National Aeronautics and Space Administration

Mars Surface Habitat (MSH) Concept Study

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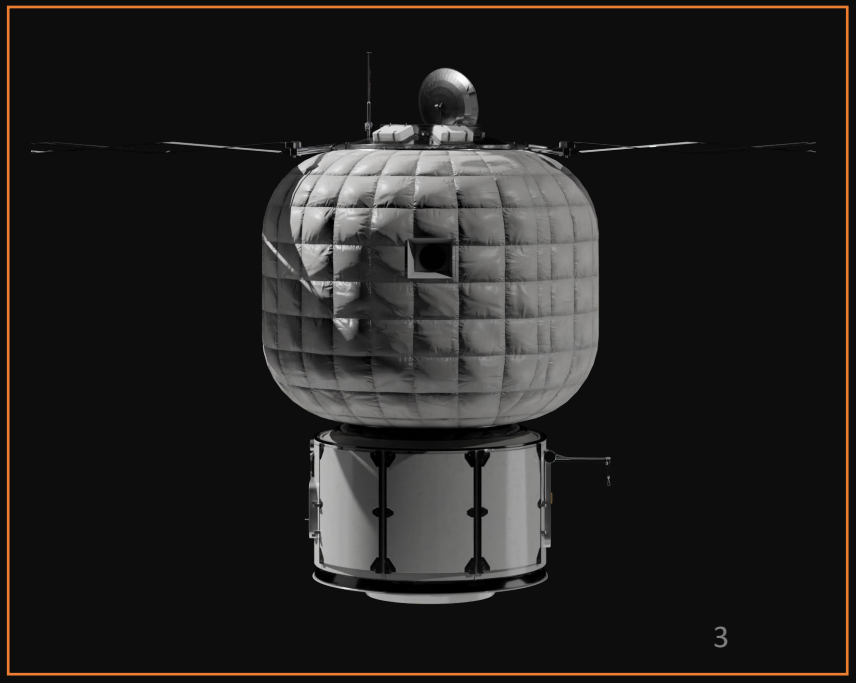
Overview

- Mars Habitation Considerations
- Study Basis and Extensibility
- MSH Overview and Benefits
- Findings & Next Steps
- Questions

