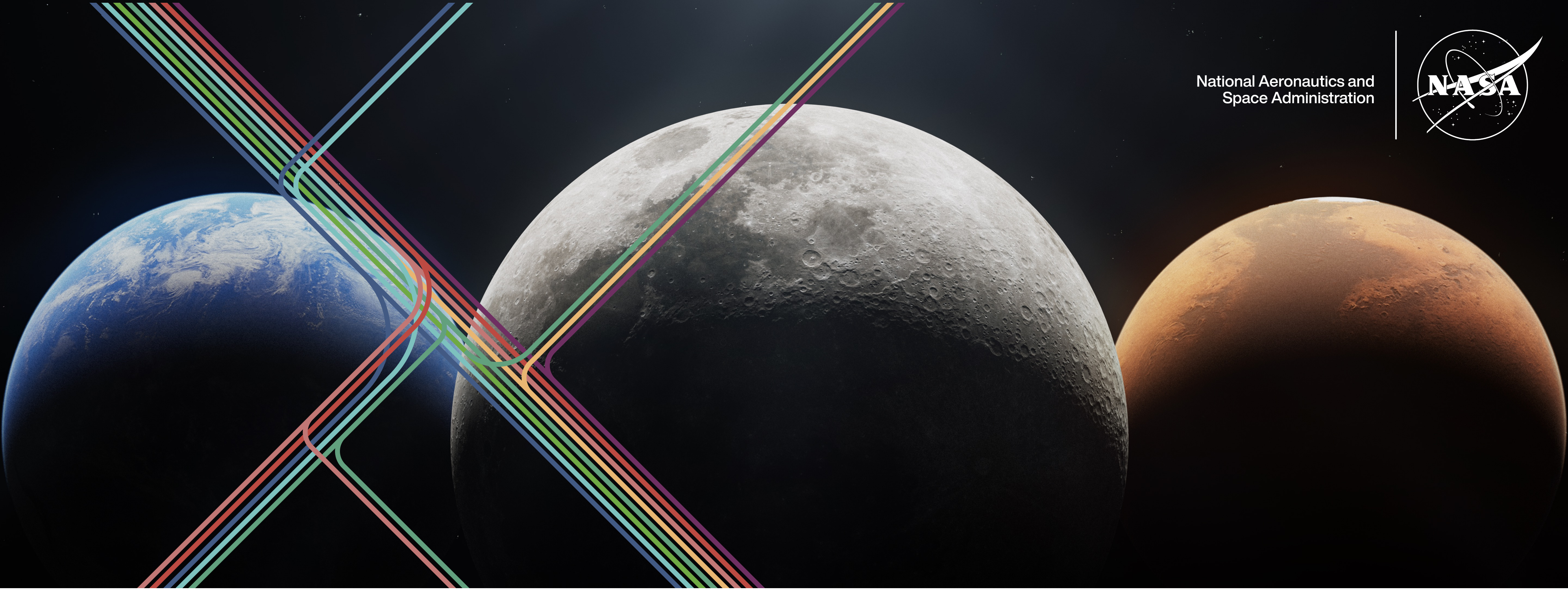


NASA International Partnerships

Office of International and Interagency Relations (OIIR)

