

May 15, 2023
NAC HEO Public Meeting



Strategy and Architecture

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Mission Directorate**

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Deep Space Exploration Priorities

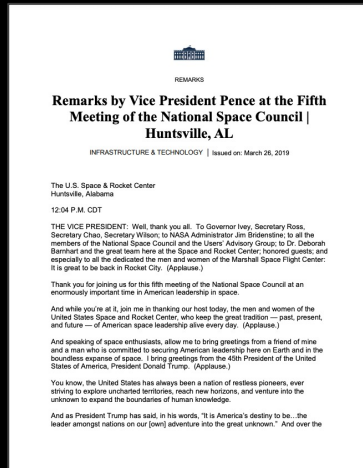


“...Human and robotic space exploration missions will land the first woman and person of color on the Moon, advance a robust cislunar ecosystem, continue to leverage human presence in low-Earth orbit to enable people to live and work safely in space, and prepare for future missions to Mars and beyond.”

— The White House U.S Space Priorities Framework, Dec 2021



Space Policy Directive-1
December 2017



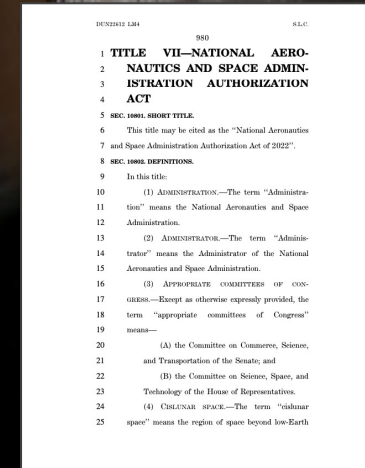
National Space Council
March 2019



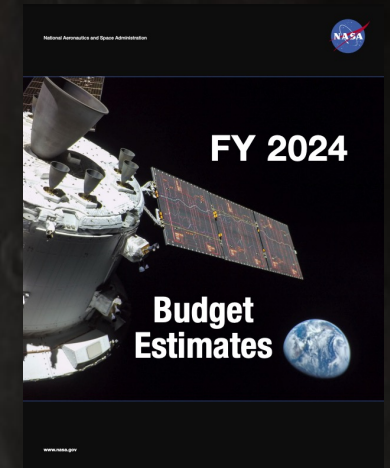
Space Priorities Framework
December 2021



