Dina Contella
Gateway Program, NASA

Manager for Operations Integration &
Acting Manager for Utilization

2019 APD SMEX & MO
Pre-proposal Conference
May 2, 2019

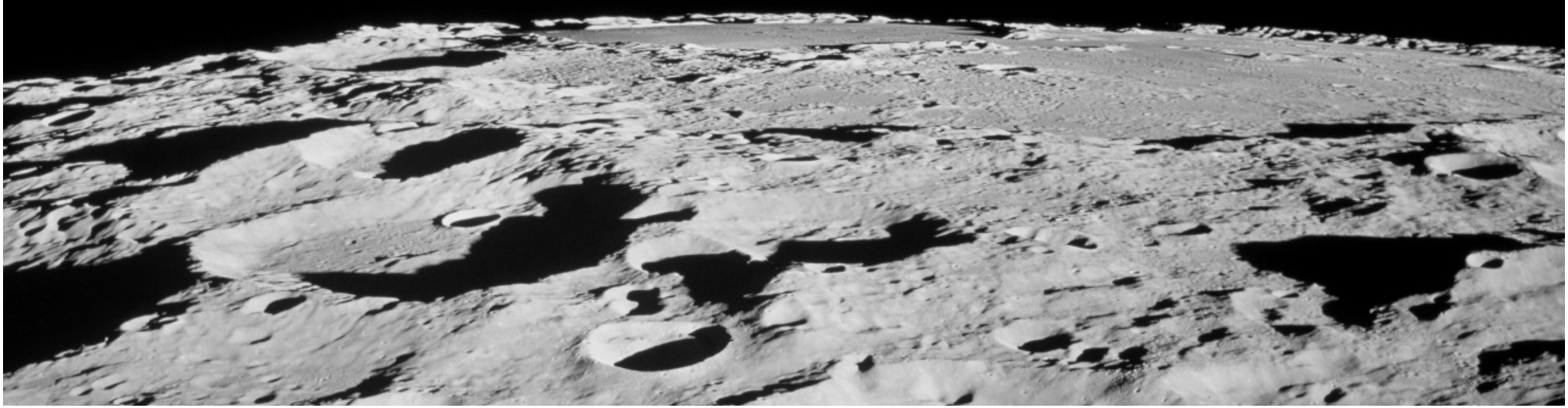
FORWARD TO THE MOON

- NASA is leading a sustainable return to the Moon with commercial and international partners to expand human presence in space and bring back new knowledge and opportunities

