



HUMAN LANDING SYSTEM

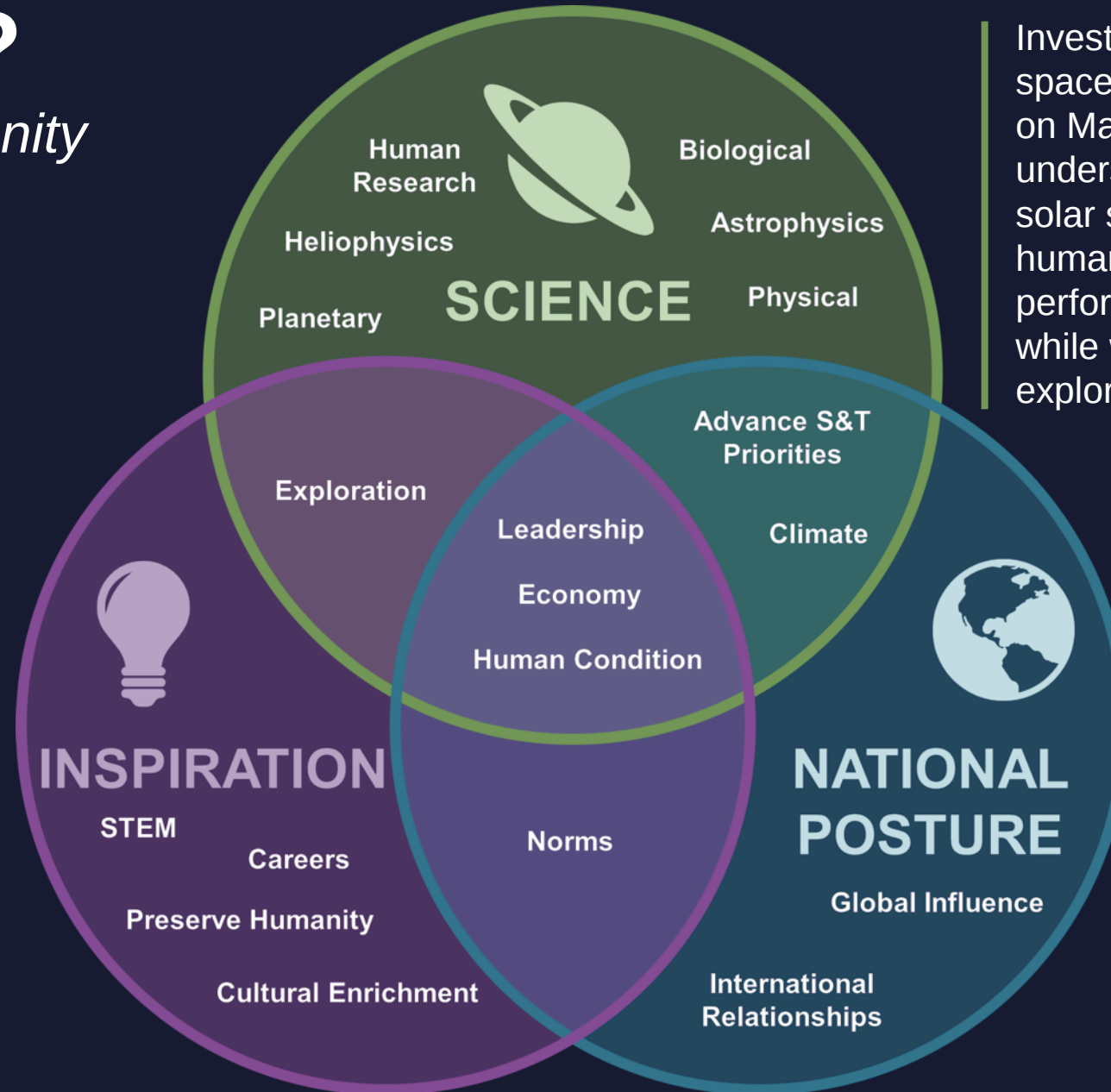
Lisa Watson-Morgan
Program Manager

Why Go?

Benefits to Humanity



Investigations in deep space, on the Moon, and on Mars will enhance our understanding of the solar system, Earth, the human body, and how to perform new operations while we are out there exploring.



Accepting audacious challenges and succeeding through perseverance and tenacity in the face of adversity motivates current and future generations to dare mighty things.

What we choose to do, how we do those things, and who we do them with greatly impacts our place in the world today, our quality of life, and our possibilities for the future.

