



Cislunar and Gateway Overview

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SPACE POLICY DIRECTIVE-1



“Lead an innovative and sustainable program of exploration with commercial and international partners to enable human expansion across the solar system and to bring back to Earth new knowledge and opportunities.

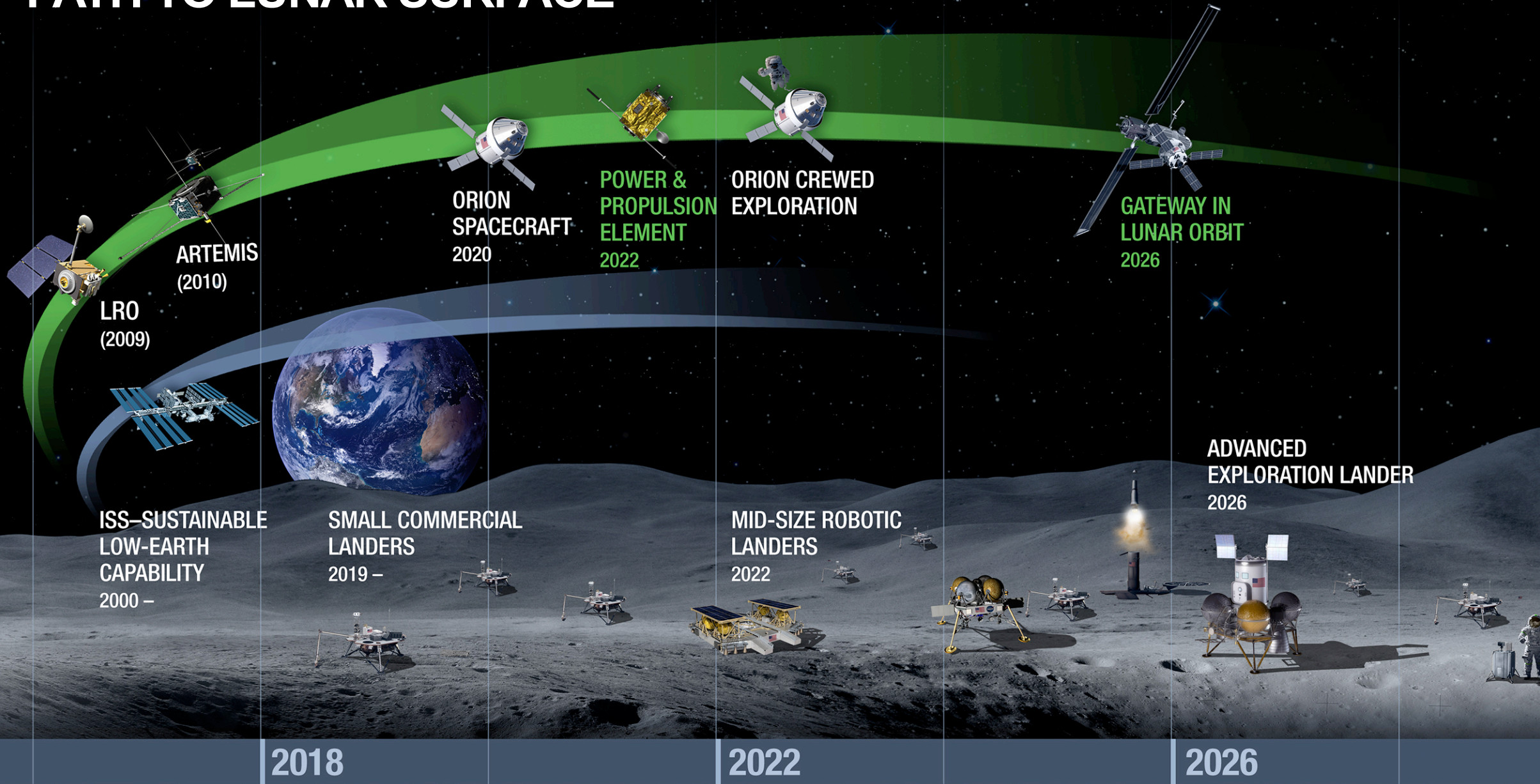
Beginning with missions beyond low-Earth orbit, the United States will lead the return of humans to the Moon for long-term exploration and utilization, followed by human missions to Mars and other destinations.”