NASA Strategic Plan
March 2022



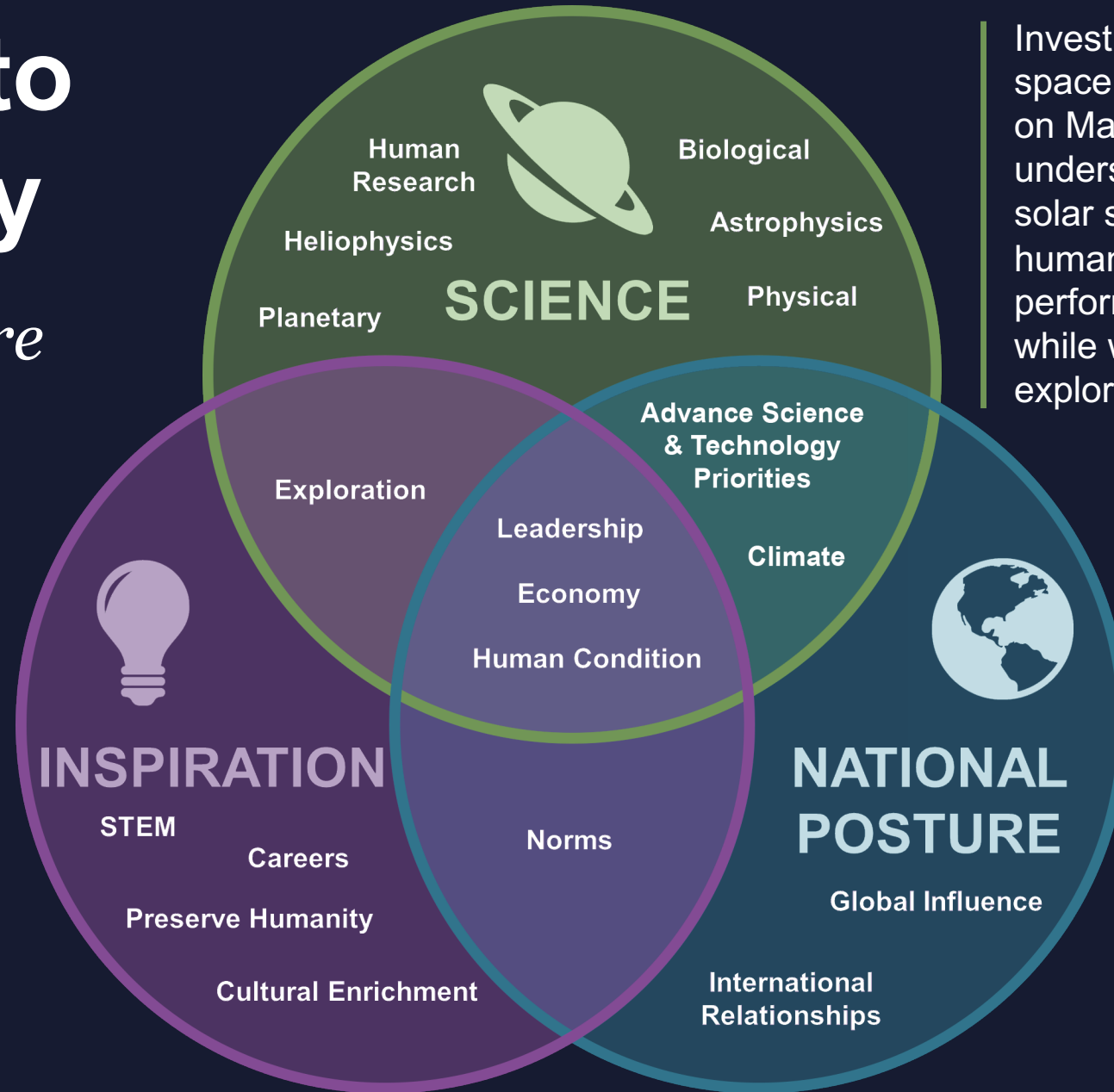
NASA Authorization Act
July 2022



President's Budget Request
March 2023

Benefits to Humanity

Why We Explore



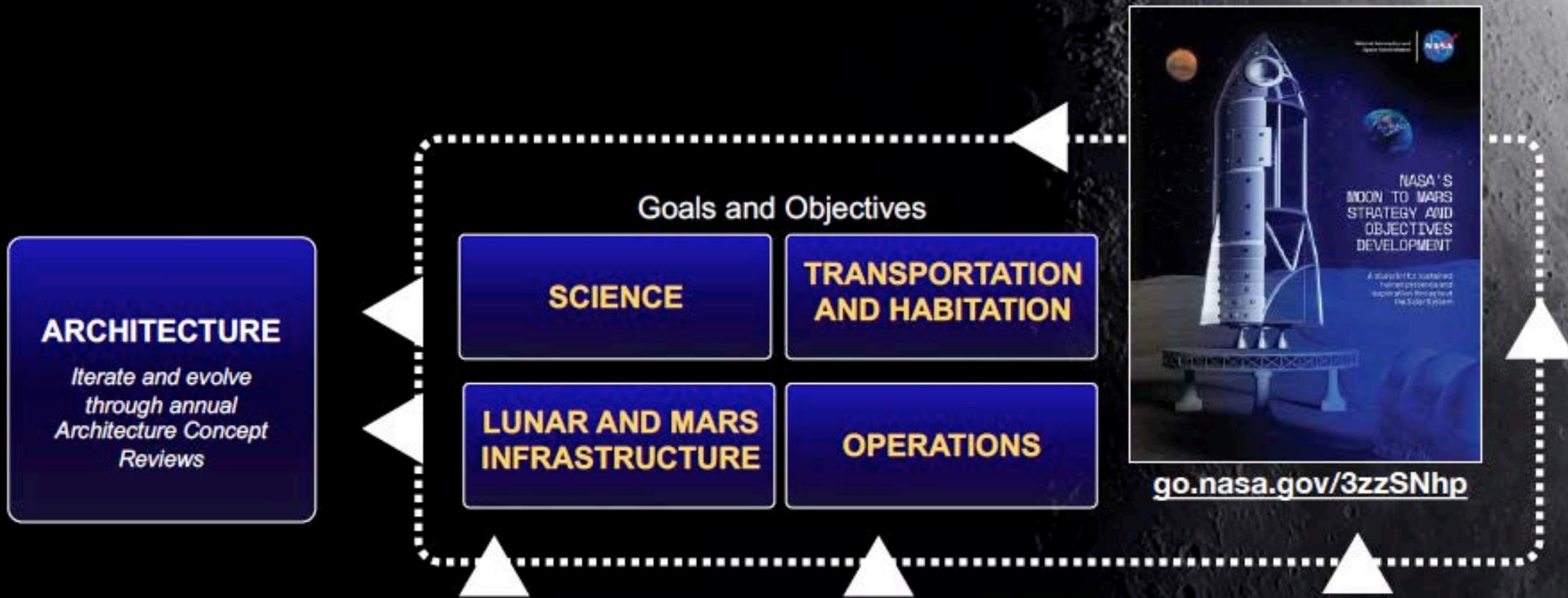
Investigations in deep space, on the Moon, and on Mars will enhance our understanding of the solar system, Earth, the human body, and how to perform new operations while we are out there exploring.

