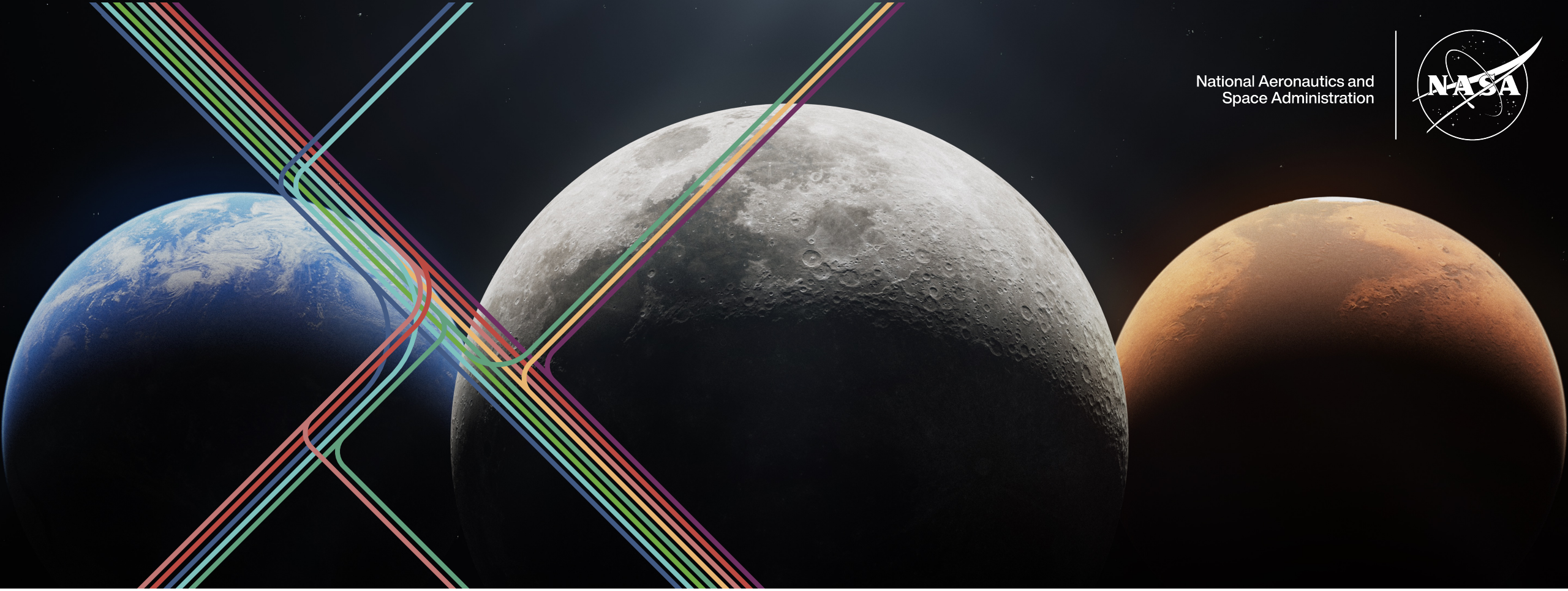

National Aeronautics and Space Administration

Gaps and Needs Opportunities for Partnership

Nujoud Merancy
Deputy Associate Administrator
Strategy and Architecture Office
NASA – ESDMD – SAO

