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National Aeronautics and Space Administration

HUMAN MARS EXPLORATION

JACOB BLEACHER, NASA HQ
MICHELLE RUCKER, NASA JSC

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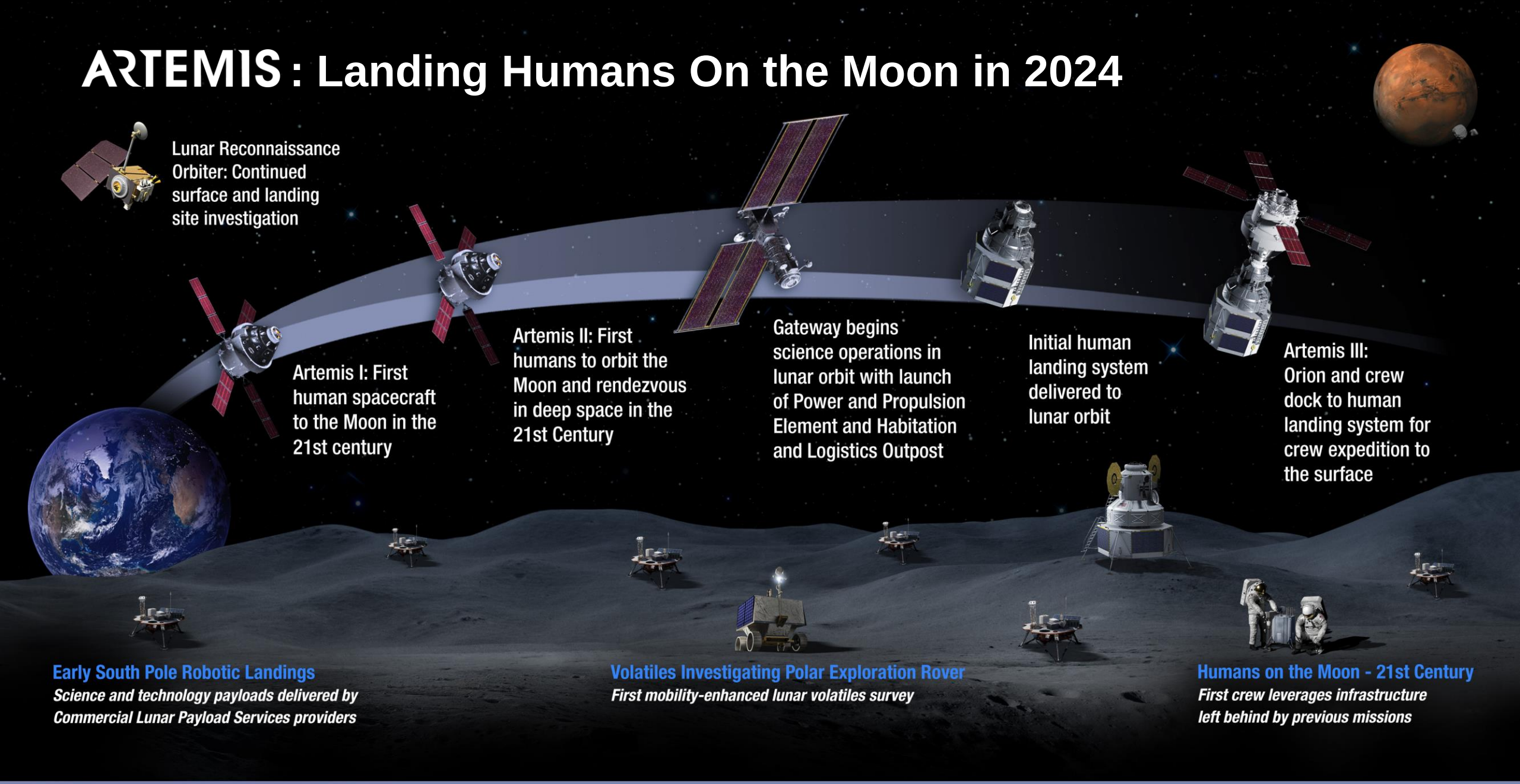
Intended Audience: Mars Exploration Program Analysis Group (MEPAG)