LEADING FUTURE EXPLORATION - STRATEGIC PRINCIPLES



Fiscal Realism | Commercial & International Partnerships | Scientific Exploration
Technology Pull and Push | Gradual Buildup of Capability
Architecture Openness and Resilience
Global Collaboration and Leadership | Continuity of Human Spaceflight

PATH TO LUNAR SURFACE



LRO
(2009)

ARTEMIS
(2010)

ISS-SUSTAINABLE
LOW-EARTH
CAPABILITY
2000 -

SMALL COMMERCIAL
LANDERS
2019 -

ORION
SPACECRAFT
2020

POWER &
PROPULSION
ELEMENT
2022

ORION CREWED
EXPLORATION

MID-SIZE ROBOTIC
LANDERS
2022

GATEWAY IN
LUNAR ORBIT
2026

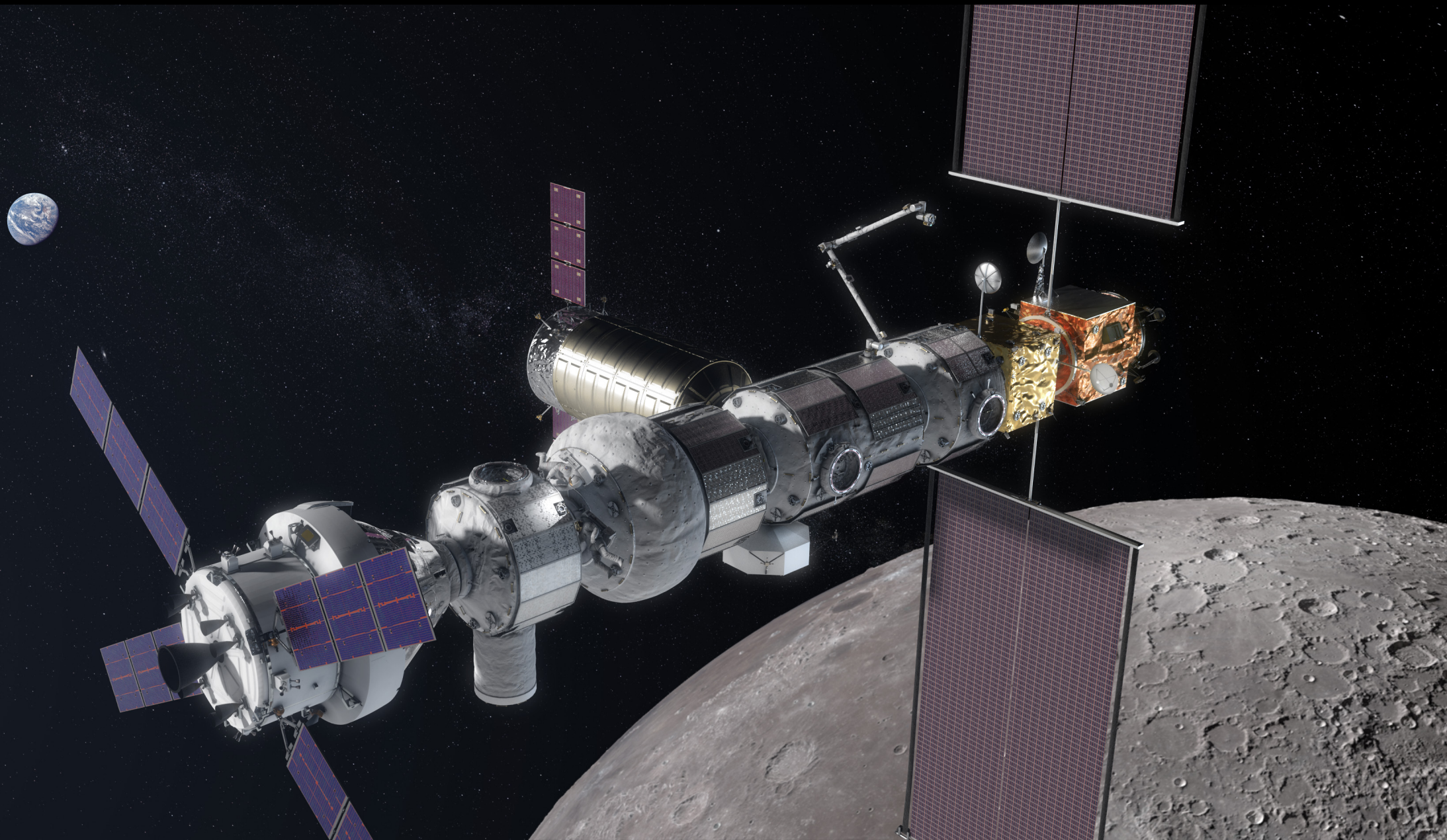
ADVANCED
EXPLORATION LANDER
2026

2018

2022

2026

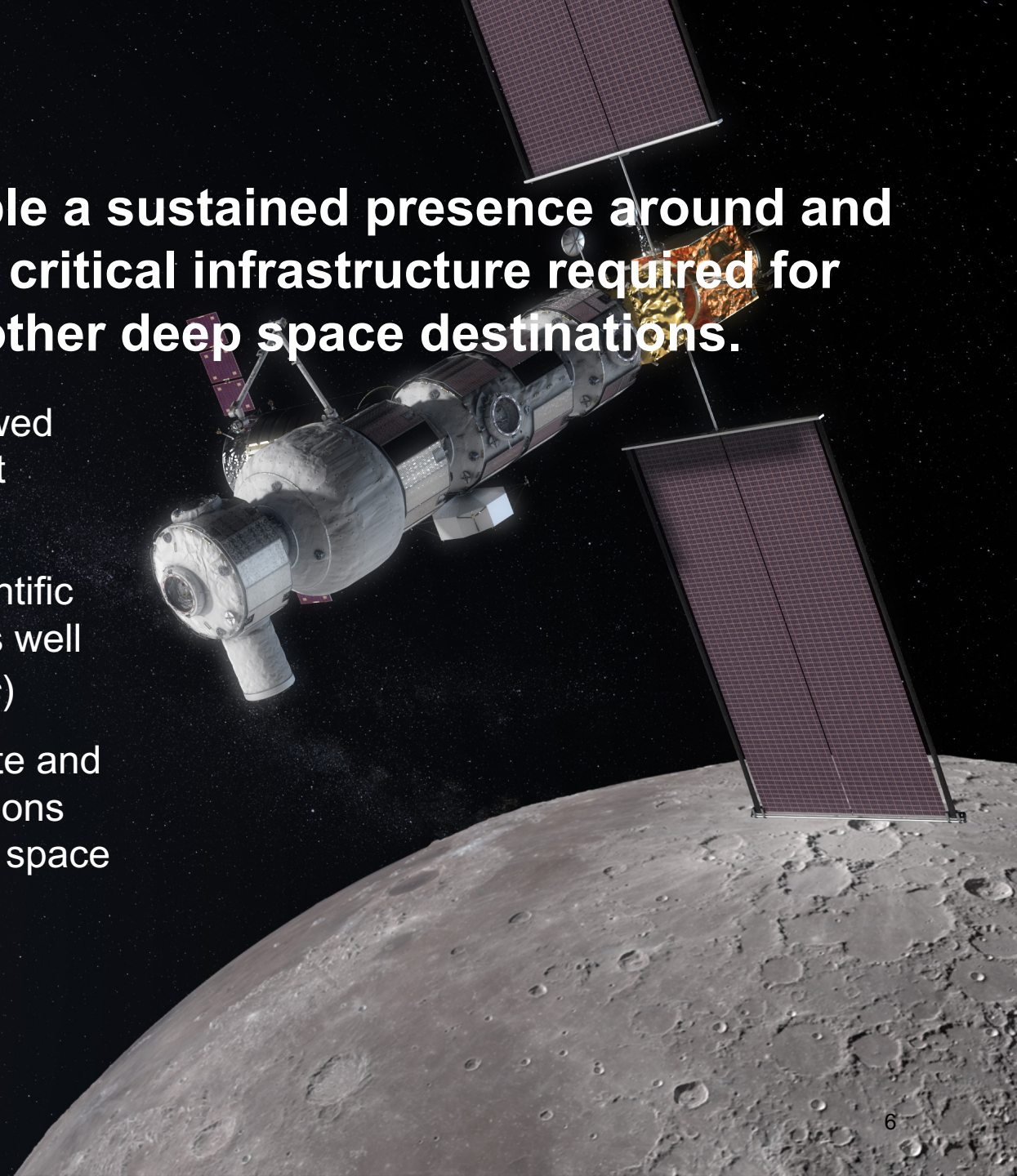
The Gateway



The Gateway Objectives

NASA shall establish a Gateway to enable a sustained presence around and on the Moon and to develop and deploy critical infrastructure required for operations on the lunar surface and at other deep space destinations.

