

National Aeronautics and  
Space Administration



# Moon to Mars Architecture Updates

NASA Advisory Council

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Deputy Associate Administrator

Strategy and Architecture Office

Exploration Systems Development Mission Directorate

11/17/2023

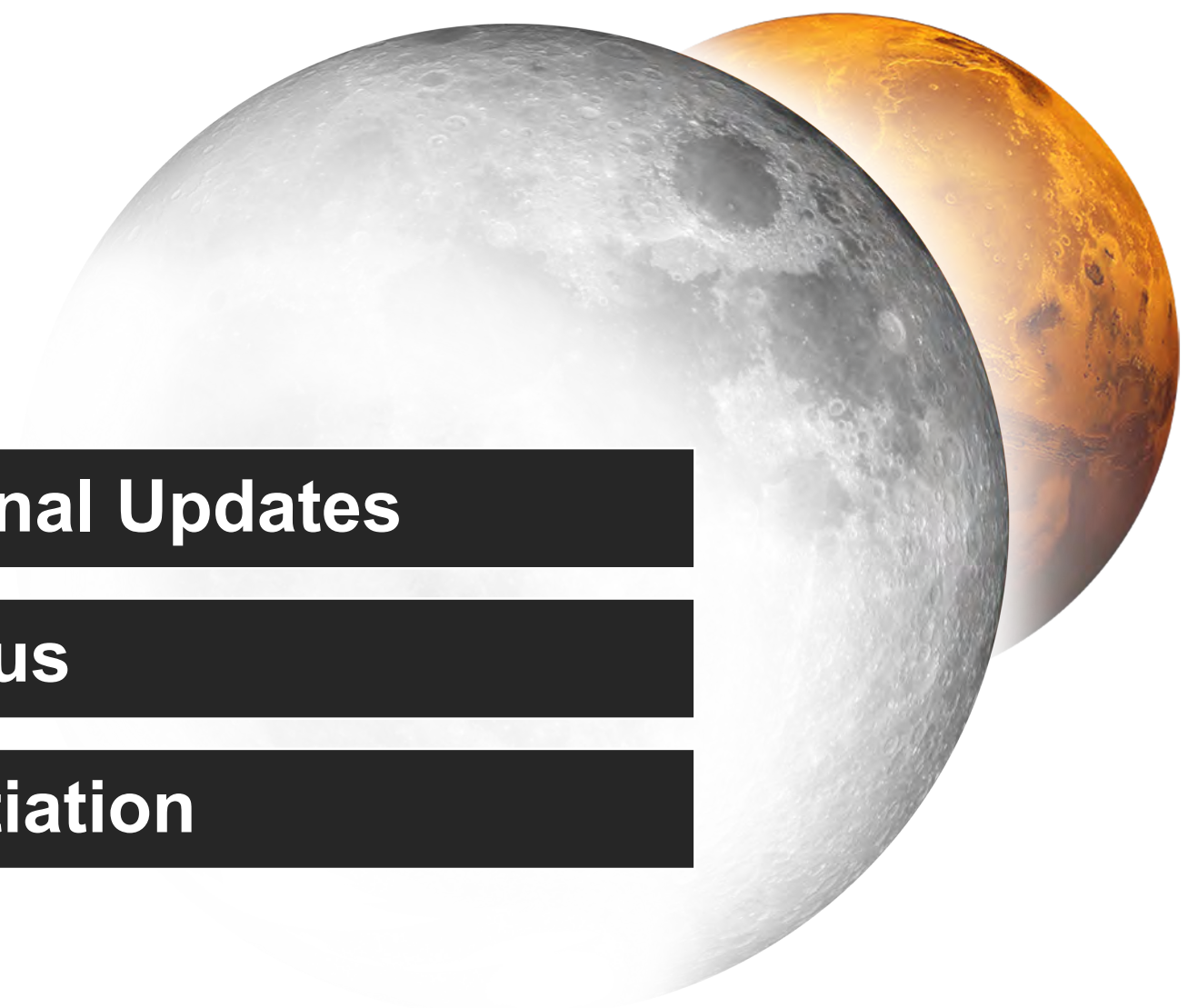
STRATEGY AND ARCHITECTURE OFFICE

EXPLORATION SYSTEMS DEVELOPMENT MISSION DIRECTORATE



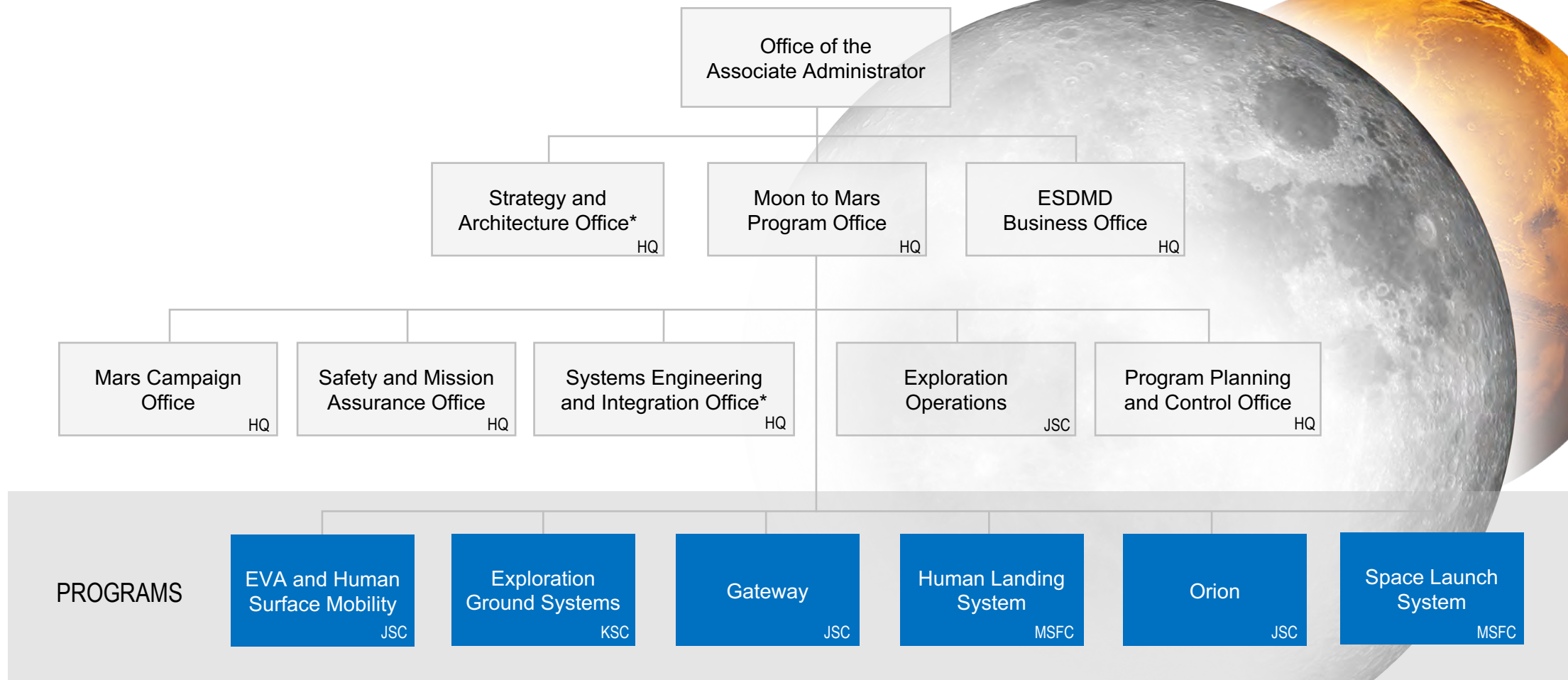
# Agenda

- **Organizational Updates**
- **ACR23 Status**
- **Element Initiation**





# Exploration Systems Development Mission Directorate (ESDMD)



\*Strategy and Architecture and SE&I have direct integration with SMD and STMD



# Exploration Systems Development Mission Directorate (ESDMD)

## Strategy and Architecture Office\*

- Defines architecture for crewed exploration of the Moon and Mars.
- Maintains the agency's baseline exploration architecture.
- Engages and integrates other stakeholder input into the architecture.
- Guides applicable programs and projects through the pre-formulation phase.

## Moon to Mars Program Office

- Supervises development and operations of individual Moon to Mars elements.
- Manages and accepts risk for Moon to Mars crewed exploration efforts.
- Integrates the design, engineering, operations, and budget formulation for elements.
- Oversees Artemis mission preparation, training, operations, and execution.