Artemis: A Foundation for Deep Space Exploration



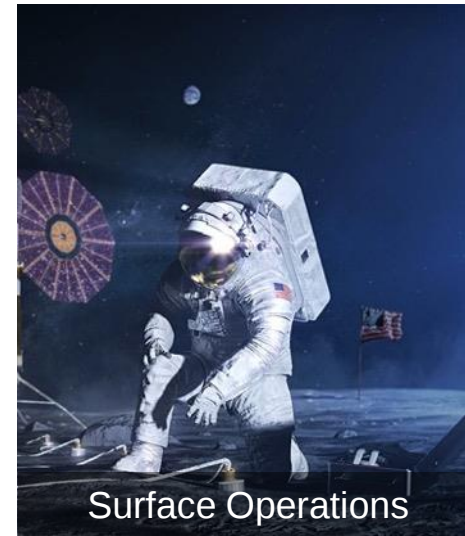
Space Launch System



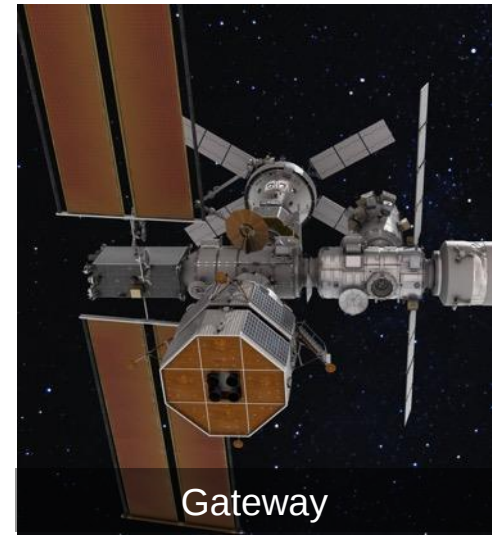
Orion spacecraft



Human Landing Systems



Surface Operations



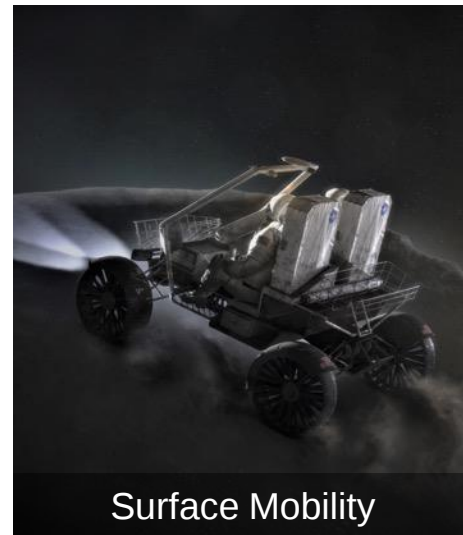
Gateway



Exploration Ground Systems



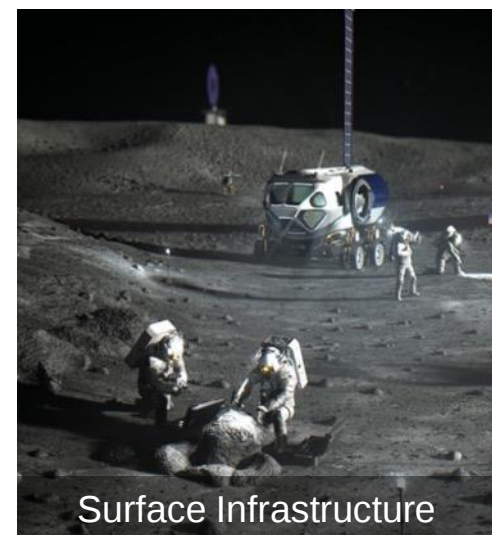
Space Communications
& Navigation



Surface Mobility



Spacesuits



Surface Infrastructure

Artemis I

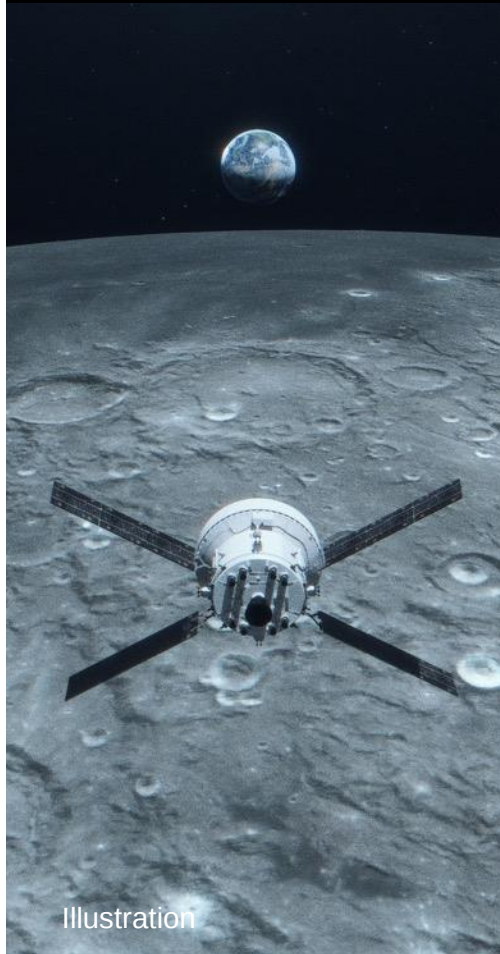
Uncrewed flight test
COMPLETE



SLS, Orion, EGS

Artemis II

Crewed flight test



Illustration

SLS, Orion, EGS

Artemis III

Crewed surface expedition

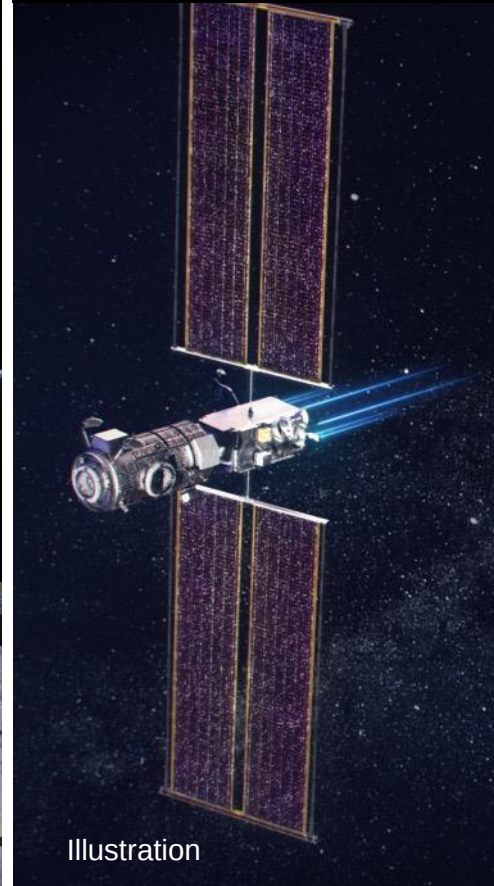


Illustration

SLS, Orion, EGS, HLS

Artemis IV

*Gateway assembly,
crewed sustaining
lander expedition*



Illustration

SLS, Orion, EGS,
HLS, Gateway
(PPE/HALO, I-HAB)