Accepting audacious challenges and succeeding through perseverance and tenacity in the face of adversity motivates current and future generations to dare mighty things.

What we choose to do, how we do those things, and who we do them with greatly impacts our place in the world today, our quality of life, and our possibilities for the future.

NASA's Moon to Mars Strategy and Objectives

A blueprint for future human exploration (Architecting from the Right)



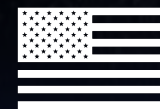
Requested feedback on these objectives in summer 2022 from the following key stakeholders:



NASA workforce:
our greatest asset

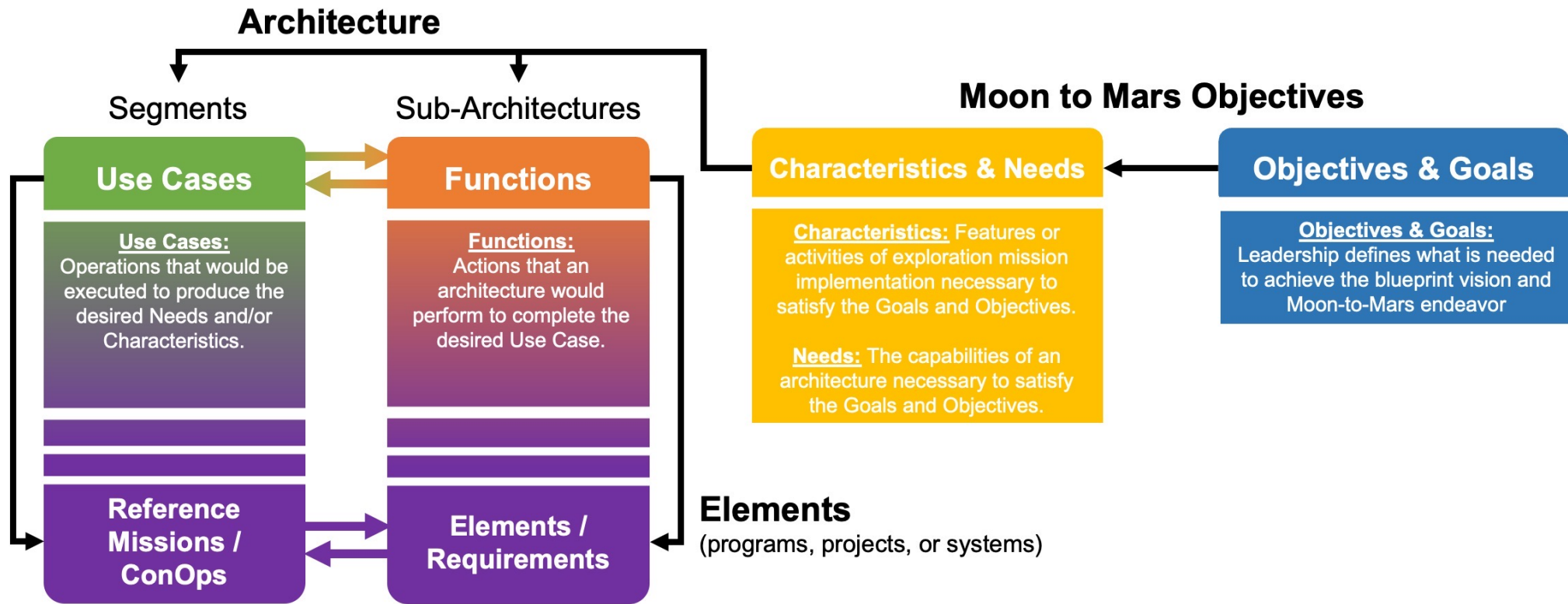


International partners: our key
current and future, anticipated
collaborators



U.S. industry, academia, DOE, NIH,
NSF, etc.: our national leaders in
space research and capabilities

