



***PLANETARY SURFACE OPERATIONS AND UTILIZATION:  
HOW ISS AND ARTEMIS MISSIONS CAN BE USED  
TO MODEL HUMAN EXPLORATION OF MARS***

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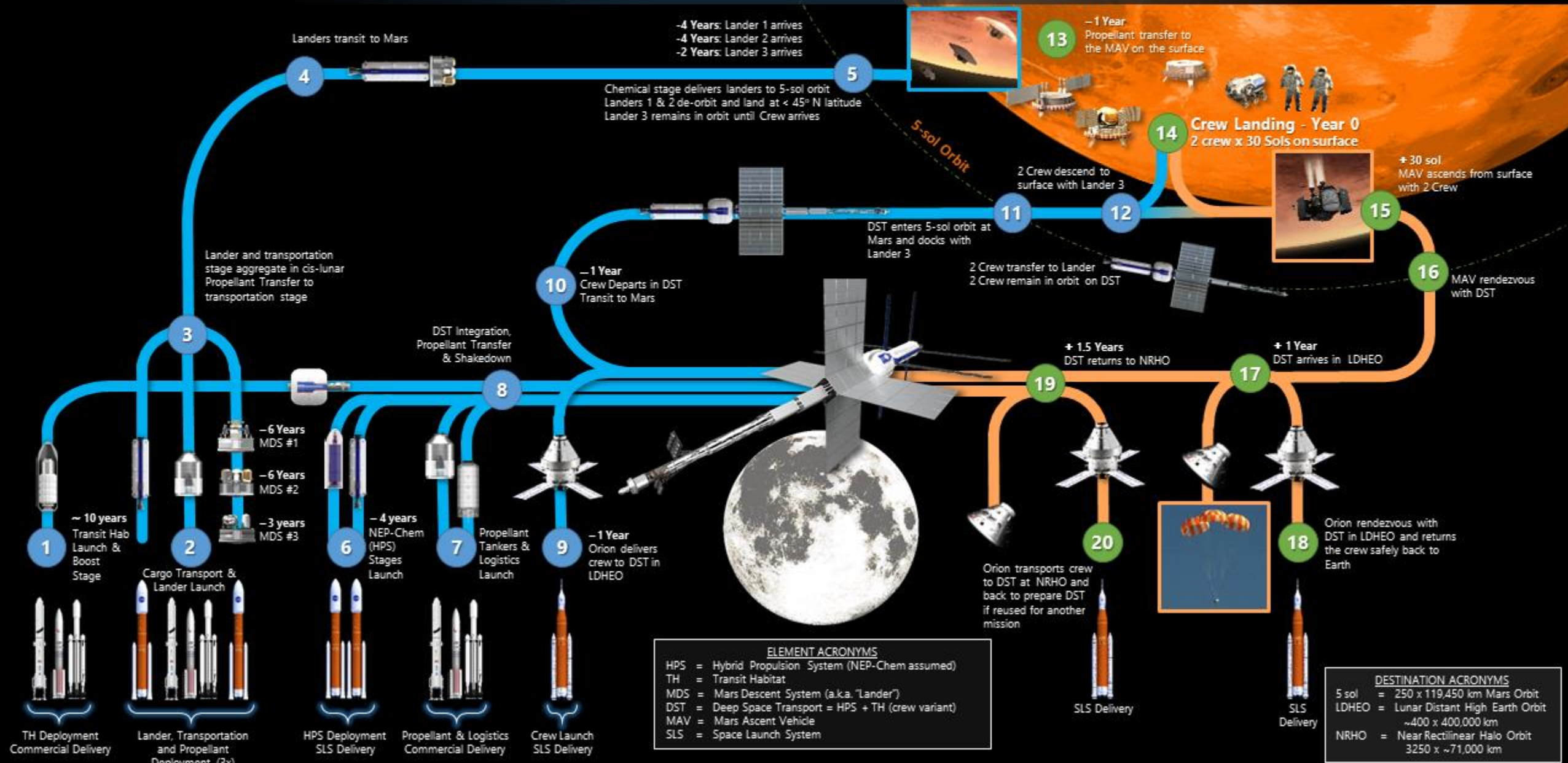
# Introduction