Artemis V

*Crewed mobile
surface exploration,
Gateway expansion*



Illustration

SLS, Orion, EGS,
HLS, LTV, Gateway
(ESPRIT, Canadarm3)



LANDING

humans and cargo on the lunar surface

- Developed by U.S. industry, based on NASA requirements
- Carries crew and cargo to the lunar surface and returns crew to lunar orbit
- Serves as a habitat on the lunar surface for early Artemis missions
- Houses equipment for surface activities including moonwalks, sample collection, and scientific experiments

STARSHIP

Human Landing System (HLS)

NASA is working with SpaceX to develop its Starship Human Landing System for use on:

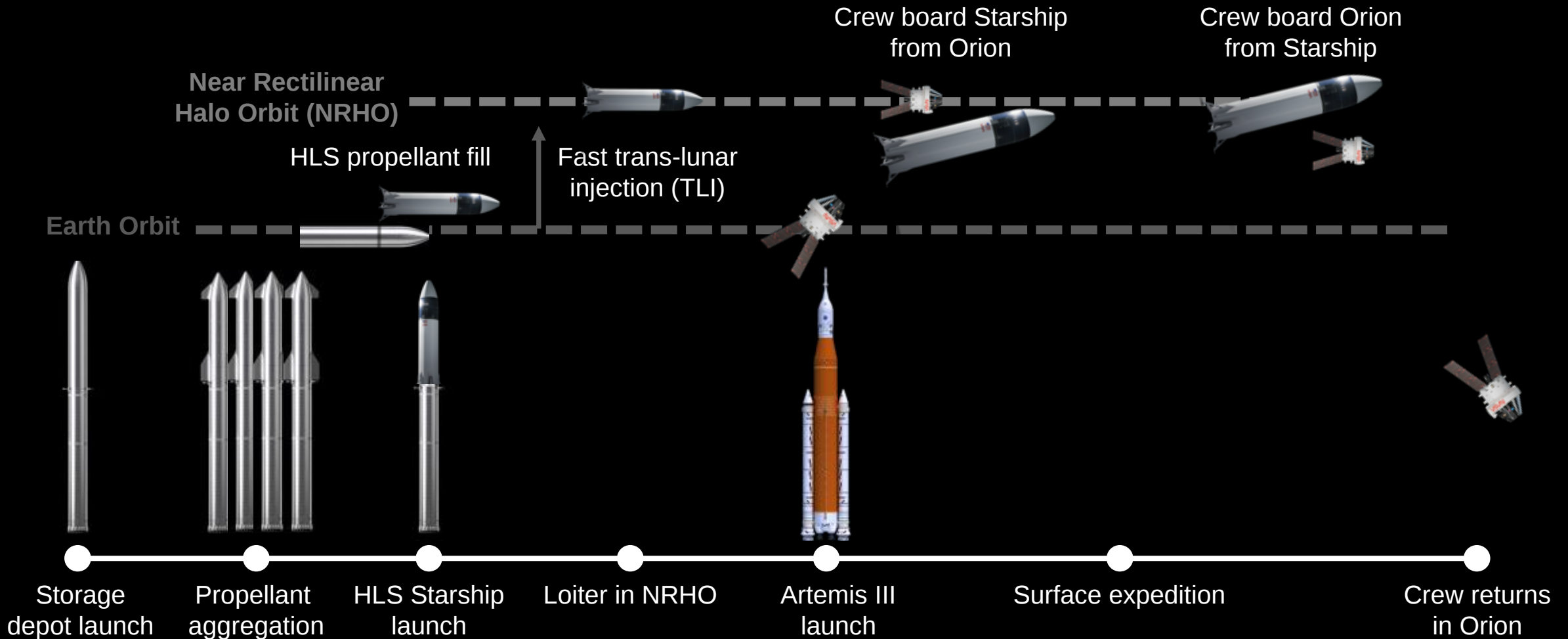
- Artemis III - the mission that will put the next two Americans on the surface of the Moon
- Artemis IV - which meets an extended set of requirements such as docking with Gateway for crew transfer, more mass to the surface, and longer mission durations