Youshay Rizvi
International
Program Specialist

Outline

National Aeronautics and
Space Administration

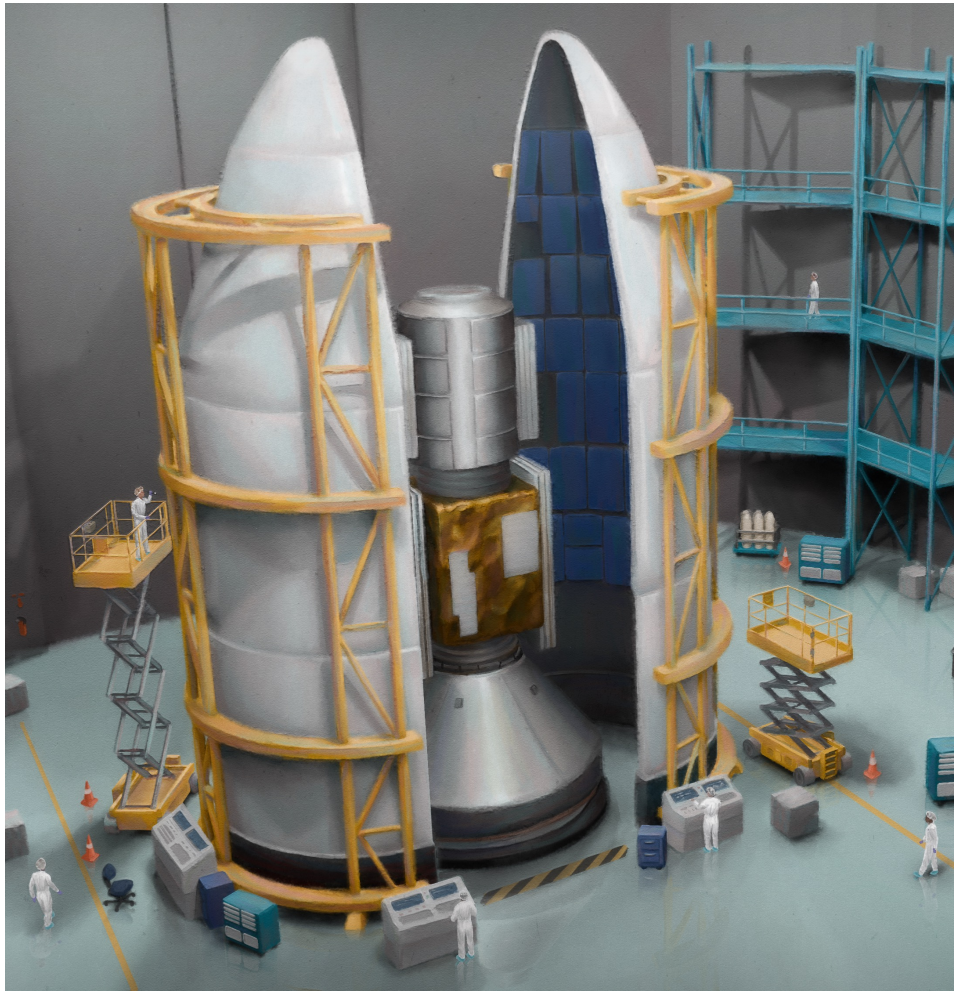
Partnership Guidelines

Cooperation Models

Guidelines

National Aeronautics and Space Administration

- Cooperation is generally government-to-government, between civilian agencies.
- Each partner generally funds their own activities, but activities need not be equivalent in terms of financial value.
- Cooperation should have scientific and technical merit and demonstrate specific benefits to NASA.
- Collaboration is structured to establish clearly defined managerial and technical interfaces to minimize complexity and protect against unwarranted technology transfer.



Guidelines *(cont.)*

National Aeronautics and Space Administration

- International partnerships generally do not involve joint development of technology. Each party retains intellectual property rights in the technology/hardware it brings to the partnership, developed independently of the other party.
- The results of the cooperation are fully shared, generally published and do not involve products or processes that are potentially of near-term commercial value.
- Exploratory discussions are welcome and encouraged, consistent with export control limitations.
- Specific cooperative activities are documented in written, legally binding agreements, closely coordinated with the U.S. Department of State.

Cooperation Models

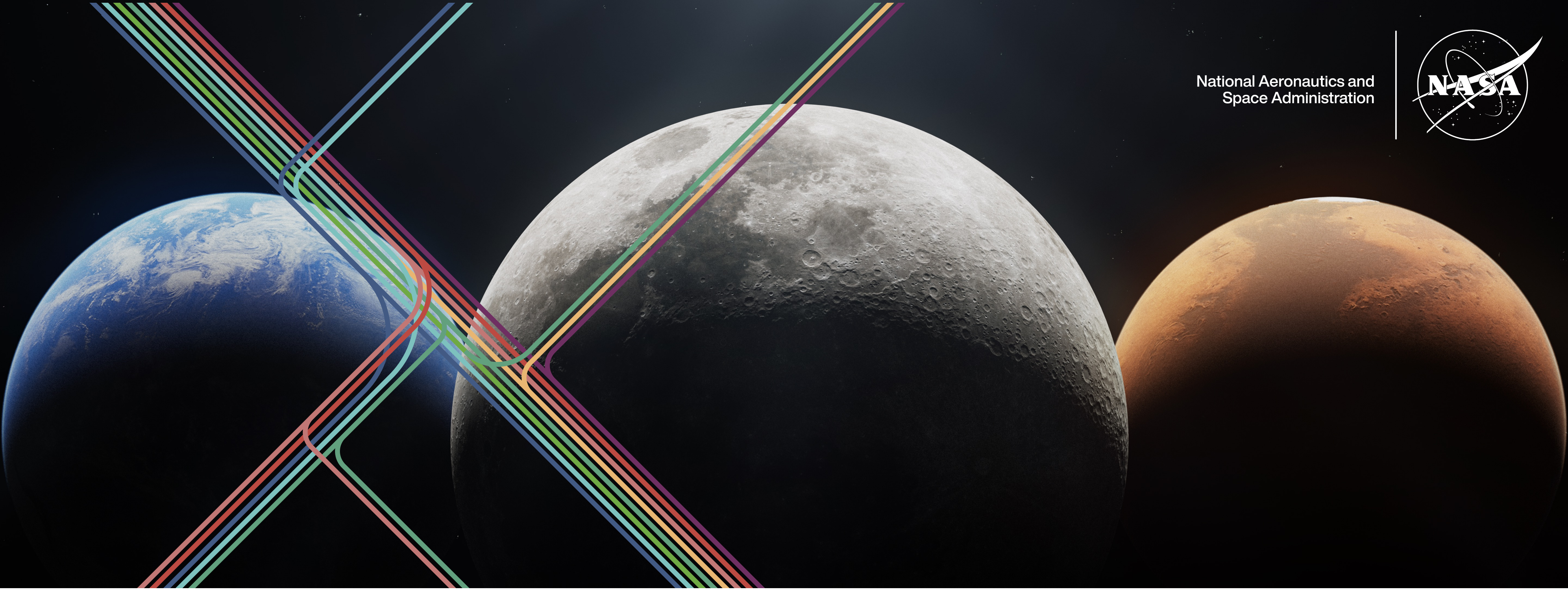
National Aeronautics and
Space Administration

Bottom Up
Competed

- Mid to low level missions are often conceived by scientists and engineers with a familiarity of global capabilities.
- These scientists work with their international counterparts to develop proposals for cooperative activity.
- Scientist to scientist collaboration generates the vast majority of NASA's international cooperative activity.