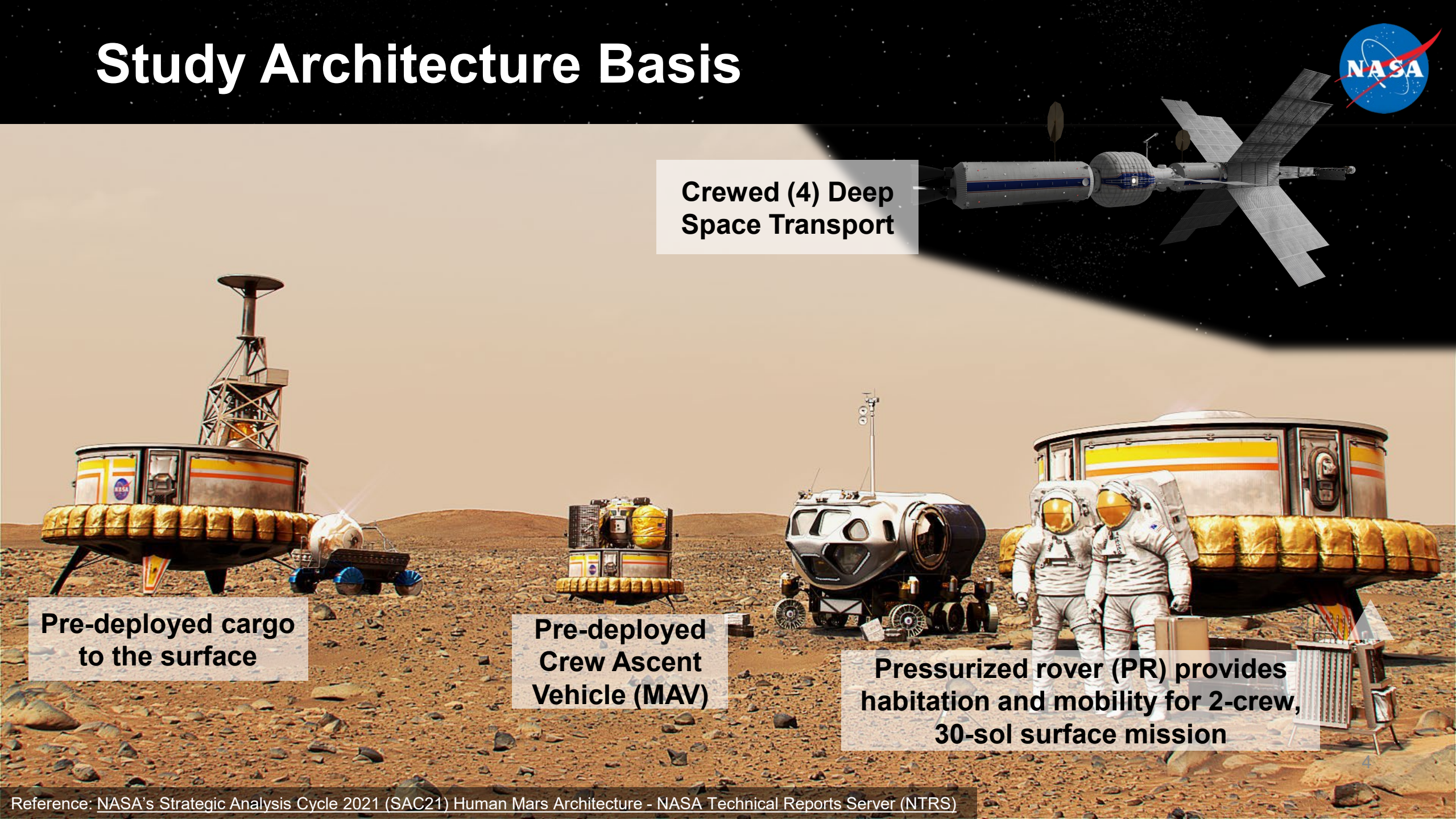
Important contextual note:
NASA's Exploration Systems Development Mission Directorate (ESDMD) is currently evaluating the Moon to Mars architecture as part of the annual Architecture Concept Review Process.
This study was intended to inform the architecture development/trade space and should not be considered the final plan nor a formal recommendation.

Key Mars Surface Habitation Challenges

- Dust contamination
- Communication delays and blackouts
- Ability to recover from major habitation failures
- Activation following long-term transit
- Radiation and Thermal protection
- Maintenance and sparing
- Planetary protection
- Gravity readaptation following transit

