Key Mars Architecture Decisions

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

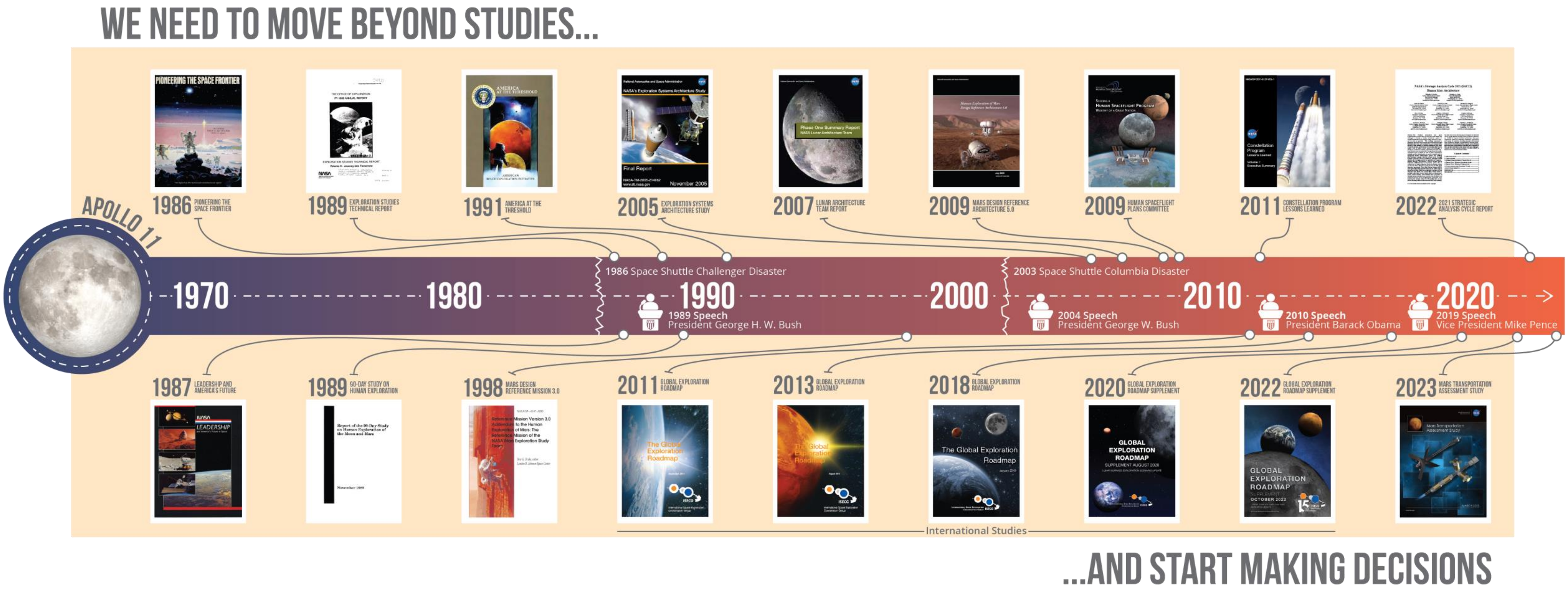
Enabling capabilities, systems, and operations to support regional and global utilization, economic opportunity, and a steady cadence of human presence on and around the Moon.