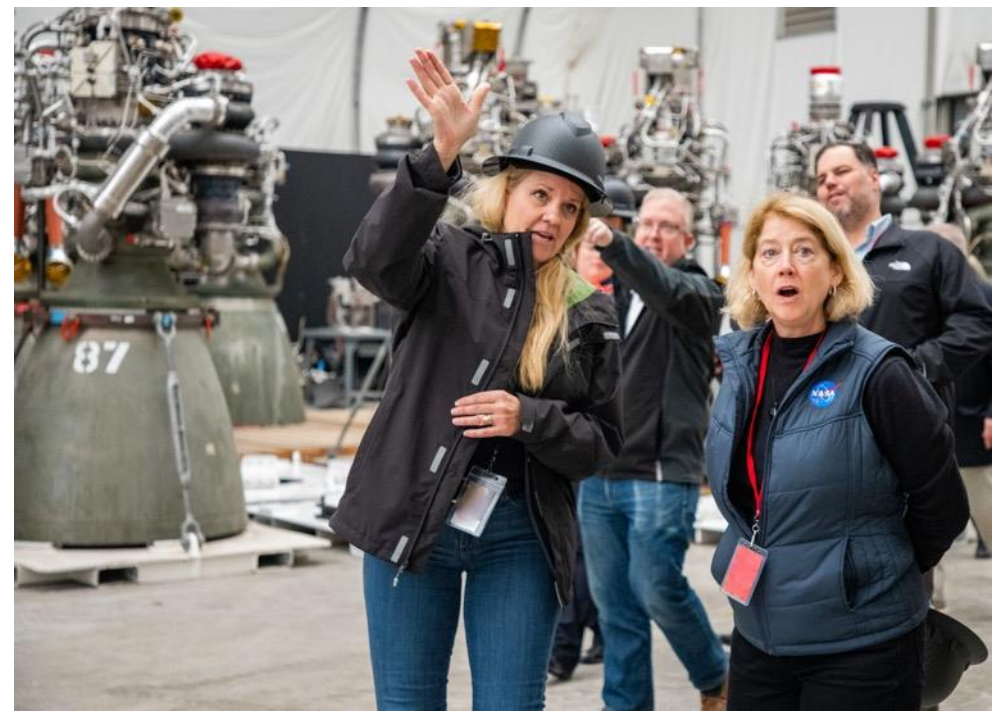
SpaceX will perform an uncrewed demonstration mission prior to the crewed Artemis III mission.



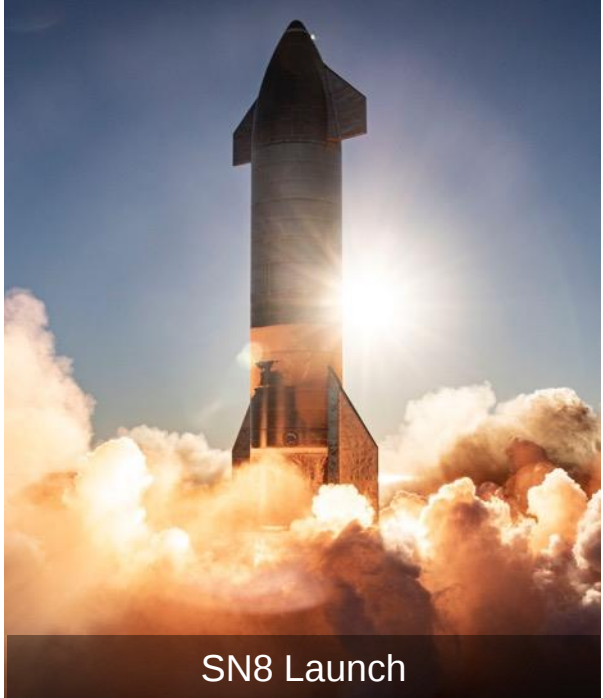
Image Credit: SpaceX

Starship Human Landing System (HLS) Artemis III Concept of Operations









SN8 Launch



SN15 Landing



Booster 7 Static Fire



Ship 24 + Booster 7 Wet Dress

BLUE MOON

Human Landing System (HLS)

NASA awarded Blue Origin a contract to develop a human landing system built to meet NASA's plans for regularly occurring, long-term access to the lunar surface.

The contract includes one uncrewed demonstration mission and one crewed demonstration mission (Artemis V).

The team's architecture consists of **Blue Origin's** Blue Moon lander and **Lockheed Martin's** Cislunar Transporter as well as:

- **Draper** - guidance software and analysis on the lunar lander; developing pilot simulator and training system
- **Boeing** - active docking adapter for the integrated lander; engineering design; mission support operations
- **Astrobotic** - cargo accommodation system; landing sensor maturation; mission operations
- **Honeybee Robotics** - motion control systems and robotics



