SPACE EXPLORATION:
TURNING VISION INTO REALITY

Aeronautics and Space Engineering Board

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HEOMD'S Vision for Exploration

Maximize use of the International Space Station to reach its fullest potential

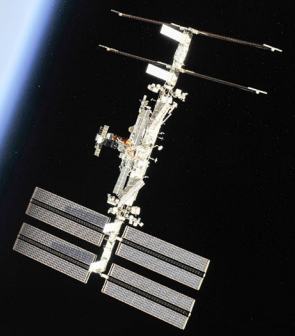
Make commercial human spaceflight to low-Earth orbit a robust, sustainable enterprise with many providers and a wide range of users

Build a coalition of public/private partnerships that will help us send astronauts to the Moon quickly and sustainably, together

Deliver more missions, more science, more technology, and more innovation at a better value to the American taxpayer

Make new discoveries, expand human knowledge, and push human presence deeper into the solar system

Return benefit to Earth



Objectives for low-Earth orbit

HEO is dedicated to laying the foundation for America to maintain a constant human presence in low-Earth orbit (LEO) and support commercial operations in LEO.

Comprised of the International Space Station (ISS), Space Transportation, Space and Flight Support, and Commercial LEO Development themes, NASA plans to: develop American-led space infrastructure enabled by a commercial market enhance space access and services to both Government and commercial entities perform research and develop capabilities to safeguard our astronaut explorers.

These activities, which support existing and future space operations for both NASA and non-NASA missions, are a catalyst for economic development. Additionally, these activities advance scientific knowledge and foster new technologies that improve our lives.

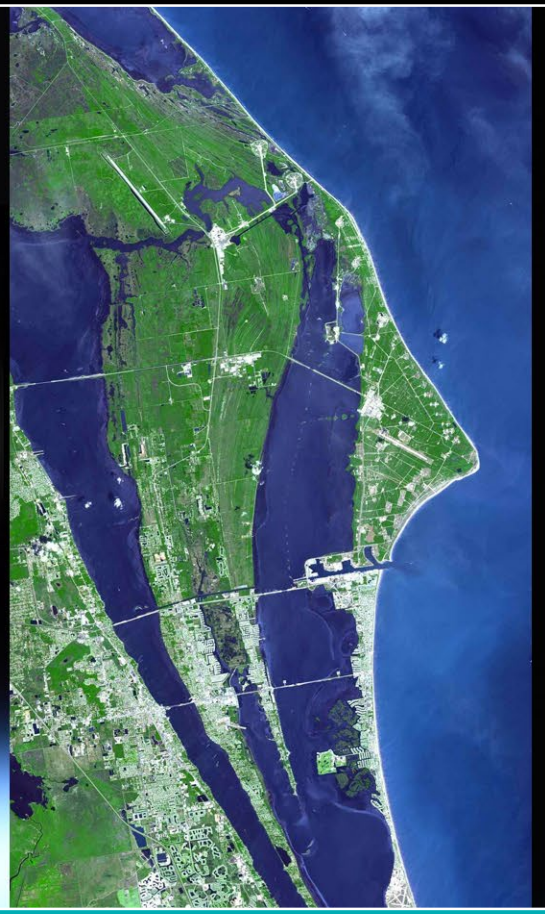
VISION FOR LEO ECONOMY

A World of New Possibilities

Commercial on ISS or Future Platforms

Private Astronaut Missions

Commercial Destinations in LEO



A Robust Industrial Base

Ongoing Research & Science Activities

Objectives for deep space exploration

HEO is focused on returning humans to the Moon and enabling eventual missions to Mars and beyond.

In addition to the next man, NASA will land the first woman and first person of color on the Moon to explore more of the lunar surface than ever before.

In collaboration with our commercial and international partners, NASA will establish sustainable lunar exploration under Artemis.

