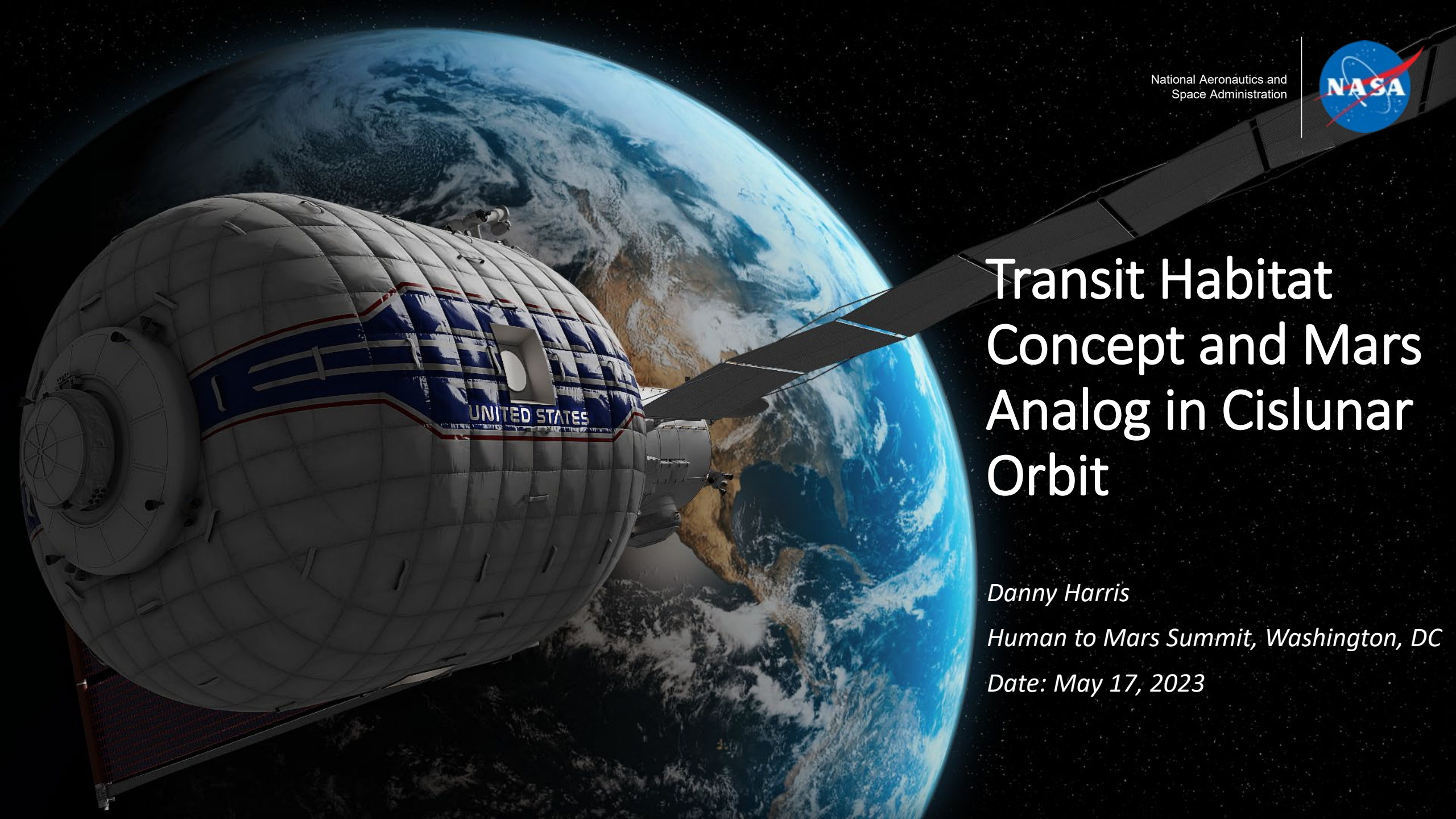


National Aeronautics and Space Administration

Transit Habitat Concept and Mars Analog in Cislunar Orbit

Danny Harris

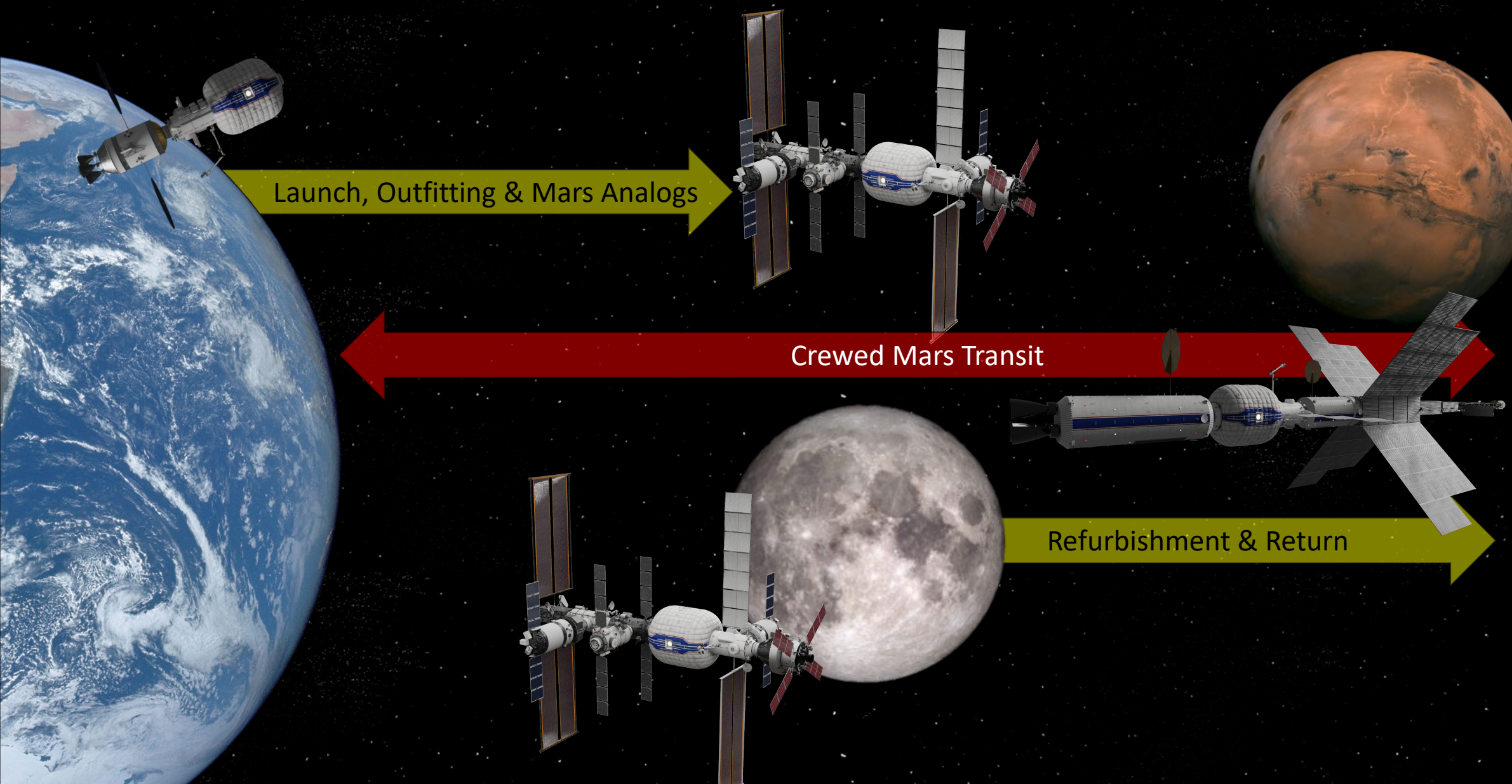
Human to Mars Summit, Washington, DC

Date: May 17, 2023

Transit Habitat Overview

- Supports 4-crew during Lunar-Mars Analog missions leading up to a 700-1110-day Mars mission
- Hybrid inflatable-metallic habitat structure
- Launched commercially and outfitted with logistics in cis-lunar orbit (NRHO)
- Docks w/ Gateway or an interim propulsion bus for up to several years until Mars Propulsion System (MPS) elements available
- Extends Gateway operations beyond 60 days
- Contingency Airlock and EVA capability
- Planned reuse for multiple missions over 15-year lifetime
- Builds on ISS and commercial investment in deep space habitation
- Early to Mid-2030s launch to NRHO