Architecture Gap Definition

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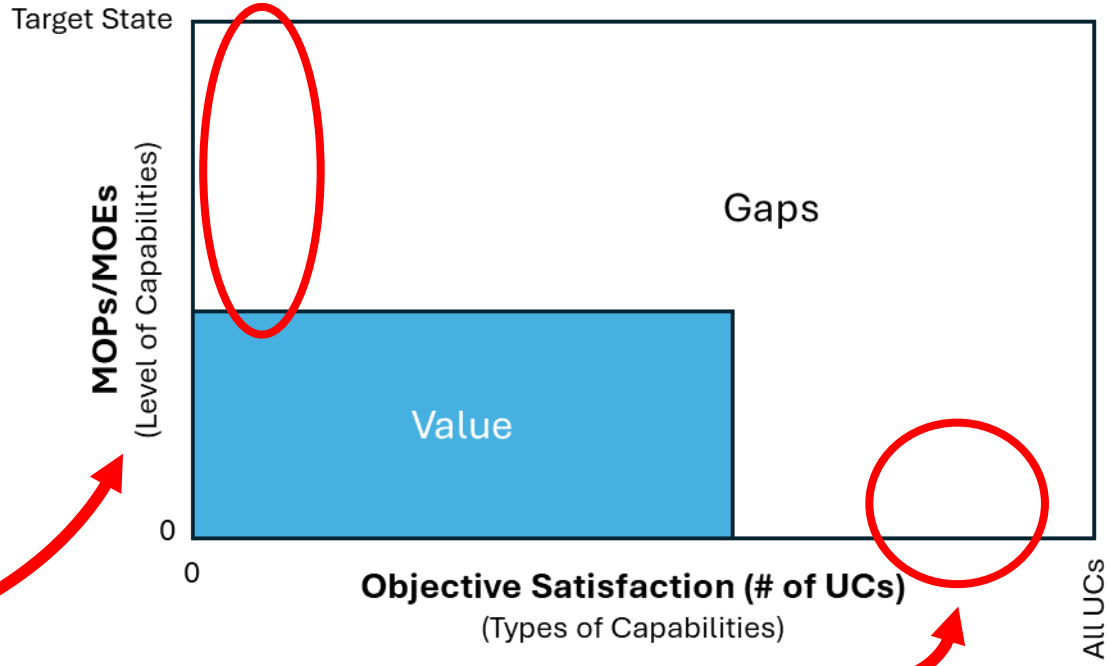
- NASA continues to assess needs to achieve the Moon to Mars Objectives
- Gaps can be identified two ways:
  - Unfilled Use Cases/Functions
  - Performance gap with only partially addressed capability



Example Performance Gap

FN-H-102 L	Enable a pressurized, habitable environment on the lunar surface for moderate duration (month+) use
FN-X-103 L	Provide crew countermeasure system(s) to support the crew for moderate durations (month+) on the lunar surface

Example Capability Gap from ADD

FN-P-101 L	Generate power in the south pole region on the lunar surface
FN-P-202 L	Store energy in the south pole region on the lunar surface

Foundational Exploration Gap Example

National Aeronautics and Space Administration

Power Sharing at Lunar South Pole

Key Functions	
FN-P-101 L	Generate power in the south pole region on the lunar surface
FN-P-202 L	Store energy in the south pole region on the lunar surface
FN-P-301 L	Distribute power in the south pole region on the lunar surface
FN-P-401 L	Provide power for deployed surface utilization payloads(s) and/or equipment
FN-P-402 L	Provide power for deployed external surface utilization payloads(s) and/or equipment for long durations (months to years+)
FN-U-414 L	Provide resources to condition refrigerated sample containers on the lunar surface
FN-U-415 L	Provide resources to condition frozen sample containers on the lunar surface

Key Performance Targets	
Dist. Power on Lunar Surface	>10 kW estimated distributable power in South Pole region

Power generation, storage, and distribution to exploration assets at the lunar South Pole sites, supporting sunlight and eclipse periods.

- Minimum closure 2 major elements:
  - Power generation and/or storage of 10kW
  - Power distribution/interface/cabling system
- Stretch and/ or alternate capabilities:
  - Redundant power systems at multiple locations
  - Power system ranges from 3 to 10 kW or greater
- Estimate 2-4 ton relocatable systems

Multiple ways to address this gap are possible, characterizing the need and constraints enable collaboration

High Priority Gaps

Foundational Exploration Segment

National Aeronautics and Space Administration

Sub-Architecture	Integrated Gap	Summary Element Need	Expressed Partner Interest
Power	Power Sharing at Lunar South Pole	2 Major (power + interface/cabling), stretch 2-3 more elements	●●●●
Mobility	High-Capacity Mobility at Lunar South Pole	2-3 Major Elements	●●●●●●●
Logistics	Logistics Delivery and Mgmt Systems	1 major/1 minor both with repeat production	
Logistics	Water and Gas Transfer on Lunar Surface	multiple sub-elements with repeat production	
Transportation	Large Cargo Delivery to the Lunar Surface	2-3 major elements	●●●
Transportation	Large Cargo Return from NRHO to Earth or from Lunar Surface to Earth	2 major elements, return vehicle & Gateway docking mitigation	●
Habitation	Extended Crew Habitation at Lunar South Pole	1 -2 major elements, multiple sub-elements/systems	●●
Habitation	Extended Crew Habitation in NRHO	1 major element	●
Utilization	Resource Identification on Lunar Surface	Pending Utilization Analysis	
Utilization	Deep Subsurface Sampling on Lunar Surface	Pending Utilization Analysis	
Utilization	Storage of Cryogenic Samples	Pending Utilization Analysis	