The operational knowledge, technological advances, and scientific discoveries we gain from exploring the Moon in collaboration with international and commercial partners will position us to take the next giant leap – sending astronauts to Mars.

VISION FOR SUSTAINABLE INFRASTRUCTURE AT THE MOON

Balancing exploration goals, capabilities and the funding needed to implement missions on a time scale that is both achievable and inspiring.

QUALITIES OF SUSTAINABILITY

- **Repeatable:** Operations are designed and executed with the goal of repetition across missions to gain confidence, reduce risk, and increase safety
- **Reusable:** Each mission builds upon the previous one, reusing or leveraging the systems from previous missions
- **Affordable:** The campaign takes into account realistic cost profiles and workforce limits
- **Adaptable:** Missions and strategies can be affordably adapted based on new discoveries and changing priorities
- **Evolvable:** Technologies can be inserted when ready or needed, scope can increase via replication instead of new starts

Collaborative Science and Technology Investment

International Space Station

SERFE – Developing Exploration technology by testing life support systems for xEMU spacesuits

UWMS – Advancing life support systems with the Universal Waste Management System, which can be easily integrated into different spacecraft and life support systems

TISSUE CHIPS – Learning about microgravity and radiation impact on human health through the study of model cells and tissue systems

EXPLORATION MEDICAL – Developing and validating the next generation equipment and operations to provide crew medical care autonomously and without the option to evacuate to Earth

APH – Researching space-based agricultural cycles with the Advanced Plant Habitat, an enclosed and automated chamber producing fresh foods that are critical to astronaut health

Perseverance

MOXIE's successful conversion of carbon dioxide from the Martian atmosphere into oxygen proves a new capability that can support long-duration crewed missions

CLPS

Early CLPS payloads like MSolo, NSS, and NIRVSS, may help identify resources for future missions; the VIPER resource-mapping mission will seek signs of water ice

Gateway

The space weather instrument suite on the Power and Propulsion Element; NASA's HERMES and ESA's ERSA will monitor the lunar radiation environment, enabling safer human exploration

The Lunar Surface Innovation Initiative

Works across industry, academia and government through in-house efforts and public-private partnerships to develop transformative capabilities for lunar surface exploration

Artemis I

As many as 4 science investigations on pressurized payloads, including radiation sensors built by NASA and ESA, launching on the uncrewed test demo

Capstone

A precursor to Gateway, CAPSTONE will test elliptical lunar orbits, validating innovative navigation technologies and reducing risk for future spacecraft

LunaNet

A unique communications and navigation architecture that will extend internetworking to the Moon, offering unprecedented flexibility and access to data

Prizes, Challenges, Crowdsourcing

Engages people in problem solving including crowdsourced challenges and prize competitions, citizen science projects, and competitions aimed at advancing technology innovation for lunar exploration

SPACE LAUNCH SYSTEM STATUS

NASA REFERENCE DESIGN

JAN 2020	✓	Core Stage 1 delivered to Stennis Space Center
JUN 2020	✓	Booster motor segment processing complete, shipped to Kennedy Space Center
AUG 2020	✓	Launch Vehicle Stage Adapter complete, delivered to Exploration Ground Systems
SEPT 2020	✓	Flight Support Booster 1 Hot Fire complete
OCT 2020	✓	6 of 8 Green Run tests complete
NOV 2020	✓	Artemis I booster stacking begins at Vehicle Assembly Building
DEC 2020	✓	Wet Dress Rehearsal Test (TC #7) Complete
MAR 2021	✓	Green Run Hot Fire Test (TC #8) Complete
APR 2021	✓	Core Stage 1 Ship To Kennedy Space Center
SUMMER 2021		Core Stage Mate Completed
SUMMER 2021		Core Stage and Booster Power Up and Test