Transit Habitat CONOPS Phasing



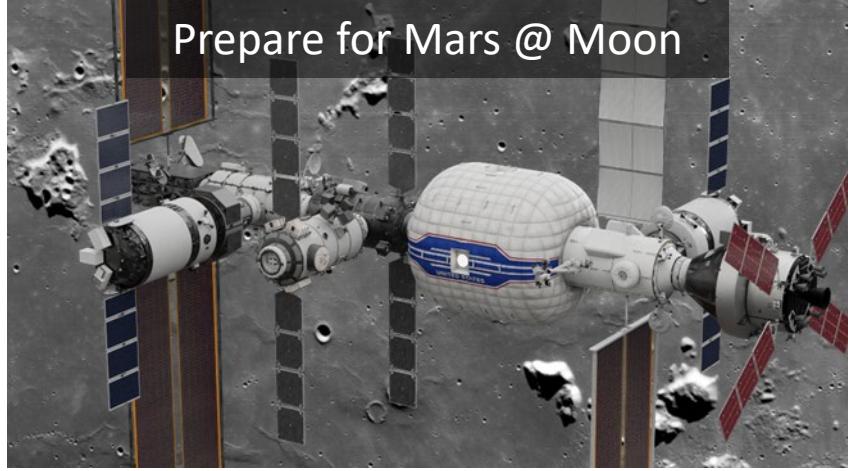
TH: Mars Driven, Gateway Enabling

<u>Lunar/Mars Analog Mission</u>

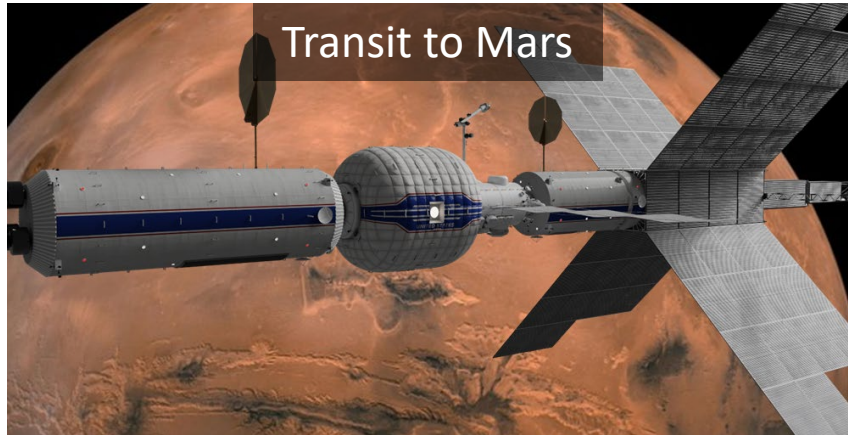
- Long-term Gateway visiting vehicle
- Expands habitation capability beyond 60-days
- Crew analogs and TH system shakedown prior to Mars departure
  - Buy-down risk
  - Solidify crew operations and element interaction