Priority defined by the significance of closure to objective satisfaction and overall mission capability achieved

Secondary Gaps

Foundational Exploration Segment

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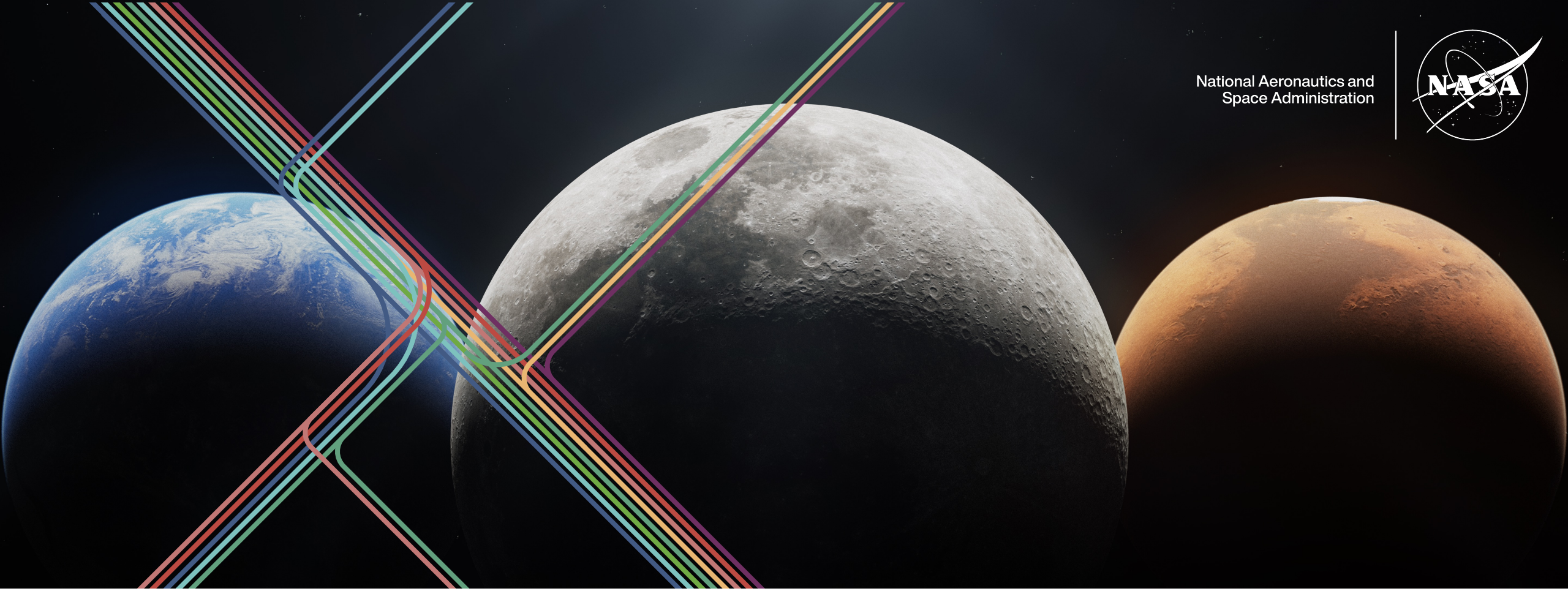
Sub-Architecture	Integrated Gap	Expressed Partner Interest
Mobility	Crew Mobility at Distributed Locations on the Lunar Surface	
Power	Power Sharing at Distributed Locations on the Lunar Surface	
Mobility	Extra Vehicular Activity Capability on Lunar Far Side	
Utilization	Lunar Surface Observation	●
C&PNT	PNT Capabilities at non-South Pole Sites on the Lunar Surface	●●●●
Data	In-Space Processing of Data	
Transportation	Delivery of Payloads and Equipment to Deep Space	
Utilization	Hosting of Utilization Payloads in Deep Space	
Auto/Robotics	Robotic Assistance of Crew on Lunar Surface	●●●
Habitation	Management of Waste Streams on Lunar Surface	●
ISRU	Demonstration of Oxygen and Water ISRU on Lunar Surface	●
ISRU	Demonstration of Regolith-Based ISRU on Lunar Surface	
Auto/Robotics	Demonstration of Autonomous Construction on Lunar Surface	●
Transportation	Long-Term Storage of Propellants	
Transportation	Access Tank Residuals from Transportation Elements	●
Habitation	Demonstration of Advanced ECLSS Capabilities	