- The Gateway shall be utilized to enable human crewed missions to cislunar space including capabilities that enable surface missions. (*Crewed Missions*)
- The Gateway shall provide capabilities to meet scientific requirements for lunar discovery and exploration, as well as other science objectives. (*Science Requirements*)
- The Gateway shall be utilized to enable, demonstrate and prove technologies that are enabling for Lunar missions and that feed forward to Mars as well as other deep space destinations. (*Proving Ground & Technology Demonstration*)
- NASA shall establish industry and international partnerships to develop and operate the Gateway. (*Partnerships*)

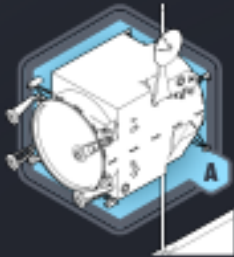


GATEWAY

An exploration and science outpost in orbit around the Moon

Power and Propulsion Element:

Power, communications, attitude control, and orbit control and transfer capabilities for the Gateway.



ESPRIT:

Science airlock, additional propellant storage with refueling, and advanced lunar telecommunications capabilities.

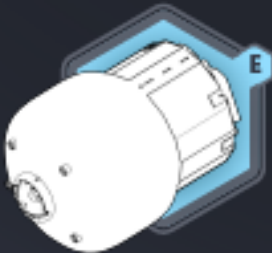
U.S. Utilization Module:

Small pressurized volume for additional habitation capability.



Habitation Modules:

Pressurized volumes with environmental control and life support, fire detection and suppression, water storage and distribution.



Robotic Arm:

Mechanical arm to berth and inspect vehicles, install science payloads.



Logistics and Utilization:

Cargo deliveries of consumables and equipment. Modules may double as additional utilization volume.



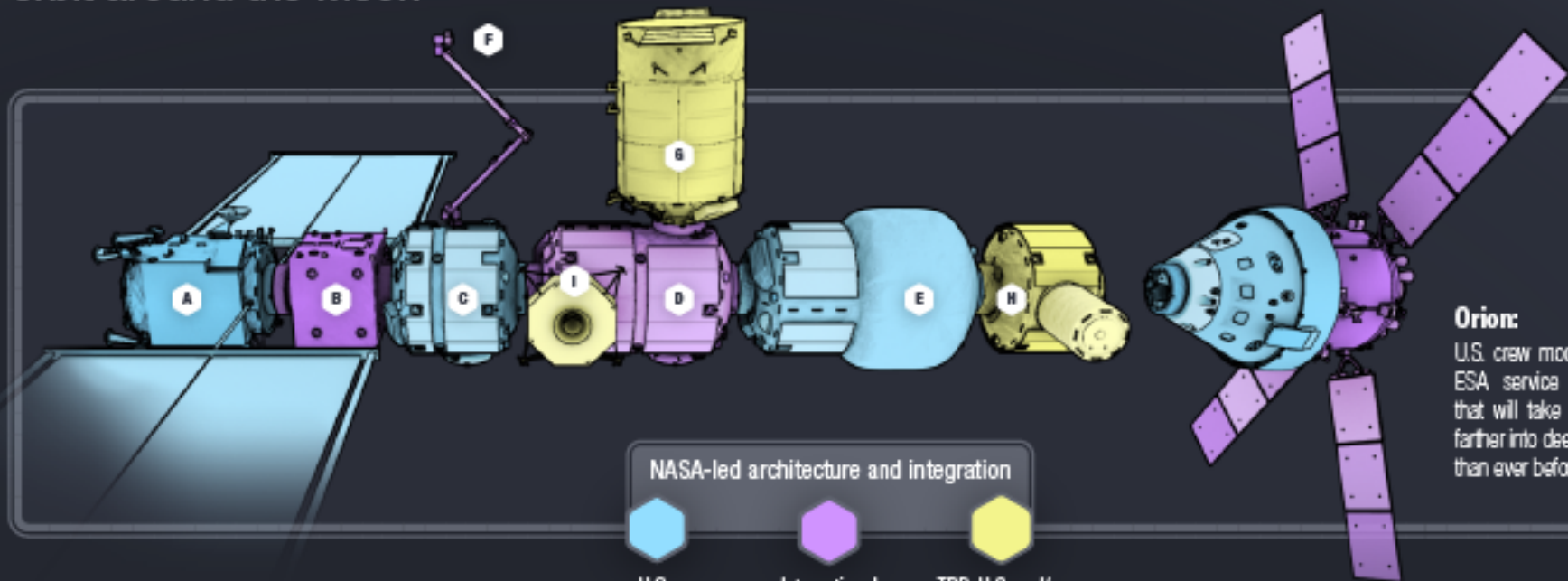
Airlock:

Enables spacewalks, potential to accommodate docking elements.



Sample Return Vehicle:

A robotic vehicle capable of delivering small samples or payloads from the lunar surface to the Gateway.



NASA-led architecture and integration

U.S.

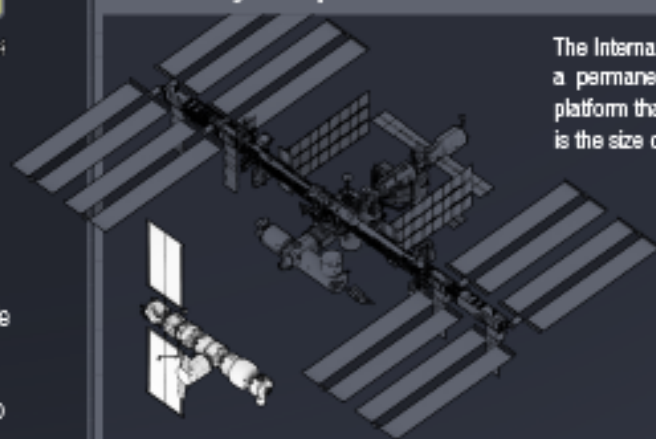
International

TBD: U.S. and/or International

Orion:

U.S. crew module with ESA service module that will take humans farther into deep space than ever before.

Gateway Compared to the International Space Station



The International Space Station is a permanently crewed research platform that has 11 modules and is the size of a football field.

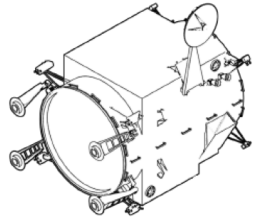
The Gateway is a much smaller, more focused platform for extending initial human activities into the area around the Moon.

Gateway Modules



ADVANCED SEP

Power and Propulsion Element: 2022
Power, in-space transportation, and initial lunar communications

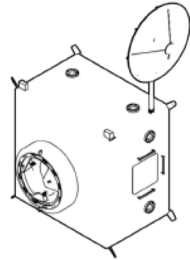


- One or more competitive awards to U.S. industry
- Launching 2022 on partner-provided commercial launch vehicle.
- Acquisition time: 3 years

EARLY OPERATIONAL CAPABILITY

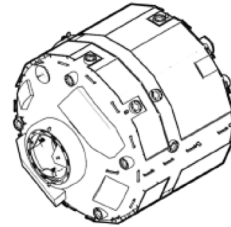
Launch package: ESPRIT and U.S. utilization module: 2023

ESPRIT provides PPE refueling, science airlock and additional lunar communications. The U.S. Utilization Element provides initial habitation volume and logistics for up to 15 days



ESPRIT:

- International partner provided
- Launching NET 2023 on SLS
- Acquisition time: 3-4 years



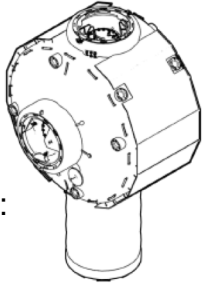
U.S. Utilization Module:

- Provided by NASA
- Launching NET 2023 on SLS
- Acquisition time: 3-4 years

EVA CAPABILITY

Airlock: *Enables EVAs and additional docking*

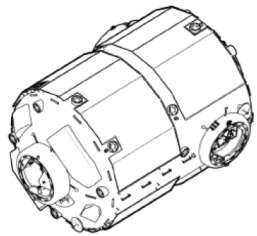
- Acquisition approach deferred until 2020
- Acquisition time: 3-6 years



ENHANCED HABITATION

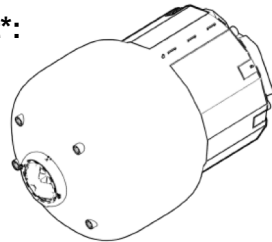
International partner and U.S. habitat modules: 2024 and 2025

Two habitats provide increased volume for crew operations and science.



International Partner Habitat*:

- Launching NET 2024 on SLS
- Acquisition time: 5 years



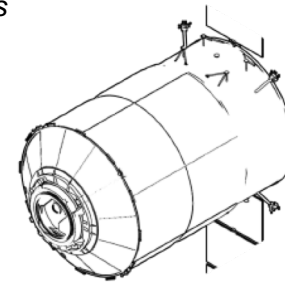
U.S. Habitat*:

- U.S. provided by competitive award to industry
- Launching NET 2025 on SLS
- Acquisition time: 5-6 years

*Habitat functional allocations are currently under review

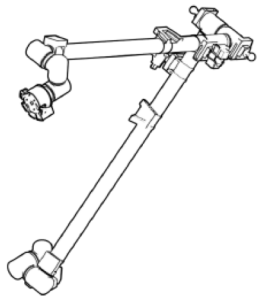
ENHANCED SCIENCE & OPERATIONS

Launch package: *Provides logistics and utilization payloads, external robotic capabilities*



Logistics:

- U.S. and international partner provided
- Earliest delivery 2024
- Acquisition time: 3-4 years