Top Down
Strategic

- Senior NASA leadership can look at specific agency needs and direct new missions.
- These are often large, highly visible programs with multi-year funding commitments.



Paths to Partnership

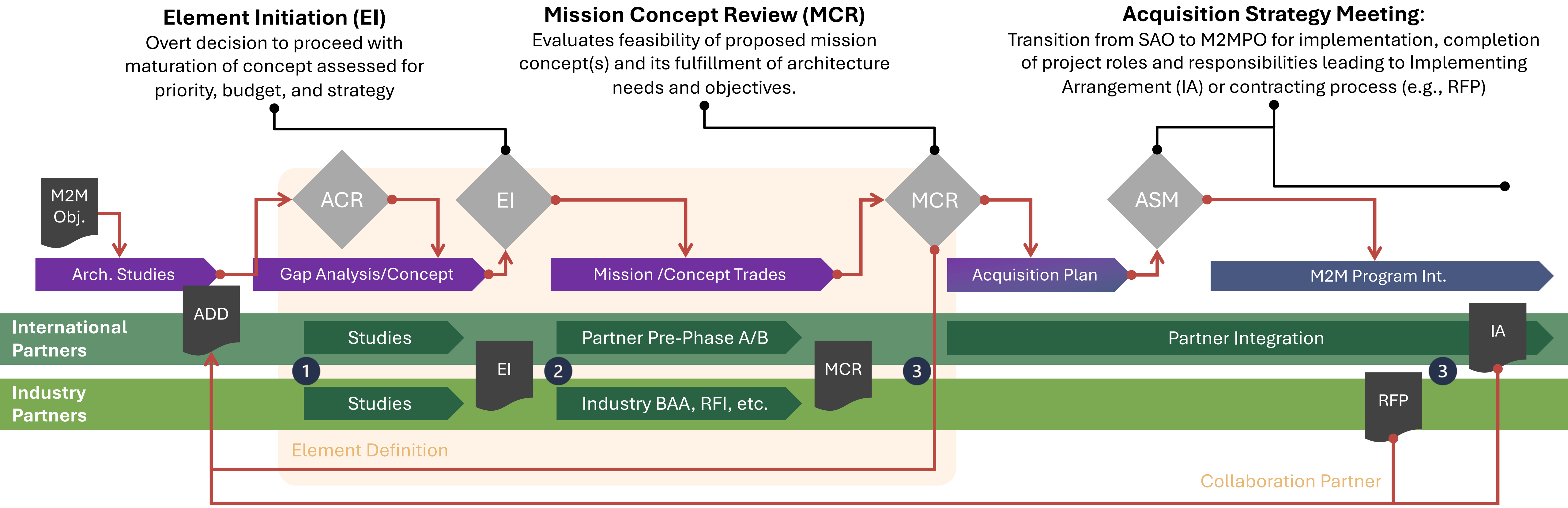
Exploration Systems Development Mission Directorate

Julie Grantier
Deputy Manager for Integration
Strategy and Architecture Office
NASA – ESDMD - SAO

Partner Pre-Formulation Process

Exploration Systems Development Mission Directorate

National Aeronautics and Space Administration



Document(s)

NASA Milestone

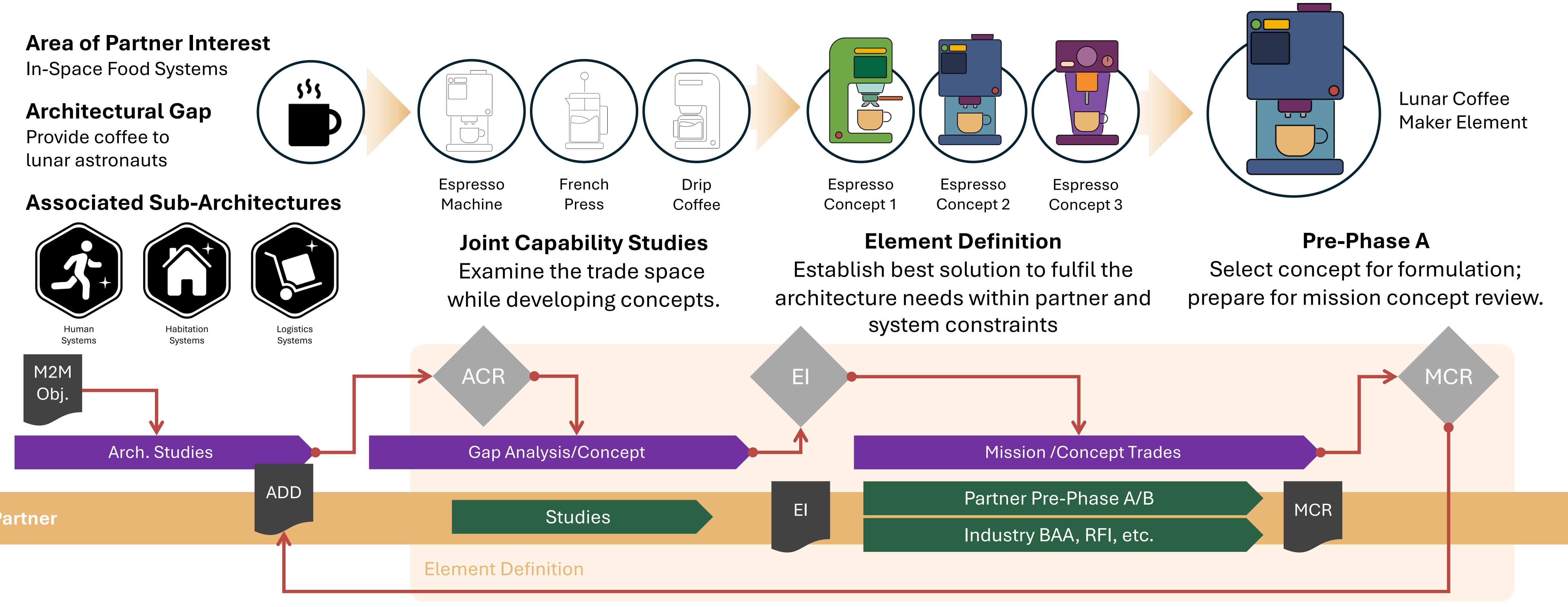
1. Feasibility studies and collaboration identify potential concept.
2. Mission refinement to optimize for strategic value and functional achievement, using study mechanisms to better inform planning.
3. Feedback incorporated into architecture products as milestones occur.