Targeted needs and gaps to enhance the Foundational Exploration segment and/or enable technology and capabilities for Humans to Mars Segment



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Foundational Exploration Capability Gaps for Science

Brad Bailey
Assistant Deputy Associate Administrator for Exploration
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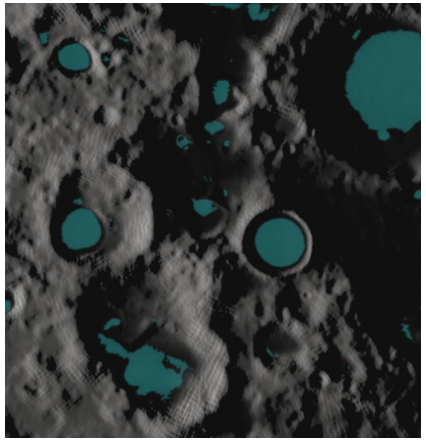
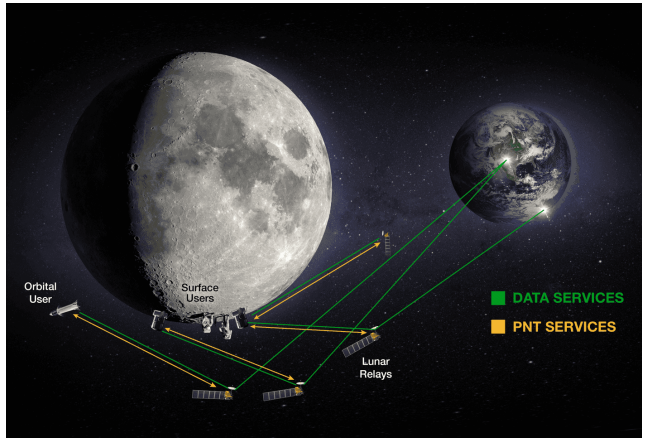
NASA - SMD