Architecting from the Right



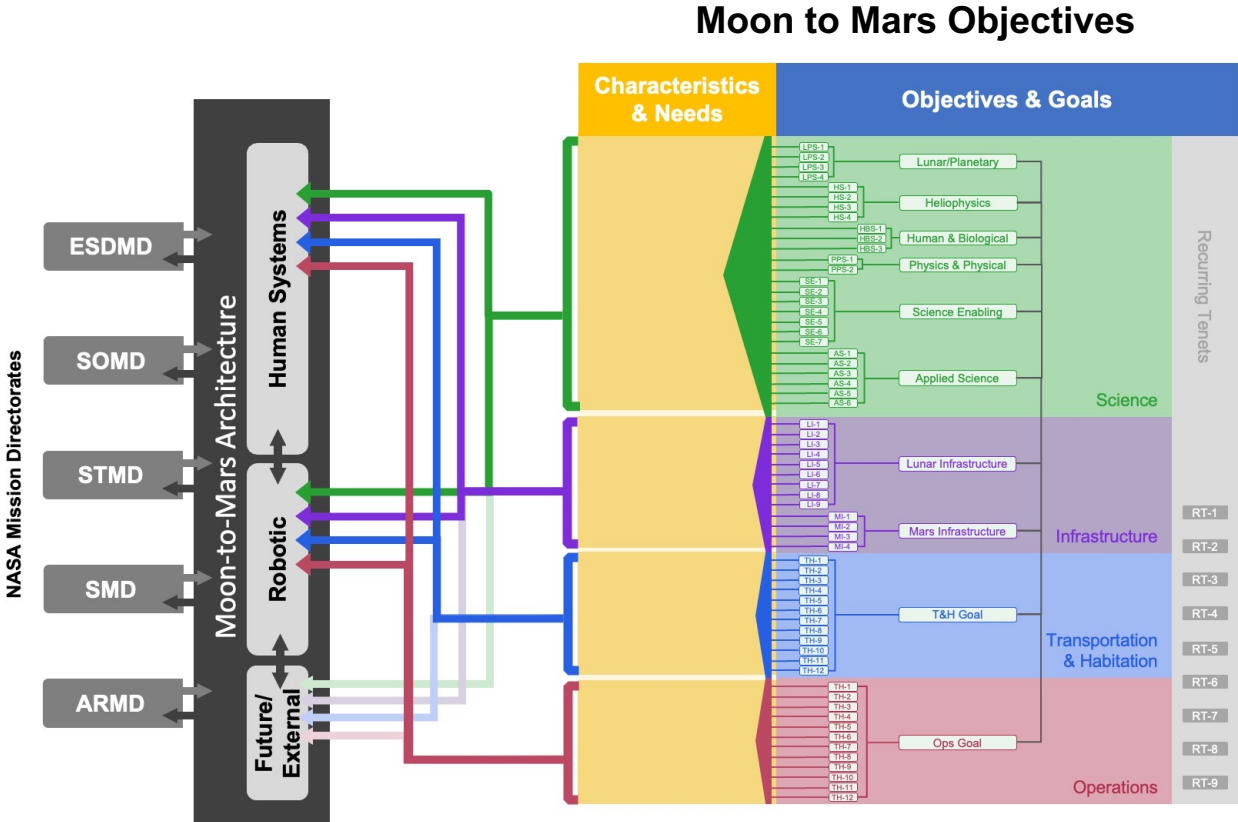
Architecture organized by Segments and Sub-architectures in the ADD to group similar features and express progression of capabilities over time.

The Architecture process requires a decomposition of Moon to Mars Objectives to element functions and mission use cases to complete the process of “architecting from the right.” This establishes the relationship of executing programs and projects to the driving goals and objectives.

Integrating Human and Supporting Robotic Science Needs



- ACR22 and associated products were focused on the Human Lunar Return segment of the architecture
 - Included related SOMD systems, SMD robotic missions, STMD technology demonstrations, and ARMD activities
- The Moon to Mars Architecture Definition Document (ADD) includes use cases, functions, and reference missions for uncrewed periods of operations in lunar orbit and on the surface



Architecture Concept Review



The purpose of an Architecture Concept Review (ACR) is to help unify the agency, promote advocacy for the architecture, and generate inputs from across NASA.