## ESDMD Business Office

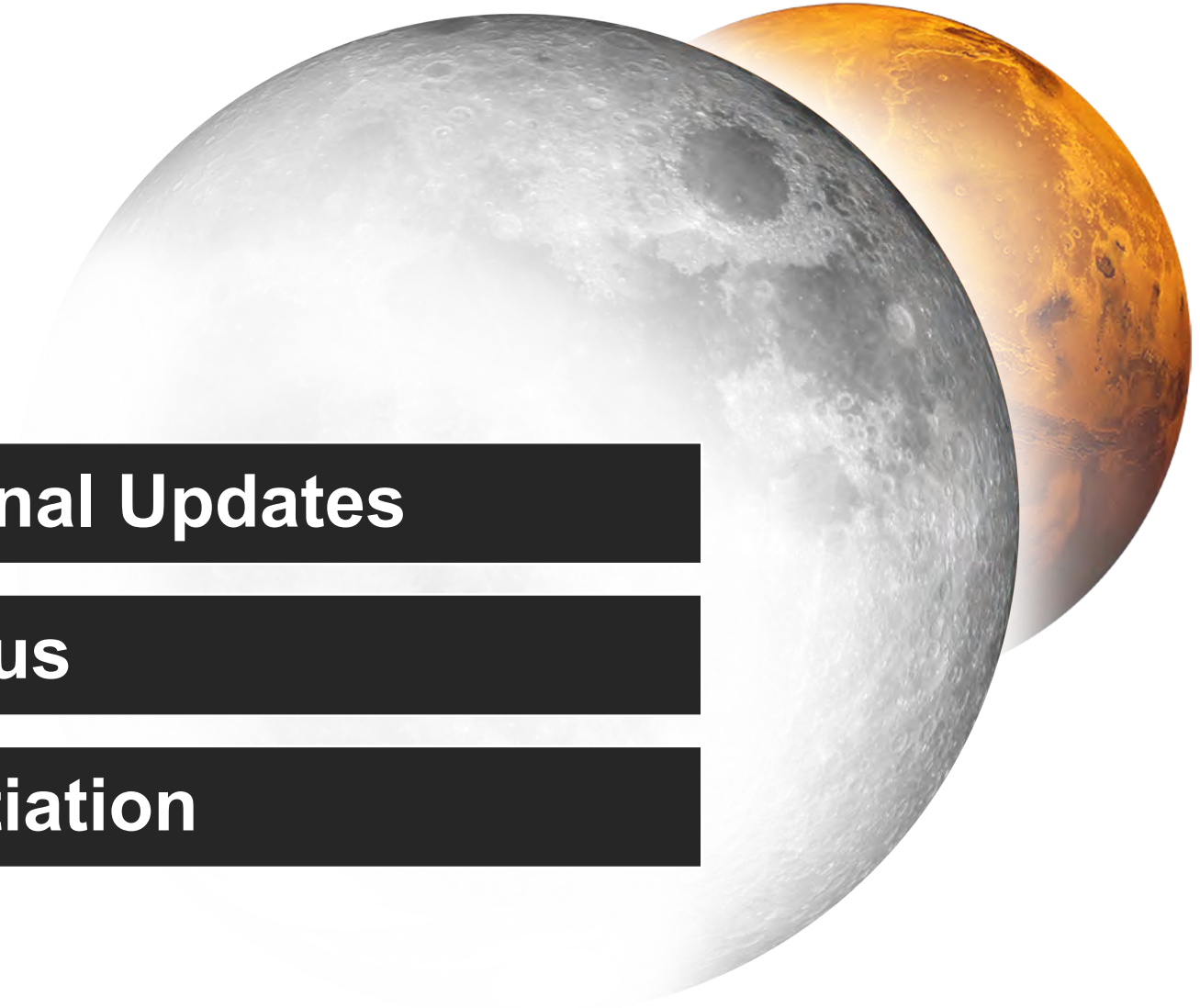
- Takes responsibility for budget formulation and integration for the mission directorate.
- Reports budget, cost, and performance to stakeholders.
- Distributes funding for directorate efforts.
- Oversees planning, documentation, human resources, information technology, etc.