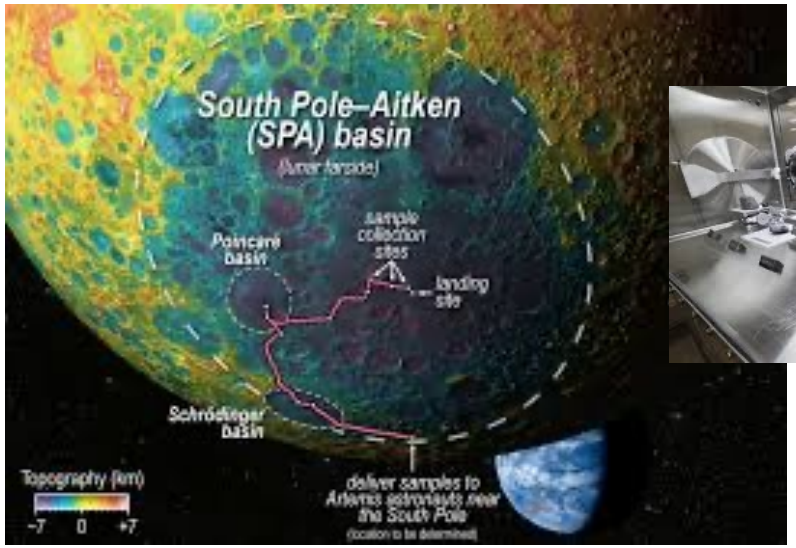
Key Gaps Existing for Science

Foundational Exploration Segment

National Aeronautics and Space Administration





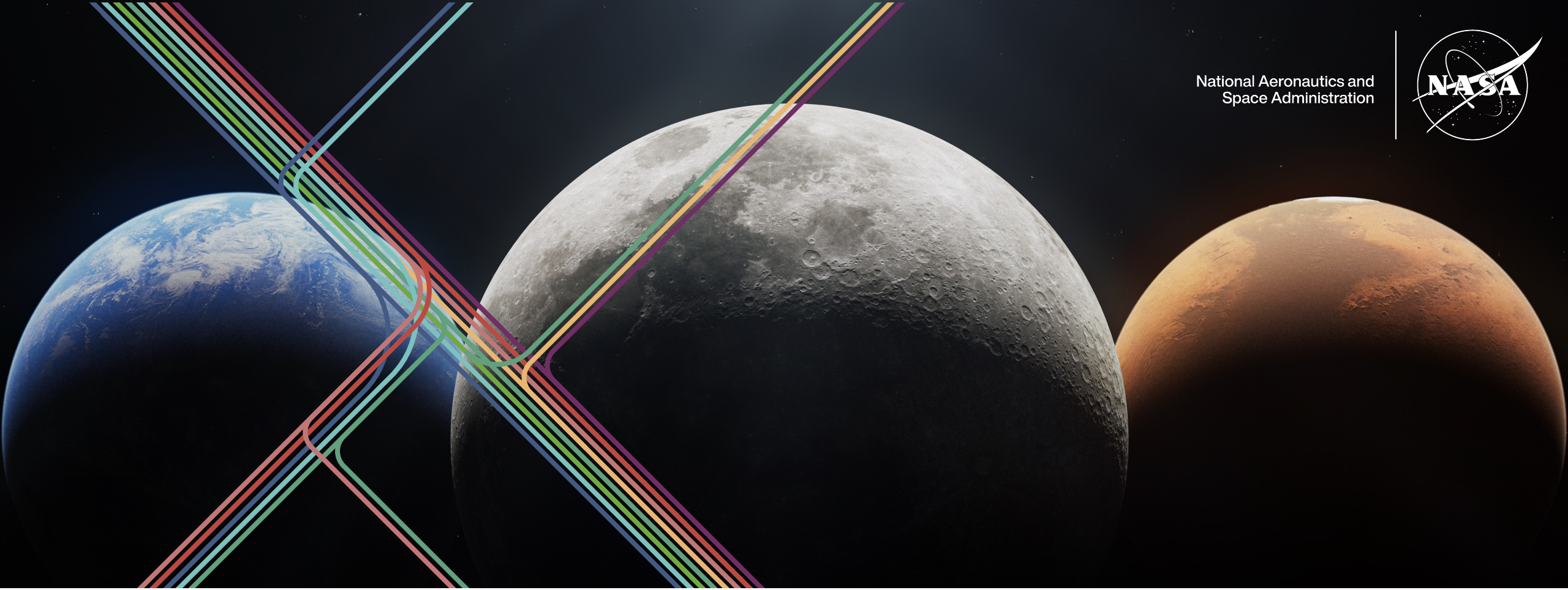


Current High Priority Gaps for Science

- Payload delivery, transport, and survive/operate the night
- Far Side Sample Return
- Large Cargo Return
- Communications (EVA, deployed instruments, far side/global)
- Power (long lived instruments, recharge, storage, StN/operate through night)
- Cold conditioned sampling and curation (sampling/PSR conops, technologies, curation, analytical facilities)

Upcoming Academy / SDT Studies That Will Inform Architecture

- High Priority Science Campaigns for Human Explorers on the Surface of Mars
- SPA Return & Exploration (SPARX) Science Definition Team
- Key Destinations Across the Moon to Address Decadal-level Science Objectives with Human Explorers
- *Science Accomplished during Human Mars Transit (planned)*
- *Science Addressed from a Sustained Lunar Basecamp (planned)*



Connections to LEO Microgravity Strategy

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Director, Cross-Directorate
Technical Integration Office
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LEO Microgravity Strategy

National Aeronautics and Space Administration

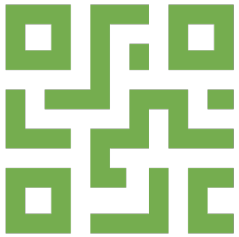
NASA's Low Earth Orbit Microgravity Strategy document outlines what NASA intends to achieve by continuing human activities in low Earth orbit after the retirement of the International Space Station.

By maintaining a robust presence in low Earth orbit, NASA will continue to drive scientific discovery, technological innovation, commercial growth, and international cooperation, all while positioning the United States to remain at the forefront of space in the coming decades.

Read the Strategy
https://bit.ly/3EycgVg

LEO Exploration Goals

National Aeronautics and Space Administration



Exploration Technology

Leverage the unique environment of low Earth orbit to advance technologies that enable future human exploration on and around the Moon and Mars.

