



NASA's Moon to Mars Architecture Workshop

Breakout Session: ACR Products

Nujoud Merancy

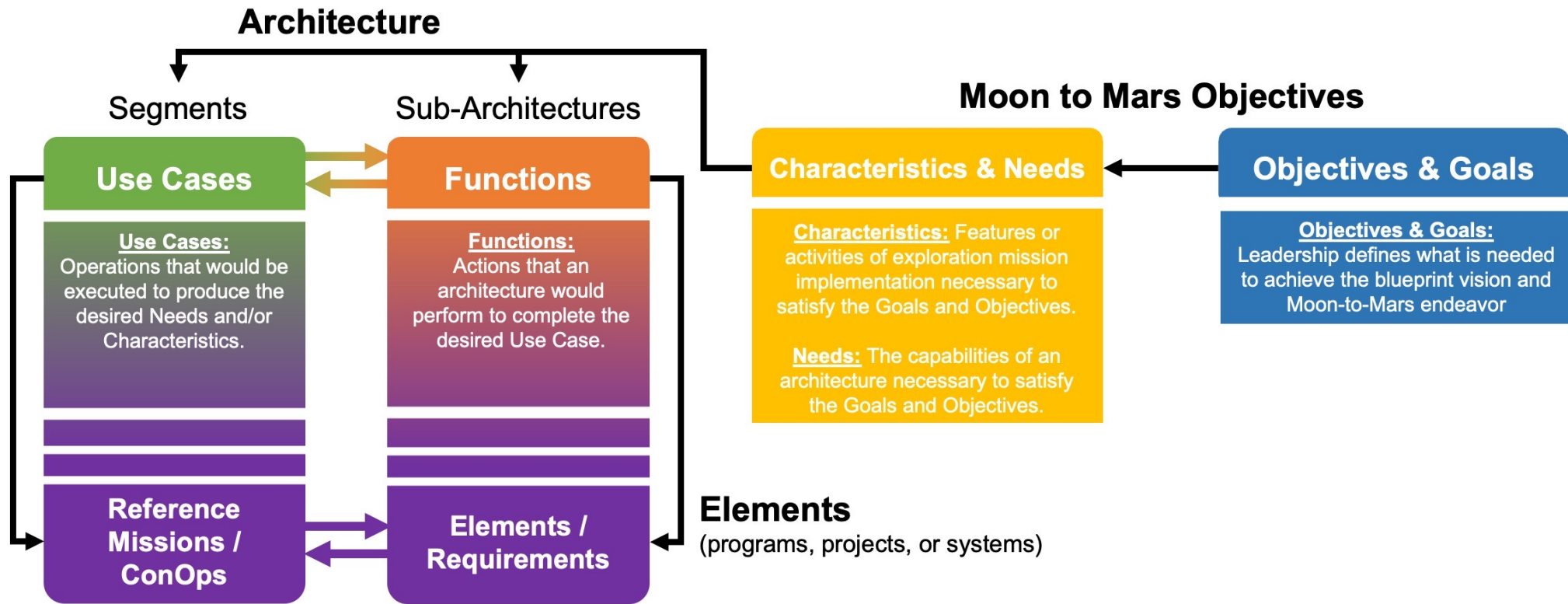
Architecture Lead