- Charged to get Americans to the Moon by 2024

- Proving ground to test technologies for Mars

- Sustainable, reusable architecture

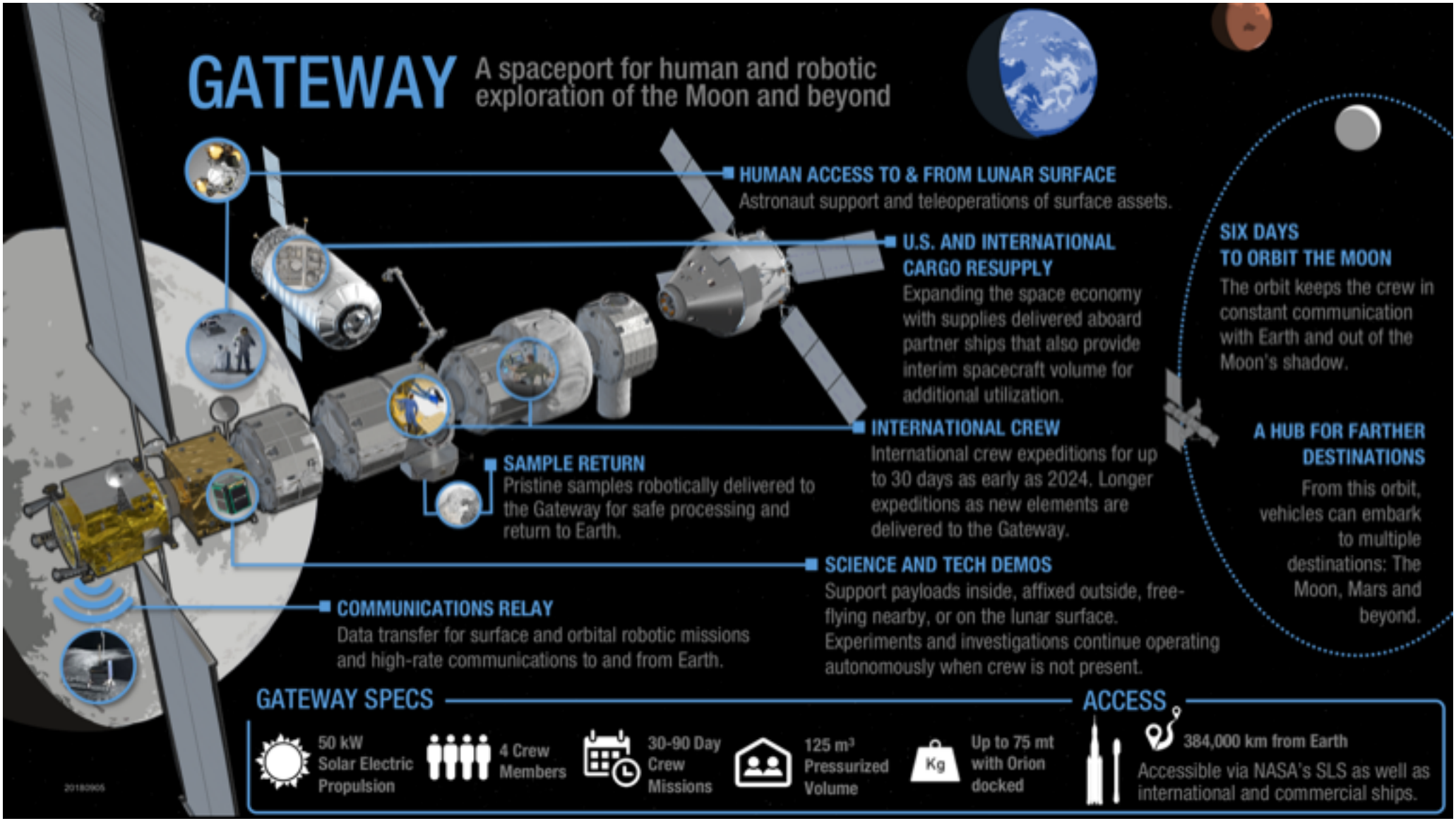


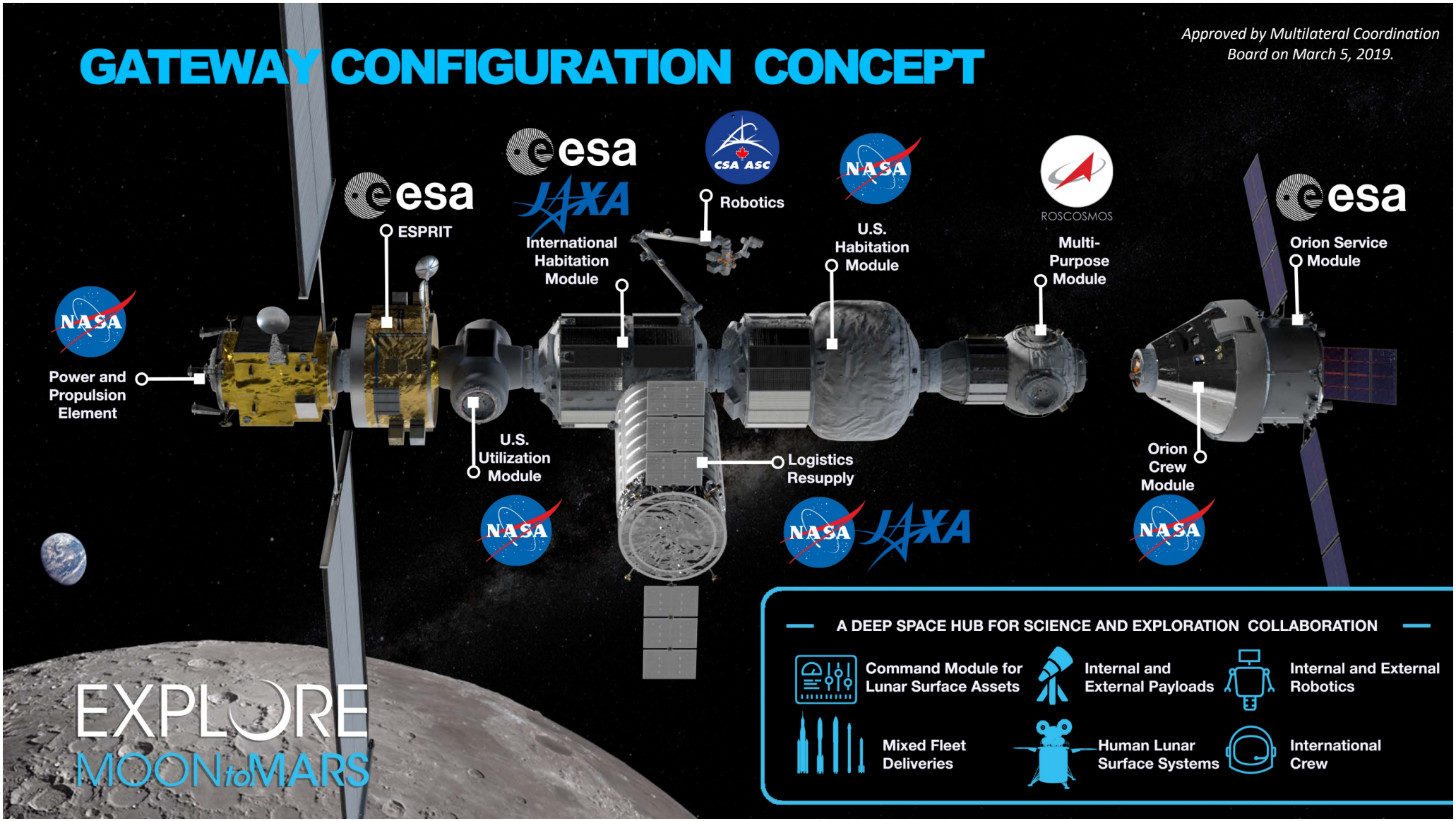
Moving beyond LEO

SPD-1: Reinvigorating America's Human Space Exploration Program

"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."


GATEWAY
A spaceport for human and robotic exploration of 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.
INTERNATIONAL CREW
International crew expeditions for up to 30 days as early as 2024. Longer expeditions as new elements are delivered to the Gateway.
SAMPLE RETURN
Pristine samples robotically delivered to the Gateway for safe processing and return to Earth.
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
50 kW Solar Electric Propulsion
4 Crew Members
30-90 Day Crew Missions
125 m³ Pressurized Volume
Kg
Up to 75 mt with Orion docked
ACCESS
384,000 km from Earth
Accessible via NASA's SLS as well as international and commercial ships.
20180905


GATEWAY CONFIGURATION CONCEPT
Approved by Multilateral Coordination Board on March 5, 2019.
esa
ESPRIT
esa
JAXA
International Habitation Module
CSA ASC
Robotics
NASA
U.S. Habitation Module
ROSCOSMOS
Multi-Purpose Module
esa
Orion Service Module
NASA
Power and Propulsion Element
U.S. Utilization Module
Logistics Resupply
Orion Crew Module
NASA
NASA
JAXA
NASA
A DEEP SPACE HUB FOR SCIENCE AND EXPLORATION COLLABORATION