ORION SPACECRAFT STATUS

NASA REFERENCE DESIGN

MAR 2020	✓	Artemis I Spacecraft Environmental Testing complete
AUG 2020	✓	Crew and Service Module Testing complete
	✓	Spacecraft Adapter Install
NOV 2020	✓	Solar Array Wings/Solar Adapter Jettison Fairing Install
	✓	Forward Bay Cover/Final Installs
JAN 2020	✓	Crew and Service Module delivery to Exploration Ground Systems
SUMMER 2021		Orion Stage Adapter Integrations to Space Launch System (SLS)
SUMMER 2021		Mass Simulator for Orion Integration to SLS
SUMMER 2021		Integrated Modal Test Complete

EXPLORATION GROUND SYSTEMS STATUS

NASA REFERENCE DESIGN

SEP 2020	✓	Terminal Countdown Simulation
SEPT 2020	✓	Booster Stacking Demo complete
OCT 2020	✓	Mobile launcher rollout to Pad 39B
NOV 2020	✓	Cryogenic Loading Simulation Countdown
JAN 2020	✓	Crew and Service Module delivery to Exploration Ground Systems
APR 2021	✓	Core Stage delivery to Exploration Ground Systems
MAY 2021		Start of Integrated Test and Checkout (ITCO)
SUMMER 2021		Secondary Payload Install Completed at Kennedy Space Center
SUMMER 2021		Integrated Modal Test Complete

Human Landing System Status

APR 2020	Base Period Selections Announced
MAY 2020	Base Period Contracts Awarded
AUG 2020	Provider Certification Baseline Reviews (CBRs)
OCT 2020	Issue Option A Solicitation
DEC 2020	Provider Continuation Reviews (CRs) Closeouts
APR 2021	SpaceX selected for Option A DDT&E and a Crewed Demo Mission*
TBD 2021	Option A Contract Award**