- The specific purpose of the Architecture Concept Review 22 (ACR22) was to:
 - Concur on the newly established yearly ACR process
 - Concur on disposition of key issues from ESDMD-001 Moon to Mars (M2M) Architecture Definition Document (ADD) Change Request
 - Human Lunar Return segment focus
 - Concur on priority tasks for the next ACR



Future ACRs will be conducted annually in November to continue refining the architecture based on evolving policy, budget, partner contributions, and development schedules. Annual ACRs shifted to align with the NASA budget cycle.

Segments and Sub-architectures



Segment: A portion of the architecture, identified by one or more notional missions or integrated use cases, illustrating the interaction, relationships, and connections of the sub-architectures through progressively increasing operational complexity and objective satisfaction.



Human Lunar Return

Initial capabilities, systems, and operations necessary to re-establish human presence and initial utilization (science, etc.) on and around the Moon.

Focus for ACR 22



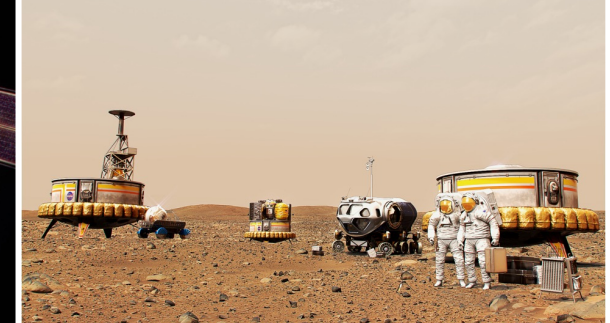
Foundational Exploration

Expansion of lunar capabilities, systems, and operations supporting complex orbital and surface missions to conduct utilization (science, etc.) and Mars forward precursor missions.



Sustained Lunar Evolution

Enabling capabilities, systems, and operations to support regional and global utilization (science, etc.), economic opportunity, and a steady cadence of human presence on and around the Moon.



Humans to Mars

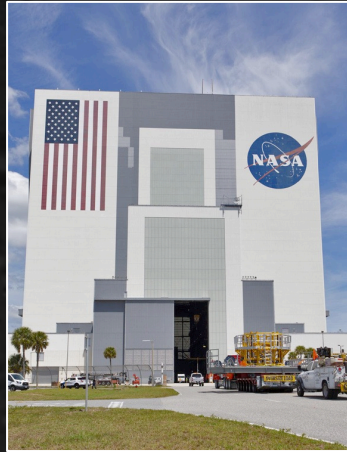
Initial capabilities, systems, and operations necessary to establish human presence and initial utilization (science, etc.) on Mars and continued exploration.

Focus for ACR 23

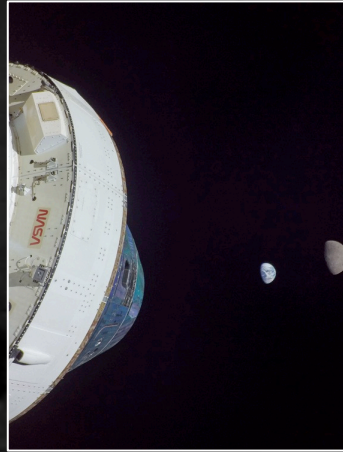
Sub-architecture: A group of tightly-coupled systems, functions, and capabilities that perform together to accomplish architecture objectives.

- Communication, Positioning, Navigation, and Timing
- Habitation
- Human Systems
- Logistics
- Mobility Systems
- Power
- Transportation
- Utilization Systems