Gateway + TH + Orion + Logistics Modules


Launches from Earth
UNITED STATES


Prepare for Mars @ Moon

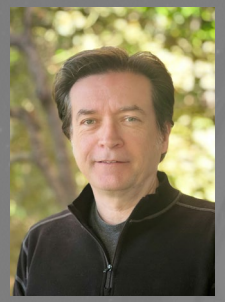

Collect Crew from Earth


Transit to Mars

National Aeronautics and
Space Administration

Questions/Back-up

Habitation Concepts Team



Danny Harris
Habitation Concepts Pre-Formulation Lead

Tiffany Nickens
Habitation Concepts Pre-Formulation Deputy Lead

Andrew Choate
Transit Habitat Technical Lead

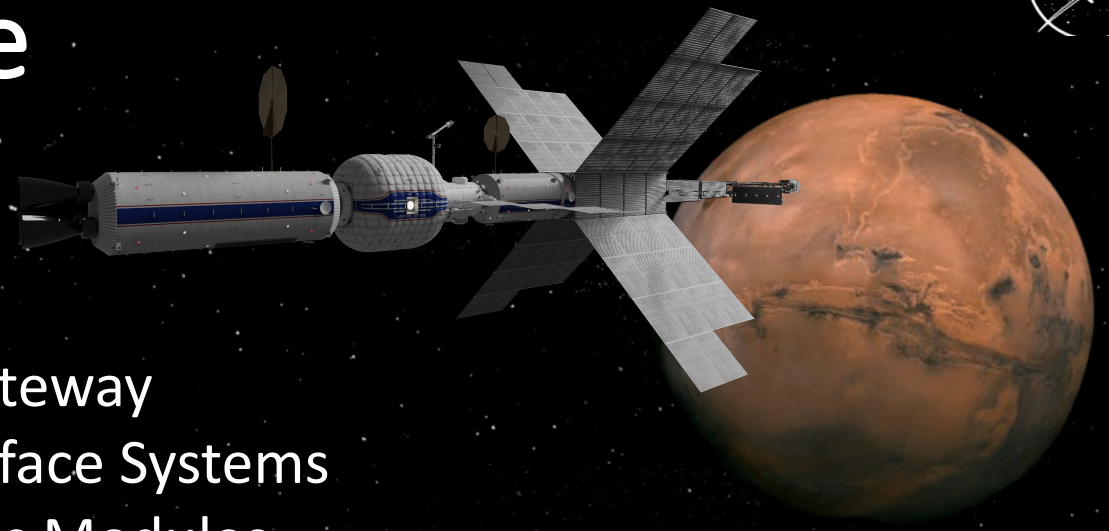
Paul Kessler
Surface Habitat Technical Lead

Key Mission & Functional Challenges

- No spares resupply chain during transit
- Impact on propulsion element size
- Waste and trash management in transit/loiter orbits
- Logistics storage capacity for mission
- Human health and performance for long duration missions
- Long duration shakedown
- Radiation & MMOD protection
- Communication delays/blackouts
- Ability to recover from major habitation failures

Transit Hab Integration Across Moon to Mars Architecture

Orion
Boost stage
Logistics Module(s)