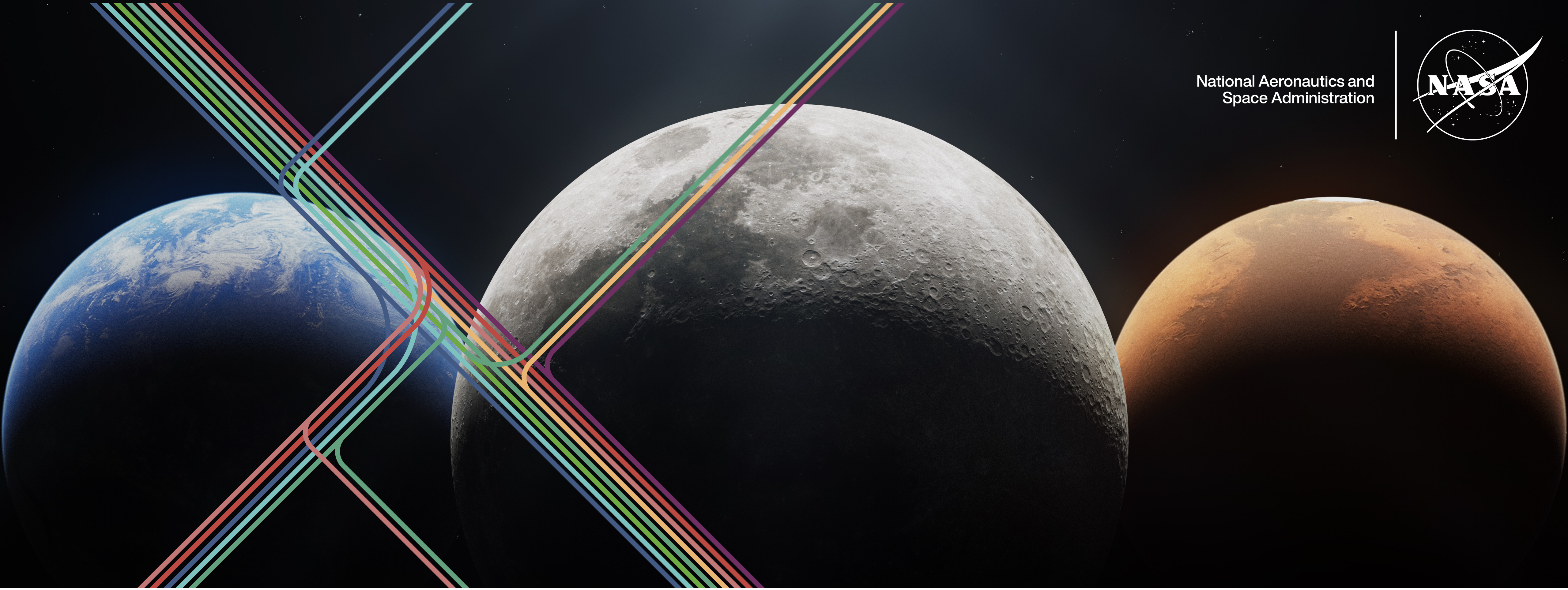
- Collaboration Partner
- Strategy and Architecture Office (SAO)
- Moon to Mars Program Office (M2MPO)

Concept Maturity Mapped to Process

Fictional Example: Lunar Coffee Maker

National Aeronautics and Space Administration





National Aeronautics and Space Administration

Paths to Partnership

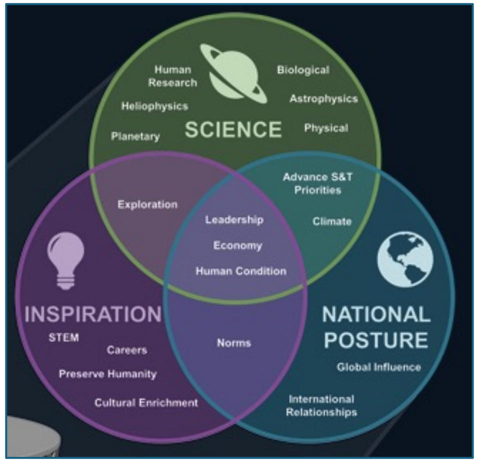
Space Operations Mission Directorate

Steve Bowen
Cross Directorate Technical Integration
Space Operations Mission Directorate
NASA – SOMD