Exploration Systems Development

Mission Directorate



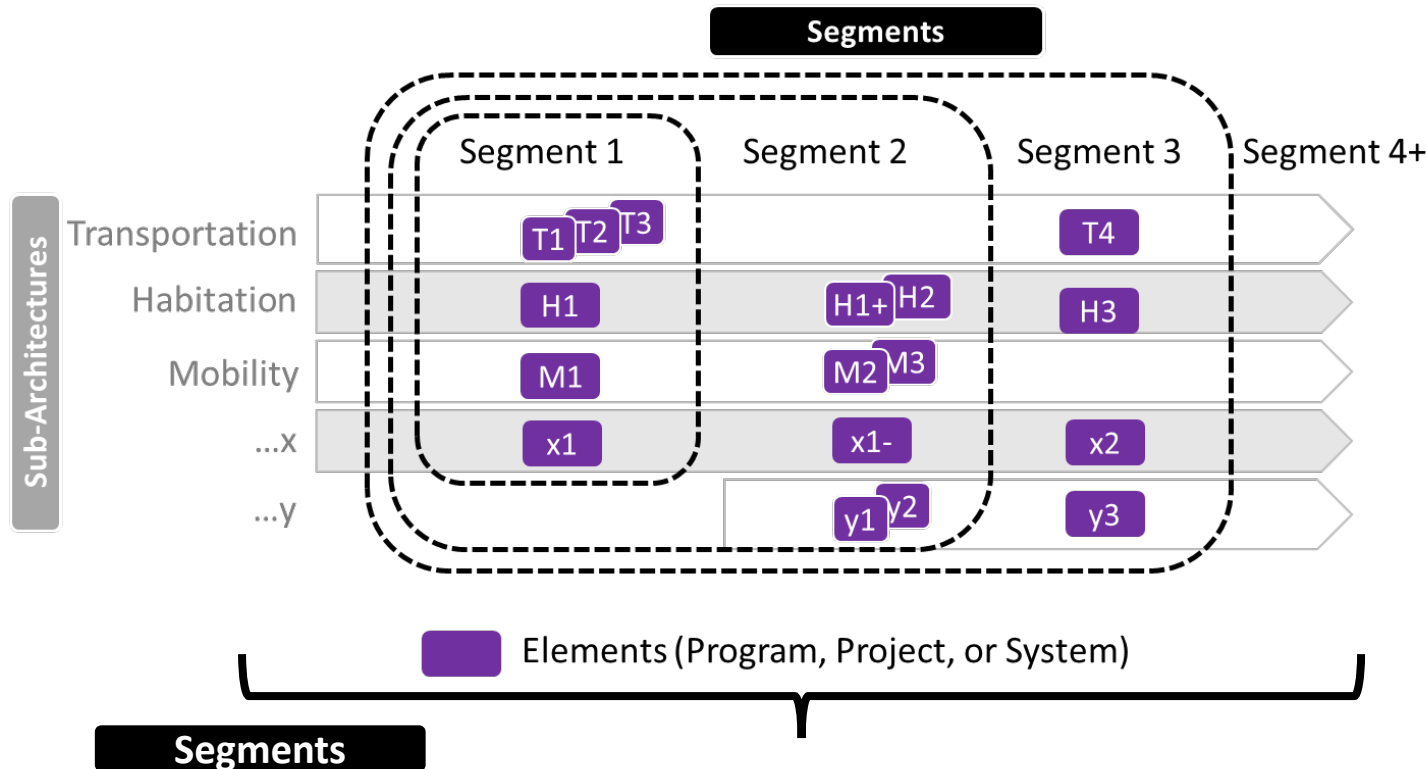
Architecting from the Right



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.