Presentation Objectives: Provide the latest NASA Human Exploration and Operations Mission Directorate (HEOMD) approach and concepts for human missions to Mars

Dr. Jacob **BLEACHER**

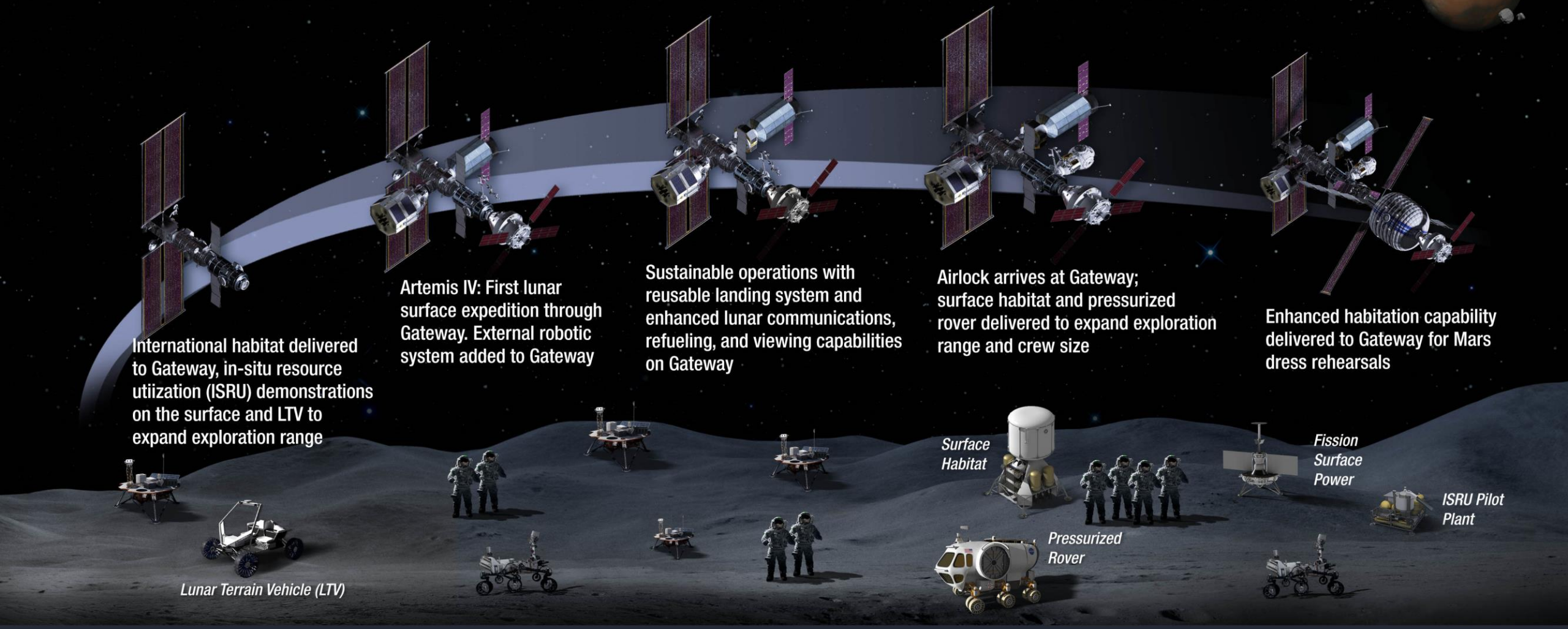
HEOMD Chief Exploration Scientist
NASA Headquarters

ARTEMIS: Landing Humans On the Moon in 2024



LUNAR SOUTH POLE TARGET SITE

ARTEMIS: Extending Lunar Missions to Prepare for Mars



SUSTAINABLE LUNAR ORBIT STAGING CAPABILITY AND SURFACE EXPLORATION

MULTIPLE SCIENCE AND CARGO PAYLOADS | U.S. GOVERNMENT, INDUSTRY, AND INTERNATIONAL PARTNERSHIP OPPORTUNITIES | TECHNOLOGY AND OPERATIONS DEMONSTRATIONS FOR MARS