Future Segments

Humans to Mars

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

To send Humans to Mars…

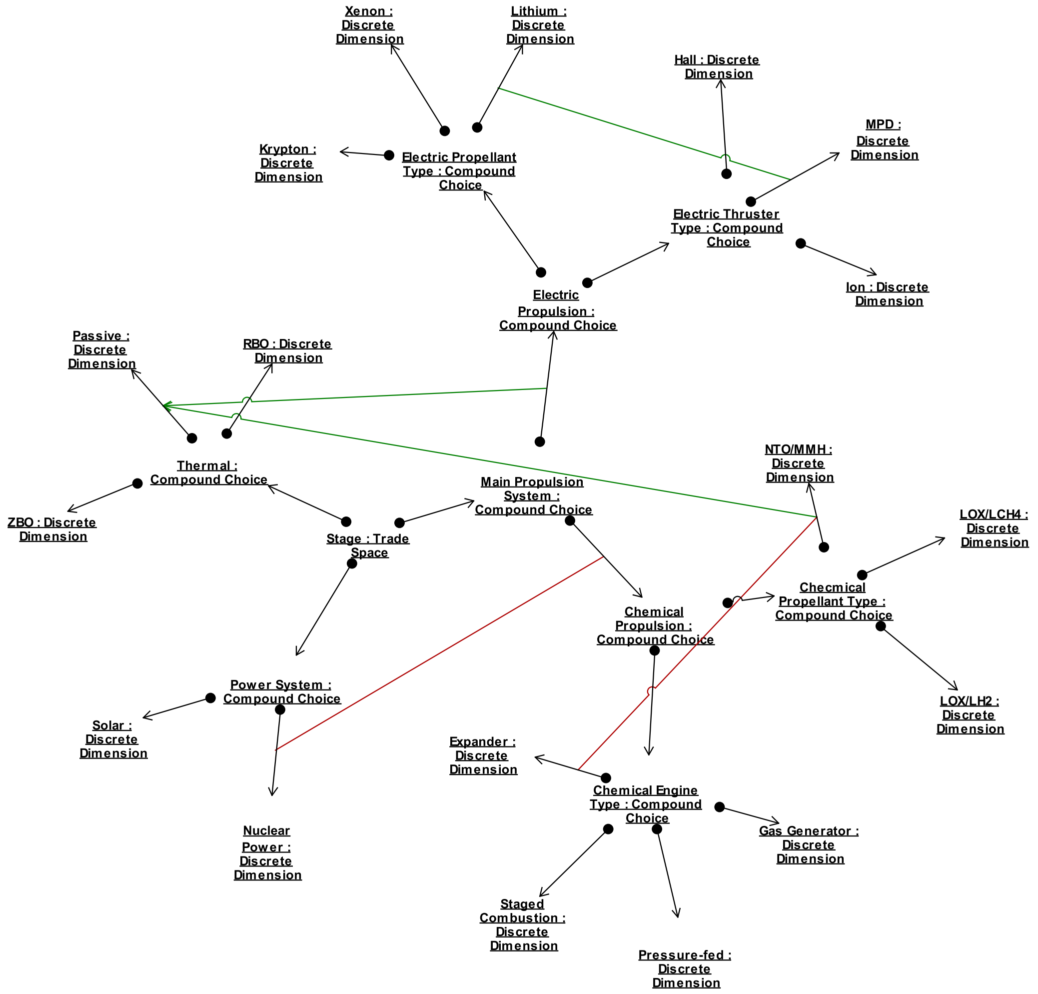


Decision Space Modeling

NASA is developing a decision modeling process and tools.

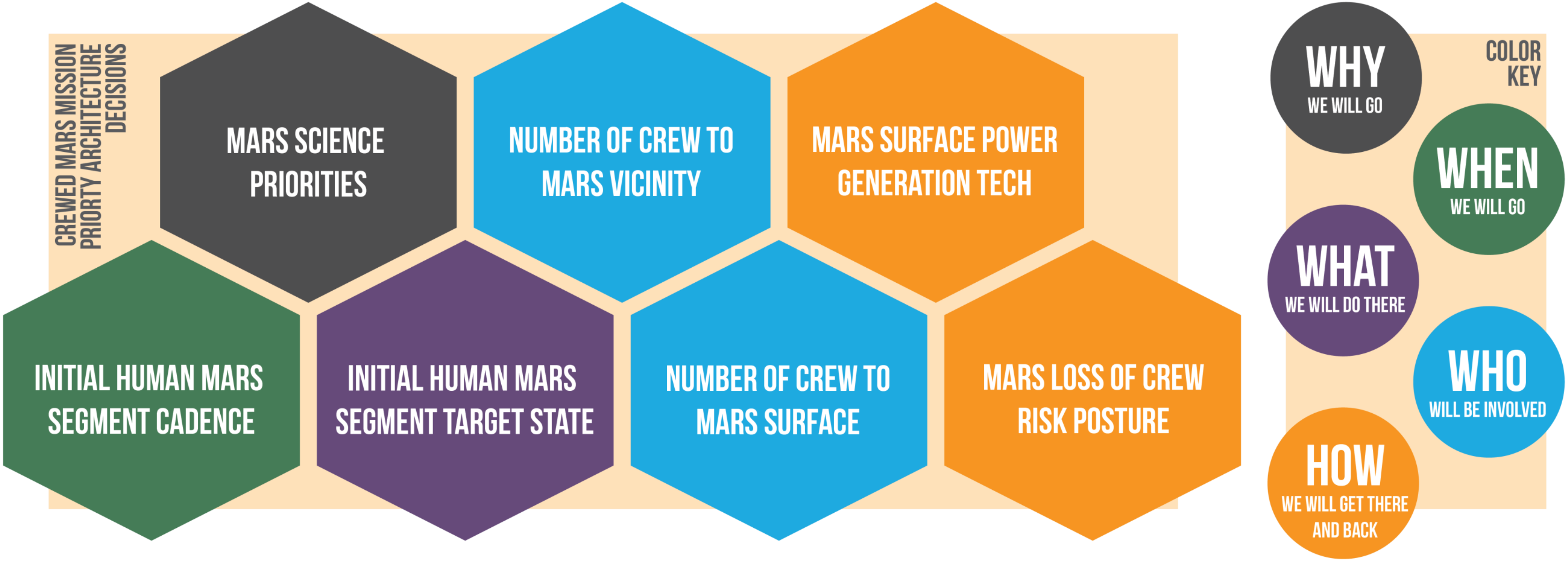
- *Preliminary analysis identified nearly 100 key architecture decisions.*
- *NASA is currently refining the catalog of needed decisions and modeling in a decision trade space that maps linkages between decisions.*

