



**NASA Advisory Council
NASA Human Exploration and Operations
Overview; NASA Humans to Moon 2024**

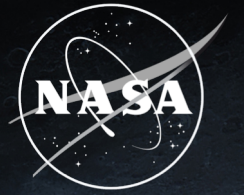
**William Gerstenmaier
Associate Administrator**

**Human Exploration and Operations Mission Directorate
NASA Headquarters, Washington, D.C.
May 31, 2019**

LEADING FUTURE EXPLORATION - STRATEGIC PRINCIPLES



Fiscal Realism | Commercial & International Partnerships | Scientific Exploration
Technology Pull and Push | Gradual Buildup of Capability
Architecture Openness and Resilience
Global Collaboration and Leadership | Continuity of Human Spaceflight



FORWARD TO THE MOON: NASA's Strategic Plan for Lunar Exploration


Updated 5/30/2019



The NASA Charge to the Moon

In keeping with SPD-1, NASA is charged with landing the first American woman and next American man at the South Pole of the Moon by 2024, followed by a sustained presence on and around the Moon by 2028.

NASA will “use all means necessary” to ensure mission success in moving us forward to the Moon.



Vice President Mike Pence speaks about NASA's mandate to return American astronauts to the Moon and on to Mars at the U.S. Space & Rocket Center in Huntsville, Alabama.

Why Go to the Moon?

Establishes American leadership and strategic presence

Proves technologies and capabilities for sending humans to Mars

Inspires a new generation and encourages careers in STEM

Leads civilization changing science and technology

Expands the U.S. global economic impact

Broadens U.S. industry & international partnerships in deep space

The Artemis Program

Artemis is the twin sister of Apollo and goddess of the Moon in Greek mythology. Now, she personifies our path to the Moon as the name of NASA's program to return astronauts to the lunar surface by 2024.

When they land, Artemis astronauts will step foot where no human has ever been before: the Moon's South Pole.

With the horizon goal of sending humans to Mars, Artemis begins the next era of exploration.

American Leadership in Space Exploration



EARTH ORBIT

- Grow a robust commercial space industry with a constant human presence
- Expand our international partnerships through the ISS
- Conduct exploration science and technology demonstrations aboard ISS
- Continue critical earth science research
- New jobs through in-space manufacturing and assembly
- Low-Earth orbit launches us to farther destinations



LUNAR ORBIT

- The next step for commercial space development
- Conduct ground-breaking decadal science
- A new venue to strengthen international partnerships
- Stepping stone and training ground for extending human presence into deep space
- Sustainable and affordable human and robotic programs



LUNAR SURFACE

- Seed investments in commercial lunar landers
- Opportunities to develop technologies for long-term survival
- Explore and exploit space resources
- Create a foothold on a new frontier



MARS & BEYOND

- America's next giant leap – reaching new worlds
- Push the boundaries of human knowledge
- Answer the question of 'are we alone?'
- Unlock the mysteries of the universe



THE ARTEMIS PROGRAM

PHASE ONE:
South Pole by 2024



Strategic Changes to Achieve 2024



Feature	Previous 2028 Target Features	Revised Target features for 2024 crew
Gateway	Significant platform; multi-element	Phase One; Absolute minimum configuration
Crew Size	Sizing for up to 4 crew to the lunar surface	2 to surface initially with up to 2 crew on-orbit
Access	Global	South Pole first. Access to Global locations.
Partners	Commercial and international opportunities; interoperability standards	Much stronger commercial engagement sooner, international opportunities remain; interoperability standards enable all partners
Launch Vehicles	SLS and commercial	SLS with increased number of commercial launches
Mission Duration	7 day lunar sorties	Trade lower number of mission days as needed
Schedule	2028 with a paced approach	Focused urgency and energy to accomplish 2024
NASA Organizational Change	<p>Landing humans on the surface of the Moon in 2024 will require changes to established internal and external policies, procedures, and processes including: Legal/Procurement, Budget/Resources, Staffing/Workforce, Governance/Organization</p> <p>Teams across the agency are working detailed recommendations in these, and other categories to support meeting the 2024 objective</p>	