All contents represent notional planning and are for discussion purposes only

PREPARING FOR MARS AT THE MOON

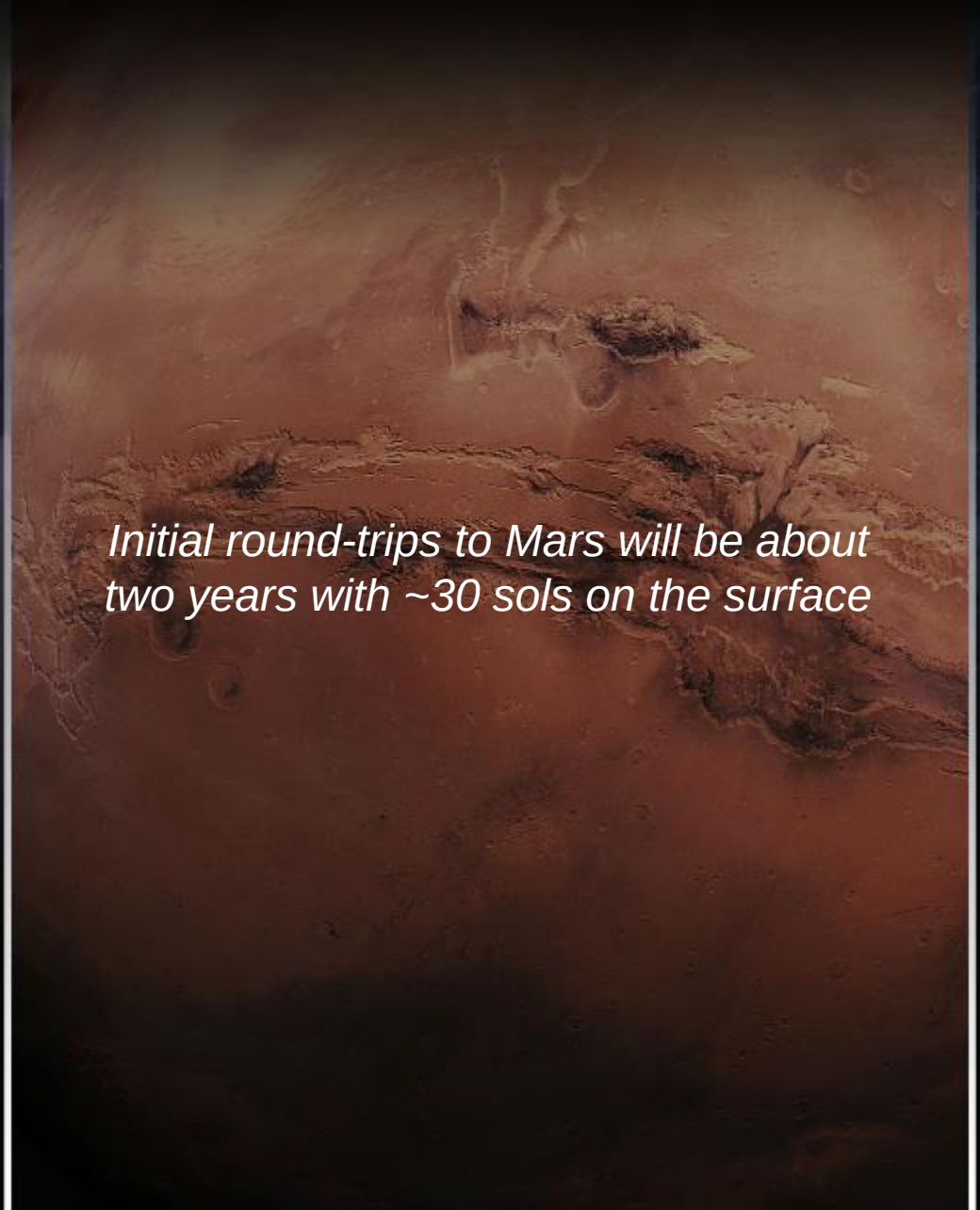
IN ORBIT

DEEP SPACE AGGREGATION
Assembling a complex ship in deep space using international interoperability standards