Seven key decisions recommended for priority analysis in the 2024 analysis cycle.



Decision Time Criticality

Mars Priority Architecture Decisions



MARS SCIENCE PRIORITIES

Candidate Key Mars Architecture Decision

Science Priorities for Initial Human Mars Segment

Needed Decision Outcome: Identify the highest science priorities *for the initial human Mars segment*

- *Includes both planetary and biological science priorities*

Context: Picking where before considering why may force us to revisit our how decisions

INITIAL HUMAN MARS SEGMENT TARGET STATE

Candidate Key Mars Architecture Decision

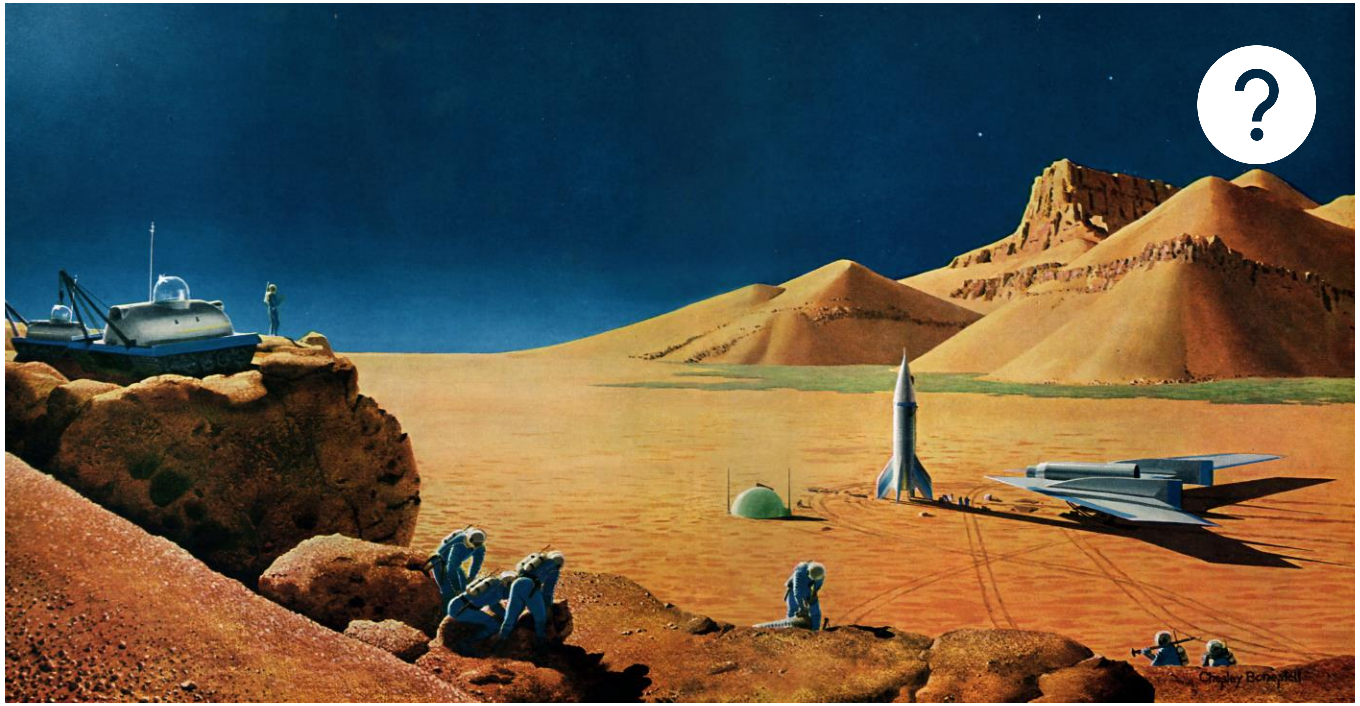
Initial Human Mars Segment Target State

Needed Decision Outcome: What is the target state ("vision") for the *initial human Mars segment*?