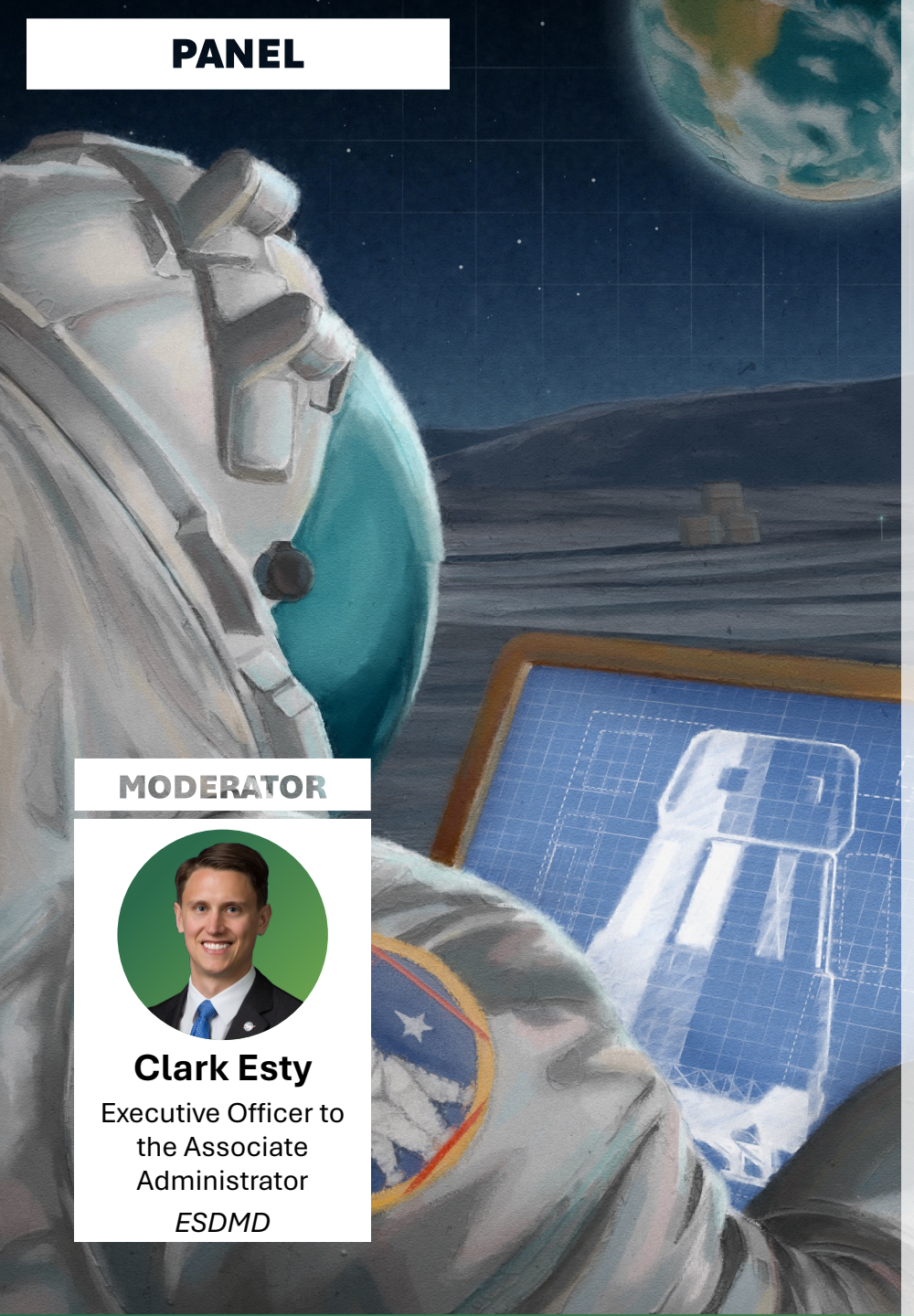
Human Health and Performance Research in Exploration Analog Environments

Advance understanding of how to sustain human health and performance using relevant exploration analog environments in low Earth orbit to reduce risks and inform Moon, Mars, and deep space missions.

Using Low Earth Orbit Operations to Prepare for Deep Space Exploration

Validate crewed mission operations in low Earth orbit as part of a timely and effective methodology to test the agency's evolutionary approach to living and working in environments relevant to Moon and Mars exploration.

PANEL



MODERATOR

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Executive Officer to the Associate Administrator
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National Aeronautics and Space Administration

Foundational Exploration:
Capability Gaps, Partnership Opportunities

Moon to Mars Architecture Workshop

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February 2025

Moon to Mars Architecture Workshops