Human Lunar Return Segment



EXPLORATION GROUND SYSTEMS



ORION SPACECRAFT



SPACE LAUNCH SYSTEM



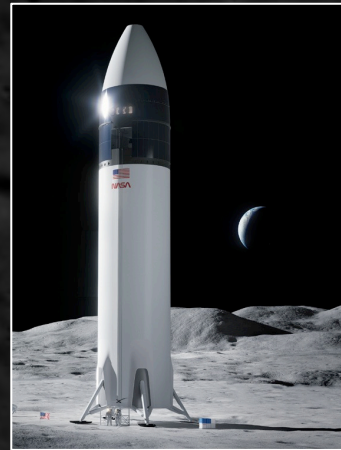
GATEWAY



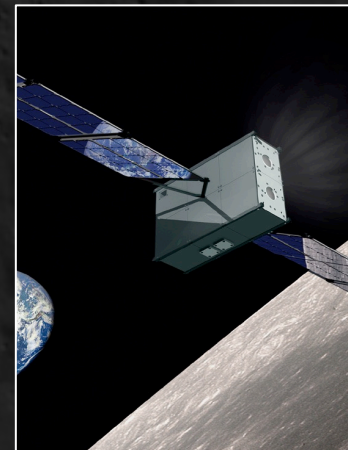
DEEP SPACE LOGISTICS



xEVA Systems



HUMAN LANDING SYSTEM



COMM, POSITIONING, NAV, TIMING (CPNT)



COMMERCIAL LUNAR PAYLOAD SERVICES

MOON TO MARS CAMPAIGN SEGMENTS

ELEMENTS SHOWN BEYOND
HUMAN LUNAR RETURN ARE NOTIONAL

LEO AND EARTH ANALOGS



ISS AND
COMMERCIAL
LEO PLATFORMS

HUMAN LUNAR RETURN



SLS BLOCK 1 ORION NEAR-TERM ARTEMIS MISSIONS SLS BLOCK 1B



GATEWAY

Increased Crew Size & Longer Durations in Micro-gravity

SUSTAINED LUNAR EVOLUTION

FOUNDATIONAL EXPLORATION

HUMANS TO MARS MODEST FIRST MISSION OF THE TRADE SPACE SHOWN



SLS BLOCK 2



TRANSIT HABITAT
AND MARS TRANSIT

COMMUNICATIONS RELAYS

Nuclear Surface Power

Habitation Systems

Partial Gravity Operations

Mobile Expedition Duration / Mobile Exploration Range

In-Situ Resource Utilization

Autonomous Robotics Systems & Contingency Crew Transportation



HUMAN
LANDING
SYSTEM



LUNAR
TERRAIN
VEHICLE



PRESSURIZED
ROVER

SURFACE
HABITAT

LOGISTICS
LANDER

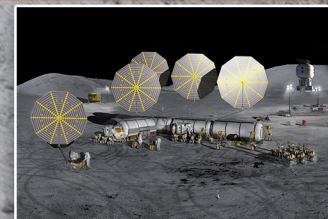
Nuclear Surface Power

MARS
ASCENT
VEHICLE

PRESSURIZED
ROVER

MARS
TERRAIN
VEHICLE

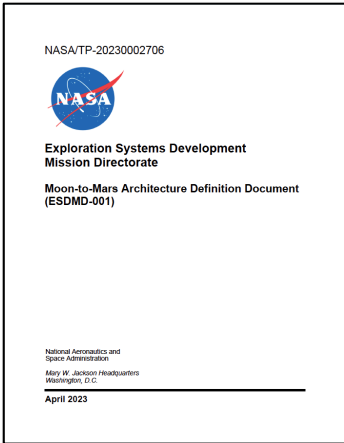
Sustained Lunar Evolution



MARS
ASCENT
VEHICLE

ACR Public Products

Available at www.nasa.gov/MoonToMarsArchitecture



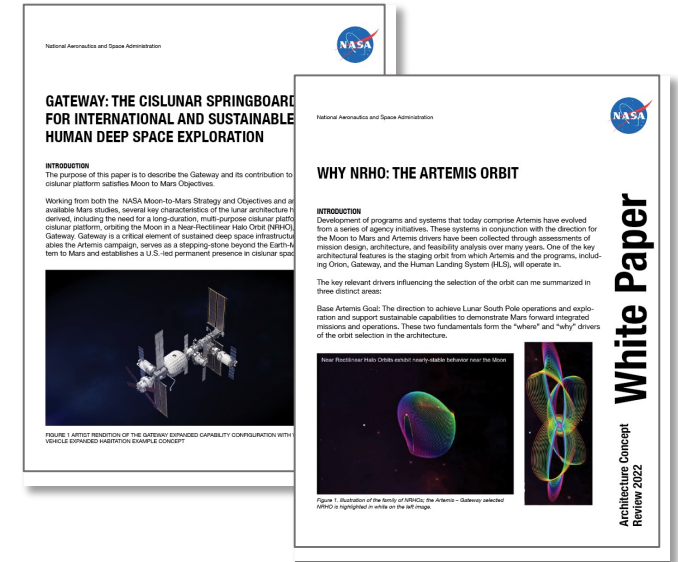
Architecture Definition Document

- **Length:** 150 pages
- **Purpose:** detailed documentation of a snapshot of the human spaceflight architecture and exploration strategy
- **Audience:** highly technical – NASA, industry, international partners, committee staffers
- **Publication:** NASA Technical Reports Server
- **Update cadence:** Annual ACRs