- *Science missions to different sites, excursions from an established base at one site, or something else?*

Context: Segment scope should focus on the target state, not just a first mission

- *Apollo focused on getting to the Moon and back, so architecture wasn't suited for more crew, longer stays, larger exploration radii, or ambitious infrastructure*



Chesley Bonestell, The Exploration of Mars, 1953, oil on board. (Chesley Bonestell, Smithsonian Institution)

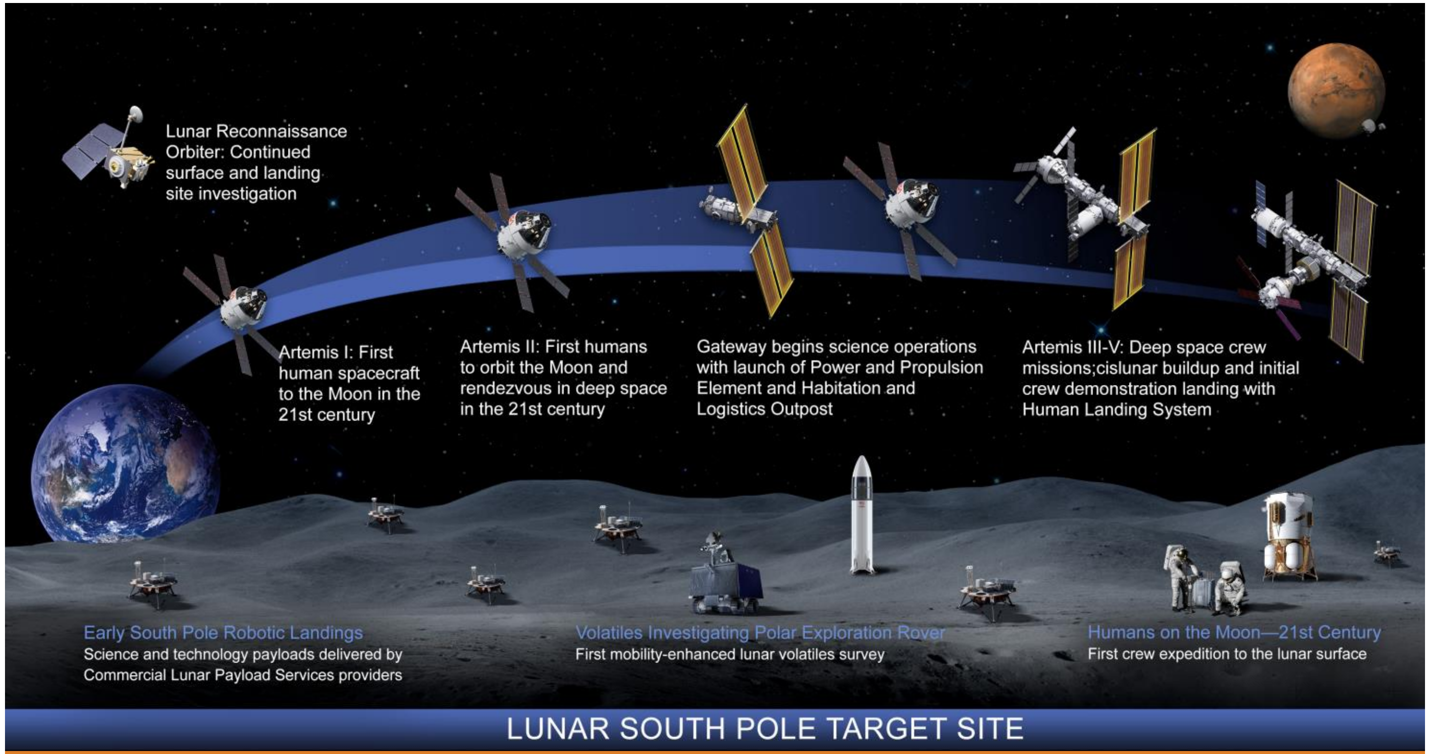
Candidate Key Mars Architecture Decision

Initial Human Mars Segment Mission Cadence

Needed Decision Outcome:
What is the cadence of missions for the *initial human Mars segment*?