# Agenda

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# ACR23 Status

## 2023 Architecture Concept Review

### Key Dates



#### **ACR23**

*November 14-16, 2023*



#### **Executive Council**

*January 18, 2024*



#### **Product Release**

*January 22, 2024*



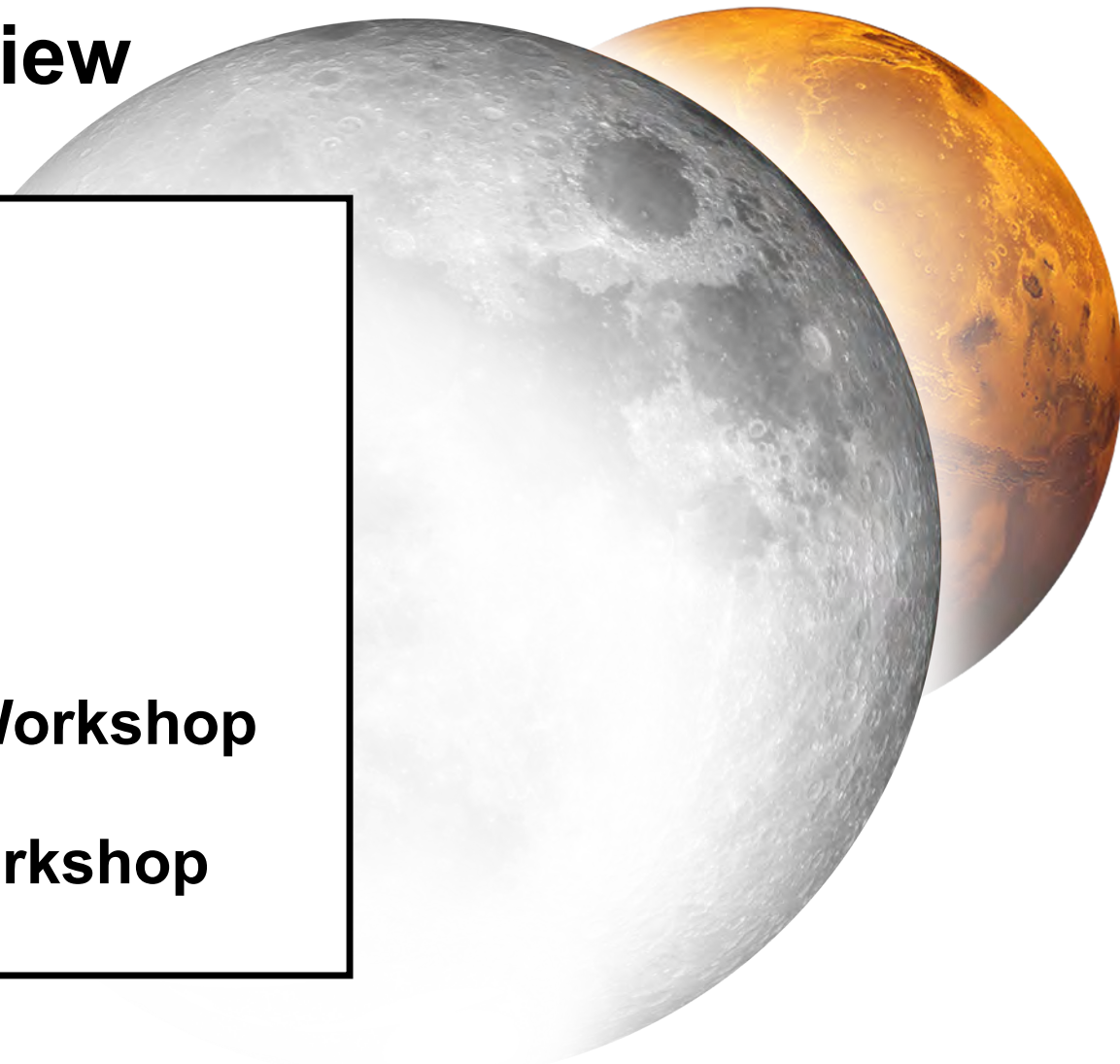
#### **International Partner Workshop**

*February 20, 2024*



#### **Industry/Academia Workshop**

*February 22, 2024*





# 2023 Architecture Concept Review



## NASA's Kennedy Space Center

*November 14-16, 2023*

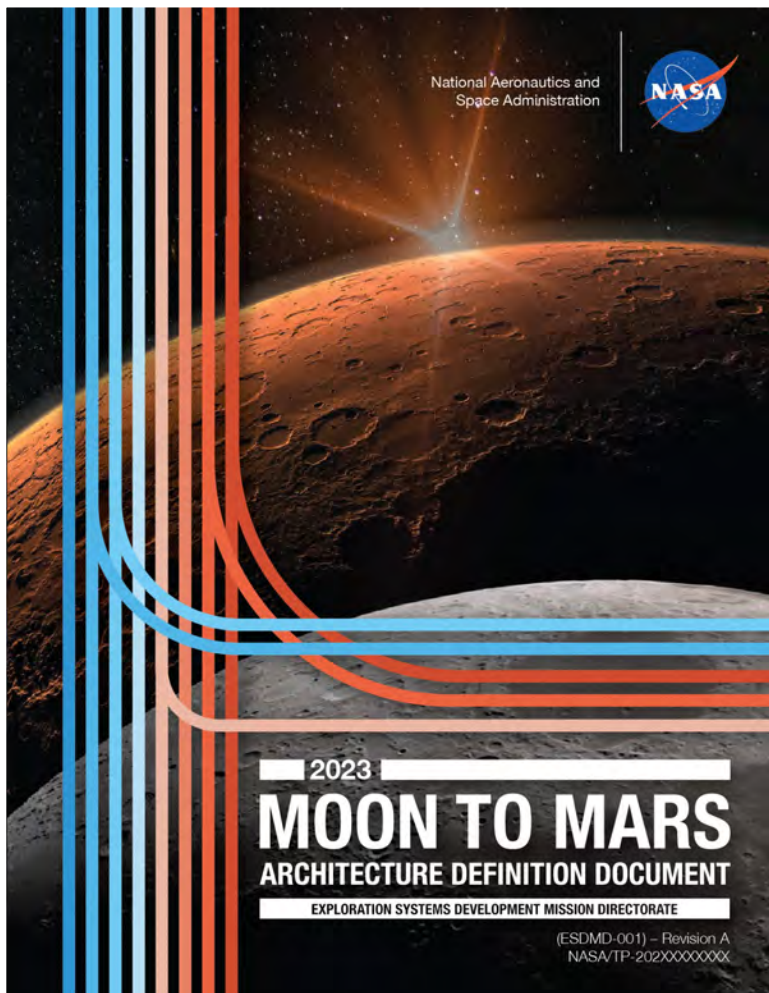


- The agency's annual Architecture Concept Review process enabled stakeholders across NASA and among its partners to provide feedback on our Moon to Mars exploration plans.
- Products that come out of the Architecture Concept Review include updates to the agency's Architecture Definition Document and White Papers highlighting key results from that year's Strategic Analysis Cycle.
- ACR23 focused on refining and adding subarchitectures, adding mature elements, and architectural strategies for the first crewed missions to Mars.





# Architecture Definition Document (ADD)



Draft Cover Art for the 2023 Revision of the ADD



## Rev A Publication

January 22, 2024