Command Module for Lunar Surface Assets
Internal and External Payloads
Internal and External Robotics
Mixed Fleet Deliveries
Human Lunar Surface Systems
International Crew
EXPLORE
MOON to MARS

Gateway Elements and Modules

ELEMENTS	Power and Propulsion	Habitation	Logistics	External Robotics	Airlock
MODULES	 Power and Propulsion Element	 International Habitat  U.S. Habitat  ESPRIT  U.S. Utilization Module	 Logistics Vehicle	 Robotic Arm	 Multi Purpose Module
SYSTEMS & CAPABILITIES *not exhaustive*	• Solar arrays • High Power Electric Propulsion • Initial Communications • Power transfer • Passive NASA Docking System (NDS) • Orbit transfer	• ECLSS • Exercise equipment • NDS and International Berthing and Docking Mechanism (IBDM) • Command and Control • Science airlock • Thermal radiators • Logistics stowage • Crew systems	• Automated rendezvous and docking • Proximity operations • Pressurized and unpressurized cargo holds • Logistics stowage • Trash disposal	• Sensors • Wedge Mounting Interfaces (WMIs) • Low Profile Grapple Fixtures (LPGFs) • Payload docking and berthing • Operations and maintenance	• EVA support • Thermal radiators • Logistics stowage • Additional docking

APPROACH

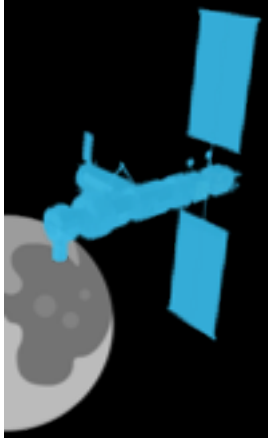
- **We are going forward to the Moon in two phases:**
  - Land the next man, and first woman, on the Moon by 2024
  - Establish sustainable missions by 2028

