HSF Transition from ISS to cis-lunar space
and
ISS Status

Sam Scimemi

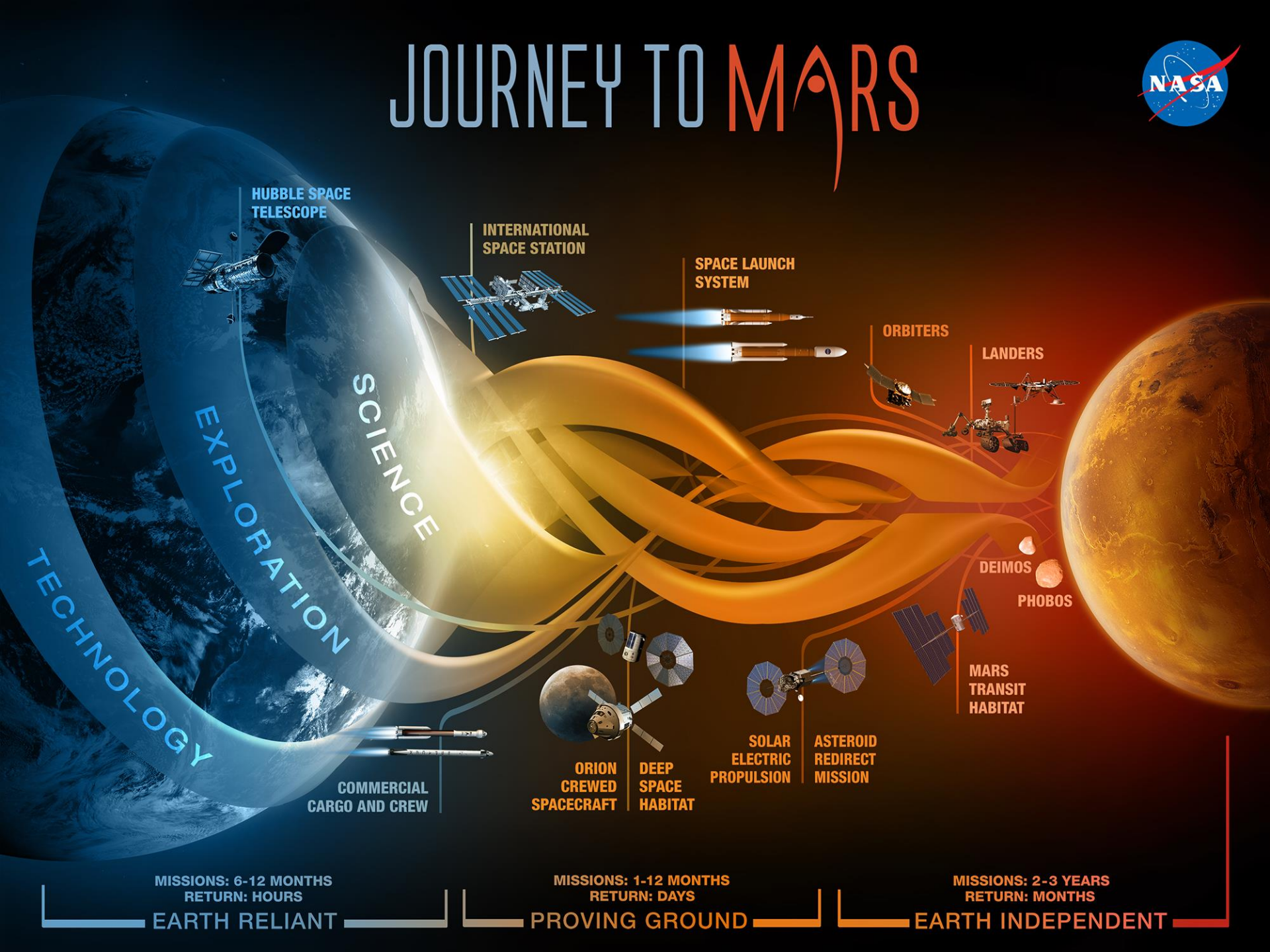
Director, International Space Station
NASA Headquarters

HEOMD NAC
November 4, 2015

Agenda

- **HSF transition from ISS to cis-lunar space**
  - Goals, objectives and research perspective
- **ISS Overview Status**
- **Utilization Status**
- **Visiting Vehicle Status**

JOURNEY TO MARS



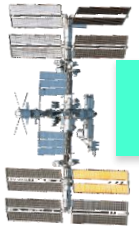
MISSIONS: 6-12 MONTHS
RETURN: HOURS
EARTH RELIANT

MISSIONS: 1-12 MONTHS
RETURN: DAYS
PROVING GROUND

MISSIONS: 2-3 YEARS
RETURN: MONTHS
EARTH INDEPENDENT

Transitioning HSF from ISS to Cis-Lunar Space (Earth Reliant to the Proving Ground)

Earth Reliant



Long Duration Human Health & Habitation Research and Demonstrations

* Currently building a plan to demonstration on ISS the Mars habitation systems.