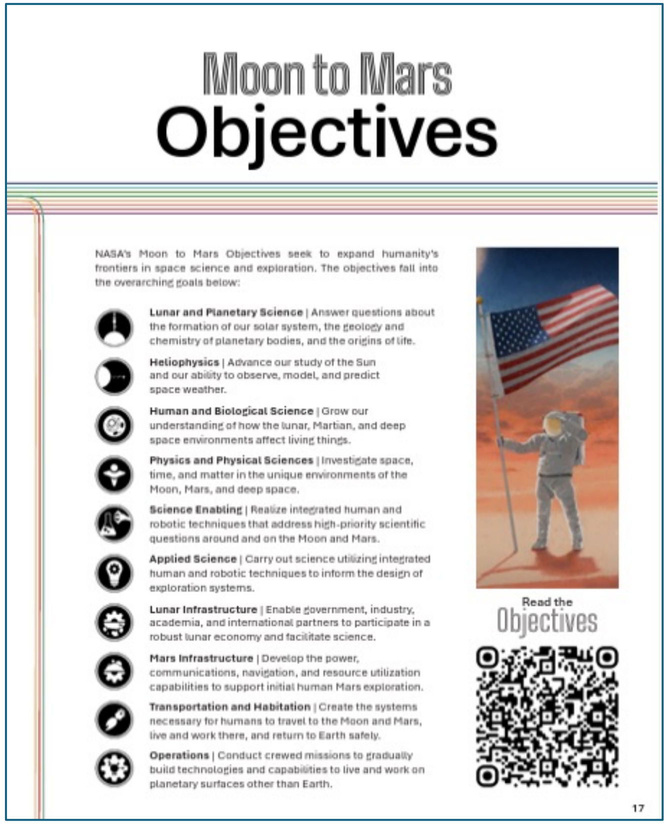
The Human System Represented in M2M Architecture

Find areas where your agency would like to collaborate or contribute

National Aeronautics and Space Administration



Pillars



Moon to Mars Objectives

NASA's Moon to Mars Objectives seek to expand humanity's frontiers in space science and exploration. The objectives fall into the overarching goals below:

- **Lunar and Planetary Science** | Answer questions about the formation of our solar system, the geology and chemistry of planetary bodies, and the origins of life.
- **Heliophysics** | Advance our study of the Sun and our ability to observe, model, and predict space weather.
- **Human and Biological Science** | Grow our understanding of how the lunar, Martian, and deep space environments affect living things.
- **Physics and Physical Sciences** | Investigate space, time, and matter in the unique environments of the Moon, Mars, and deep space.
- **Science Enabling** | Realize integrated human and robotic techniques that address high-priority scientific questions around and on the Moon and Mars.
- **Applied Science** | Carry out science utilizing integrated human and robotic techniques to inform the design of exploration systems.
- **Lunar Infrastructure** | Enable government, industry, academia, and international partners to participate in a robust lunar economy and facilitate science.
- **Mars Infrastructure** | Develop the power, communications, navigation, and resource utilization capabilities to support initial human Mars exploration.
- **Transportation and Habitation** | Create the systems necessary for humans to travel to the Moon and Mars, live and work there, and return to Earth safely.
- **Operations** | Conduct crewed missions to gradually build technologies and capabilities to live and work on planetary surfaces other than Earth.