Image Credit: Blue Origin

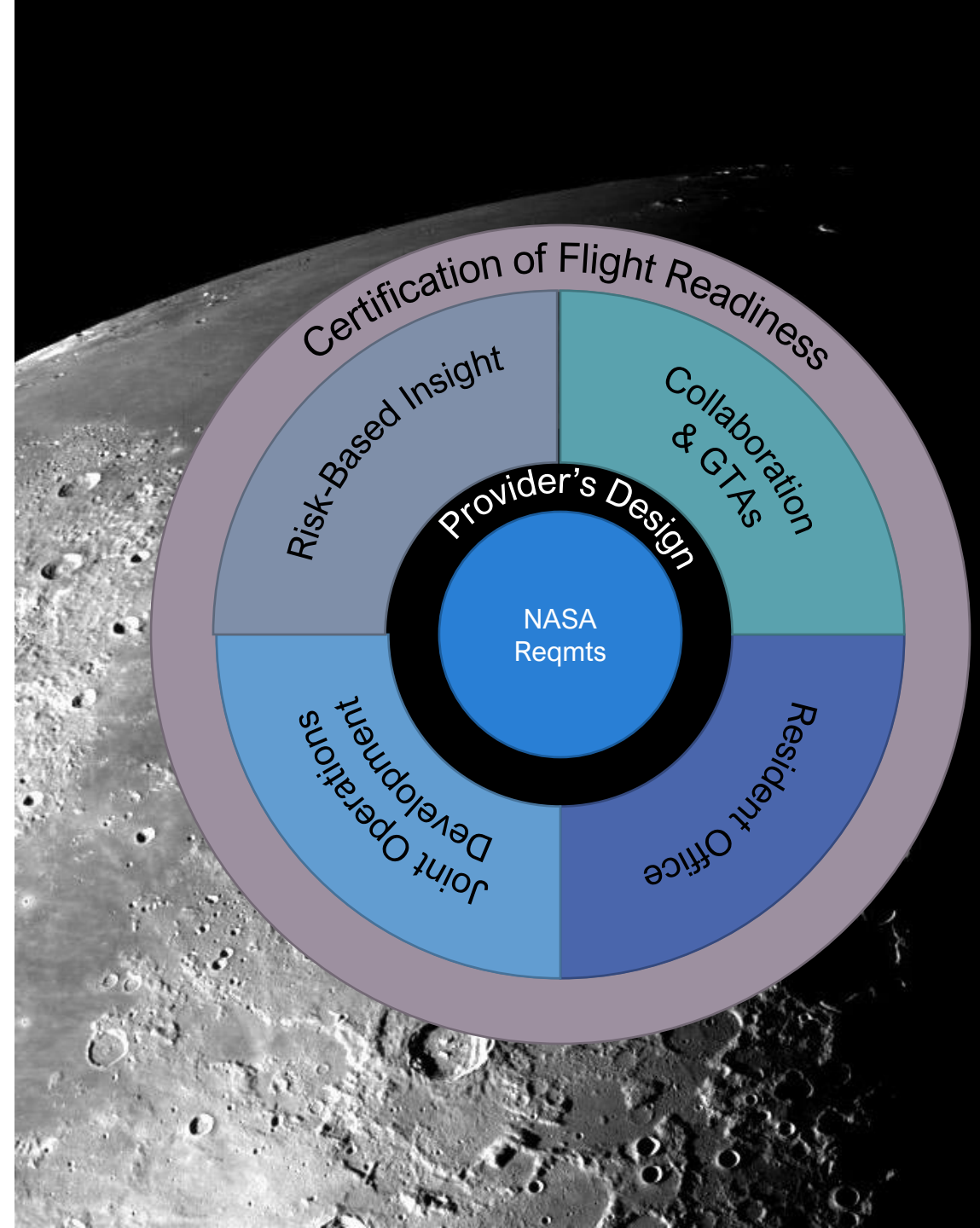
Insight

- Risk based focusing on targeted areas of program concern
- Ensures HLS resources are applied efficiently, and that Providers are not overly burdened by excessive insight activity in low risk areas

Collaboration

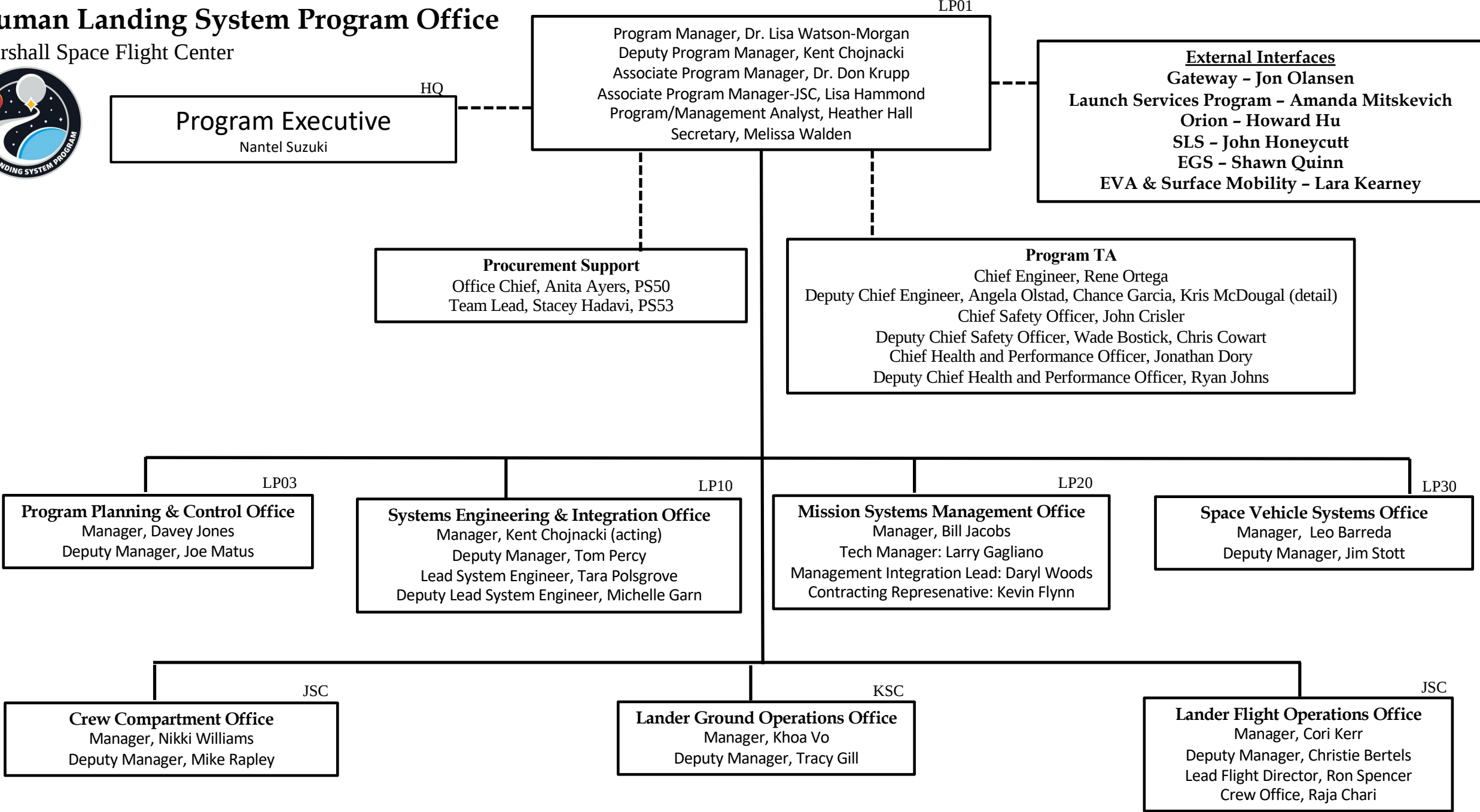
- Personnel that are assigned to work with the Provider and part of their team
- Accomplish tasks that are specified by the Provider, and deliverable to the Provider as in-line work

NASA maintains ultimate authority on certification of flight readiness.