- **For Gateway:**

  - **Phase 1** is focused on developing the systems required for the 2024 surface mission (PPE and Minimal Habitat)

  - **Phase 2** will support additional modules that will enable longer surface stays for crew (US Hab) and maintains existing agreements with international partners (ESPIRIT, IHAB, External Robotics, Airlock)

POTENTIAL GATEWAY SCIENCE OPPORTUNITIES



CREWS LIVING AND WORKING IN THE DEEP SPACE ENVIRONMENT

- » Human health and performance associated with living and working in deep space

ELEMENTS WILL HAVE INTERNAL AND EXTERNAL PAYLOAD ACCOMMODATIONS

- » Earth science, heliophysics, astrophysics, lunar/planetary science, and fundamental physics
- » Technology and capability testing for future exploration destinations
- » Combined radiation effects and microgravity on biological organisms

LUNAR SURFACE OPPORTUNITIES

- » Crewed and robotic surface missions
- » Sample return
- » Lander and systems development

OTHER CISLUNAR LOCATIONS ACCESSIBLE

- » Potential for use of logistics modules as science platforms post departure from Gateway, including heliocentric disposal orbit
- » Variations of NRHO, Low Lunar Orbit, Distant Retrograde Orbit, Earth-Moon Lagrange Points

GATEWAY COMMUNICATIONS RELAY

- » Coverage of lunar poles, craters/valleys and lunar farside not possible from Earth
- » Teleoperations of surface assets by crew or Earth-based operators
- » In support of CubeSats and small satellite communications relay

PAYLOAD INTERFACES

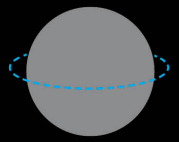
- NASA and the Gateway Program are still defining Gateway requirements – design details are not available
- Some key payload-related draft requirements as they are known to-date are included in the Library Cislunar documentation
  - Mass, power, communication, etc.
- Gateway will adhere to the International Deep Space Interoperability Standards: https://www.internationaldeepspacestandards.com/
  - Seven standards defined to date: Avionics, Communications, ECLSS, Power, Rendezvous, Robotics, and Thermal
  - Gateway still evaluating which will apply to external payloads, to be documented in the Interface Definitions Document (IDD)
  - Robotics Standard defines interfaces for external payloads
- External payloads may be transported externally or transported internally and transferred to an external location via science airlock
  - Gateway will likely implement Small ORU Platform Interfaces for external mounting and transfer (details in Library)
- No EVA interaction is assumed for payloads
- Internally launched payloads would likely be launched in a bag in protected “foam”, with no hard mount during launch in the logistics element

BACK-UP

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.

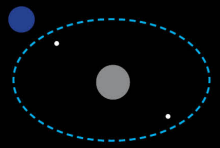
ORBIT TYPES



LOW LUNAR ORBITS

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

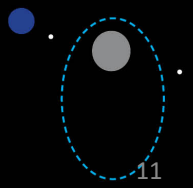
» Orbit period: 2 hours



DISTANT RETRO-GRADE ORBITS

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

» Orbit period: 2 weeks



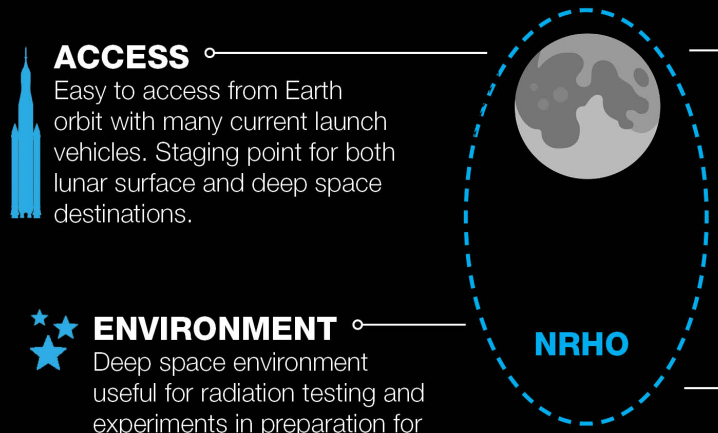
HALO ORBITS

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

» Orbit period: 1-2 weeks

NEAR-RECTILINEAR HALO ORBIT (NRHO)

1,500 km at its closest to the lunar surface, 70,000 km 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.