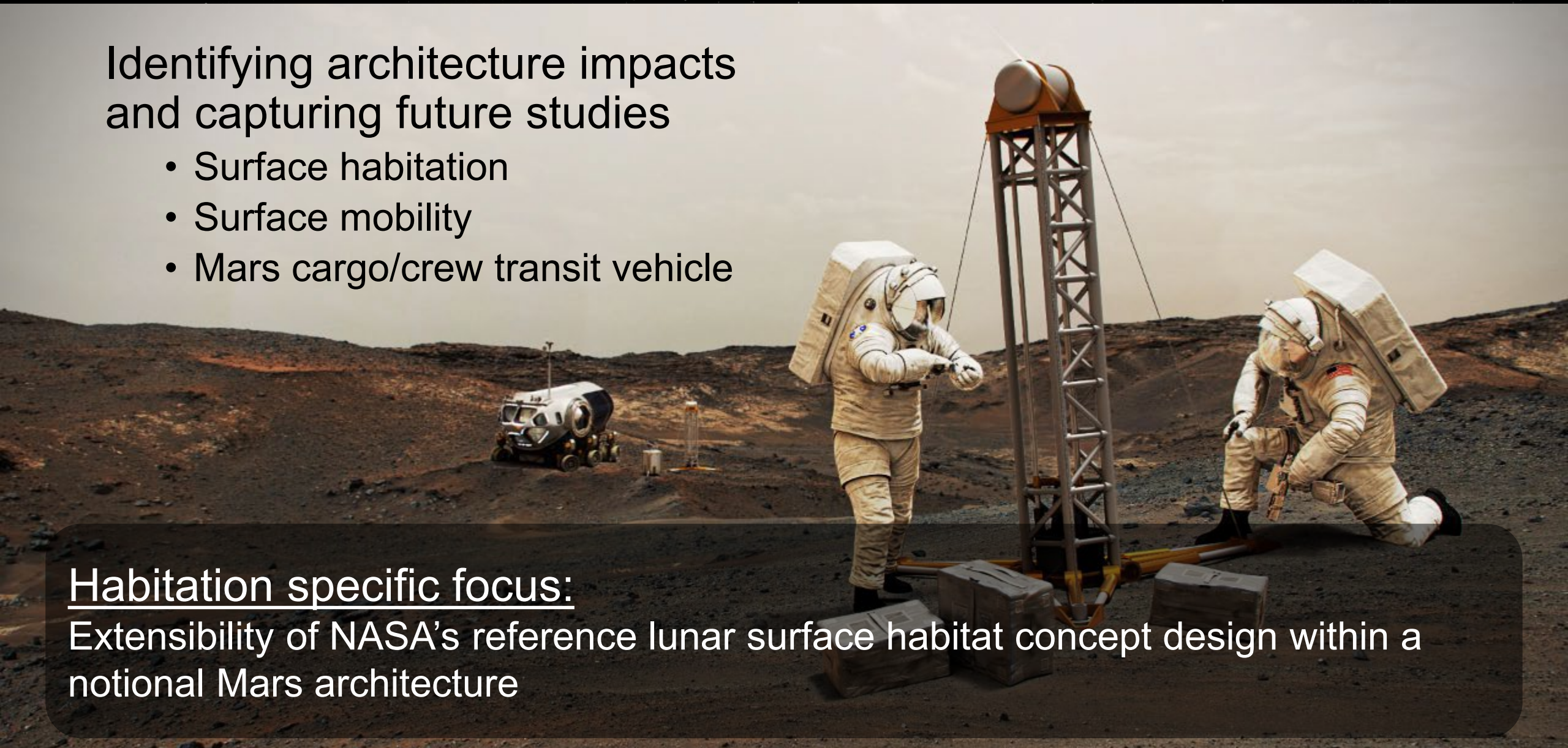


Study Architecture Basis



Reference: NASA's Strategic Analysis Cycle 2021 (SAC21) Human Mars Architecture - NASA Technical Reports Server (NTRS)

MSH in lieu of Pressurized Rover



Identifying architecture impacts and capturing future studies

- Surface habitation
- Surface mobility
- Mars cargo/crew transit vehicle

<u>Habitation specific focus:</u>

Extensibility of NASA's reference lunar surface habitat concept design within a notional Mars architecture

MSH Key Operational Differences

Lunar SH Concept

- Crew lands separately via HLS
- Lands in deflated state
- Self powered during crewed ops
- Planned re-use over 15-years

Habitat Commonality:

- 2-crew, 30-sol mission
- 8.2 psia 34% O2 atmosphere
- Remains on lander
- Suitport airlock
- Hybrid softgoods/metallic structure

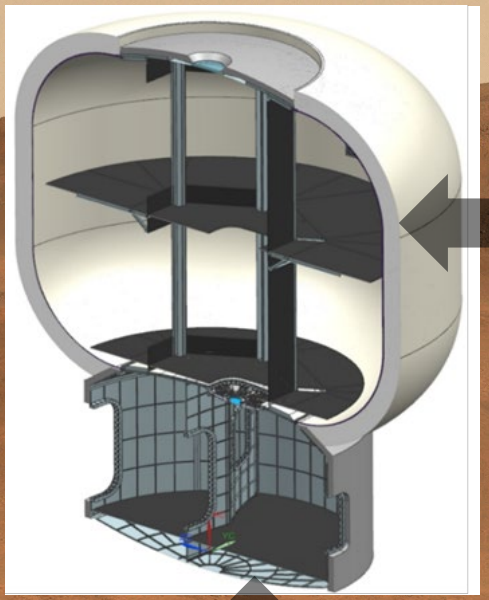
Mars SH Concept

- Airlock re-configured for crew landing
- Activates in Mars orbit
- Lands inflated on lander
- Crew in multiple gravitational environment
- Requires external power for sustained crew ops
- In-space docking & crew/logistics transfer
- Mission logistics landed with crew