Architecture Framework



Sub-Architectures

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

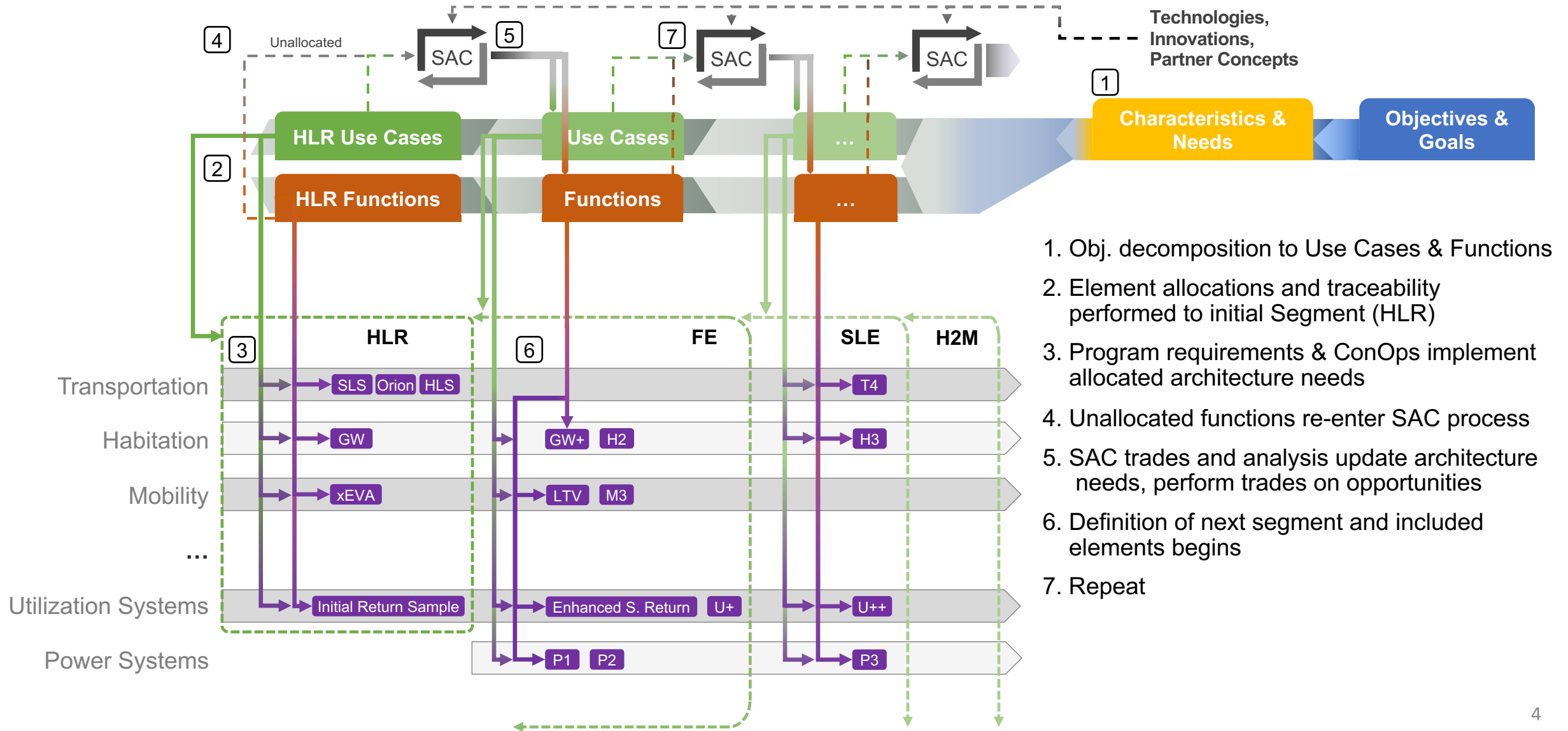
Ex: Transportation Systems: Contain common functions (e.g. RPOD) & need to ensure end-to-end allocation for crew transport from Earth to destinations to safe return

Segments

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.

Ex: Human Lunar Return integrated use case similar to current Artemis IV operations