Moon to Mars Architecture Summary

- **Length:** 18 pages
- **Audience:** technically informed – Advisory, legislative, investigative, auditing organizations
- **Purpose:** high-level documentation of M2M architecture and exploration strategy
- **Publication:** nasa.gov
- **Update cadence:** as needed

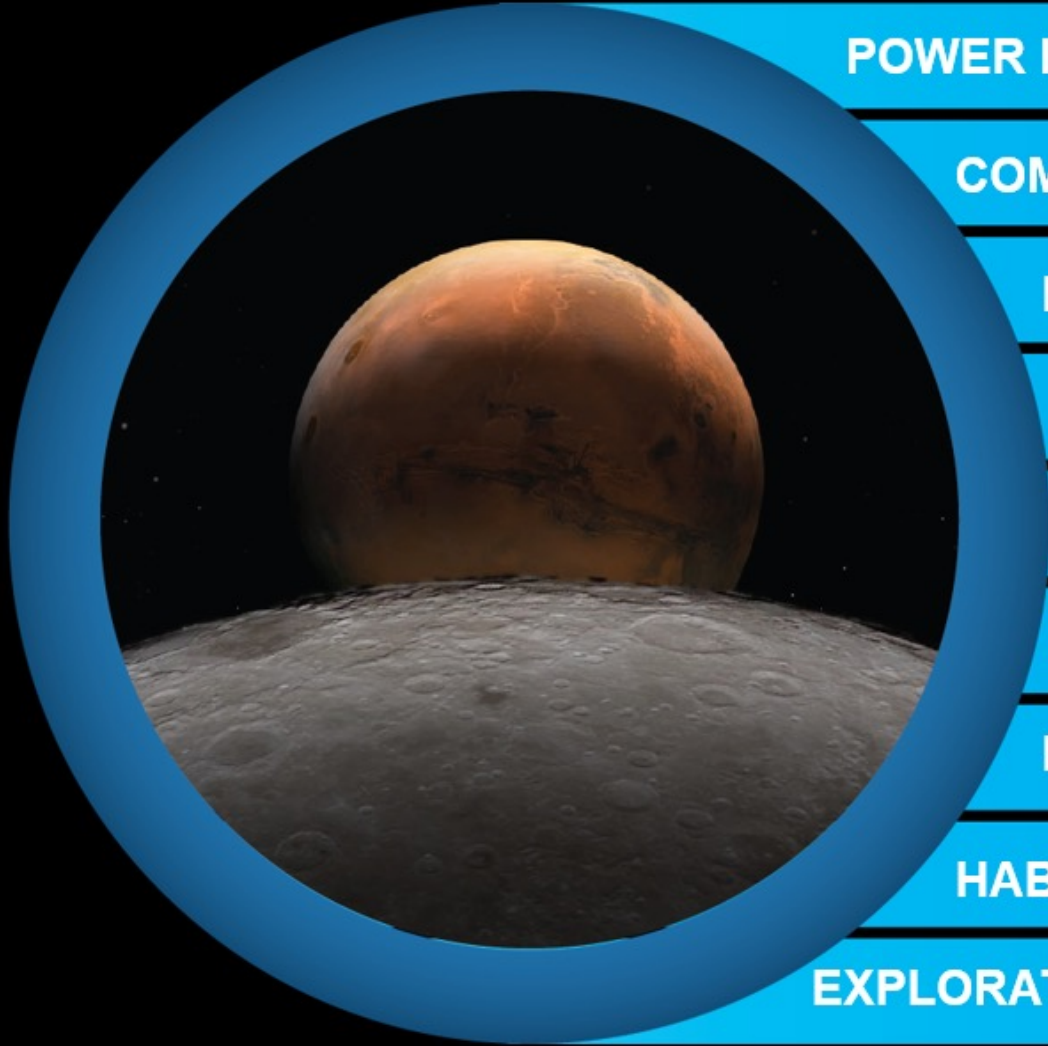


White Papers

- **Length:** 4-6 pages each
- **Purpose:** document architecture study details on frequently discussed topics
- **Audience:** technically informed – industry, international partners, staffers
- **Publication:** nasa.gov
- **Update cadence:** ACRs and as needed

Areas for Collaboration

The Moon to Mars architecture is flexible, and there are opportunities to contribute, creating opportunity.



