Moon to Mars Architecture Overview and Updates
Why Go?

Investigations in deep space, on the Moon, and on Mars will enhance our understanding of the universe and our place in it.

What is done, how it's accomplished, and who participates affect our world, quality of life, and humanity's future.

Accepting audacious challenges motivates current and future generations to contribute to our voyage deeper into space.
NASA’s Moon to Mars Objectives document a systems engineering approach to crewed deep space exploration.

In contrast to a capabilities-based approach, an objectives-based approach focuses on the big picture, the “what” and “why,” before prescribing the “how.”

The methodology for the Moon to Mars Objectives is guided by five inter-related principles:

- Objectives-based Approach
- Constancy of Purpose
- Enhanced Communication and Engagement
- Unity of Purpose
- Architect from the Right
  Execute from the Left
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.
**Architecture Components**

**Segments**
A portion of the architecture that integrates sub-architectures and progressively increases in complexity and objective satisfaction.

**Sub-Architectures**
A group of tightly coupled elements, functions, and capabilities that work together to accomplish one or more objectives.

**Elements**
A notional exploration system that enables a set of functions.
Architecture Segments

Human Lunar Return:
Initial capabilities, systems, and operations necessary to re-establish human presence and initial utilization on and around the Moon.

Foundational Exploration:
Expansion of lunar capabilities, systems, and operations supporting complex orbital and surface missions to conduct utilization and Mars forward precursor missions.

Sustained Lunar Evolution:
Enabling capabilities, systems, and operations to support regional and global utilization, 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 on Mars and continued exploration.

Future Segments
Communications, Navigation, Positioning, and Timing Systems enable transmission and reception of data, determination of location and orientation, and acquisition of precise time.

Habitation Systems ensure the health and performance of astronauts in controlled environments.

Human Systems execute human and robotic missions; this includes crew, ground personnel, and supporting systems.

Logistics Systems package, handle, transport, stage, store, track, and transfer items and cargo.

Mobility Systems move crew and cargo around the lunar and Martian surfaces.

Power Systems generate, store, condition, and distribute electricity for architectural elements.

Transportation Systems convey crew and cargo to and from Earth to the Moon and Mars.

Utilization Systems enable science and technology demonstrations.

NEW for 2023

Data Systems and Management transfer, distribute, receive, validate, secure, decode, format, compile, and process data and commands.

In-situ Resource Utilization (ISRU) Systems extract resources in space or on the Moon or Mars to generate products.

Infrastructure Support includes facilities, systems, operations planning and control, equipment, and services needed on Earth, in space, and on planetary surfaces.

Autonomous Systems and Robotics employ software and hardware to assist the crew and operate during uncrewed periods.
ACR23 Updates

ACR23 Products
Architecture Definition Document - Revision A
Moon to Mars Architecture Executive Overview
13 White Papers
ADD Rev-A includes refined and expanded Moon to Mars objective decomposition, sub-architectures, and elements

Added, refined, removed, or modified characteristics and needs, use cases, and functions for lunar objectives

179 characteristics and needs added for Mars objectives
The United Arab Emirates Implementing Arrangement was signed shortly after ACR23. The collaboration will be included in ADD Rev-B during ACR24.
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Suggestion from 2023 Architecture Workshops

White paper added after ACR23 Concurrence
NASA catalogued nearly 90 needed decisions for an initial crewed Mars mission and developed a decision roadmap. That process resulted in seven interrelated decisions needed to begin planning.

In 2024, NASA has begun analyses needed to allow for informed decision-making by agency leadership.
Architecture Concept Review Process

An Evolutionary Architecture Process
Formulating an Architecture and Exploration Strategy Based on Objectives

- **Product Review**
- **Architecture Definition Document**
- **Revised Architecture**

**Traceability**
Decomposition of Blueprint Objectives to executing Architecture elements

**Architecture Framework**
Organizational construct to ensure system/element relationships are understood and gaps can be identified

**Process and Products**
Clear communication and review integration paths for stakeholders

**Annual Cycle to Mature Architecture**
The 2024 Strategic Analysis Cycle (SAC24) will focus on:

- Addressing Human Lunar Return and Foundational Exploration segment gaps, including lunar logistics, large cargo return, conceptual reference missions, and cargo offloading/relocation.
- Performing strategic analysis for segment sub-architectures, including surface communication, large-scale mobility, power systems, in-situ resource utilization (ISRU), and ingress/egress strategies.
- Developing decision packages for initial seven Mars exploration decisions and continuing progress on other Mars trade studies.