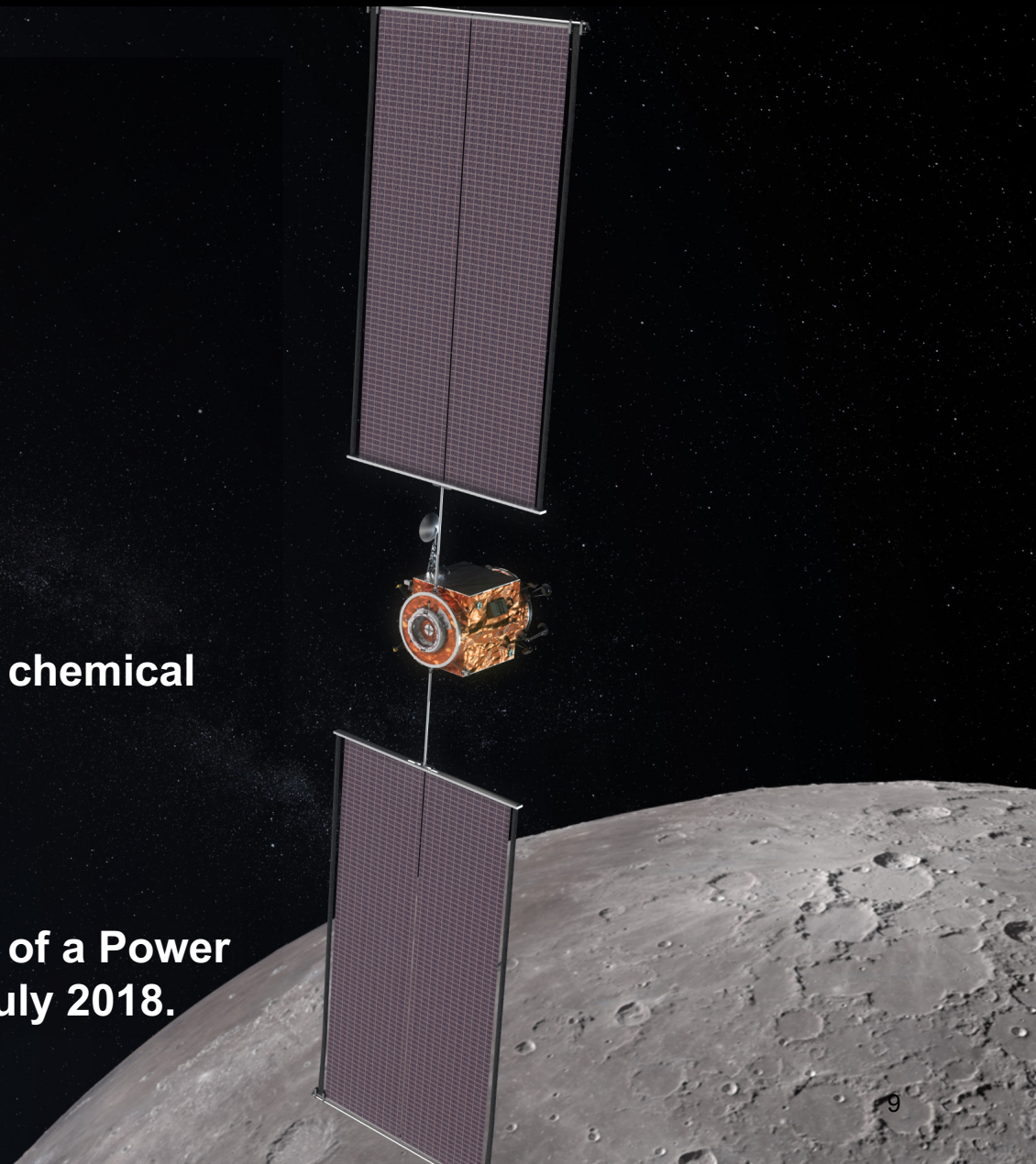


Robotic Arm:

- International partner provided
- Earliest delivery on first logistics flight (2024)

Power and Propulsion Element: *First Module in Lunar Orbit for Gateway*

- 2022 launch on partner-provided commercial rocket
- 50 kW class spacecraft with 40 kW class EP system
- Power transfer to other gateway elements
- Passive docking using IDSS compliant interface
- Capability to move gateway to multiple lunar orbits
- Orbit control for gateway stack
- Communications with Earth, visiting vehicles, and initial communications support for lunar surface systems
- 2t class xenon EP propellant capacity, refuelable for both chemical and xenon propellants
- Accommodations for utilization payloads
- 15 year life
- NASA issued a synopsis for a Spaceflight Demonstration of a Power and Propulsion Element in Feb. 2018. Draft BAA issued July 2018. Final BAA expected Sept. 6, 2018



U.S. Habitation Development Partnerships

Five full-sized ground prototypes will be delivered for testing in 2019. In final negotiations with NanoRacks for sixth habitat prototype demonstrator.