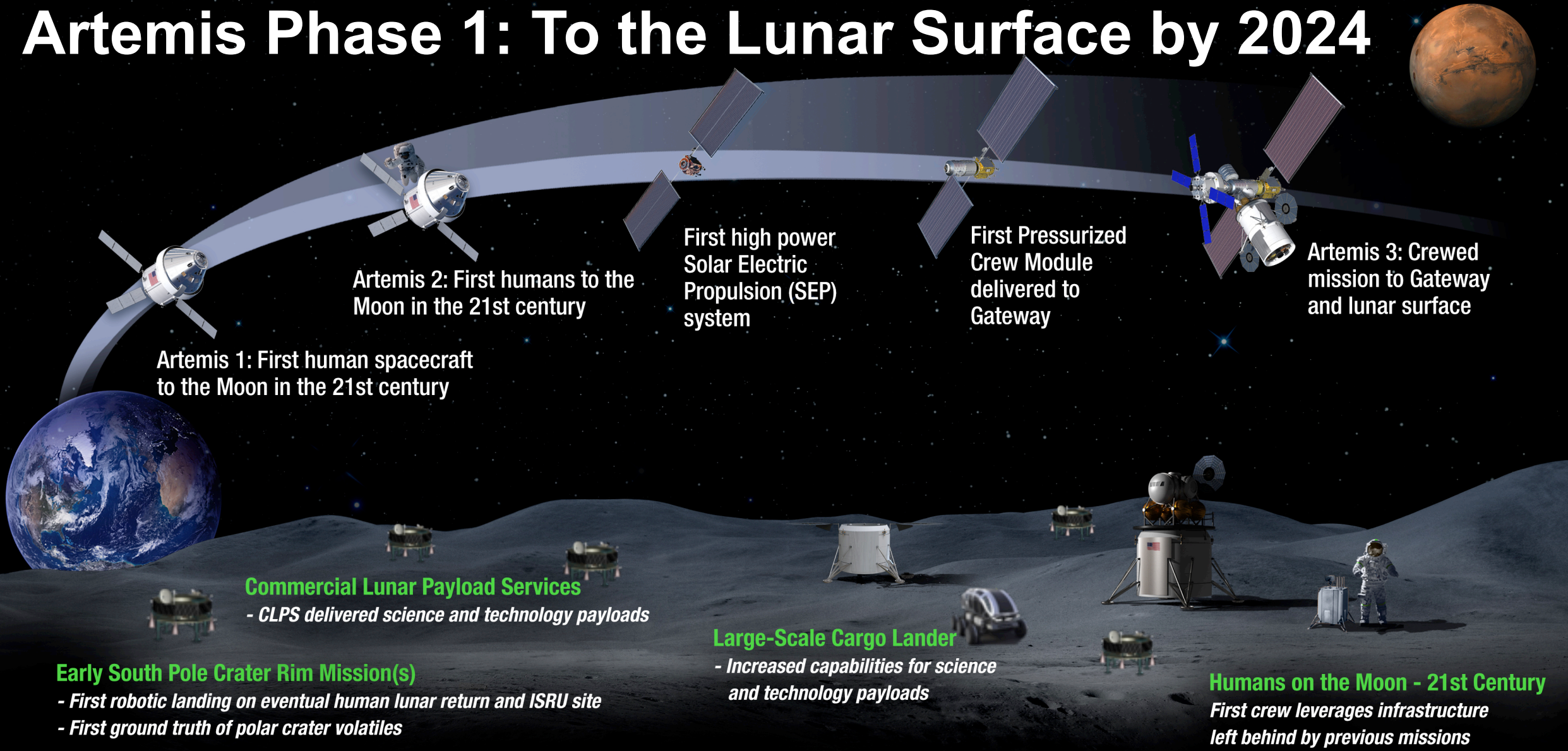
A Budget Increase Toward 2024



- The FY2020 budget amendment provides an **increase** of **\$1.6 billion** above the president's initial **\$21 billion** budget request with no money taken from existing NASA programs. This is the **boost** NASA needs.
 - \$1 billion to accelerate development of human lunar transportation systems to take astronauts to the surface and back to Gateway*
 - \$651 million towards the completion of SLS and Orion to support a 2024 landing.
 - \$132 million for new technologies to help astronauts live and work on the lunar surface and in deep space.
 - \$90 million for Science to increase robotic exploration at the lunar South Pole in advance of astronauts.

