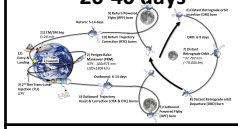
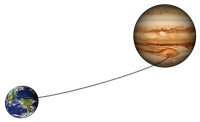
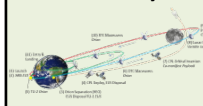
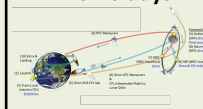
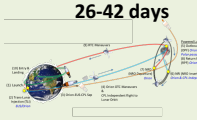
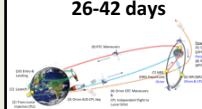
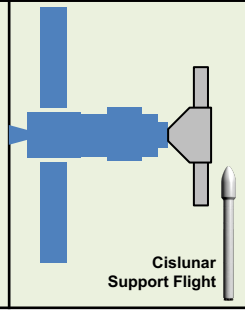
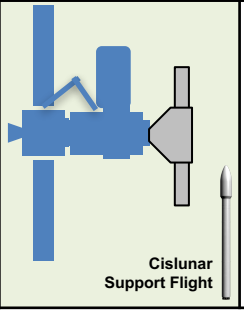
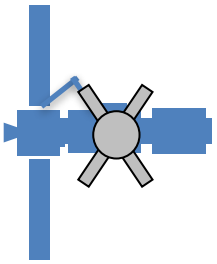
- **Assumptions**
  - Deep Space Gateway provides ability to support multiple NASA, U.S. commercial, and international partner objectives in Phase 1 and beyond
  - The Gateway is designed for deep space environments
    - Supports (with Orion docked) crew of 4 for total mission up to 42 days
    - Supports 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**
2018 - 2025					**2026**
SLS Block 1 **Crew: 0**	**SLS Block 1B Cargo**	**SLS Block 1B** **Crew: 4** **CMP Capability: 8-9T**	**SLS Block 1B** **Crew: 4** **CMP Capability: 10mT**	**SLS Block 1B** **Crew: 4** **CMP Capability: 10mT**	**SLS Block 1B** **Crew: 4** **CPL Capability: 10mT**
	  **Europa Clipper** (subject to approval)	  **40kW Power/Prop Bus**	  **Habitation**	  **Logistics**	  **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 (blue) Configuration (Orion in grey)			 **Cislunar Support Flight**	 **Cislunar Support Flight**	

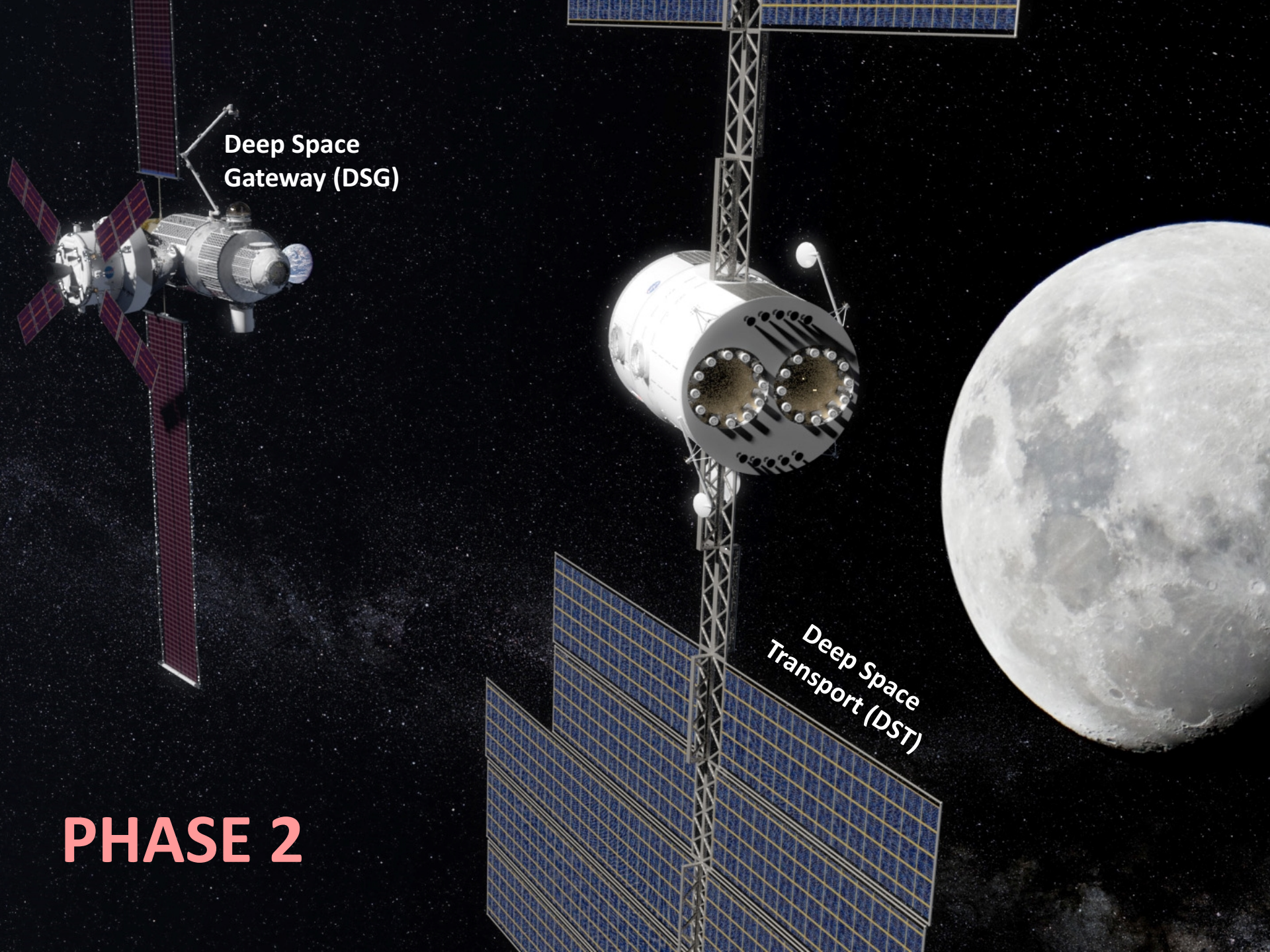
These essential Gateway elements can support multiple U.S. and international partner objectives in Phase 1 and beyond

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


Deep Space
Gateway (DSG)
Deep Space
Transport (DST)
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+	
SLS Block 1B Cargo P/L Capability: 41t TLI	SLS Block 1B Crew: 4 CMP Capability: 10t	SLS Block 1B Cargo P/L Capability: 41t TLI	SLS Block 2 Crew: 4 CMP Capability: 13+t	SLS Block 2 Cargo P/L Capability: 45t TLI	SLS Block 2 Crew: 4 CMP Capability: 13+t
Deep Space Transport	Logistics	DST Logistics & Refueling	Logistics	DST Logistics & Refueling	Logistics
DST checkout in NRHO 191-221 days		DSG: continued operations in cislunar space DST: shakedown in cislunar space with return to DSG in NRHO 300-400 days		DSG: continued operations in cislunar space DST: Mars transit and return to DSG in NRHO	
Cislunar Support Flight		Cislunar Support Flight		Cislunar Support Flight	

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?

- 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