Context: Initial Mars Segment Target State key decision will establish the segment scope

- *How many unique missions (including robotic precursors, cargo, and demonstrations) are necessary to achieve desired scope?*



What does a Mars-equivalent campaign look like?

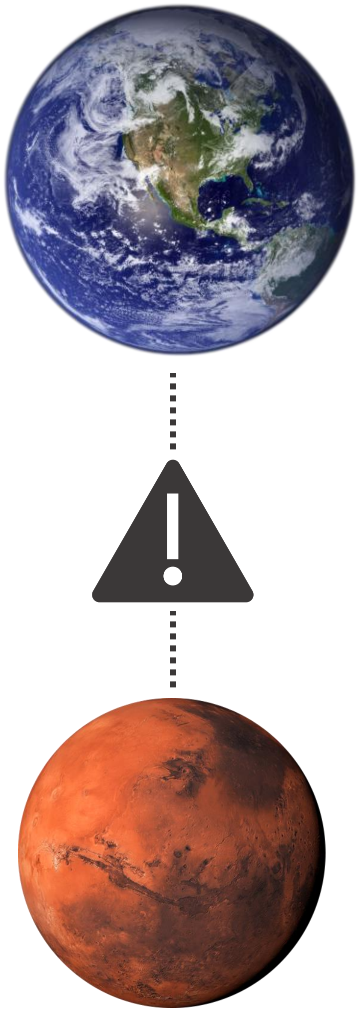
MARS LOSS OF CREW RISK POSTURE

Candidate Key Mars Architecture Decision

Mars Architecture Loss of Crew (LOC) Risk Posture

Needed Decision Outcome: Define probability LOC risk posture for a Mars mission.

Context: Human spaceflight programs typically develop an understanding of the overall LOC risk for the candidate operations and define a minimum level of acceptable risk (i.e., safety threshold) for the mission.