** Focusing Gateway on just the capabilities needed for Phase 1 allowed for a \$321M scope reduction and shifts potential development and expanded capabilities for Gateway into Phase 2.*

Artemis Phase 1: To the Lunar Surface by 2024



Artemis 1: First human spacecraft to the Moon in the 21st century

Artemis 2: First humans to the Moon in the 21st century

First high power Solar Electric Propulsion (SEP) system

First Pressurized Crew Module delivered to Gateway

Artemis 3: Crewed mission to Gateway and lunar surface

Commercial Lunar Payload Services
- CLPS delivered science and technology payloads

Large-Scale Cargo Lander
- Increased capabilities for science and technology payloads

Early South Pole Crater Rim Mission(s)
- First robotic landing on eventual human lunar return and ISRU site
- First ground truth of polar crater volatiles

Humans on the Moon - 21st Century
First crew leverages infrastructure left behind by previous missions

LUNAR SOUTH POLE TARGET SITE

Achieving 2024 – A Parallel Path to Success

Artemis will see government and commercial systems moving in parallel to complete the architecture and deliver crew

CREW

NASA Programs SLS and Orion



Artemis 1

First flight test of SLS and Orion as an integrated system

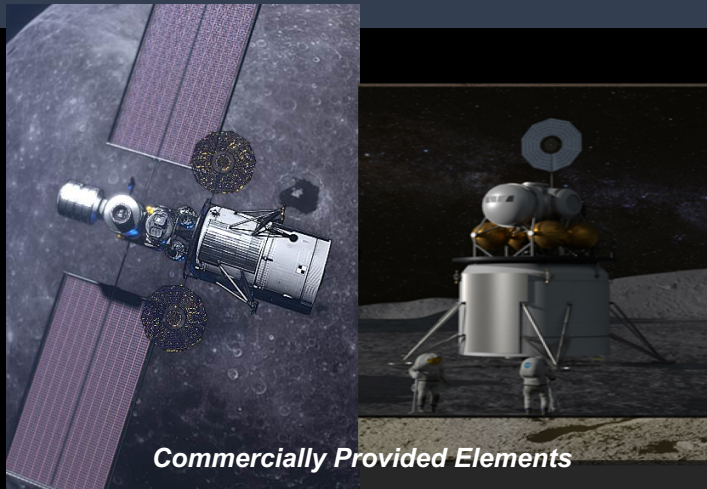
Artemis 2

First flight of crew to the Moon aboard SLS and Orion

Artemis 3

First crew to the lunar surface; Logistics delivered for 2024 surface mission

Between now and 2024, U.S. industry delivers the launches and human landing system necessary for a faster return to the Moon and sustainability through Gateway.



Commercially Provided Elements

CARGO

PPE

Power Propulsion Element arrives at NRHO via commercial rocket

Crew Module

Small pressurized crew module launches to Gateway on a commercial rocket

Human Landing System

Transfer

Transfers lander from Gateway to low lunar orbit

Descent

Descends from Transfer Vehicle to lunar surface

Ascent

Ascends from lunar surface to Gateway

Up to three commercial rocket launches, depending on distribution of the Transfer, Descent, and Ascent functions.

The Power of SLS and Orion

A low-angle photograph of the Space Shuttle SLS and Orion spacecraft being mated to the External Tank and Solid Rocket Boosters on the Vehicle Assembly Building. The SLS is the central orange and white structure, with the Orion spacecraft attached to its side. The background is a dark, cloudy sky. A tall service structure is visible to the right, and a lighting rig is in the foreground on the right.

ORION

The only spacecraft capable of carrying and sustaining crew on missions to deep space, providing emergency abort capability, and safe re-entry from lunar return velocities