POWER INFRASTRUCTURE AND DISTRIBUTION



COMMUNICATION AND NAVIGATION



LUNAR ENVIRONMENT MITIGATION



ROBOTICS AND MOBILITY



LOGISTICS



UTILIZATION OPERATIONS



LUNAR SAMPLING AND CURATION



HABITATION AND CREW HEALTH SYSTEMS



EXPLORATION SYSTEMS AND OPERATIONS ANALOG TESTING





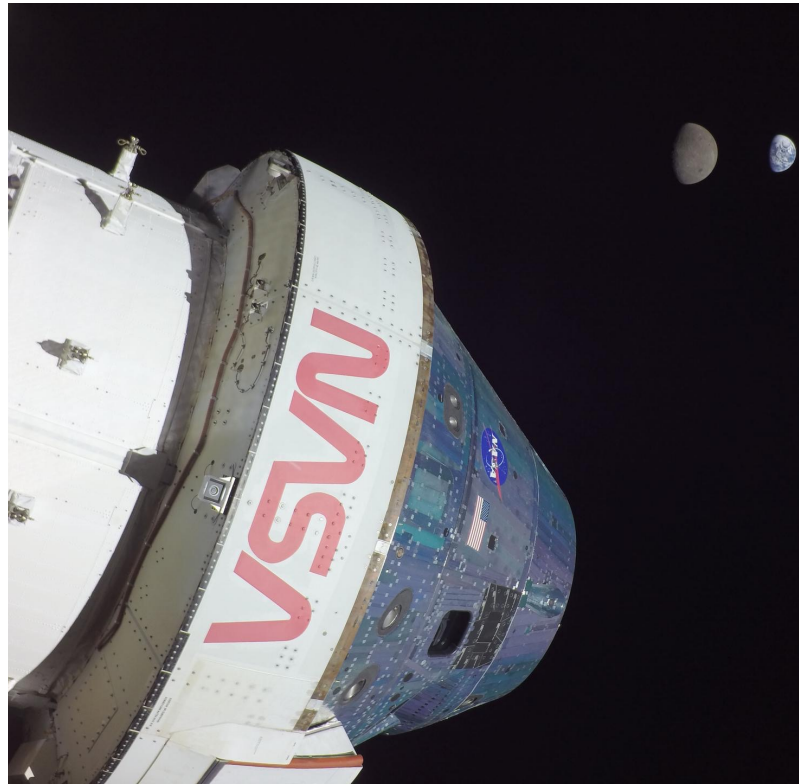
Engagement and Feedback

Stakeholders provide input during existing interactions including: conference meetings, partner discussions, bi-laterals, etc.

NASA-led workshops planned summer of 2023, which are geared toward soliciting feedback on processes and documentation.

Partner professional society workshops provide additional opportunities for engagement.



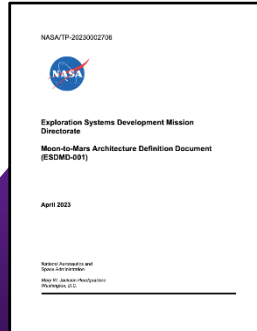


The Artemis Generation is Now!

Architecture Concept Review Products

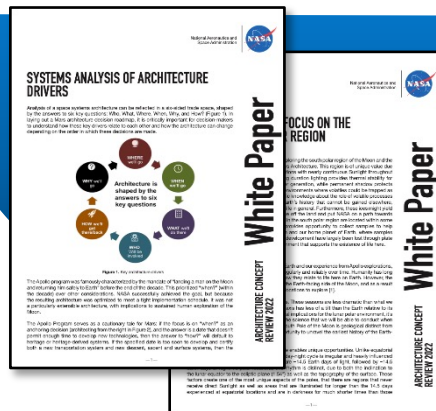


www.nasa.gov/MoonToMarsArchitecture



Architecture Definition Document
Detailed documentation of a snapshot of NASA's human spaceflight architecture and exploration strategy

Moon to Mars Architecture Summary
High-level overview of NASA's Moon to Mars architecture and exploration strategy



White Papers
Six papers on architecture study details for frequently discussed topics