National Aeronautics and Space Administration

NASA's Moon to Mars Architecture Workshop

System Analysis of Architecture Drivers

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Introduction

Exploration architecture trade space is shaped by the answers to six key questions:

1. Who?
2. What?
3. Where?
4. When?
5. Why?
6. How?

It is critically important to understand how these drivers relate to each other *because the architecture will change depending on the order that these decisions are made*

Historical Perspective

- **Apollo program's mandate: "landing a man on the Moon and returning him safely to Earth" before the end of the decade**
  - Prioritized "when?" (within the decade)
- **NASA achieved the goal with an architecture optimized to meet the "when"**
  - Once "when?" was achieved, there was little compelling rationale to stay
  - The architecture wasn't suited for sustained human exploration

Apollo demonstrates how the first decision made can profoundly influence the exploration architecture

Making "when?" the anchoring decision will ripple through the architecture, resulting in systems that may not be extensible for sustained exploration

INFLUENCES WHY TO GO

To beat a deadline

Mission pull for current programs or technology development

Expand human spaceflight experience

INFLUENCES WHERE TO GO

Go where we can get to fastest

Go where our heritage assets are best suited

Go where we can get back fast

INFLUENCES WHO WILL BE INVOLVED

Number of crew based on time available to develop systems

Number of crew based on heritage systems

Faster → Fewer crew

INFLUENCES HOW TO GO & RETURN

Do we have time to develop advanced technologies? (Orbital only if no time to develop lander/surface systems?)

What program assets/tech have to be assumed?

Shorter duration drives architecture selections

WHAT CAN BE DONE IN THE TIME AVAILABLE THERE?

Stay in orbit if no time to develop lander/ascent/surface systems

Architecture limited to indexed assets

Limited surface stay means limited operations

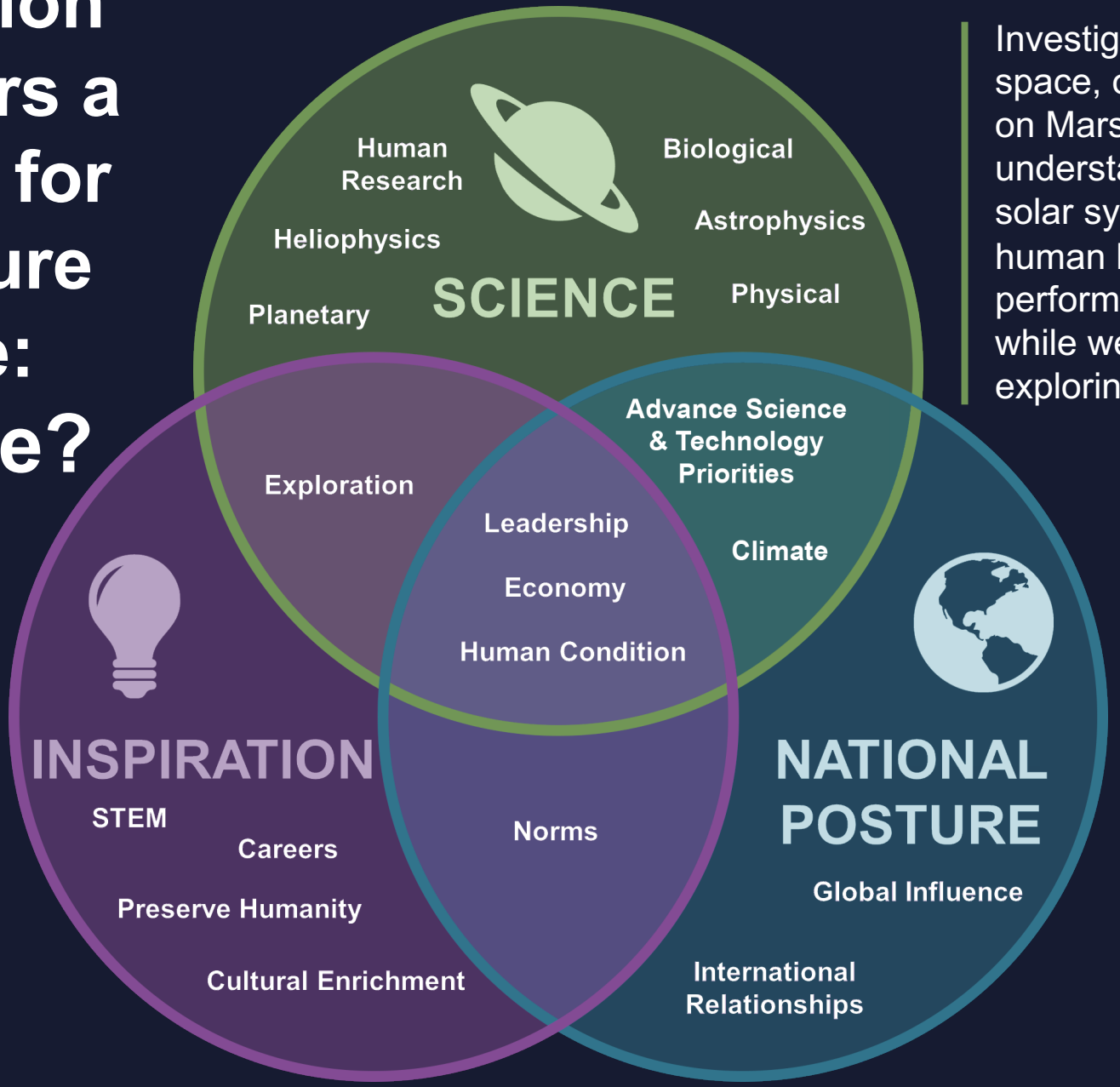
WHEN TO GO

By a particular date?

Index to another program or technology development timeline?

Get there and back within a limited total duration?

New Exploration Blueprint offers a better anchor for the architecture trade space: Why 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.

WHEN WILL WE ACHIEVE LUNAR OBJECTIVES?

Multi-decadal campaign

Support annual cadence of crewed missions

Development of permanent infrastructure

Expansion of economic sphere to the Moon

WHO DOES THIS APPROACH INCLUDE?

NASA

U.S Government

Industry

International Partners

Academia

Public

WHAT FOUNDATIONAL CAPABILITIES ARE NEEDED

Long-duration microgravity systems

Partial gravity destination platforms

Low Earth Orbit assets and infrastructure

WHERE SHOULD SYSTEMS BE?

Ensure access to the Lunar South Pole

Capability for non-polar expeditions

HOW WILL WE GET THERE AND RETURN?

Lunar Microgravity staging in NRHO

Earth ⟷ NRHO ⟷ Lunar surface

Surface Mobility

WHY EXPLORE?

- SCIENCE -

Understand the universe
Direct observations

- INSPIRATION -

“Artemis Generation”
Overcome challenges
Succeed with hard work

- NATIONAL POSTURE -

Enrich lives on Earth
Technology development
International partnerships

Summary

- **Exploration architecture is shaped by the answers to six questions:**
  - Who, What, Where, When, Why, and How?
- **It is critically important to understand how these key decisions relate to each other**
  - And how the architecture varies depending on the order these decisions are prioritized

The answer to any one of these questions is less important than whether the answers to all six complement one another as a set and meet the overall exploration Objectives

Access the white paper with this QR code or at www.nasa.gov/MoonToMarsArchitecture