Architecture Iteration Process

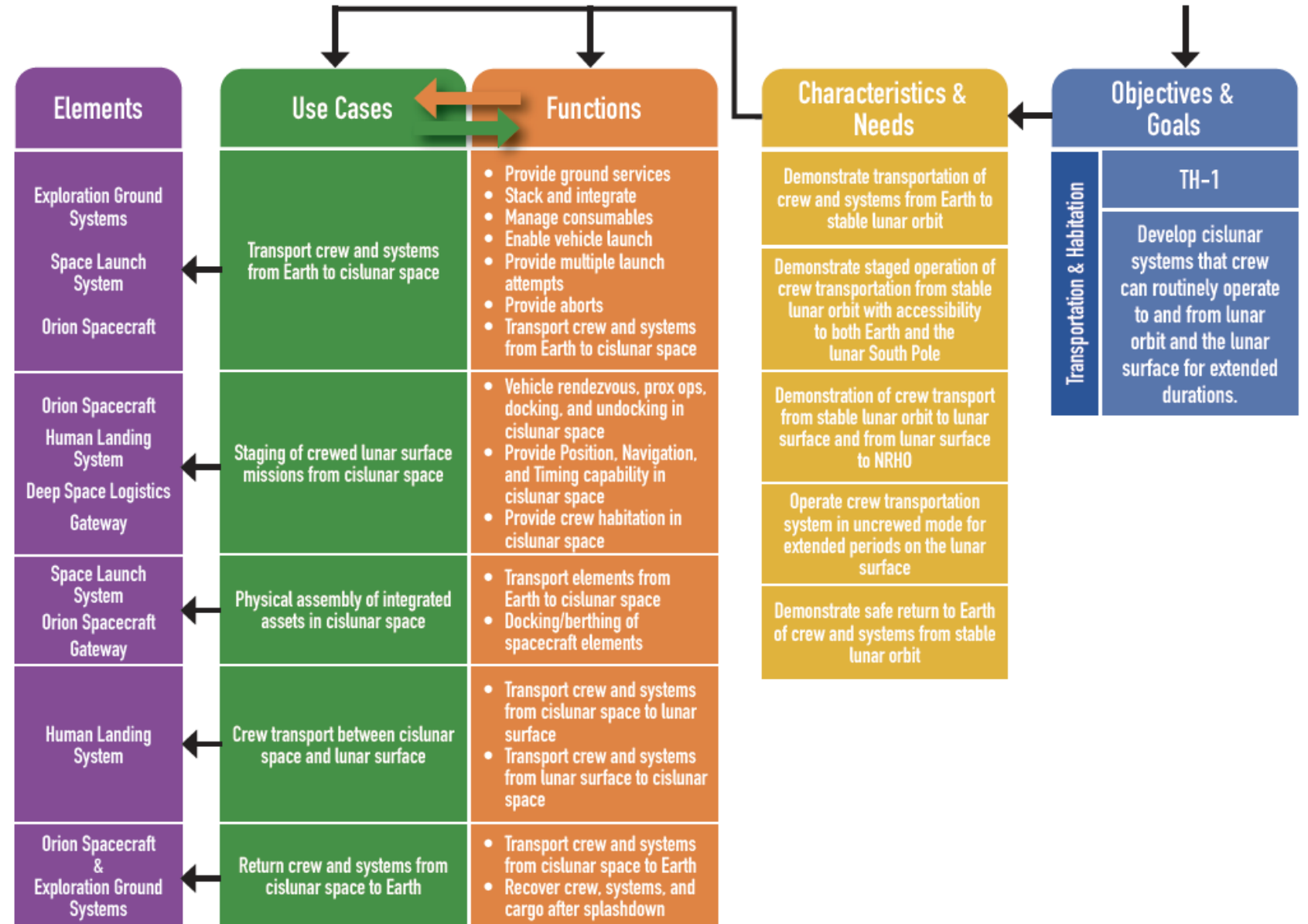


ARCHITECTING FROM THE RIGHT

Start Here

Example Objective Decomposition

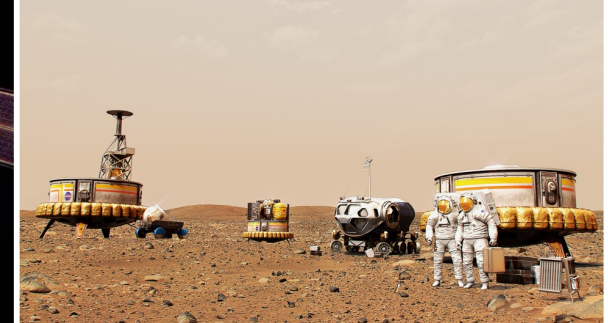
Example of the full distillation of the objectives into lunar-specific Use Cases, Functions, and Elements for the *Human Lunar Return* segment using one of 12 Transportation and Habitation Objectives.



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

Foundational Exploration

Sustained Lunar Evolution

Humans to Mars

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

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

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.

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

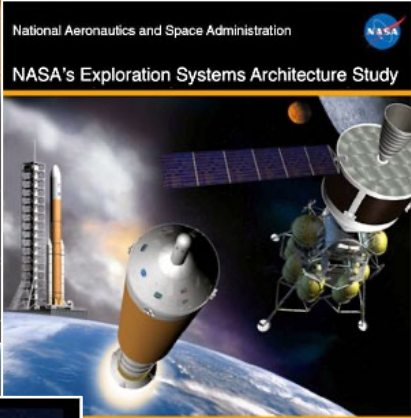
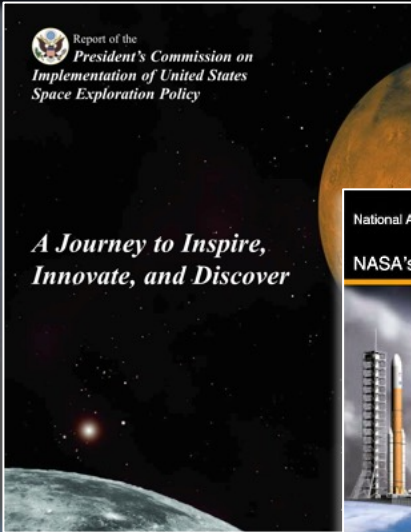
Focus for ACR 22