Read the Objectives

17

Objectives

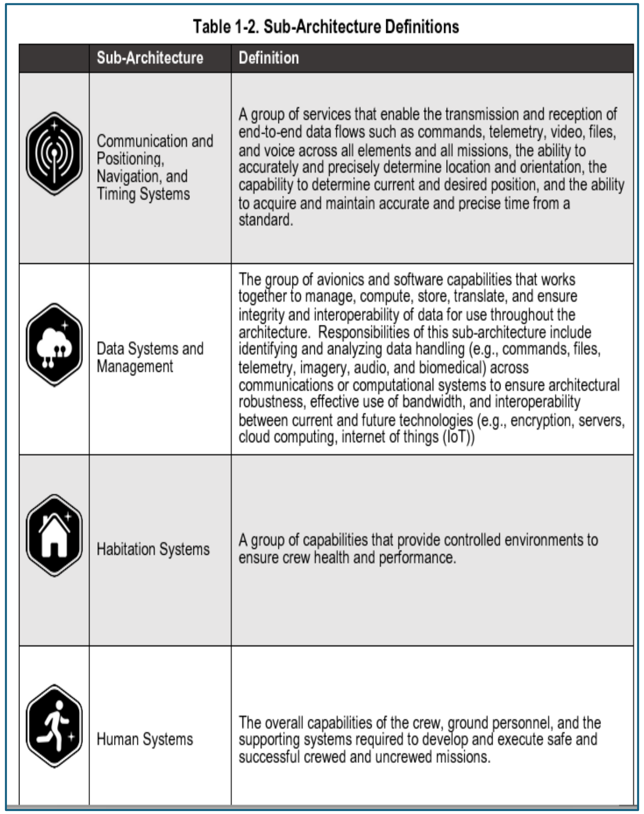


Table 1-2. Sub-Architecture Definitions

Sub-Architecture	Definition
Communication and Positioning, Navigation, and Timing Systems	A group of services that enable the transmission and reception of end-to-end data flows such as commands, telemetry, video, files, and voice across all elements and all missions, the ability to accurately and precisely determine location and orientation, the capability to determine current and desired position, and the ability to acquire and maintain accurate and precise time from a standard.
Data Systems and Management	The group of avionics and software capabilities that works together to manage, compute, store, translate, and ensure integrity and interoperability of data for use throughout the architecture. Responsibilities of this sub-architecture include identifying and analyzing data handling (e.g., commands, files, telemetry, imagery, audio, and biomedical) across communications or computational systems to ensure architectural robustness, effective use of bandwidth, and interoperability between current and future technologies (e.g., encryption, servers, cloud computing, internet of things (IoT))
Habitation Systems	A group of capabilities that provide controlled environments to ensure crew health and performance.
Human Systems	The overall capabilities of the crew, ground personnel, and the supporting systems required to develop and execute safe and successful crewed and uncrewed missions.

Human System Sub-Architecture

National Aeronautics and Space Administration

Human Health and Performance: Keeping Astronauts Safe & Productive On a Mission to Mars

white paper | 2023 Moon to Mars Architecture

Introduction

NASA has been sending humans to space for more than 60 years, confronting the essential challenge of human spaceflight: that our bodies and minds evolved to live on Earth. Living and working off our planet, and on another planet, poses unique hazards to the human system. Understanding the effects of spaceflight on human physiology, psychology, and individual and team performance is essential to keep astronauts safe and healthy as exploration moves from low-Earth orbit to deep space destinations on and around the Moon and eventually Mars.

The five main hazards of human spaceflight are space radiation, isolation and confinement, distance from Earth, altered gravity fields, and hostile/closed environments. This paper will highlight how these hazards and the risks they pose to the human system influence NASA's Moon to Mars Architecture. These hazards are not always independent from one another; like human systems, the hazards are frequently coupled and interconnected, potentially causing synergistic effects or combined impacts.

Addressing the hazards and defining solutions will require a combination of human health and performance and engineering solutions. These solutions will be balanced with acceptable risks imposed on the crew and mission parameters such as duration, vehicle designs, operational considerations, and cost.

Integrated Human Performance

Space Radiation

Isolation & Confinement

Distance from Earth

Altered Gravity Fields

Hostile/Closed Environments

Figure 1. Five Hazards of Human Spaceflight and Associated Human System Risks

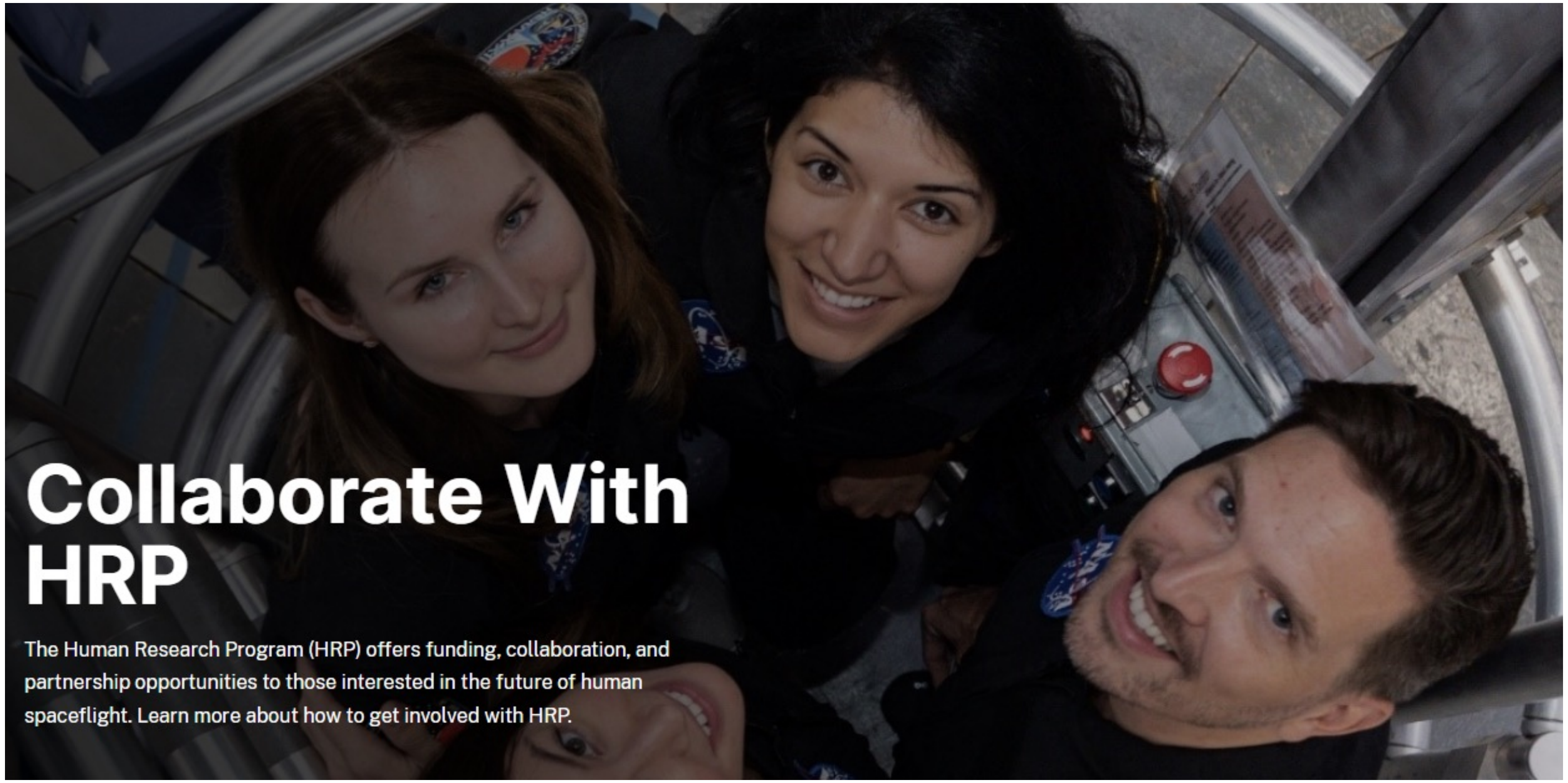
The following content integrates and summarizes NASA-STD-3001, NASA Spaceflight Human-System Standard Volume 1 and 2, which establishes agency standards that enable human spaceflight missions by minimizing health risks, providing vehicle design parameters, and enabling the performance of flight and ground crew. Applicability and tailoring of standards are determined based on each program's mission profile and procurement strategy.