NUMBER OF CREW TO MARS SURFACE

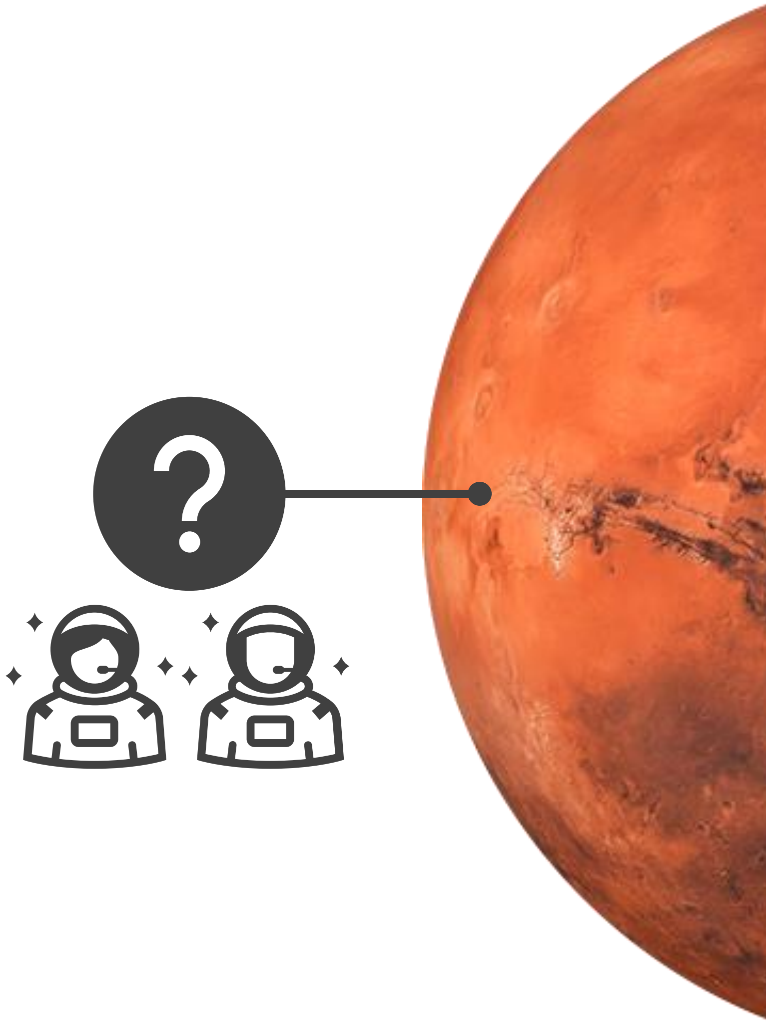
Candidate Key Decision

Crew Complement to Mars Surface per Crewed Mission

Needed Decision Outcome: How many crew will descend and land on the Mars surface per crewed mission?

- *Minimum number for first mission and upper limit for subsequent missions in the initial segment*
- *Note that number of crew to surface is not necessarily the same as number of crew to Mars vicinity*

Context: Crew complement is the most common study constraint across all architectures and elements, with implications for virtually every crewed element, plus logistics and operations.



NUMBER OF CREW TO MARS VICINITY

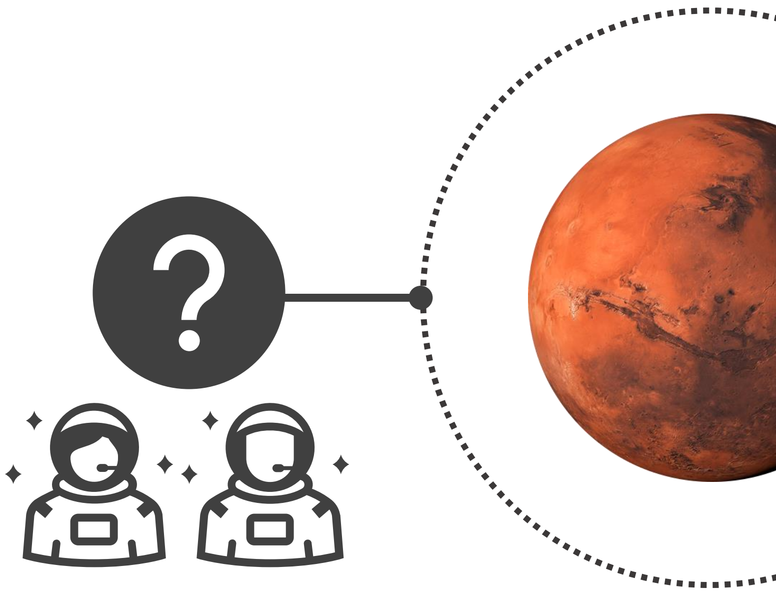
Candidate Key Mars Architecture Decision

Crew Complement to Mars Vicinity per Mission

Needed Decision Outcome: How many crew will travel to Mars vicinity per crewed mission?

- *Minimum number for first mission and upper limit for subsequent missions*
- *Note that number of crew to surface is not necessarily the same as number of crew to Mars vicinity*

Context: Crew complement is the most common study constraint across all architectures and elements, with implications for transit and Earth launch/land vehicles.