Focus for ACR 23

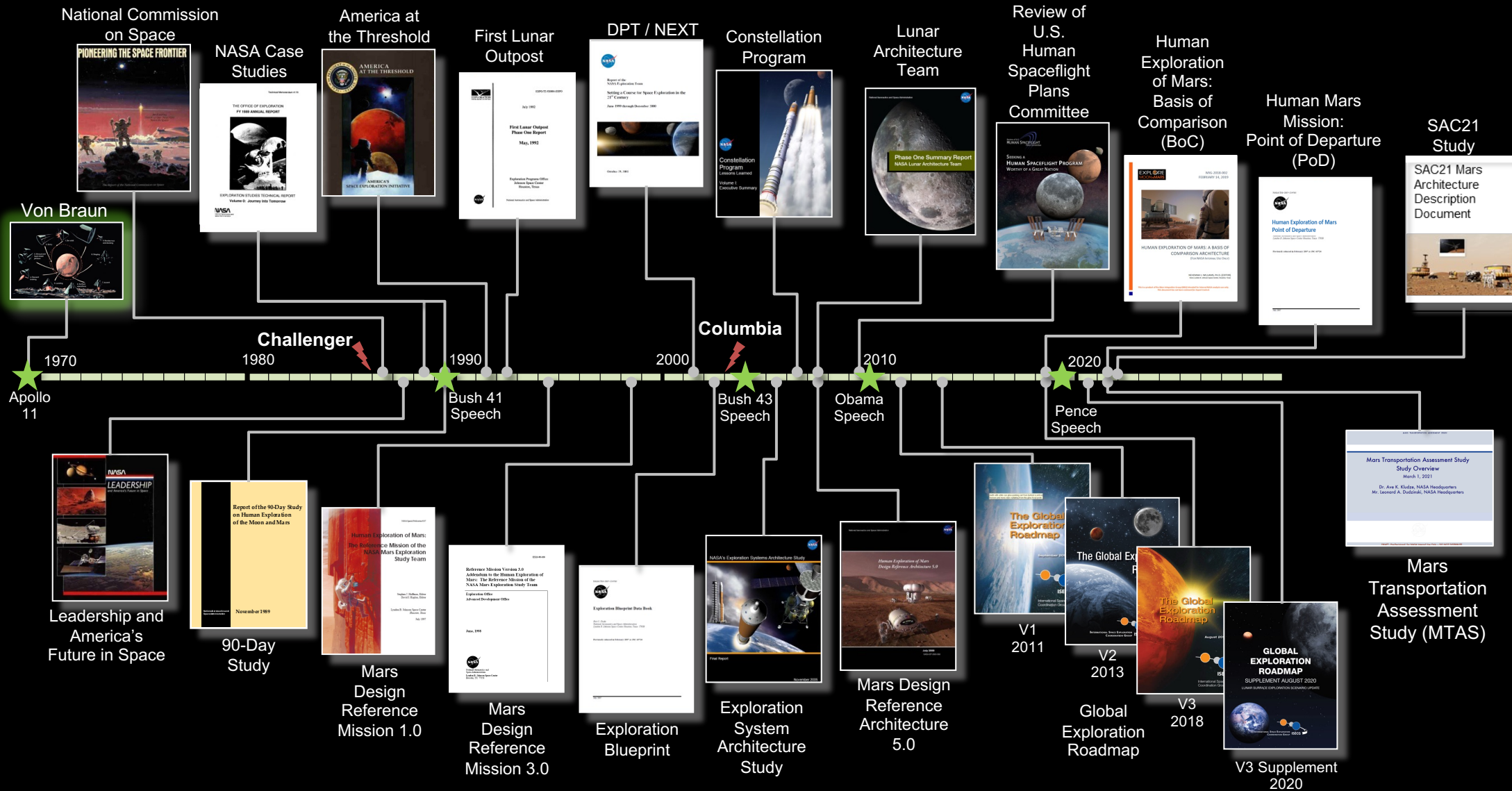
Sub-architecture: A group of tightly-coupled systems, functions, and capabilities that perform together to accomplish architecture objectives.