- The Architecture Definition Document is a NASA-published reference document that presents the current state of the human spaceflight architecture and exploration strategy.
  - The document decomposes Moon to Mars objectives into functions and use cases for allocation to implementable programs and projects.
  - It includes current partnerships presence in the architecture, identifies architectural gaps, and presents opportunities for further collaboration.
  - It is **NOT** a requirements document, a mission definition document, a planning manifest, or a procurement strategy.
  - The [current version](#) was published April 1, 2023.
- NASA plans to publish yearly updates to the Architecture Definition Document, incorporating the results of the prior year's Architecture Concept Review.





# What's New in Revision A?

## Addition of Mature Elements:

Provided by the Canadian Space Agency (CSA) 

Provided by the European Space Agency (ESA) 



**Lunar Terrain  
Vehicle (LTV)**



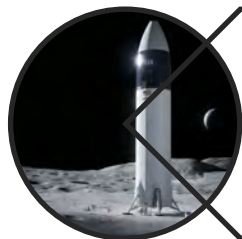
**Gateway Extra-Vehicular  
Robotic System (GERS)**



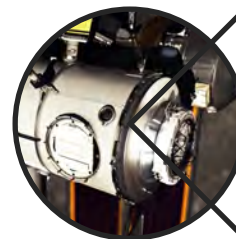
**Pressurized  
Rover (PR)**



**Gateway European System Providing  
Refueling, Infrastructure, and  
Telecommunications (ESPIRIT) Refueling  
Module (ERM)**