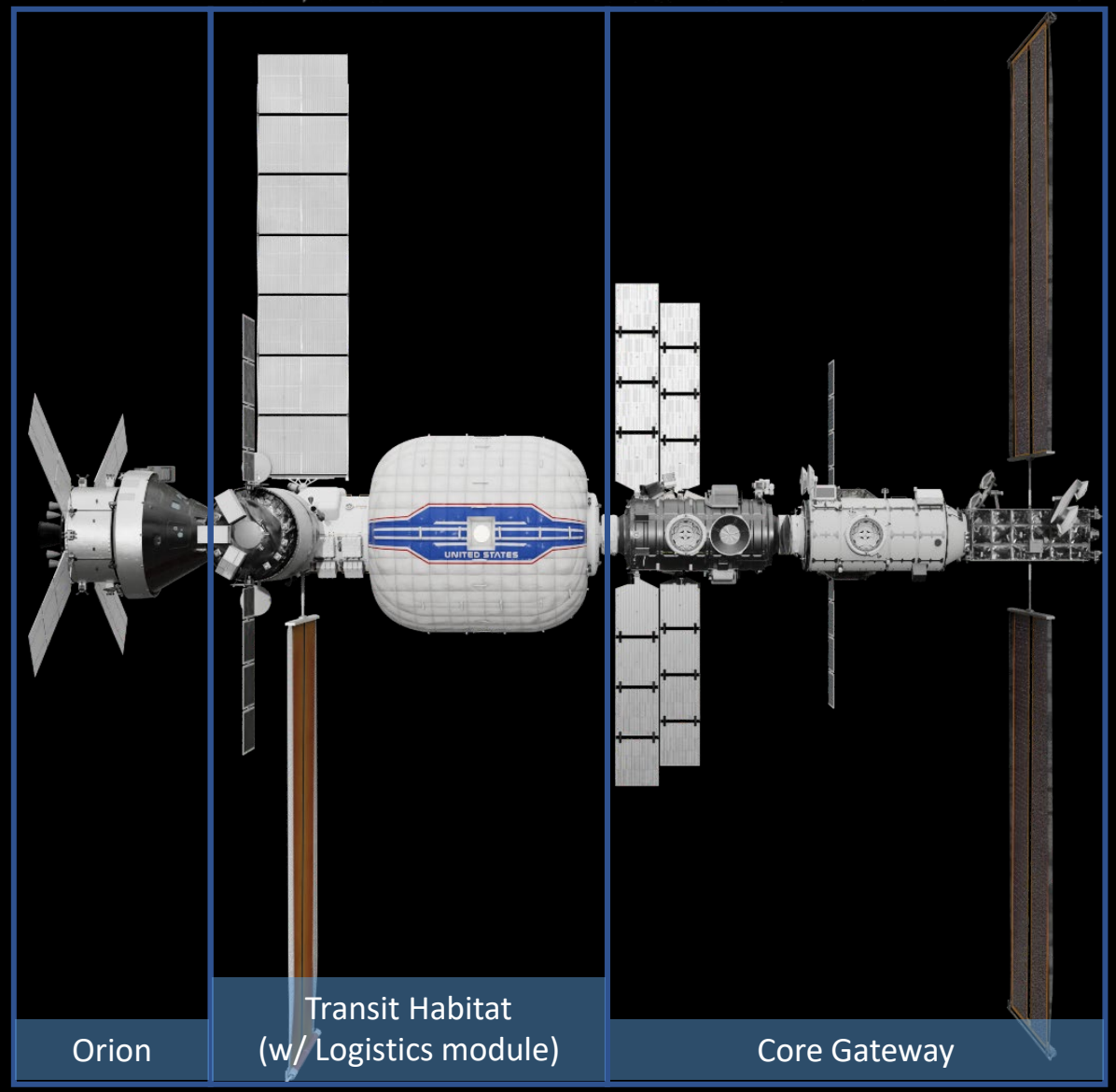


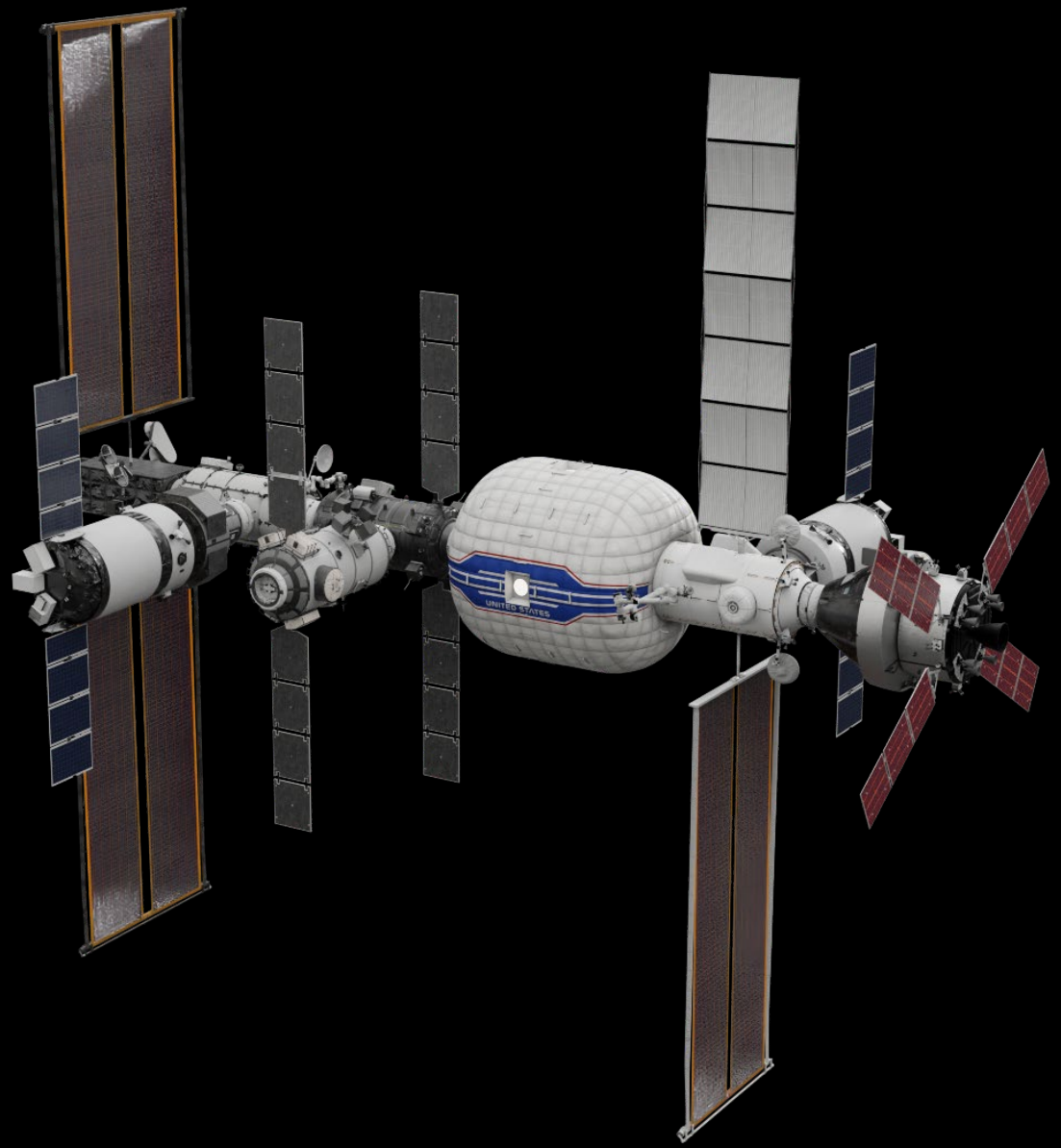
Mars Propulsion System
Mars Ascent Vehicle
Mars Descent System
Mars Surface Systems