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

Recent History Of NASA Exploration Plans



Over 50 Years of Mars Studies



Hindrances to Effective Systems Engineering



Changing and/or broad goals

External Pressures

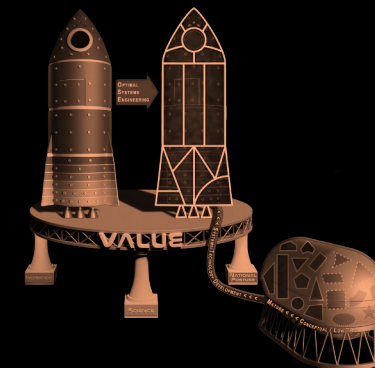
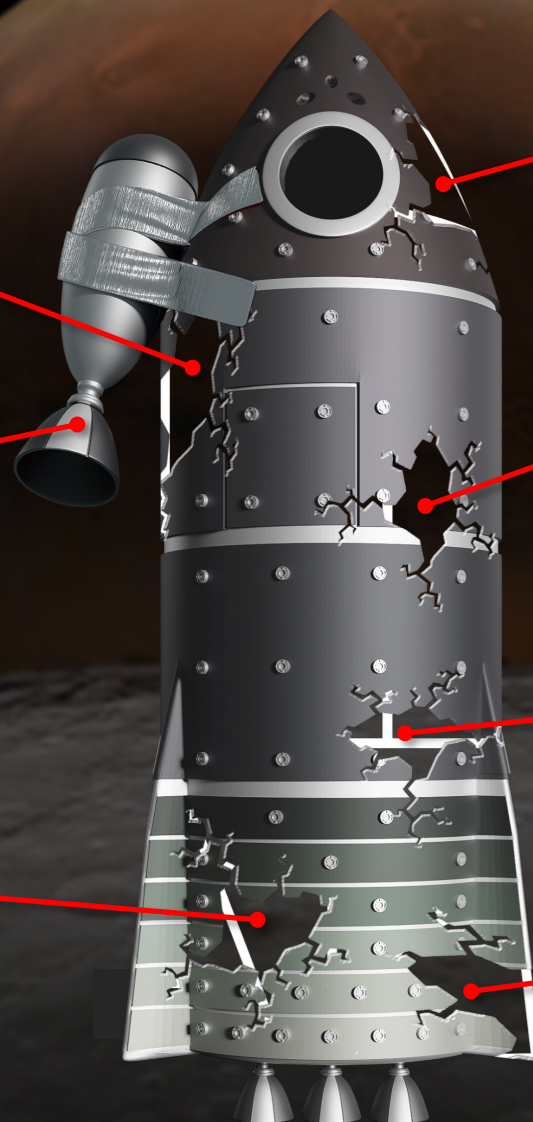
Insufficient Funding

Stovepipes

Fears of being cut

Poor/Restricted Communication

Distributed Motivations





Breadth of Current Approach

Continual Documentation

Documentation of refined objectives for distribution including rationale

Enhanced Communication and Engagement

Continued discussions with International, Industry, Academia, Workforce, and Stakeholders

Architecture Concept Review

Annual Agency wide internal sync point to ensure commitment and synchronization

White Papers

Series of short white papers on various aspects of the architecture to address common questions, concerns, and share underlying rationale

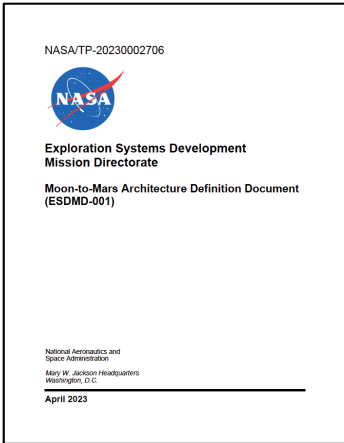
Federated Board Targeted Reviews

Periodic gap analyses and deep dives at senior level to support cross-directorate coordination