**Human-class Delivery  
Lander (HDL)**

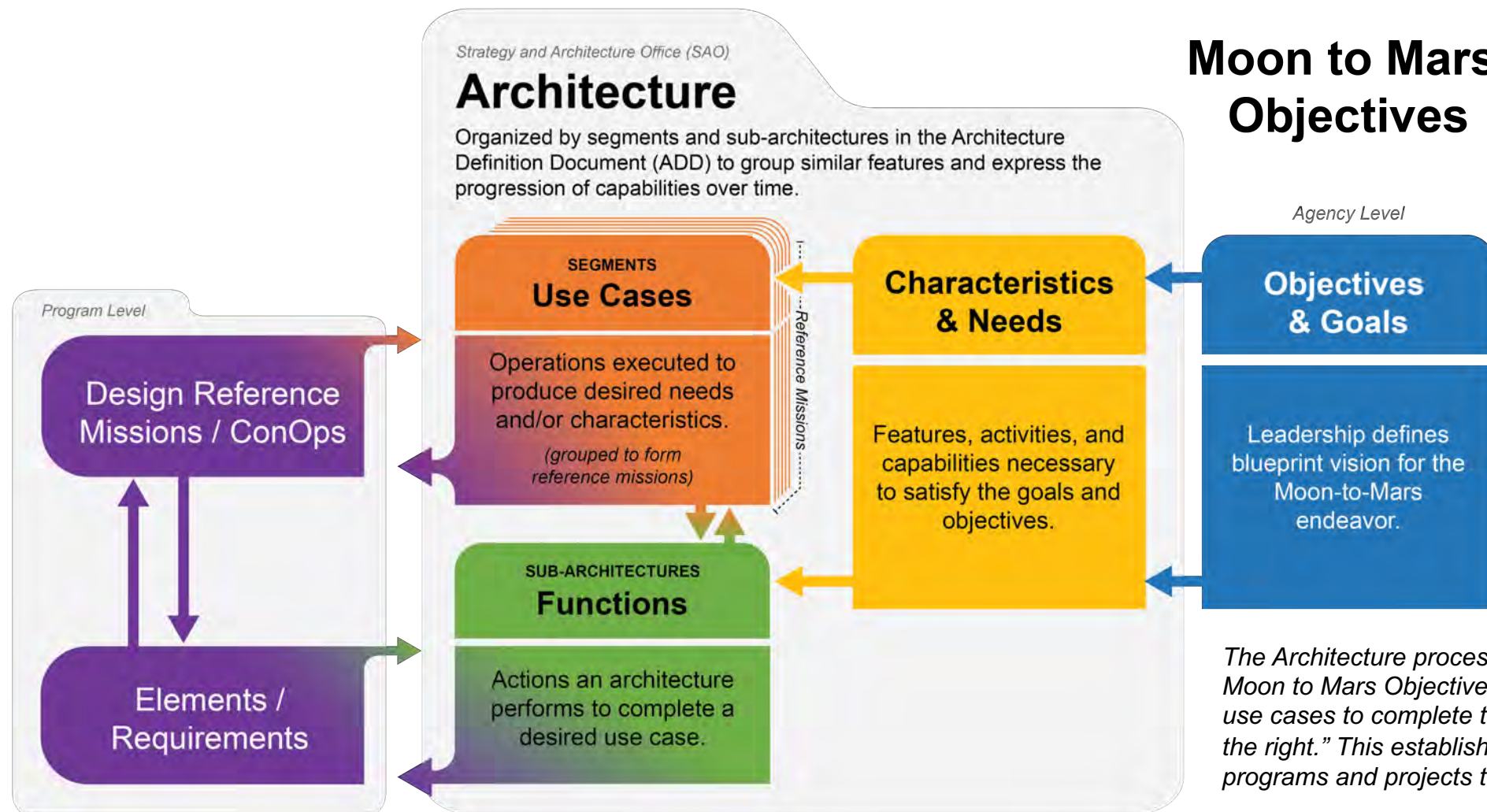


**Gateway Airlock  
Module**

*\*Elements will be documented once they pass internal NASA Mission Concept Review (MCR) Milestone and international agreements on project cooperation are concluded*



# Architecting from the Right



## Moon to Mars Objectives

*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.*

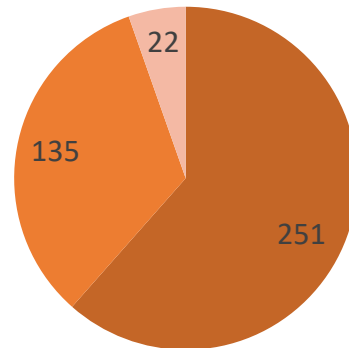


# What's New in Revision A?

## Refined/Expanded M2M Objective Decomposition into Characteristics and Needs & Use Cases and Functions:

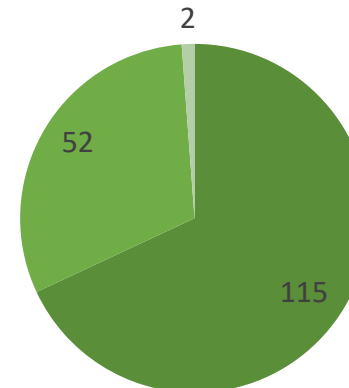


Functions\*



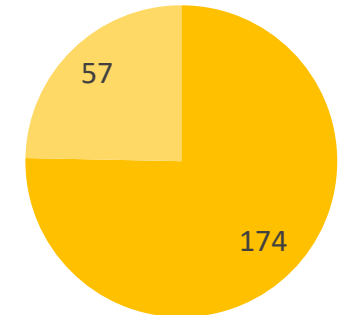
■ Unchanged ■ Updated ■ New

Use Cases\*



■ Unchanged ■ Updated ■ New

Characteristics and Needs\*



■ Unchanged ■ Updated

Added Synopsis of Architecture Decision Process and Roadmap that describes the process for determining a logical flow of architectural decisions at a high-level.