Human Landing System Program Office

Marshall Space Flight Center





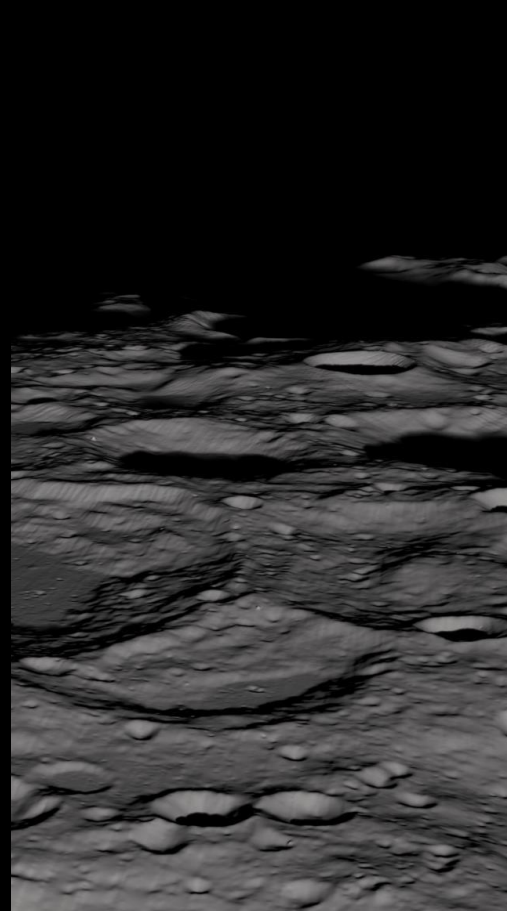
Follow the missions

@NASAARTEMIS



**HLS Uncrewed
Demo**

SpaceX Starship



2024

Artemis III

SpaceX Starship



Illustration

2025

Artemis IV

SpaceX Starship

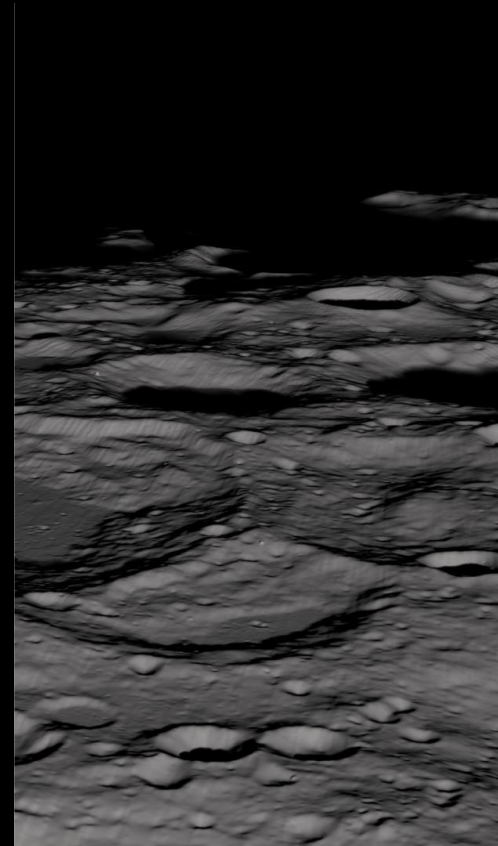


Illustration

2028

**HLS Uncrewed
Demo**

*Blue Origin
Blue Moon*



2028

Artemis V

*Blue Origin
Blue Moon*



Illustration

2029

STARSHIP

Human Landing System (HLS)

NASA has awarded two contracts to SpaceX:

- Option A – develop its HLS Starship for use on Artemis III, the mission that will put the next two Americans on the surface of the Moon
 - Uncrewed Lunar Landing Demonstration
 - Artemis III
- Option B – further develop its HLS Starship to an extended set of requirements
 - Artemis IV

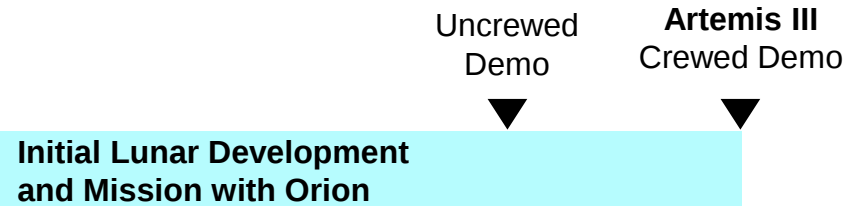
Image Credit: SpaceX



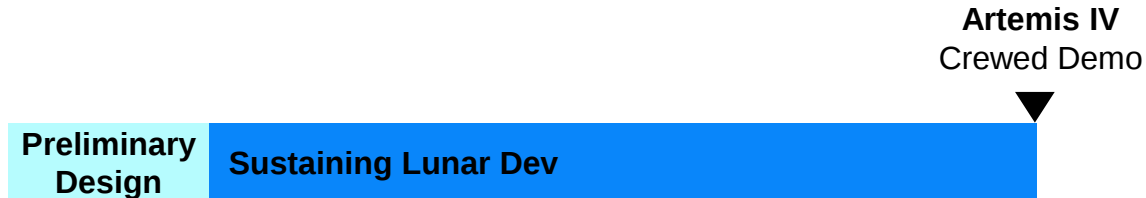
Human Landing System Acquisition Approach