MSH Concept Overview

MSH sub-system mass was assessed against the Lunar SH to quantify preliminary extensibility criteria

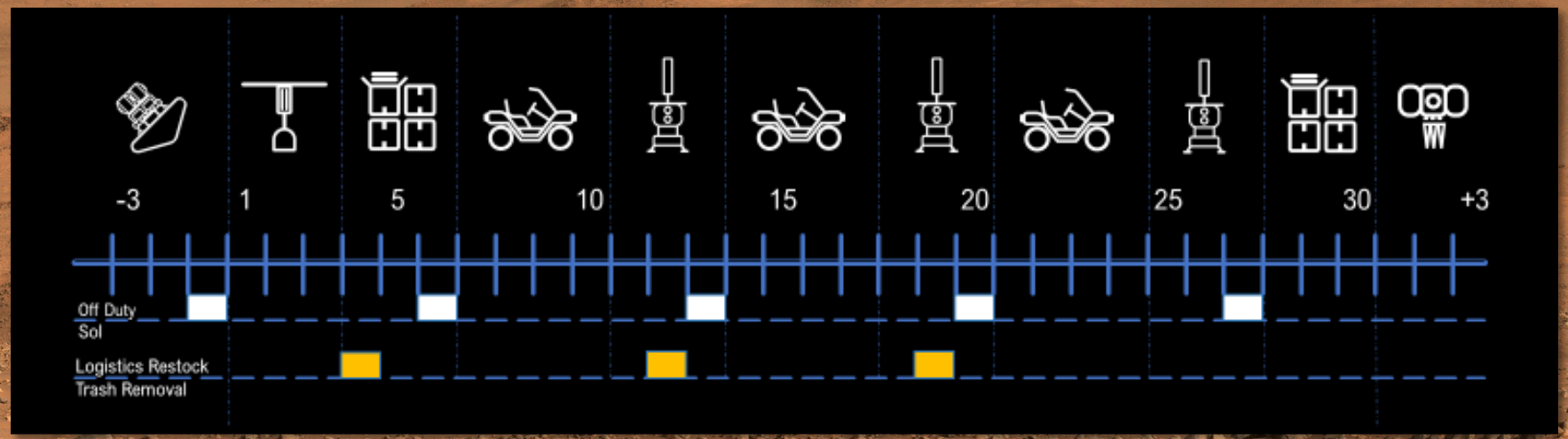
Subsystem	LSH Modifications for MSH	Mass Delta (%)
Body Structures	Minor	6%
Connection and Separation	**Passive NDS w/ vestibule & bracing**	**159%**
Landing Support	**Crew Couch w/ mounting, landing support controls**	**New capability (Not present for LSH)**
Environmental Protection	Mars compatible body insulation	20%
Power Systems	**No generation systems, FSP interfacing**	**-35%**
Command and Data Handling	No changes	0%
Communications and Tracking	Additional long-range equipment	1%
Crew Display and Controls	No changes	0%
Thermal Control Systems	**Radiator panels resized for use on Mars**	**-21%**
ECLSS	Fully open, with Zeolite 4BCO2 scrubber	74%
Crew Habitation Support Systems	Additional capacity for exercise equipment for gravity readaptation	4%
EVA Support Systems	Suits manifested with MSH	405%
Manipulation and Maintenance	IVR manifested to support automation	209%



Notional MSH Landed Mass: ~11,338 kg

MSH Benefits & Initial Mission Conops

- Extravehicular activity (EVA) Egress/Ingress
- Intravehicular Activities (IVA)
- Crew Gravity Acclimation
- Science Utilization
- Internal Logistics Storage
- Extended Mission Durations