ACR Products

Available at www.nasa.gov/MoonToMarsArchitecture



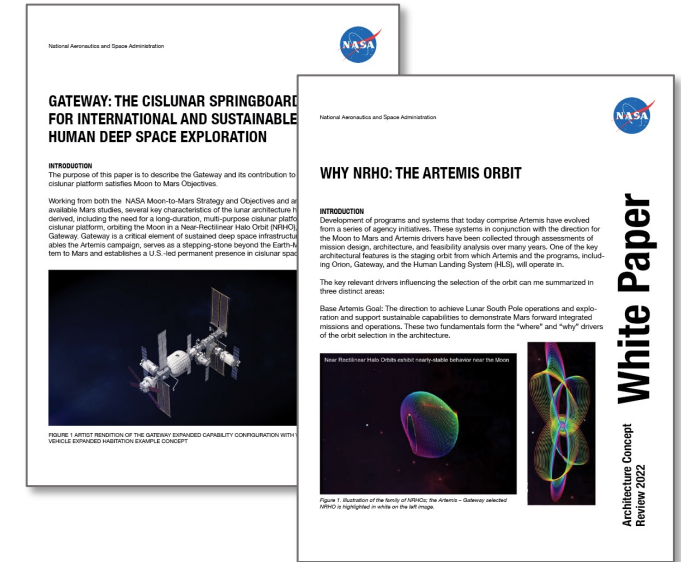
Architecture Definition Document

- **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

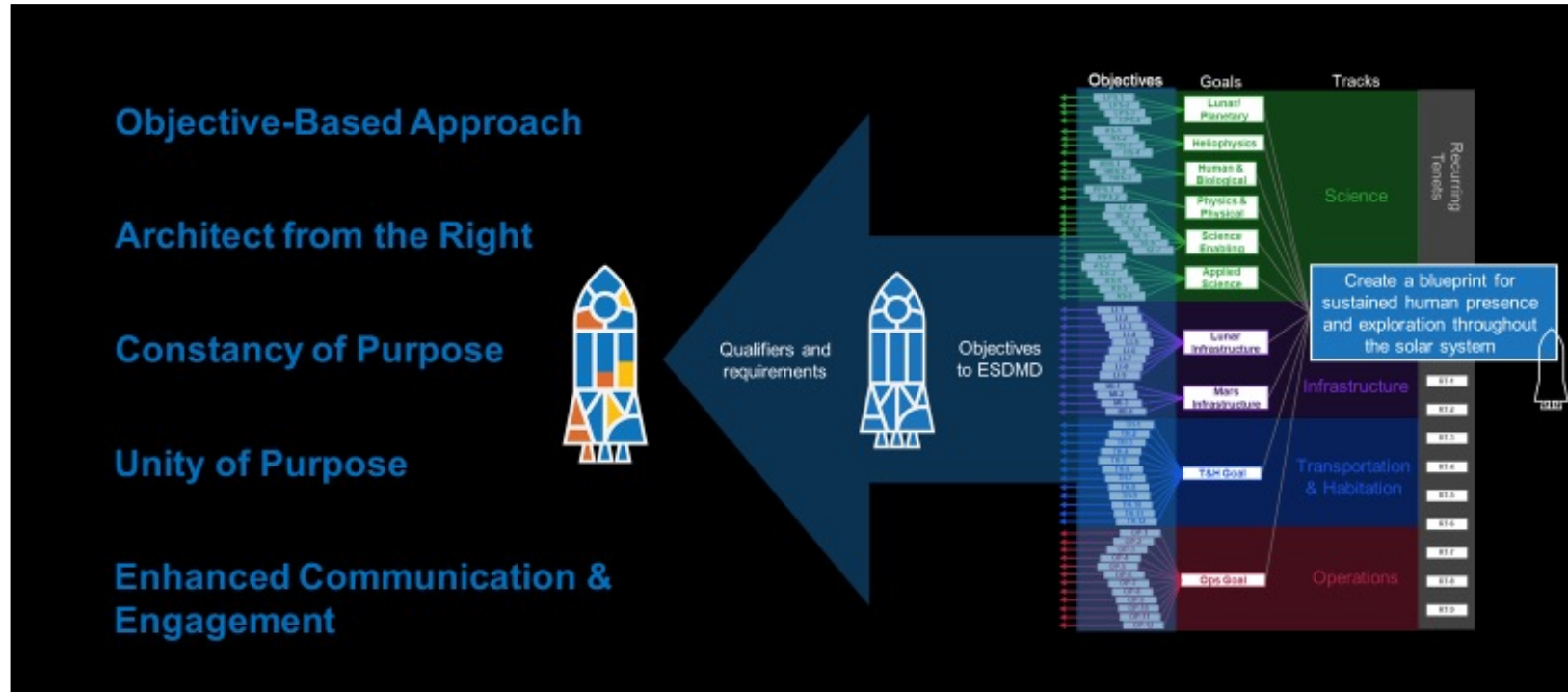
- **Length:** 4-6 pages each
- **Purpose:** document architecture study details on frequently discussed topics
- **Audience:** technically informed – industry, international partners, staffers
- **Publication:** nasa.gov
- **Update cadence:** ACRs and as needed

Moon to Mars Arch Products Are Not...