SpaceX Initial Lander Development (Option A)



SpaceX Sustaining Lander Development (Option B)



Blue Origin Team Sustaining Lander Development (Appendix P)



Future Acquisition For Landing Services



Human Landing System (HLS) Procurement Path

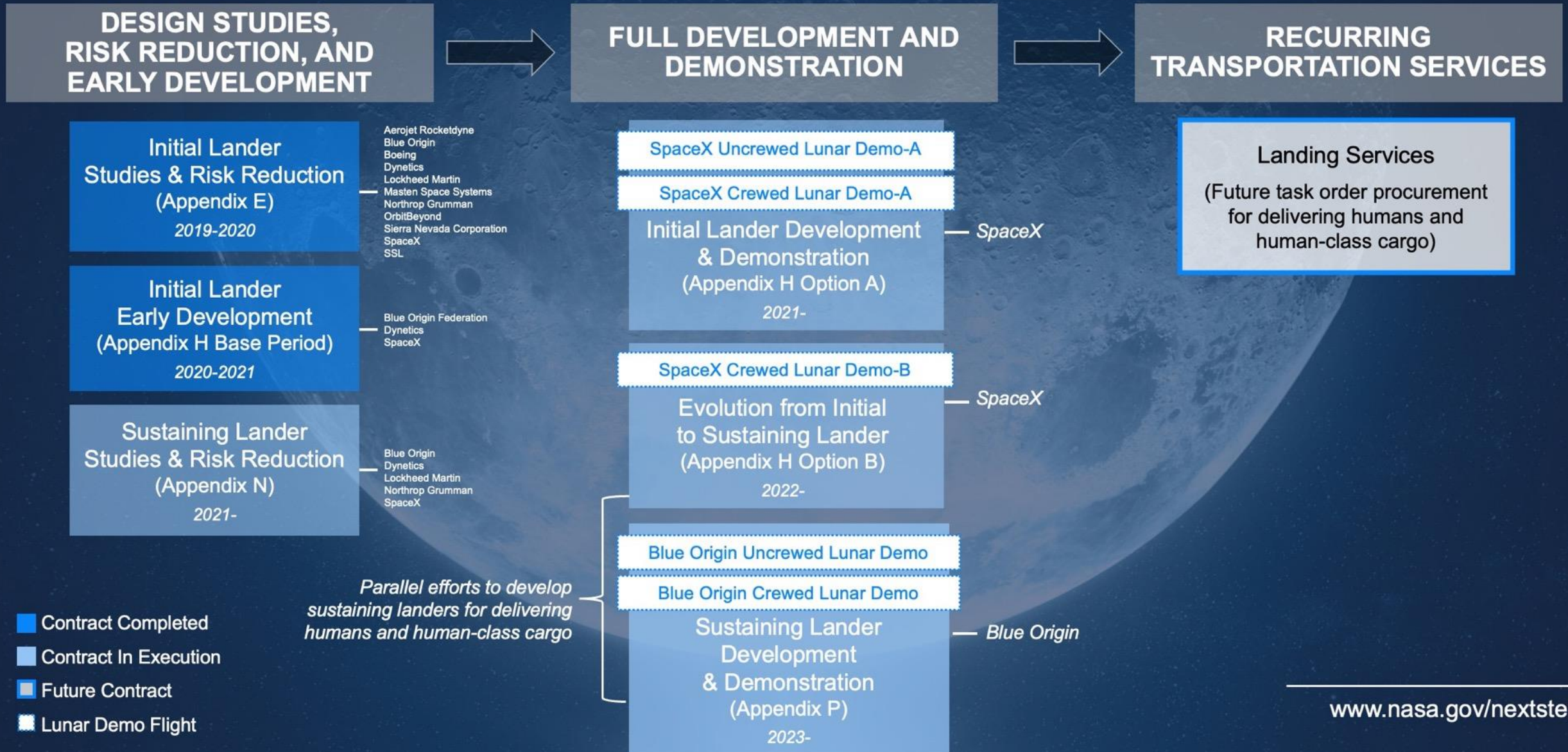




Image credit: Axiom Space



Axiom Extravehicular Mobility Unit (AxEMU)

- The spacesuit that will be worn by the first woman on the Moon during the Artemis III mission
- Built on the heritage of NASA's xEMU design and the agency's decades of spacesuit research and development
- Incorporates the latest technology, enhanced mobility, and added protection from hazards at the Moon

Image: Axiom Space Extravehicular Mobility Unit (AxEMU) spacesuit prototype



Artemis I



MISSION COMPLETE:

The Artemis I mission launched on November 16, 2022, and the Orion spacecraft successfully splashed down on December 11, 2022.

FIRSTS:

- Uncrewed integrated flight test of the Space Launch System (SLS) rocket, Orion spacecraft, and Exploration Ground Systems (EGS) at Kennedy Space Center
- Demonstration of Orion heatshield at lunar re-entry conditions

NEW ELEMENTS:

- SLS rocket Block 1 configuration
- Orion crew spacecraft
- Mobile Launcher 1 and upgraded ground systems

THE ARTEMIS II CREW

The Artemis II crew represents thousands of people working tirelessly to bring us to the stars. This is their crew. This is our crew. This is humanity's crew.