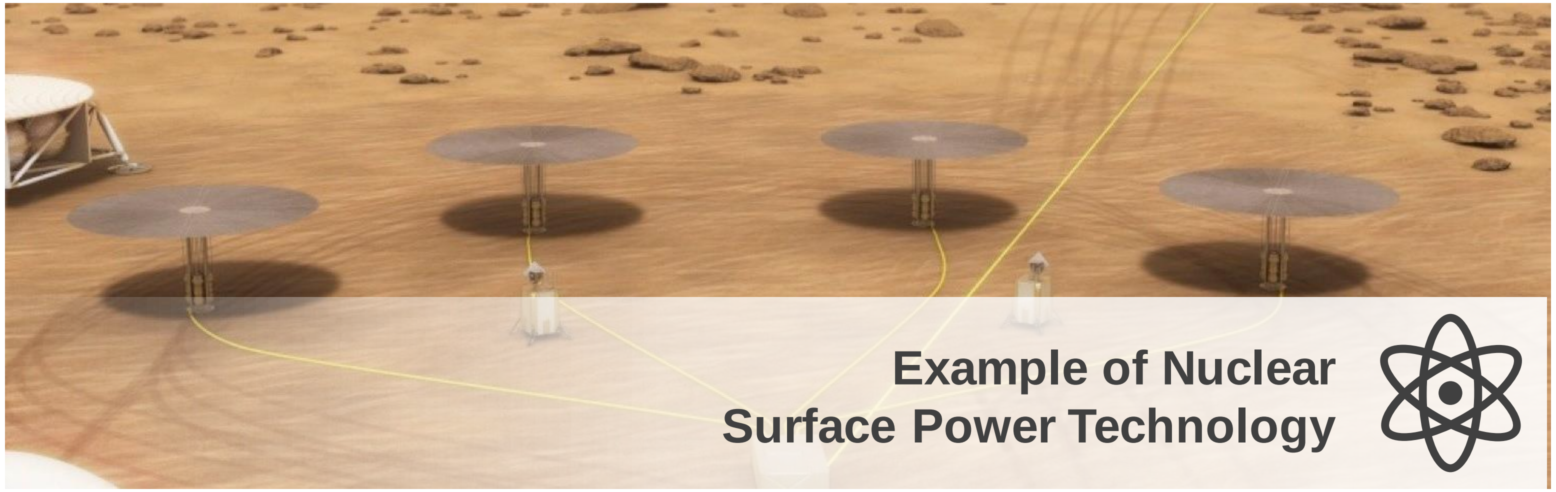
Candidate Key Mars Architecture Decision

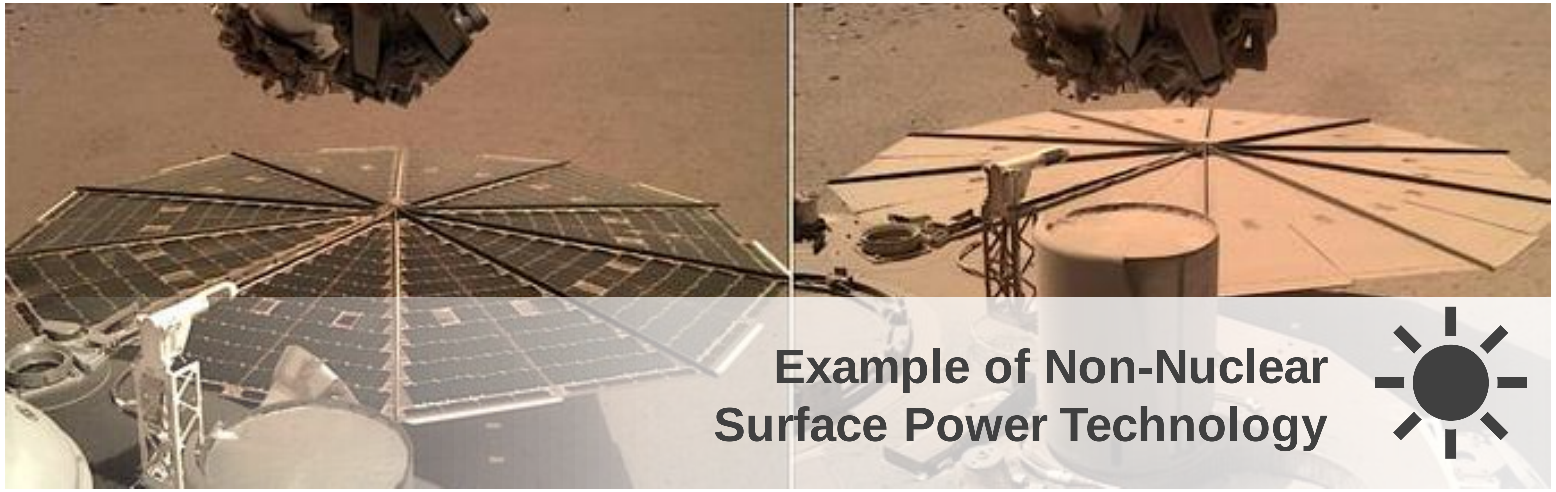
Mars Primary Surface Power Generation Technology

MARS SURFACE POWER GENERATION TECH

Decision Outcome Needed: Select *primary* surface power generation technology.

Context: Extensive robotic mission experience has made clear that reliable surface power is mission critical in Mars' challenging environment. Primary power source selected will be a scalability driver for human Mars missions.





Key Take-Aways

The **order in which key decisions are made** heavily influences exploration architectures.