Gateway
Lunar Surface Systems
Logistics Modules
Mars Propulsion System

https://www.nasa.gov/MoonToMarsArchitecture

TH as a Gateway Visiting Vehicle





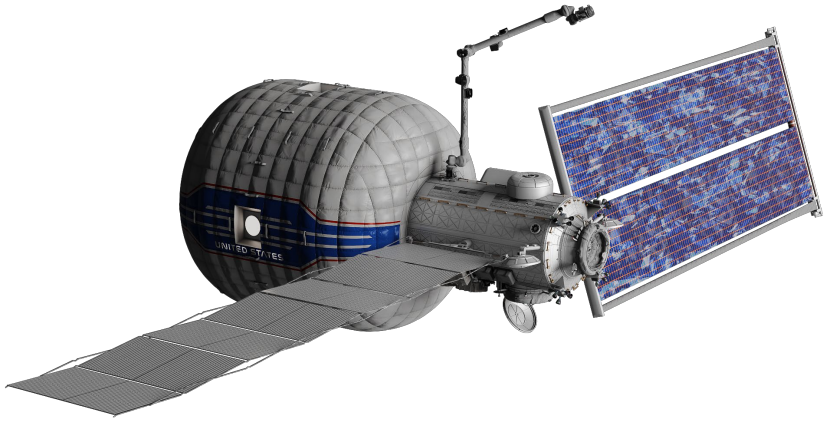
TH Ground Rules & Assumptions

Significant GRs:

- 4 crew for up to 1,200-day Mars Transit mission duration
- 26.4 mt target dry mass (including MGA and margin)
- Autonomous operation when uncrewed
- Max uncrewed dormancy of up to 3 years
- Minimum of 2 axial and 1 radial docking ports
- Performs a series of up to ~180d Mars Analog missions while docked at Gateway
- Self-sufficient habitat once fully deployed at orbits up to 1.0 AU, capable of receiving power from Mars propulsion system beyond 1.6 AU
- 14.7 psia 21% O2 atmosphere nominal, capable of 10.2 psia 26.5% O2 during Gateway docked open-hatch ops
- Safe Haven and Solar Proton Event (SPE) Shelter
- 15-year life with multiple missions of increasing duration
- TH Sparing and Maintenance - Manifested to achieve 99% system availability