# What's New in Revision A?



## Refined Human Lunar Return Segment

- Includes updated objective decomposition into use cases and functions with element mapping.

## Expanded Foundational Exploration Segment

- Establishes objective decomposition into use cases and functions with element mapping for the foundational exploration segment.

## Refined Initial Human to Mars

- Updates content based on the results of this year's Strategic Analysis Cycle (SAC23) for the Architecture Concept Review (ACR23).
- Includes discussion of drivers related to the Mars architectural efforts.

## Expanded Assessments to the Recurring Tenants

- Added discussion of Recurring Tenets (RT) throughout the architecture including updates to RT-1, International Partnerships.




# White Papers (x12)



Publishing 12 White Papers alongside Architecture Definition Document Revision A


 Mars Communication  
Disruption and Delay


 Mars Mission  
Abort Considerations

 Surface EVA  
Architectural Drivers

 Lunar Communications  
and Navigation Architecture

 Mars Surface  
Power Generation


 Lunar Logistics  
Drivers and Needs

 Safe and Precise  
Landing at Lunar Sites

 Exploration Lessons Learned  
from the Space Station

 Human Health and Performance  
for Mars Missions

 Lunar  
Site Selection

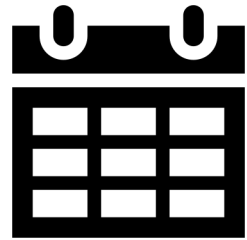
 Analytical Capabilities  
In-situ vs. Returned

 Round Trip Mars Mission  
Mass Challenges

*Suggestion from 2023 Architecture Workshops* 

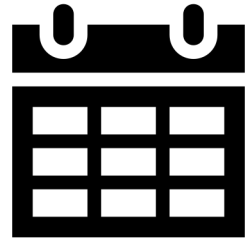


# Architecture Workshops



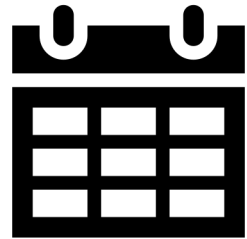
## Save the Dates Sent

*October 23, 2023*



## For International Partners

*February 20, 2024*



## For Industry and Academia

*February 22, 2024*



# 2024 Strategic Analysis Cycle



- The 2024 Fiscal Year will be first full, annual cadence for the new Architecture Concept Review.
- The architecture team endeavors to ensure repeatability and identify lessons learned for subsequent cycles.
- The volume of needed analysis, integration, and workload will be matched to available agency resources.
- Our priority is producing quality assessments that can be supported programmatically in implementation while ensuring communication with and feedback from the NASA community and government, industry, academic, and international stakeholders.



# Agenda

- Organizational Updates
- ◀ ACR23 Status
- ◀ Element Initiation



# Current Process Limits



Historically, human spaceflight formulation have often been transient teams for single efforts. As a result, repeatable processes were not been established in many cases.

- **NASA Policy Directive 1000.5**  
Acquisition strategy placement occurs after mission concept review.
- **NASA Procedural Requirement 7120.5**  
Program project process begins at formulation milestone.
- **NASA Systems Engineering Handbook**  
Describes formulation functions but does not articulate ownership or process preceding a program.

**Moon to Mars efforts are multi-decadal, necessitating consistent and repeatable processes.**



# Element Initiation

## A New Pre-formulation Process

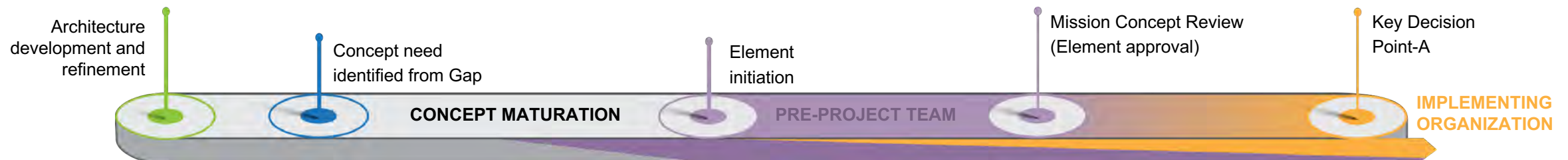
### Meeting a Need

- Historically, exploration programs and projects have been developed through a variety of teams, processes, and functions.
- Inconsistency in technical maturity and mission expectations at formulation has led to issues for implementing programs including cost, schedule, and risk.
- Clarity and consistency in formulation and definition is necessary for NASA to execute the Moon to Mars exploration effort.