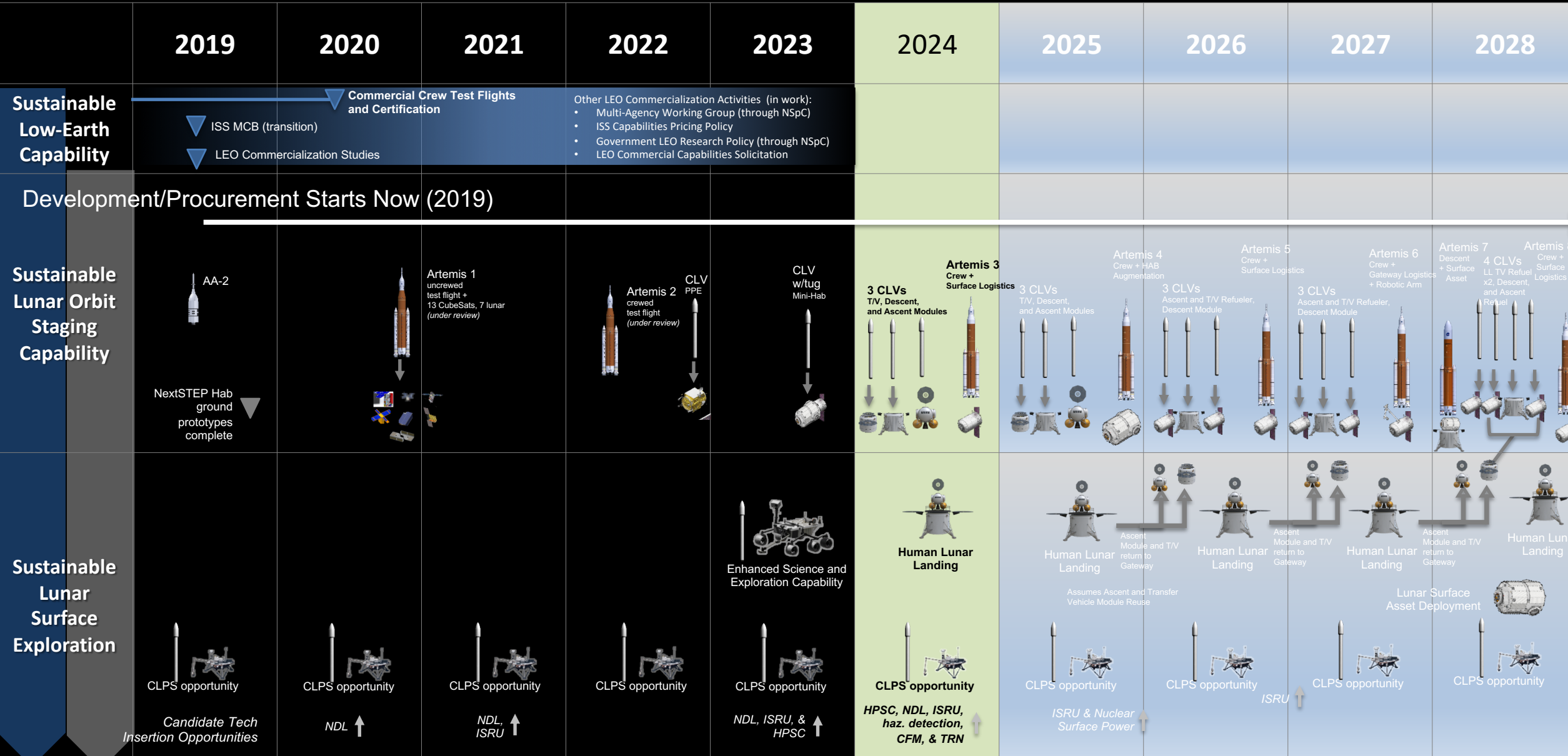
SLS

The only rocket with the power and capability required to carry astronauts to deep space onboard the Orion spacecraft