Jeremy Hansen

Mission Specialist
Canadian Space Agency Astronaut

Reid Wiseman

Commander
NASA Astronaut

Victor Glover

Pilot
NASA Astronaut

Christina Hammock Koch

Mission Specialist
NASA Astronaut



THE ARTEMIS II CREW

NASA Astronauts

REID WISEMAN

Commander

VICTOR GLOVER

Pilot

CHRISTINA HAMMOCK KOCH

Mission Specialist

Canadian Space Agency Astronaut

JEREMY HANSEN

Mission Specialist

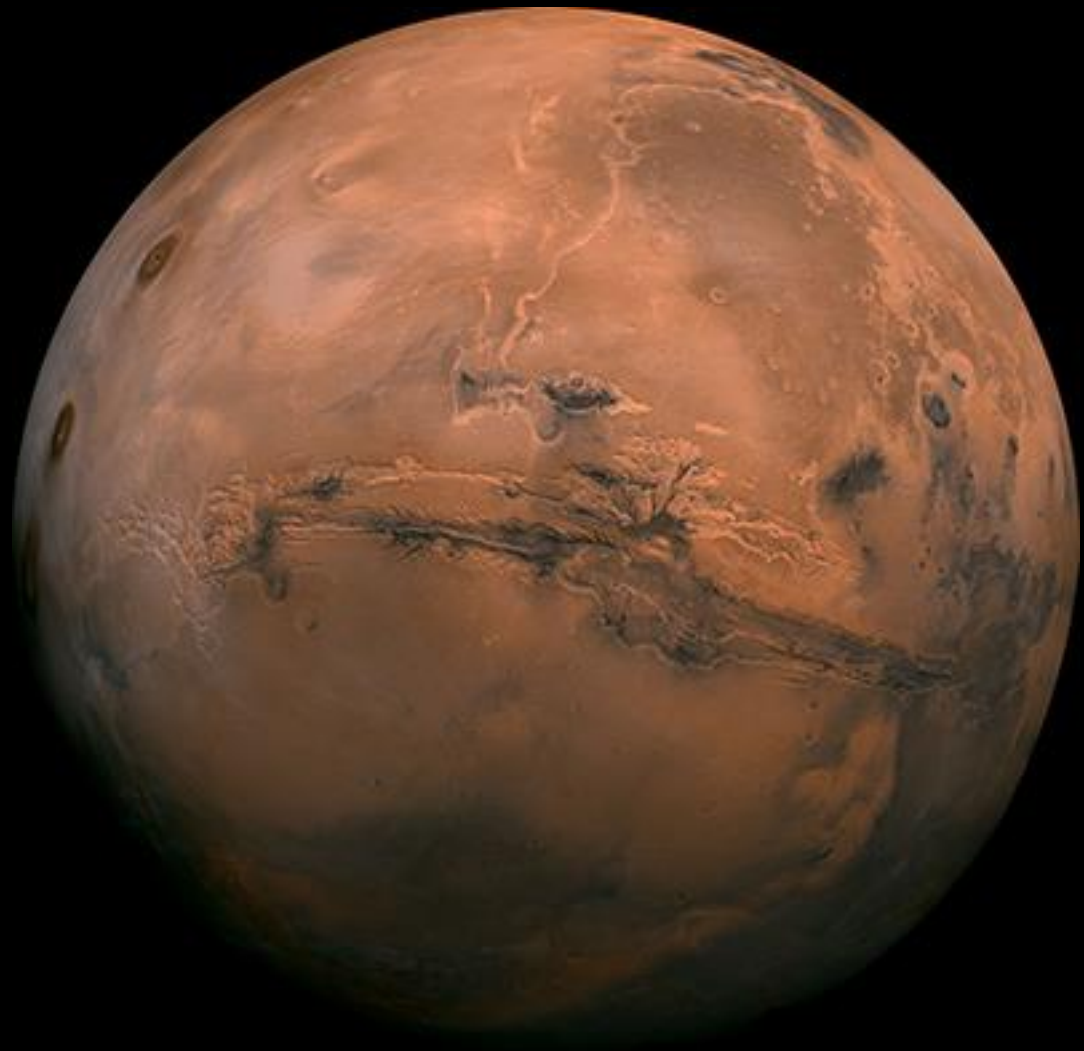
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ARTEMIS

Lunar surface infrastructure

A sustainable environment to live and work on the lunar surface



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



FIRST MISSIONS TO MARS



OPERATIONAL VALIDATED
CREW HEALTH &
PERFORMANCE

Mission Verification & Validation



ARTEMIS LUNAR-BASED ANALOGS



MICROGRAVITY /
PARTIAL
GRAVITY



DEEP
SPACE
RADIATION



EXPLORATION
MEDICAL
CAPABILITY



EXTENDED
MISSIONS

Risk mitigation of integrated hazards

Human systems validation



LOW-EARTH ORBIT RISK REDUCTION



MICROGRAVITY /
1G TRANSITIONS



GENE /
MICROGRAVITY
INTERACTIONS



CROP
PRODUCTION



TEST NEW
SYSTEMS



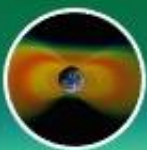
INTEGRATED
SIMULATIONS

Risk mitigation of single hazards

Risk mitigation of integrated and simulated hazards



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

One of Several Potential Concepts for a First Human Mission to Mars

Illustrating the minimum suite of elements needed for a “light exploration footprint”.

TRANSIT HABITAT AND TRANSPORTATION STAGE

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



*Several transportation systems
are being analyzed*



1

PRE-DEPLOYED
CARGO



2

PRE-DEPLOYED MARS
ASCENT VEHICLE



3

CREW AND
PRESSURIZED ROVER