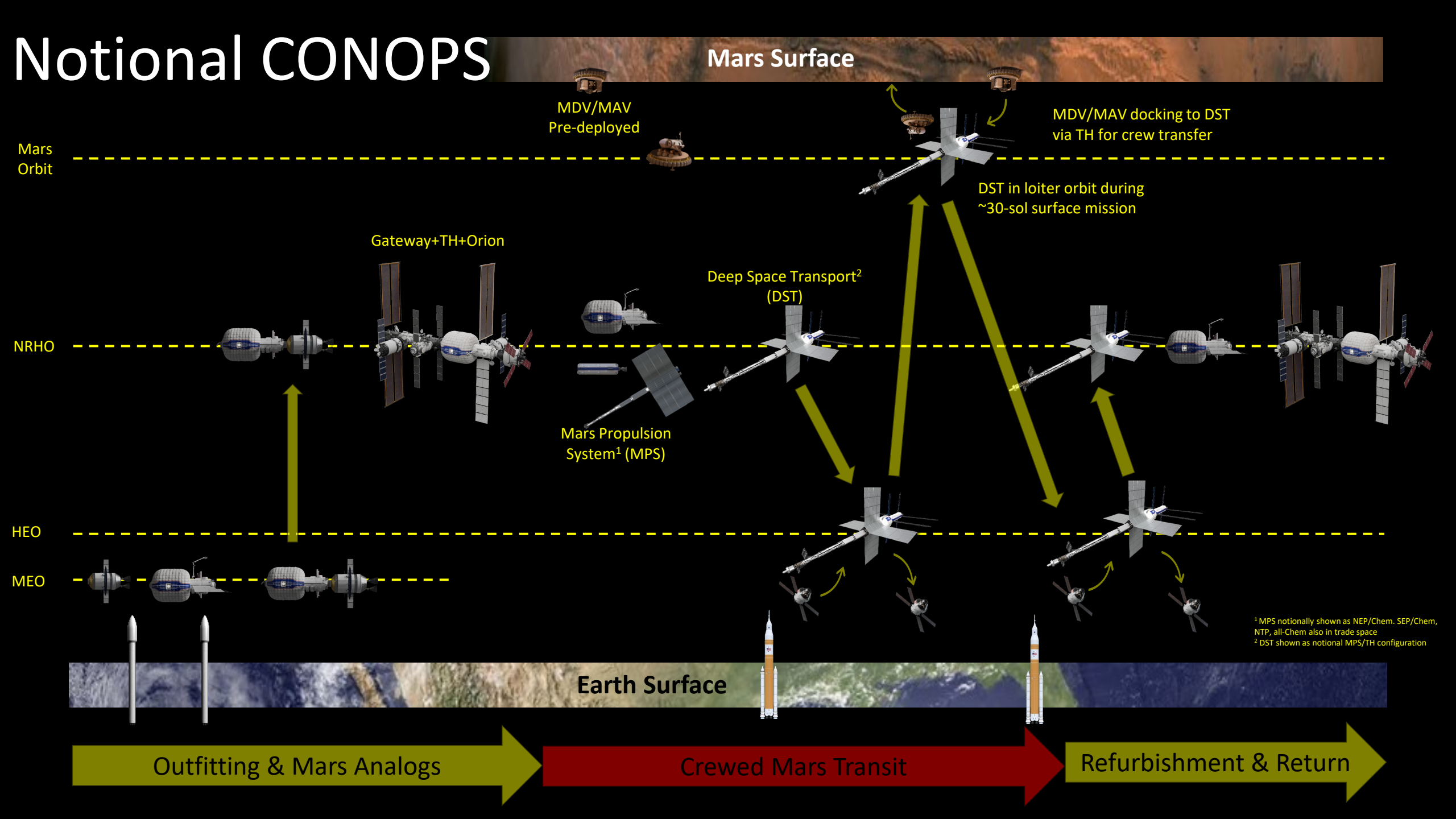
Significant Assumptions:

- Near-Rectilinear Halo Orbit (NRHO) via Commercial Launch Vehicle(s)(CLV). Options for SLS cargo delivery are possible but should feed cost assessments.
- Early 2030's launch with Mars mission in late 2030's
- Replenishable Reaction Control System (RCS) through docking or Gateway interface between mission phases (analogs, Mars Propulsion System (MPS) shakedown, Mars transit)
- Contingency EVA airlock
- Trash/waste removal (11.6 kg/day avg)
- Accommodate 1000 kg of science and utilization payloads



M2M Habitation Considerations Technical Memo.pdf

Notional CONOPS



Habitat Softgoods Deployment Concepts

Planned deployment following launch in LEO
Internal outfitting then required

- Autonomous
- Final interior outfitting by crew