- NASA recently announced it would develop a set of broad objectives to serve as a “blueprint” for exploration across the solar system
- These objectives were divided into four categories:
  1. *Transportation and habitation,*
  2. *Moon and Mars infrastructure,*
  3. *Operations, and*
  4. *Science*
- An element in NASA’s process of achieving these objectives is to leverage its assets and missions, such as
  - Crew increments sent to the International Space Station (ISS) and
  - Future Artemis expeditions to be sent to the Moon
- This paper describes one example of how this emerging process is being implemented for NASA’s plans for the *first* human mission to the surface of Mars

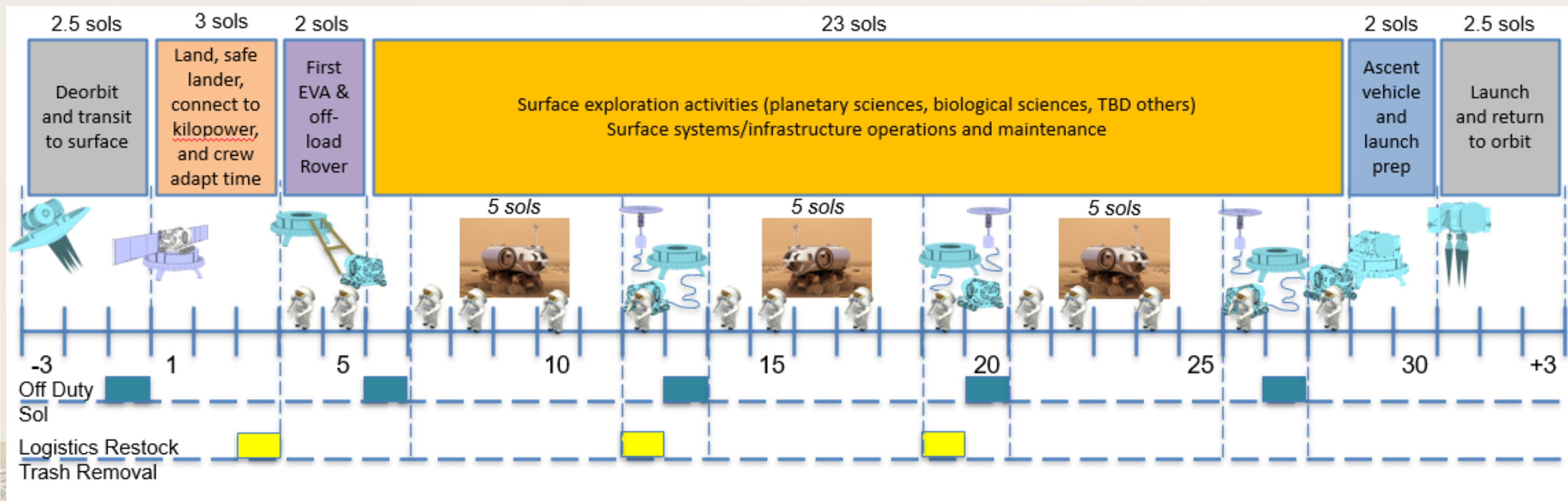
# Notional Human Mars Mission Overview



Short Stay, Date-Agnostic (Events = # years before Boots on Mars)



# 30-sol Surface Mission Timeline\*



This short-stay mission reference timeline was developed to anchor surface operations analysis, in particular to understand how much time would be available for science and exploration after partitioning out anticipated crew and equipment care allocations. Again, this timeline should not be misconstrued as “the plan.”

\* “Reference Surface Activities for Crewed Mars Mission Systems and Utilization” (HEOMD-415) <https://ntrs.nasa.gov/citations/20220000589>