**Base Period was extended up to April 30, 2021*
***Blue Origin Federation and Dynetics filed protests on April 26th*

Gateway Status

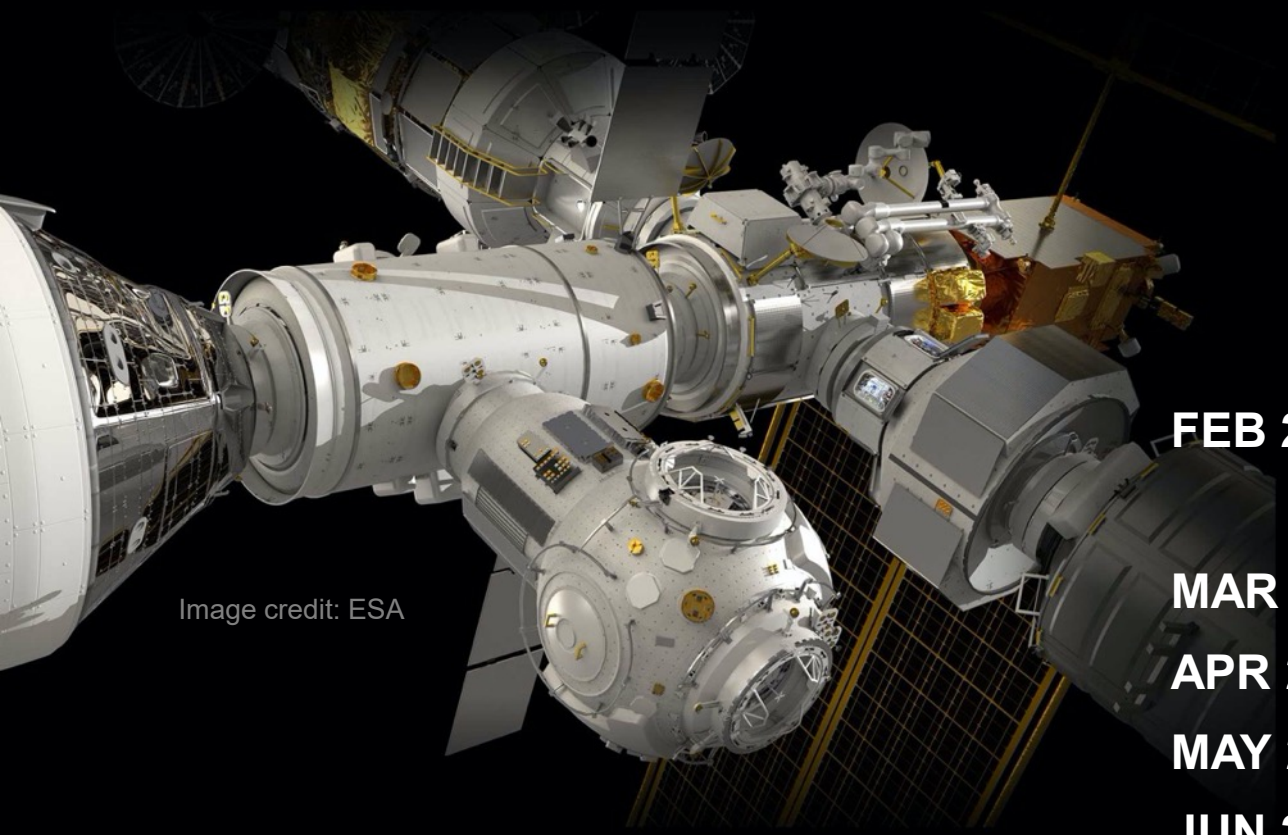


Image credit: ESA

DEC 2020	● European System Providing Refueling, Infrastructure and Telecommunications (ESPRIT) contract awarded by ESA to Thales Alenia Space (France)
	● Canadarm3 contract awarded by CSA to MDA
	● MOU with the Japan Aerospace Exploration Agency (JAXA) signed
FEB 2021	● PPE/HALO Launch Vehicle contract award
	● PPE/HALO Sync Point Review
MAR 2021	● Gateway Program SDR Delta Sync Review
APR 2021	● Gateway Program Key Decision Point 0
MAY 2021	HALO PDR Close-out
JUN 2021	HALO final contract award (fixed price)

What Will Make Artemis Work

Using space station to its fullest potential

Continuing to bring new systems online

Designing infrastructure that enables science objectives

Establishing deep space logistics supply chains

Formulating new procurement strategies

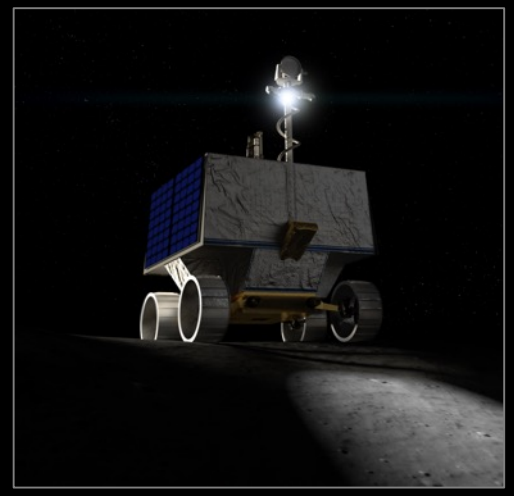
Operating in the current budget environment

Collaborating across NASA to envision new capabilities

Partnering with academia and commercial providers to leverage resources

Working with other nations to multiply efforts and strengthen global diplomacy

NASA astronauts will explore the lunar surface, perform human-tended science experiments, and conduct technology demonstrations



With VIPER, we gain a greater understanding of location and concentration data of water ice that could eventually be harvested to sustain human exploration

ISRU-Based Robotic Construction Technologies will assist in building lunar infrastructures like the Artemis Base Camp

EXPLORATION IS A TEAM SPORT

Participation and inclusiveness are critical to our success – we need innovative thinking, problem solving, diverse backgrounds, and talent.

WHAT'S NEXT FOR
HUMAN SPACEFLIGHT?