# Element Initiation Purpose

- An overt integration point initiated by the Strategy and Architecture Office where the mission directorate commits to formulate element based on an identified architecture gap.
- The element initiation affirms a proposed element aligns to an architectural need and implies intent to apply necessary resources to formulate that element.
  - Includes initial use case and functions within the architecture, as well as a preliminary concept.
  - Highlights potential scope of international contributions to further bilateral study commitments.
  - Identifies a team to develop products needed for a successful mission concept review.

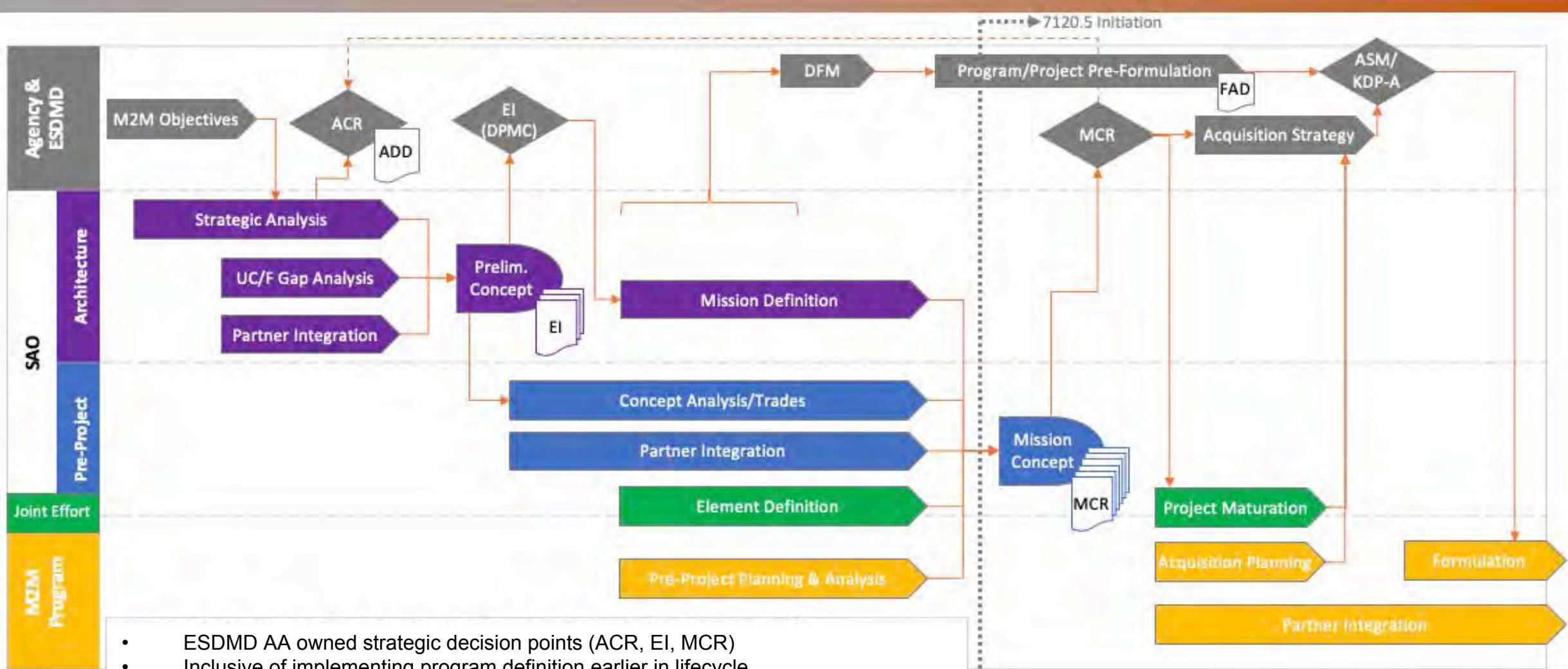




# ESDMD Process Highlights

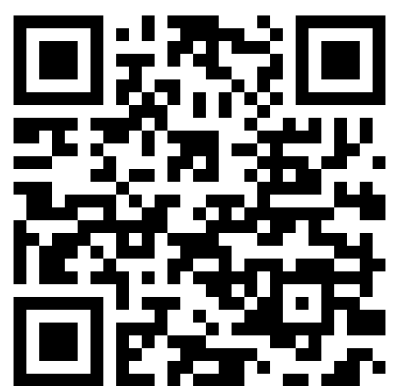


\*Tailorable for ESDMD support to program or projects led by other mission directorates.



- ESDMD AA owned strategic decision points (ACR, EI, MCR)
- Inclusive of implementing program definition earlier in lifecycle
- Process will be codified in ESDMD Operating Plan by Business Office





[nasa.gov/architecture](https://nasa.gov/architecture)

## **Moon to Mars Architecture, Objectives, White Papers and More**