# Notional Human Spaceflight Strategy for Integrated Research and Testing for Mars Mission Readiness



FIRST MISSIONS TO MARS



OPERATIONAL VALIDATED CREW HEALTH & PERFORMANCE



ARTEMIS LUNAR-BASED ANALOGS



MICROGRAVITY / PARTIAL GRAVITY



DEEP SPACE RADIATION



EXPLORATION MEDICAL CAPABILITY



EXTENDED MISSIONS



LOW-EARTH ORBIT RISK REDUCTION



MICROGRAVITY / 1G TRANSITIONS



GENE / MICROGRAVITY INTERACTIONS



CROP PRODUCTION



TEST NEW SYSTEMS



INTEGRATED SIMULATIONS



GROUND-BASED RESEARCH



SPACE RADIATION SIMULATION



BEDREST



ISOLATION ANALOGS



ANALOG FIELD TESTS



CREW HEALTH AND PERFORMANCE SYSTEM FORMULATION

TIME



GROUND & ISS

LEO COMMERCIALIZATION

ARTEMIS BASECAMP

FIRST MISSION TO MARS

# EXTENDED MISSIONS

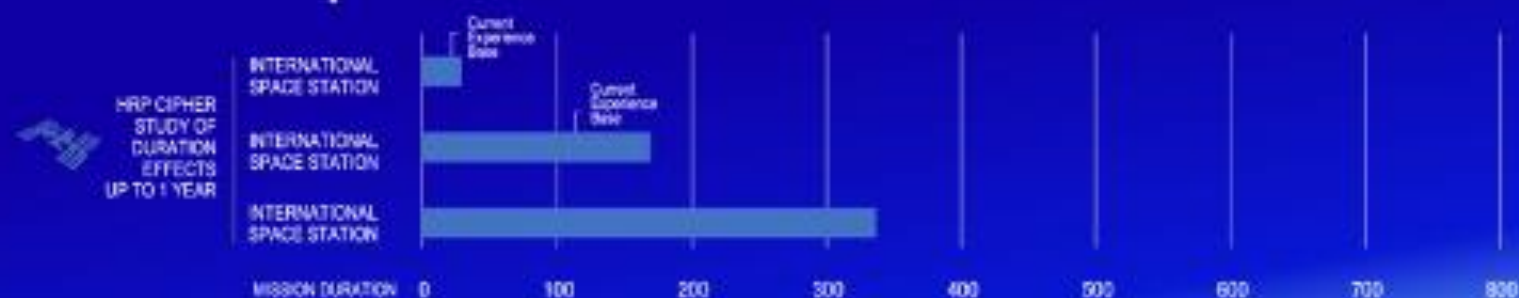
## ISS to Moon to Mars

- Test long duration spaceflight impacts on crew
- Mature and test human spaceflight systems in the relevant environment over durations representative of those for a Mars mission (platform architecture, logistics, operations)
- Tests risk mitigation strategies
- Collect scientific knowledge for both fundamental discovery and exploration benefit
- Demonstrate strategic/tactical leadership and capabilities for integrating diverse utilization needs across NASA Divisions and external NASA entities to achieve mission objectives and goals