Every decision is important, but not every decision can be first.

NASA endeavors to identify a **logical order for decision making** by modeling the decision trade space for human Mars exploration.

Methodology allows decision makers to understand the integrated impacts of each individual decision on the overarching architecture.

Application of the new process and tools resulted in **seven key Mars architecture decisions** to focus on in the current analysis cycle.

These decisions affect every subsequent decision.

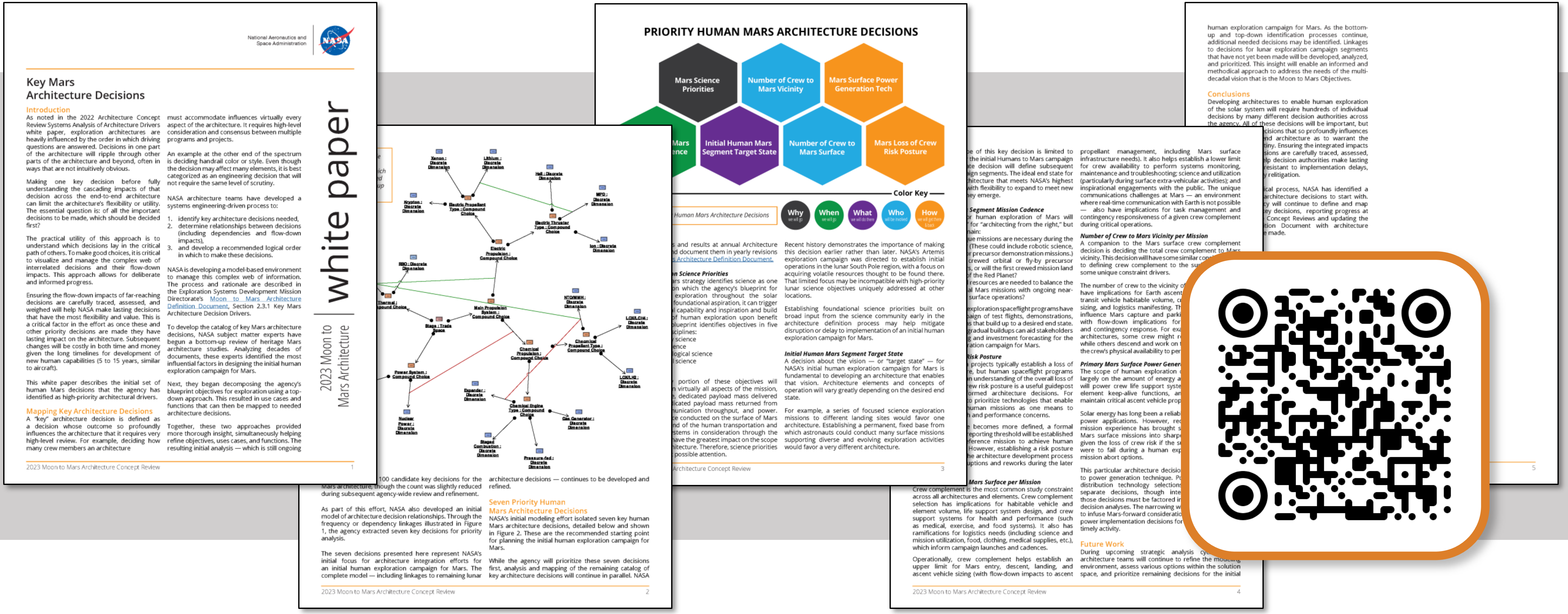
Mars serves as a **test case** for this approach.

Lessons will inform future decisions for the Moon and subsequent exploration.

As architecture decisions are made, updates will be reflected in NASA's **Moon to Mars Architecture Definition Document.**

The Architecture Definition Document is updated annually.

White Paper



National Aeronautics and Space Administration
Key Mars Architecture Decisions
white paper
2023 Moon to Mars Architecture
PRIORITY HUMAN MARS ARCHITECTURE DECISIONS
Mars Science Priorities
Number of Crew to Mars Vicinity
Mars Surface Power Generation Tech
Initial Human Mars Segment Target State
Number of Crew to Mars Surface
Mars Loss of Crew Risk Posture
Color Key
Why
When
What
Who
How
Introduction
Mapping Key Architecture Decisions
Seven Priority Human Mars Architecture Decisions
Conclusions
Future Work
2023 Moon to Mars Architecture Concept Review