MARS TRANSIT HABITAT
Round the clock, years-long operations of the Mars transport habitat and life support system

ORBIT TO SURFACE OPERATIONS
Gaining confidence in the operations involved with an orbiting outpost that deploys a lander and its crew to a planetary surface

COMMERCIAL RESUPPLY AND REFUELING
Leveraging the space logistics supply chain for industry provided cargo deliveries



Initial round-trips to Mars will be about two years with ~30 sols on the surface

ON THE SURFACE

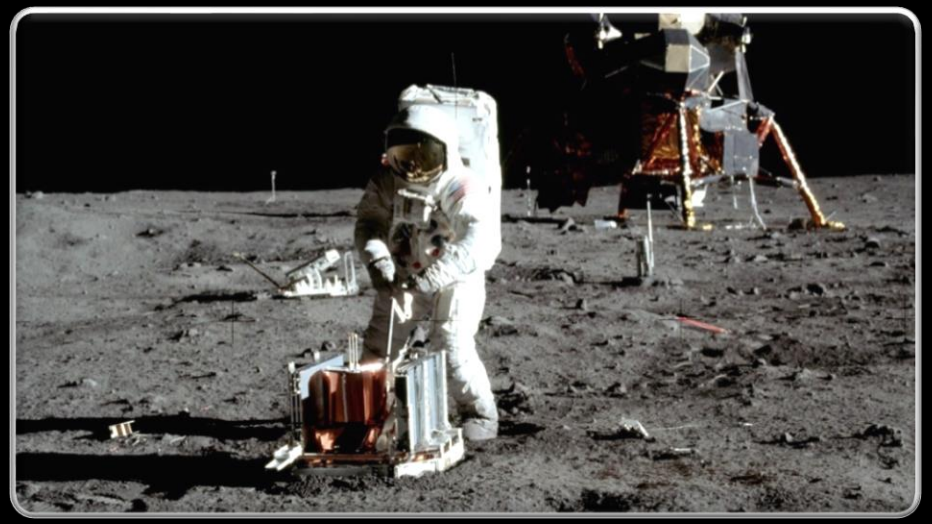
SPACESUIT ADVANCEMENTS
Improving spacesuit design across Artemis missions with astronaut input and private sector innovation

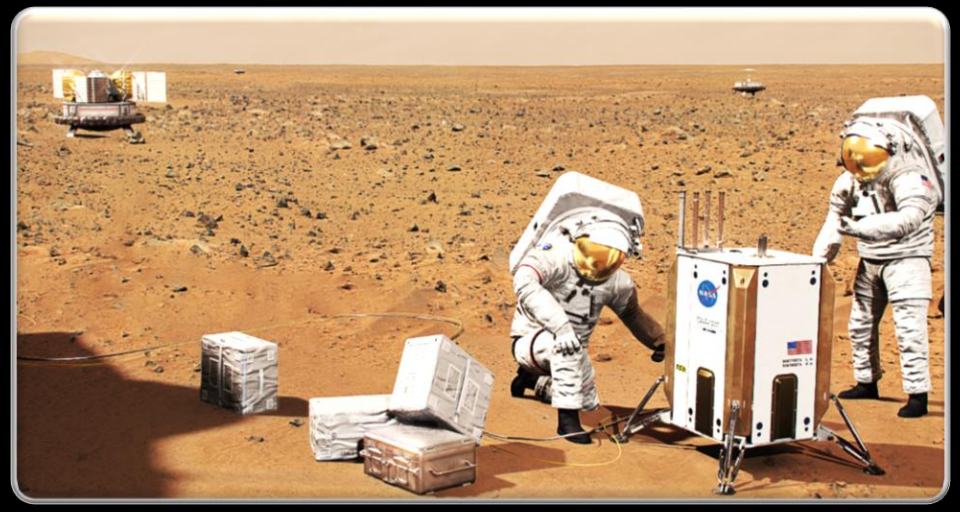
MOBILE OPERATIONS
Living and working ‘on the go’ inside a mobile habitat for weeks at a time