DURATION DESTINATION COLOR KEY

■ MICROGRAVITY    
 ■ ON LUNAR SURFACE    
 ■ ON MARS SURFACE

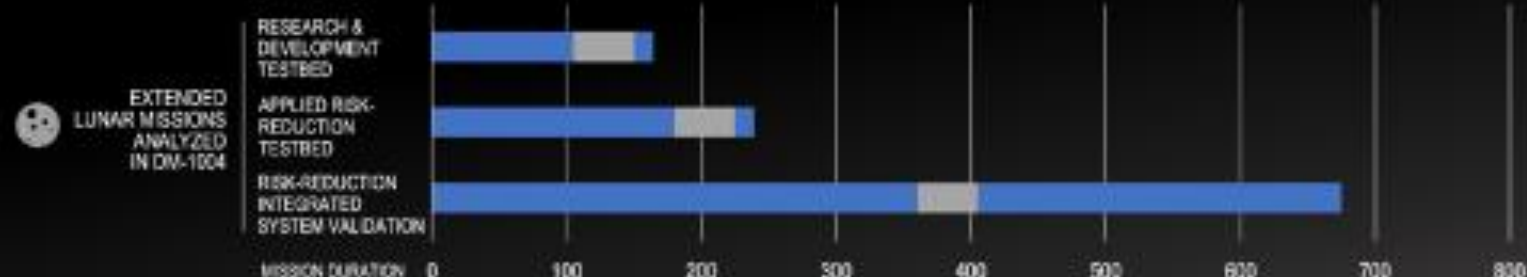
### International Space Station



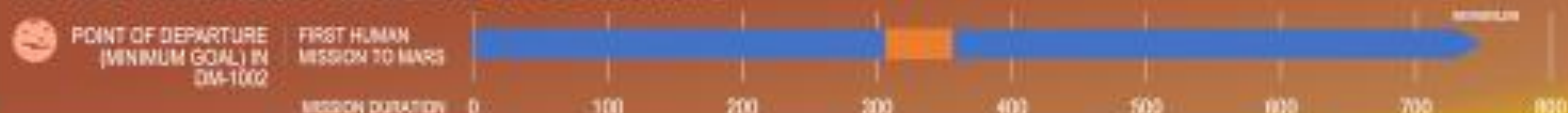
### Early Artemis Missions



### Extended Artemis Missions



### First Human Mission to Mars



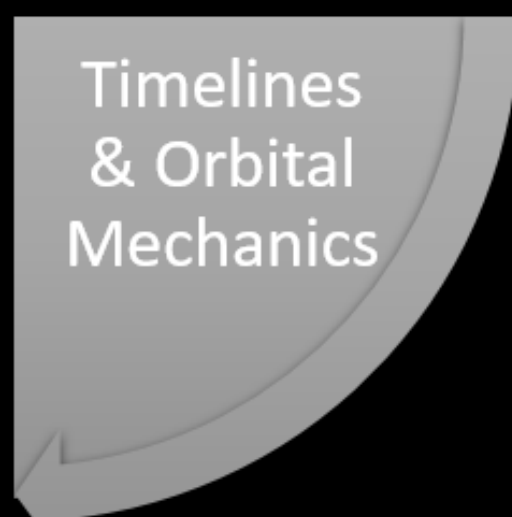
# Human Systems Risks and Mars Architecture Cycles

Identify objectives for the first and subsequent human missions

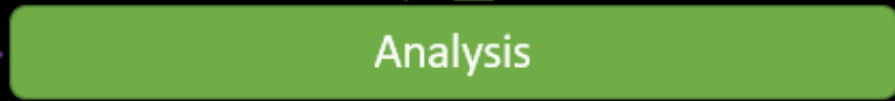
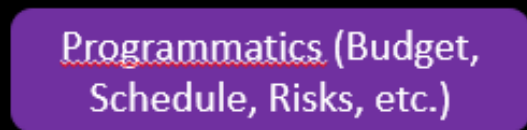


Trades between capabilities such as propulsion or landing elevation and mass

Trades between types of hazards and exposure of the crew



Trades between development timelines and orbits



# Summary

- NASA is currently looking at scenarios for the *first* human Mars mission
  - Any subsequent human Mars mission(s) are assumed to build on these capabilities and operations
- This first mission scenario envisions sending two crew to the surface of Mars for a period of 30 sols – *no final decision has been made by NASA for the human Mars mission architecture; this is one option being used for analysis and trade studies*
- This paper described how the refinement of this mission will benefit from an emerging process recently announced by NASA
- This process – built around a set of “blueprint objectives” – is designed to leverage NASA assets and missions to develop *more robust spaceflight systems* and build a *culture of interplanetary human exploration*



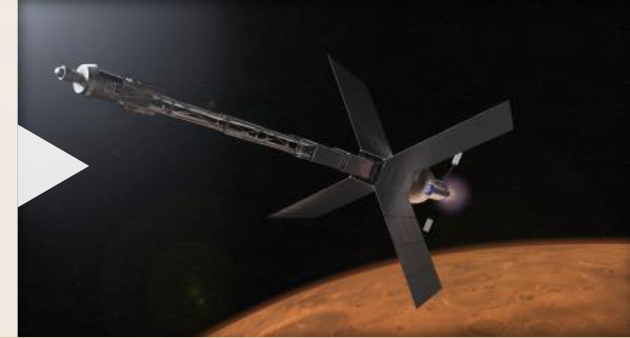


Backup

# Notional First Human Mars Mission Described in HEOMD-415

## TRANSIT HABITAT (TH) AND HYBRID NUCLEAR ELECTRIC PROPULSION (NEP) / CHEMICAL STAGE

- Supports four crew on the long mission to Mars
- Two crew remain in orbit while two crew visit the Mars surface



1

### PRE-DEPLOYED CARGO

- 25-ton class payload Mars lander
- Ascent vehicle propellant, Fission Surface Power, and surface mobility/propellant transfer system



2

### PRE-DEPLOYED CREW ASCENT VEHICLE

- Partially-fueled



3

### CREW

- Two crew land/live in pressurized rover
- Provides habitation and mobility for 30 days
- Supports science and exploration operations

