Mars Habitats

May 18, 2022

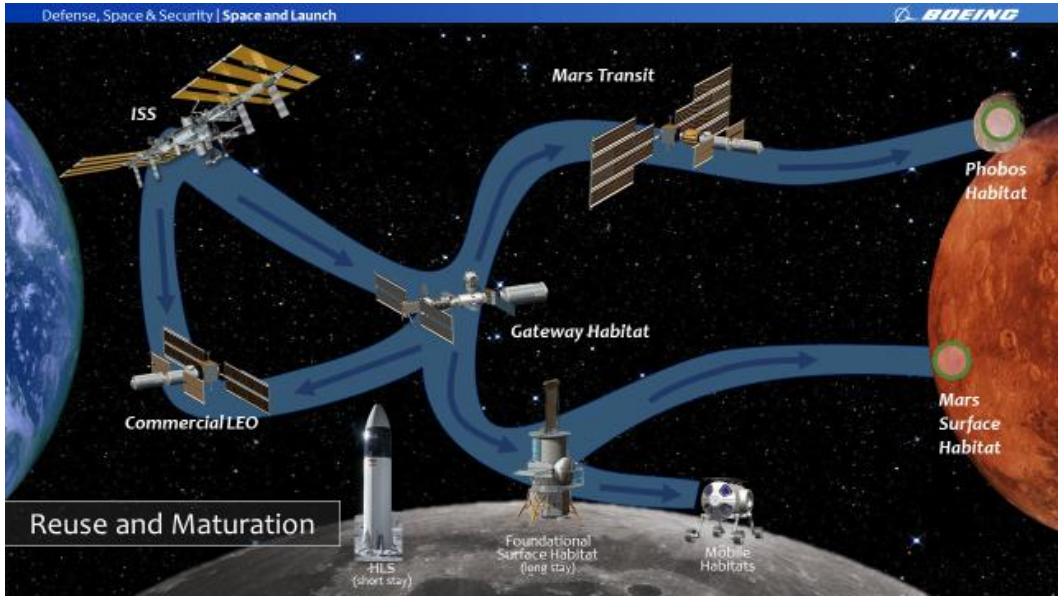
Michael Elsperman
The Boeing Company

Agenda

- Habitation Overview
- Extensibility of Common Subsystems
- Lunar Surface and Gateway as Proving Grounds

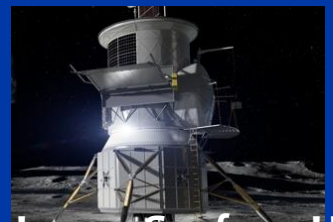
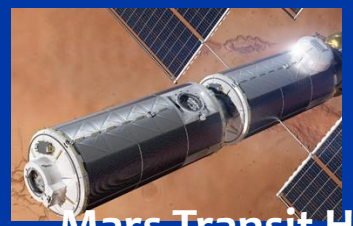
Habitation is a Critical Capability for Exploration

- Habitats provide long term living and working space for crewed missions
  - Provides shelter and life support for crews
  - Enables long duration science and exploration
    - >60 day lunar surface missions
    - ~600 - 1200 day Mars transit missions
    - Multi year Mars surface applications
- Habitats must ensure 24/365 availability of critical crew functions over the course of the mission
  - High reliability (vs mass of spares)
  - Advanced health monitoring and predictive maintenance
- Extensibility is a key consideration for deep space habitation architecture design and development
  - Envelope worst case design environments
  - Leverage "run time" on preceding applications to improve designs across the product line
- Early development and life testing reduce risk
  - Early ground based mockups, tech maturation, and demonstrations



Boeing Exploration Habitat Demonstrator @ MSFC

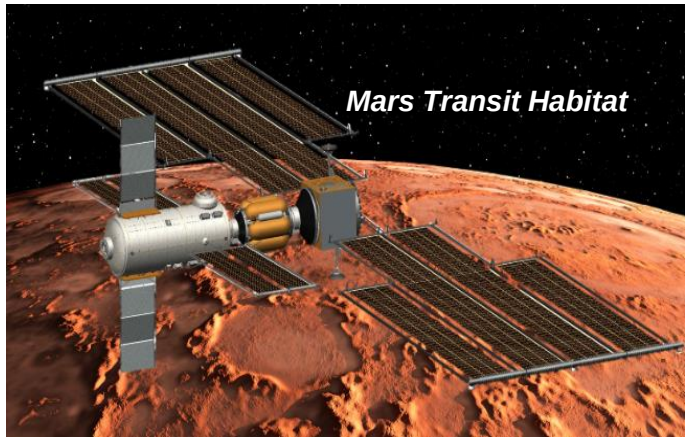
Habitation Subsystems

 LEO or Gateway Habitat	 Lunar Surface Habitat	 Mars Transit Habitat	 Mars Surface Habitat
Gateway Interoperable Avionics	Gateway Interoperable Avionics	Gateway Interoperable Avionics	Gateway Interoperable Avionics
Open Loop ECLSS	Partial Regen ECLSS	Full Regen ECLSS	Full Regen ECLSS
Body Mounted Radiators (BMR)	BMR & Deployable	Body Mounted Radiators	BMR & Deployable
Common Power	Common Power	Common Power	Common Power
Common Passive Thermal	Common Passive Thermal	Common Passive Thermal	Common Passive Thermal
0 G Crew Quarters & Hygiene	.18 G Crew Quarters & Hygiene	0 G Crew Quarters & Hygiene	.30 G Crew Quarters & Hygiene
0 G Exercise	.18 G Exercise	0 G Exercise	.30 G exercise
Common Windows	Common Windows	Common Windows	Common Windows
EVA Accommodations and Airlock	EVA Accommodations and Airlock	EVA Accommodations and Airlock	EVA Accommodations and Airlock

High degree of common subsystems and component usage supports extensibility

Artemis Provides Mars Habitation Proving Ground Opportunity

- LEO, Cislunar Space, and the Lunar Surface are well suited to conduct relevant technology maturation and system level testing to verify safe and reliable operations for Mars Surface Habitation
  - Mars gravity is close to moon (~1/3 vs 1/6 G)
  - Martian dust is assumed similarly as bad as Lunar Regolith but for different reasons
    - Extremely small particles
    - Perchlorates
  - Mars surface temperatures enveloped by lunar surface
  - Radiation comparable to deep space/lunar surface
    - Mars Odyssey probe detected ongoing radiation levels which are 2.5 times higher than what astronauts experience on the International Space Station
- Martian atmospheric effects are unknown
  - Composition effect on hab materials and crews (toxic gas metals, hydrogen peroxide, ozone)
  - Erosion due to wind blown dust



Surface data from Mars Rovers is critical to a comprehensive Mars Surface Habitat Qual program