Knowledge & Capabilities

Goal at the end of the 2020s: Mars ready - One year crewed mission(s) in cis-lunar space

Proving Ground

Short Duration Habitation & Transportation system validation

Long duration human health & habitation Validation for Mars transit

Knowledge & Capabilities

Learning how to be Earth Independent

- SLS/Orion performance validation
- Crew health and performance research and validation
- Habitation systems performance validation including EVA
- Radiation shielding characterization and validation
- Guidance and navigation in deep space
- Prox ops and docking in deep space
- Breaking the logistics chain
- Reduced reliance on the ground control
- Validating other spacecraft system validation (power, propulsion, communications, etc.)

Habitation Systems Objectives

System	Includes	Today	Cis Lunar Goal
Life Support	Air revitalization, water recovery, waste collection and processing	42% recovery of O2 from CO2; 90% recovery of H2O; <6 mo MTBF for some components	>75% recovery of O2 from CO2; >98% recovery of H2O; >2 yr MTBF
Environmental Monitoring	atmosphere, water, microbial, particulate, and acoustic monitors	Limited, crew-intensive on-board capability; rely on sample return to Earth	On-board analysis capability with no sample return; identify and quantify species and organisms in air & water
Crew Health	exercise equipment, medical treatment and diagnostic equipment, long-duration food storage	Large, cumbersome exercise equipment, limited on-orbit medical capability, food system based on frequent resupply	Small, effective exercise equipment, on-board medical capabilities, long-duration food system
EVA	Exploration suit	ISS EMU's based on Shuttle heritage technology; not extensible to surface ops	Next generation spacesuit with greater mobility, reliability, enhanced life support, operational flexibility
Fire	Non-toxic portable fire extinguisher, emergency mask, combustion products monitor, fire cleanup device	Large CO2 suppressant tanks, 2-cartridge mask, obsolete fire products. No fire cleanup other than depress/repress	Unified fire safety approach that works across small and large architecture elements
Radiation Protection	Low atomic number materials including polyethylene, water, or any hydrogen-containing materials	Node 2 CQ's augmented with polyethylene to reduce the impacts of trapped proton irradiation for ISS crew members	Solar particle event storm shelter based on optimized position of on-board materials and CQ's with minimized upmass to eliminate major impact of solar particle event on total mission dose

Human Health and Performance Research
Transition from ISS to cis-lunar space

ISS Goals for Space Exploration

- Fully utilize ISS to understand human health risks and verify capabilities to mitigate these risks
- Develop and test exploration biomedical technologies and tools
- Extend mission durations to one-year to validate six-month research and countermeasures
- Understand visual impairment/intracranial pressure risk and assess countermeasures
- Develop space radiation human protection & monitoring systems
- Investigate long-term spaceflight stressors and changes to the immune system and microbiome
- Develop and test exploration food system
- Develop, test, and verify crew habitation systems and models

Cis-Lunar Space Goals

- Validate advanced countermeasures against deconditioning for transit vehicle (bone, muscle, cardiovascular capacity)
- Validate crew performance, psychological well-being, and intervention toolkit under long-duration flight operations
- Validate integrated exploration medical capabilities (autonomous medical capability for diagnosis and treatment)
- Validate human health, performance, and environmental health in a closed spacecraft environment (immune system, microbiome)
- Validate exploration food system
- Validate space radiation human protection and monitoring systems for exploration
- Validate crew habitation systems for exploration
- Validate robustness and reliability of crew exploration exercise systems

What could we accomplish along the way with humans in cis-lunar space

- **Research objectives - origins of the universe**
  - Asteroid Redirect Mission – *currently in formulation*
  - Human/robotic Lunar exploration of far side and Shackleton crater
  - Some of the techniques and technologies/systems have been demonstrated on ISS already – more could be done
  - Human assisted Lunar sample return
  - Point of departure for human missions to asteroids in their native orbit
- **Research objectives - search for life**
  - Human/robotic construction of large diameter telescope at L2 (*18-20m, ATLAS, Space Telescope Science Institute*)
  - Some of the techniques and technologies/systems have been demonstrated on ISS already – more could be done
- **Earth/sun/moon environs monitoring**
- **Basic research for exploration**
  - Deep space radiation exposure characterization of materials and biological samples – extension of current ISS research
  - Long term zero boil off technology
- **Other basic research**
  - Astrophysics – *follow on to CREAM and AMS-02?*

Would require further study


NASA