Human System White Papers

NASA Human Research Program

National Aeronautics and Space Administration

Mission: Enable space exploration beyond low-Earth orbit by reducing risks to human health and performance



nasa.gov/hrp

International Space Life Sciences Working Group (ISLSWG)

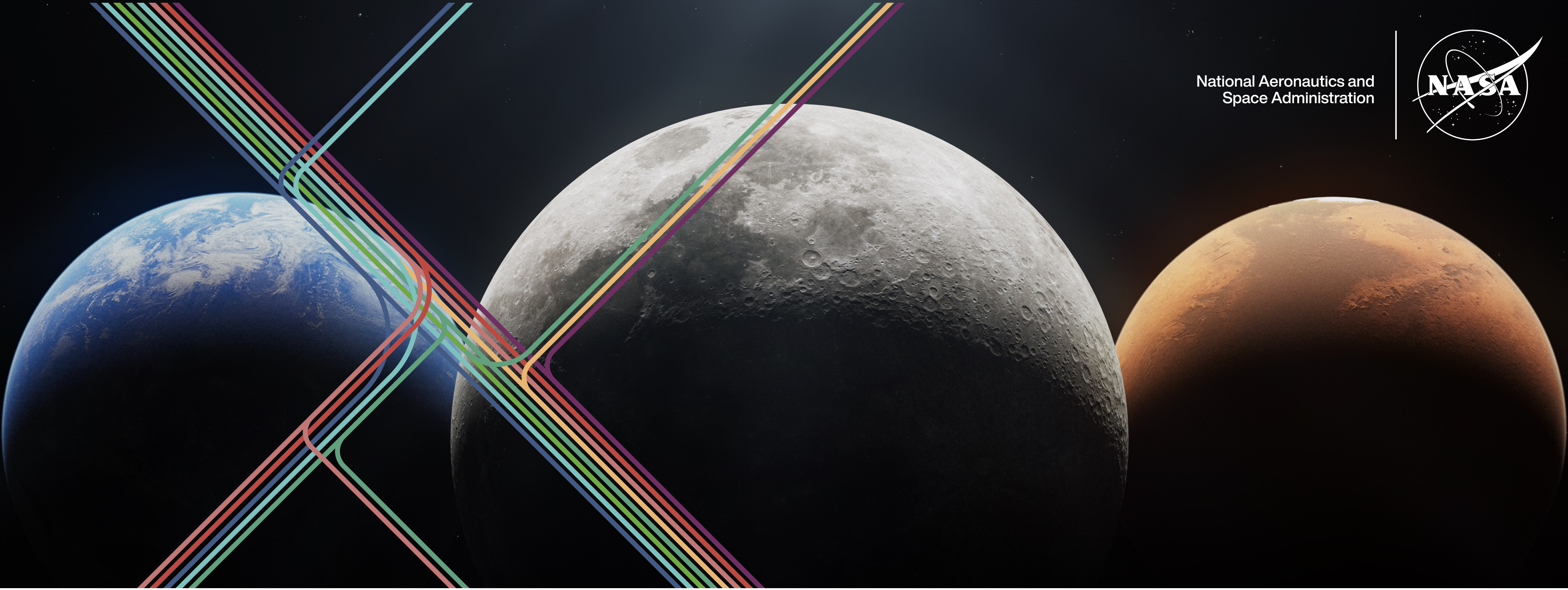
National Aeronautics and Space Administration

- Mission: to achieve coordinated strategic planning and implementation for space life sciences activities

- Forum for all eligible and interested space agencies
  - Working group to discuss life science activities across all carriers and platforms (Terrestrial, ISS, Gateway, Lunar Surface)
  - NASA, CSA, JAXA, ESA, IBMP, ASI, MBRSC, ISRO, CNES, DLR

- Two in-person meetings/year
  - Topical or subgroups meet more frequently

- A non-Member that wishes to attend ISLSWG meetings should consult with the ISLSWG Co-chairs
  - NASA POC: Benjy Neumann, benjamin.j.neumann@nasa.gov



Paths to Partnership

Science
Mission Directorate

Brad Bailey
Assistant Deputy Associate
Administrator for Exploration
Science Mission Directorate
NASA – SMD

Delivering Science

National Aeronautics and Space Administration

SMD also manages the **Commercial Lunar Payload Services (CLPS)** initiative to deliver science instruments and technology demonstrations to the lunar surface and enable operations of those payloads.