PLANETARY PROTECTION
Mitigating dust transfer and establishing pristine sample curation protocols

HUMAN ROBOTIC EXPLORATION
Robots pre-positioning surface assets and conducting reconnaissance for astronaut expeditions

Validating Crew Health and Performance *in Artemis Spacecraft* Will Help Prepare Us to Live and Work on Mars





Lunar Surface	5 Hazards of Human Spaceflight	Mars Surface
1/6 Earth Gravity	Altered Gravity	3/8 Earth Gravity
Galactic Cosmic Rays	Radiation	Galactic Cosmic Rays
Different Atmospheres, Environments, Dust	Hostile, Closed Environment	Different Atmospheres, Environments, Dust
Fast Communications, 2-3 Day return	Distance from Earth	20 min Comm. Delay, >9 month return
Small volumes, 2 days-30 days on Surface	Isolation & Confinement	Small volumes,~30 sols on Surface (first mission)

Michelle
RUCKER

HEOMD Mars Architecture Team Lead
NASA Johnson Space Center

First Human Mars Mission Concept Overview

WHO

Current analysis includes 4 crew

Some could potentially remain in Mars orbit while others explore surface

WHAT

Mars Transit

Landing and Surface Exploration

Mars Ascent and Earth Return

WHERE

Cislunar, Deep Space and Mars orbit

Mars Surface

WHEN

As early as 2030s

Crew away from Earth ~2 years

~30 sols on Mars

WHY

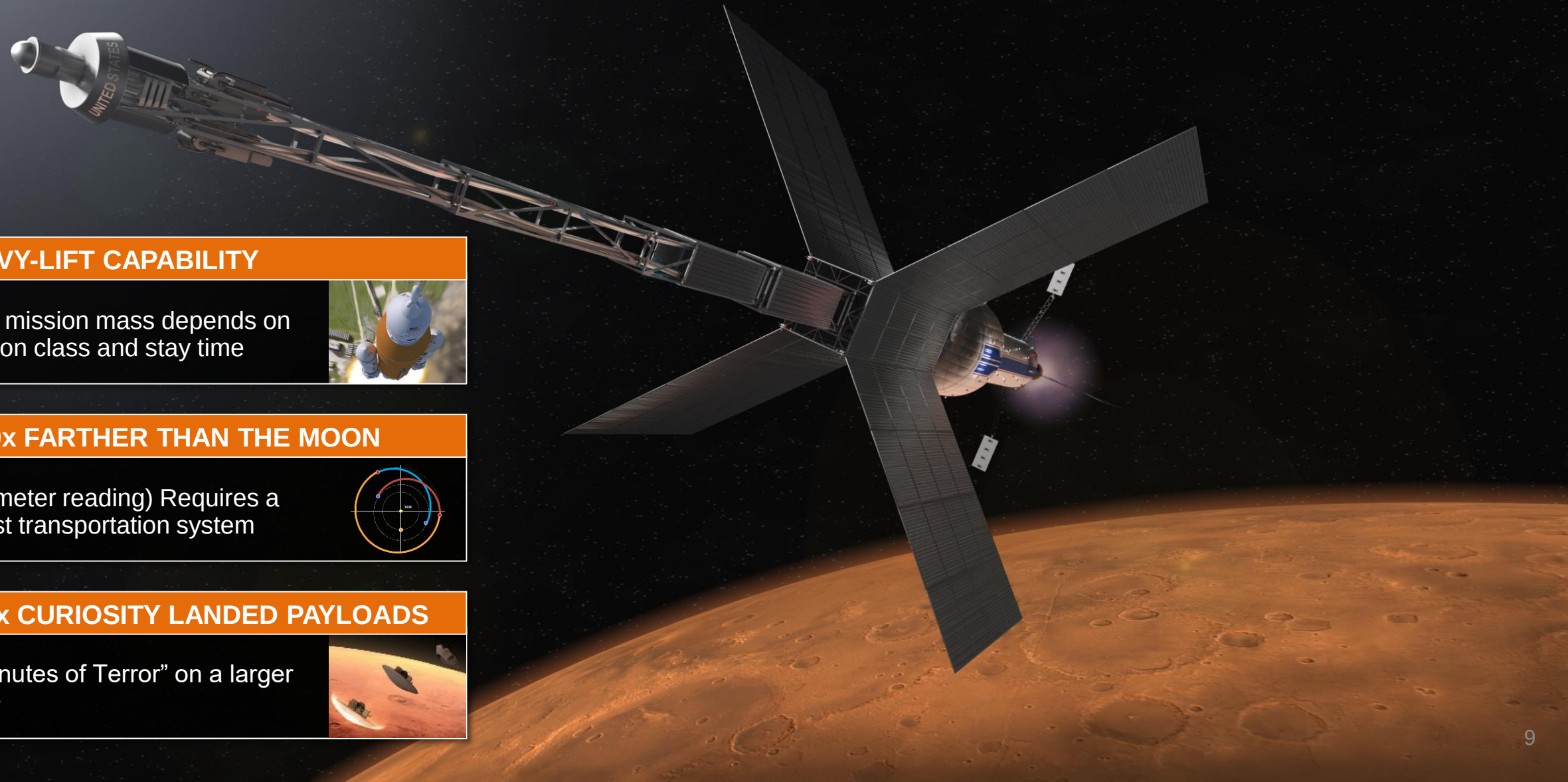
Science, Exploration, and U.S. leadership