Lockheed Martin
Denver, CO



Refurbishes
heritage hardware

**Northrop
Grumman**
Dulles, VA



Builds on proven
cargo spacecraft
development

**Bigelow
Aerospace**
Las Vegas, NV



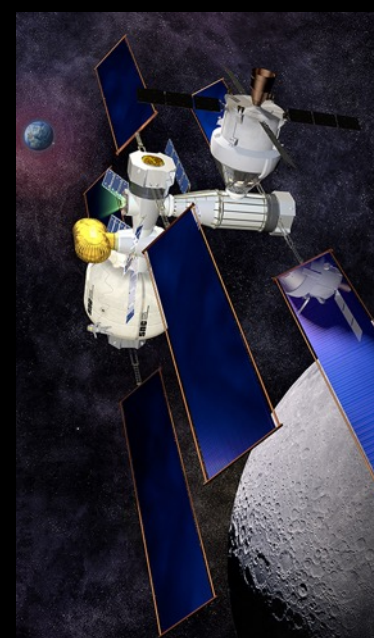
Expandable

Boeing
Pasadena, TX



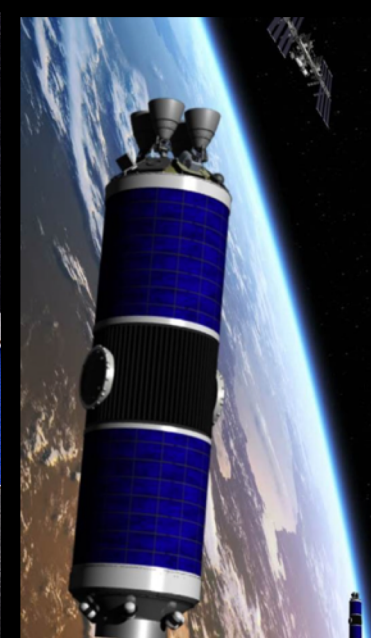
Leverages existing
technologies

Sierra Nevada
Louisville, CO



Modular buildup

NanoRacks
Louisville, CO

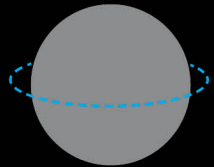


Converted Centaur
upper stages

GATEWAY ORBIT

Cislunar space offers innumerable orbits for consideration, each with merit for a variety of operations. The gateway will support missions to the lunar surface and serve as a staging area for exploration farther into the solar system, including Mars.

ORBIT TYPES



LOW LUNAR ORBITS

Circular or elliptical orbits close to the surface. Excellent for remote sensing, difficult to maintain in gravity well.

» Orbit period: 2 hours

DISTANT RETRO-GRADE ORBITS

Very large, circular, stable orbits. Easy to reach from Earth, but far from lunar surface.

» Orbit period: 2 weeks

HALO ORBITS

Fuel-efficient orbits revolving around Earth-Moon neutral-gravity points.

» Orbit period: 1-2 weeks

NEAR-RECTILINEAR HALO ORBIT (NRHO)

1,500 km (932 miles) at its closest to the lunar surface, 70,000 km (43,495 miles) at its farthest.



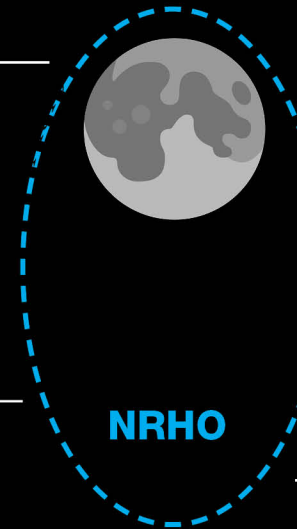
ACCESS

Easy to access from Earth orbit with many current launch vehicles. Staging point for both lunar surface and deep space destinations.



ENVIRONMENT

Deep space environment useful for radiation testing and experiments in preparation for missions to the lunar surface and Mars.



SCIENCE

Favorable vantage point for Earth, sun and deep space observations.



COMMUNICATIONS

Provides continuous view of Earth and communication relay for lunar farside.



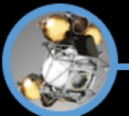
SURFACE OPERATIONS

Supports surface telerobotics, including lunar farside. Provides a staging point for planetary sample return missions.



GATEWAY

A spaceport for human and robotic exploration to the Moon and beyond



HUMAN ACCESS TO & FROM LUNAR SURFACE

Astronaut support and teleoperations of surface assets.



U.S. AND INTERNATIONAL CARGO RESUPPLY

Expanding the space economy with supplies delivered aboard partner ships that also provide interim spacecraft volume for additional utilization.



SAMPLE RETURN

Pristine Moon or Mars samples robotically delivered to the Gateway for safe processing and return to Earth.



INTERNATIONAL CREW

International crew expeditions for up to 30 days as early as 2024. Longer expeditions as new elements are delivered to the Gateway.

SCIENCE AND TECH DEMOS

Support payloads inside, affixed outside, free-flying nearby, or on the lunar surface. Experiments and investigations continue operating autonomously when crew is not present.

COMMUNICATIONS RELAY

Data transfer for surface and orbital robotic missions and high-rate communications to and from Earth.



SIX DAYS TO ORBIT THE MOON

The orbit keeps the crew in constant communication with Earth and out of the Moon's shadow.

A HUB FOR FARTHER DESTINATIONS

From this orbit, vehicles can embark to multiple destinations: The Moon, Mars and beyond.

GATEWAY SPECS



4 Crew Members



30-90 Day Crew Missions



125 m³ Pressurized Volume



Up to 75mt with Orion docked

ACCESS



384,000 km from Earth

Accessible via NASA's SLS as well as international and commercial ships.