CLPS leverages commercial innovation to enable more frequent and more affordable access to the lunar surface. These efforts enable scientific discovery and paves the way for sustainable human exploration on the surface of the Moon and for expanding humanity's reach to Mars and beyond.

CLPS Overview

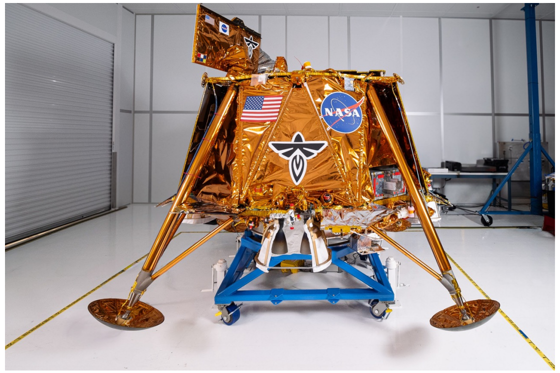
- Indefinite Quantity Indefinite Duration contract
- 14 companies in IDIQ pool
- 12 Task Orders awarded
- 2 missions executed with 1 landing on the Moon
- 1 active mission with another expected Q1 2025

Benefits to International Communities

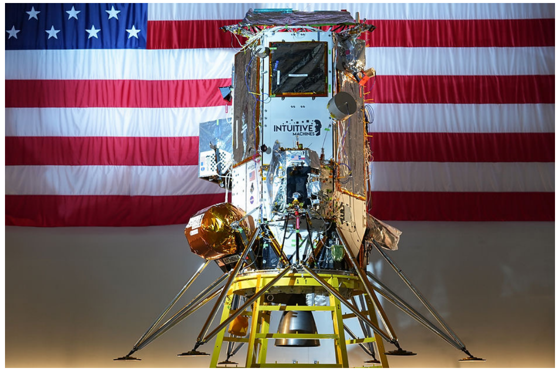
- Rapid, low-cost access to the lunar surface for emerging space organizations
- Provides access to and cooperation with US industry experts
- Give flexibility related to intellectual property and accounting requirements

Benefits to NASA

- More frequent, more affordable access to the lunar surface
- Enables global scientific discovery
- Test technologies in advance of and concurrently with human exploration on the surface of the Moon and Mars



Firefly's Blue Ghost lander is on its way to the lunar surface, carrying 10 NASA scientific instruments and technology demonstrations.



Intuitive Machines' Athena lander is IM's second mission to the Moon, delivering a NASA drill and spectrometer technology demonstration that will also address key science objectives, as well as commercial payloads contracted by IM.

Competitive Science and Partnerships

National Aeronautics and Space Administration

Through the **Research Opportunities in Space and Earth Science (ROSES)** program, SMD predominantly uses a competitive selection process to select the science instruments and investigations that seek new knowledge and understanding of our planet Earth, our Sun, the Moon, Mars, and broader solar system, and the universe out to its farthest reaches and back to its earliest moments of existence. NASA recognizes the scientists and engineers who acquire and utilize science data, are at the center of it all.

International Opportunities

International partners can contribute through multiple paths to conduct investigations on the lunar surface:

- Direct purchase of services from CLPS vendors
- Partnership with NASA to deliver directed payloads through CLPS or Artemis
- Awards through competitive solicitations for both CLPS and Artemis

Selected Solicitations that may include Int'l participation

- PRISM – Payloads and Research Investigations on the Surface of the Moon
- Artemis Deployed Instruments Solicitations
- Artemis Geology Team
- Artemis Participating Scientists

Open and Upcoming Program Elements

- Artemis IV Deployed Instruments
- PRISM SALSA - Stand-Alone Landing Site Agnostic PRISM
- SSERVI CAN 5 - Solar System Exploration Research Virtual Institute
- Artemis III Participating Scientists

Other Engagement Opportunities

- Lunar Surface Science Workshops
    - Uncrewed Science with Pressurized Rover (April)
    - Outbriefs from NASA HQ and Artemis (May)
    - Artemis Orienteering/Geolocation (TBD)
- Mars Surface Science Workshops
- Community-led Studies (e.g., Far Side Sample Return; Mars science)

PANEL

National Aeronautics and Space Administration

Charting the Course: Paths to Partnership

Moon to Mars Architecture Workshop

MODERATOR

Youshay Rizvi
International Program Specialist
NASA

Steve Bowen
Cross-Directorate Technical Integration
SOMD

Brad Bailey
Assistant Deputy Associate Administrator for Exploration
SMD

Julie Grantier
Deputy Manager for Integration
ESDMD, SAO