HOW

1 *Pre-Deployed Cargo Phase*

2 *Crewed Surface Exploration Phase*

GETTING THERE



HEAVY-LIFT CAPABILITY

Total mission mass depends on mission class and stay time

2000x FARTHER THAN THE MOON

(odometer reading) Requires a robust transportation system

> 20x CURIOSITY LANDED PAYLOADS

“7 minutes of Terror” on a larger scale

LIVING AND WORKING THERE

DUST STORMS

Reduced visibility, solar energy disruption, material abrasion

TERRAIN HAZARDS

Sand traps, dramatic elevation changes, line of sight comm

PLANETARY PROECTION

Protect science from the humans & protect humans from Mars

> 2 YEAR ROUNDTRIP MISSIONS

Limited resupply or abort opportunities, crew isolation, lengthy space exposure

COMMUNICATIONS LATENCY/BLACKOUT

Up to 44 minutes roundtrip comm, up to 2-week blackout, low data rates

COMING HOME

GRAVITY + ATMOSPHERE

> 20 tons ascent propellant needed

EARTH RE-ENTRY

Advanced heat shields needed

MISSION TURN-AROUND

Refurbish/resupply for subsequent missions

Key Take-Away: First mission emphasis is a relatively short (~30 sol) surface stay for a ~2 year round-trip first mission, with pre-deployed cargo but minimal infrastructure build-up, leveraging systems developed for lunar exploration.

Questions?

Dr. Jacob Bleacher
HEOMD Chief Exploration Scientist
NASA Headquarters

Michelle Rucker
HEOMD Mars Architecture Team Lead
NASA Johnson Space Center

Artemis Lunar Base Camp Feeds forward to Mars Surface

Helps us Practice Living on Mars

Reliable surface power generation and long distance power distribution

Operational guidelines and procedures for planetary protection

Destination reconnaissance and resource Assessment

Large scale water production from surface materials

Autonomous mobility and ISRU system operations

Crew gravity re-adaption and surface EVA physiology

Precision landing and hazard avoidance

Dust resistant textiles, seals, and mechanisms