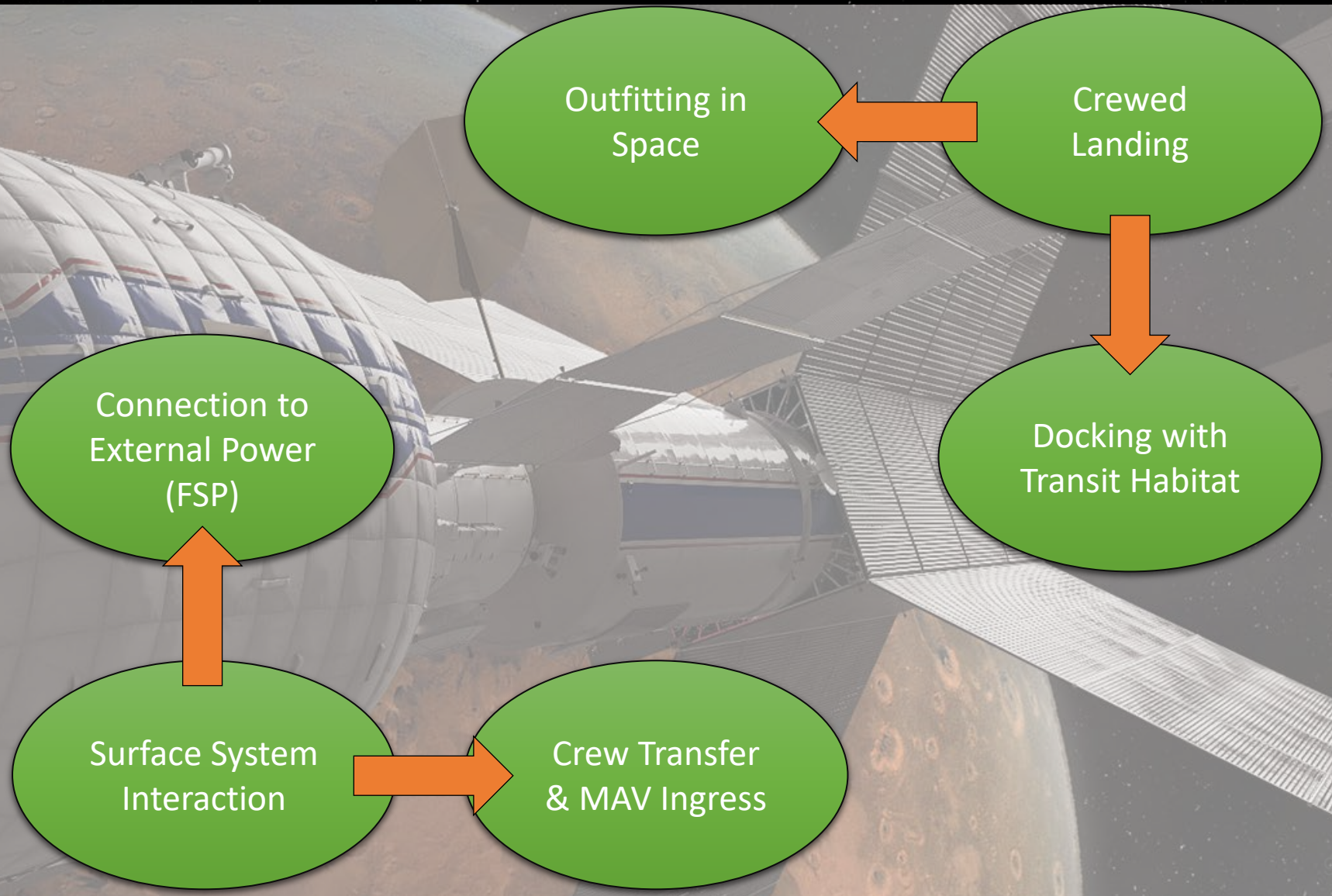


Risks and Challenges

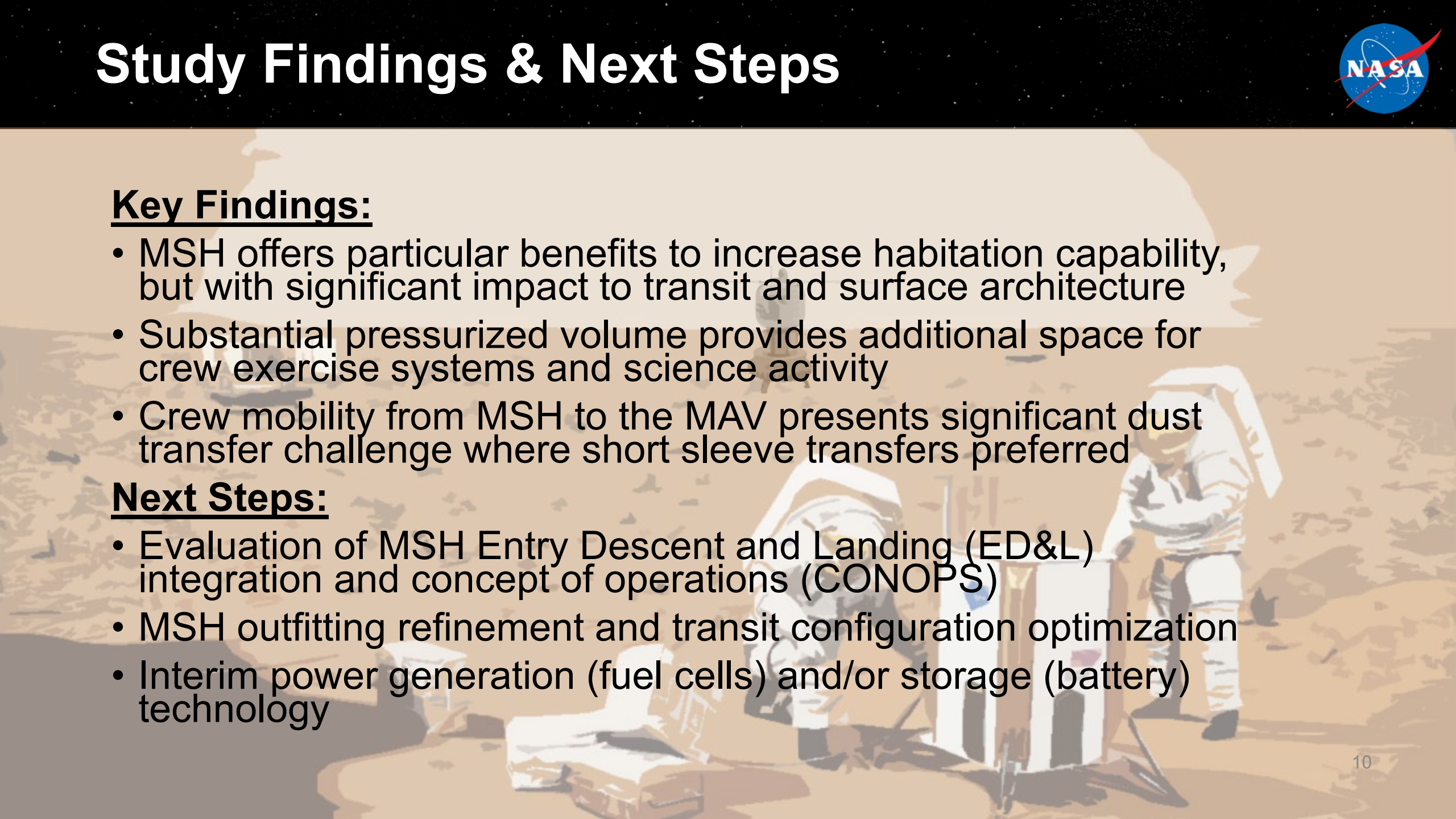
MSH faces **unique** risks and challenges **relative** to the Lunar SH and PR.

Some of these challenges are **linked.**

Additional challenges will be addressed in **future** iterations, influenced by a **final** Mars architecture.



Study Findings & Next Steps



Key Findings:

- MSH offers particular benefits to increase habitation capability, but with significant impact to transit and surface architecture
- Substantial pressurized volume provides additional space for crew exercise systems and science activity
- Crew mobility from MSH to the MAV presents significant dust transfer challenge where short sleeve transfers preferred

Next Steps:

- Evaluation of MSH Entry Descent and Landing (ED&L) integration and concept of operations (CONOPS)
- MSH outfitting refinement and transit configuration optimization
- Interim power generation (fuel cells) and/or storage (battery) technology

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Questions?