- **A Replacement for Existing Process or Agreements:**
 - Mechanisms and processes for partnerships, procurements, etc. are unchanged
 - Architecture approach is to engage and communicate in support of these processes
 - Architecture products will be updated to reflect decisions from the formal processes
 - ACR as an event will remain a NASA internal synchronization meeting
- **Procurement Direction:**
 - Products are to communicate needs and not to presuppose solutions
 - Needs may be fulfilled through various means coordinated through the existing processes and procedures
- **A Manifest:**
 - Actual flight manifests, sequences, or specific mission content or design are the responsibility of the Moon to Mars Program(s), partner planning, and contract mechanisms
 - Manifests are subject to the development, budget, schedule, etc. pressures beyond the scope of the architecture definition
- **A Budget Request:**
 - NASA and partner budget process are highly involved efforts
 - Architecture products will inform those processes and reflect progress toward the objectives as decisions and content are approved, funded, or contributed

Discussion: Methodology and Strategy



- Are there any disconnects or pressures that could become roadblocks?
- What are secondary concerns that may need to be proactively managed?
- Are there partner needs not yet addressed in the general philosophy?

Discussion: Product, Content, or Additional Needs



www.nasa.gov/MoonToMarsArchitecture

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

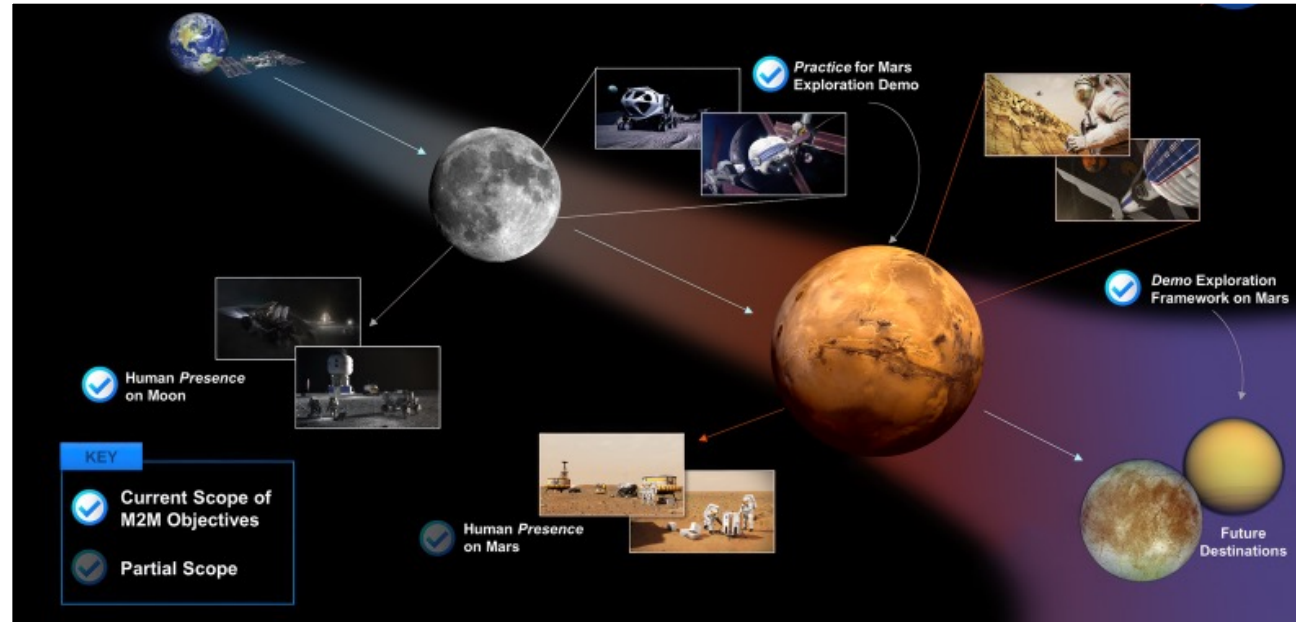
Moon to Mars Architecture Summary
High-level overview of NASA's Moon to Mars architecture and exploration strategy

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

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- Is there key information that could be added?
- Are there additional documentation approaches/formats that would be beneficial?
- Are there any additional white paper topics that would be beneficial?
- What additional science, technology, or other integration data would be beneficial?

Discussion: Current Moon to Mars Scope



- Are there modifications or clarification needs on any segments? More segments? Less?
- Are the sub-architectures sufficient?
- What content related to either of these would be of additional benefit?
- What is the right level of detail vs. risk of overspecification inhibiting innovation?

Discussion: Outreach and Engagement



- Are there effective or efficient interactions that would benefit this effort?
- Are there specific types of activities that would enhance communication?
- Is there timing of communications, workshops, etc., that would benefit you or your stakeholders?