NATIONAL CAPABILITY

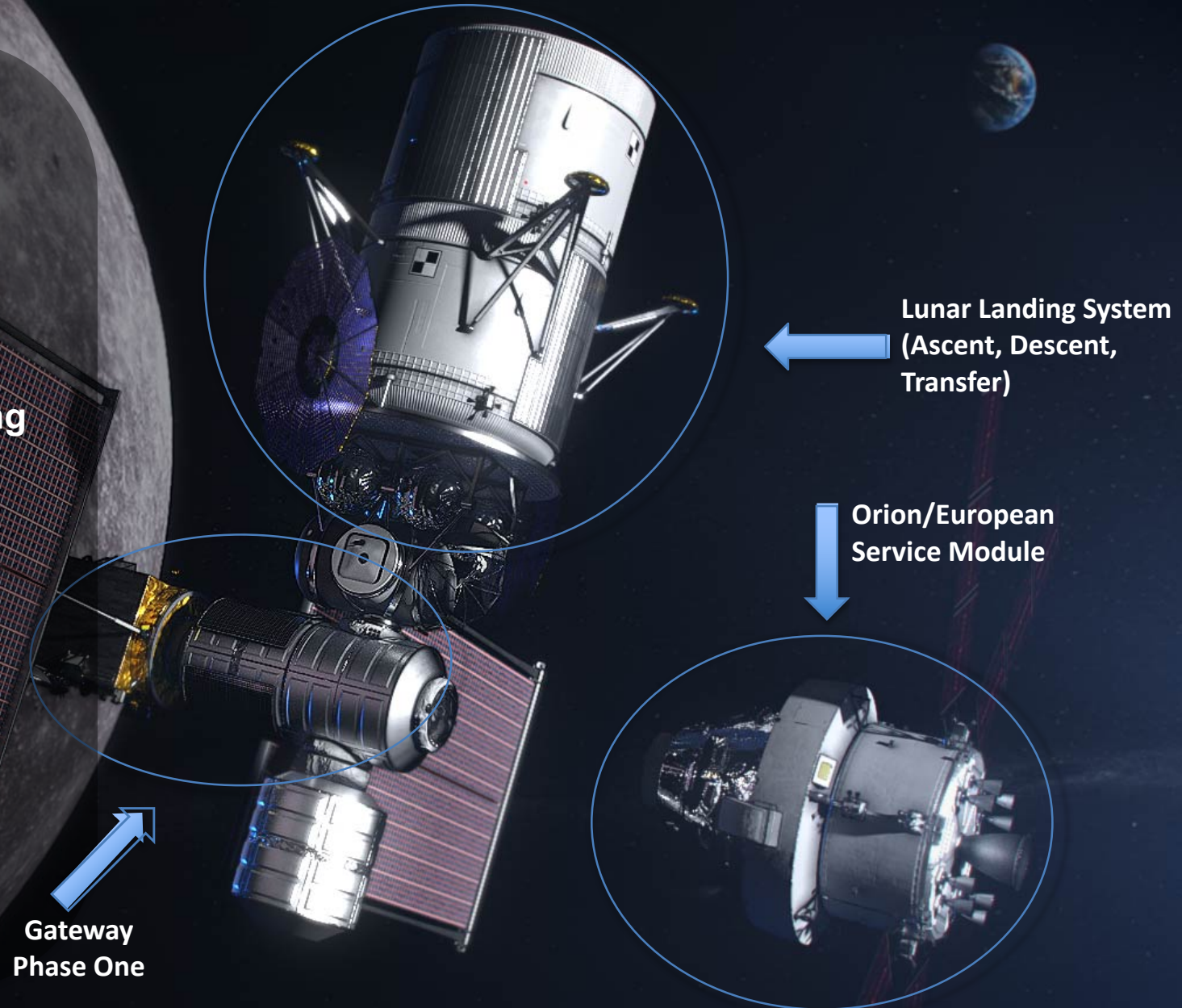
The SLS and Orion programs (including Exploration Ground Support at Kennedy Space Center) leverages over 3,800 suppliers and over 60,000 workers across all 50 states

Integrated Artemis Manifest: 2019-2024



Gateway is Essential for 2024 Landing

- Initial Gateway focuses on the minimum systems required to support a 2024 human lunar landing while also supporting Phase 2
- Provides command center and aggregation point for 2024 human landing
- Establishes strategic presence around the Moon – US in the leadership role
- Creates resilience and robustness in the lunar architecture
- Open architecture and interoperability standards provides building blocks for partnerships and future expansion



Lunar Science by 2024



Polar Landers and Rovers

- First direct measurement of polar volatiles, improving understanding of lateral and vertical distribution, physical state, and chemical composition
- Provide geology of the South-Pole Aitken basin, largest impact in the solar system

Non-Polar Landers and Rovers

- Explore scientifically valuable terrains not investigated by Apollo, including landing at a lunar swirl and making first surface magnetic measurement
- Using PI-led instruments to generate Discovery-class science, like establishing a geophysical network and visiting a lunar volcanic region to understand volcanic evolution

Orbital Data

- Deploy multiple CubeSats with Artemis 1
- Potential to acquire new scientifically valuable datasets through CubeSats delivered by CLPS providers or comm/relay spacecraft
- Global mineral mapping, including resource identification, global elemental maps, and improved volatile mapping

In-Situ Resource Initial Research

- Answering questions on composition and ability to use lunar ice for sustainment and fuel



High
Performance
Spaceflight
Computing



Precision
Landing

Solar
Electric
Propulsion



Space Technology for 2024 and Beyond



Cryofluid
Management

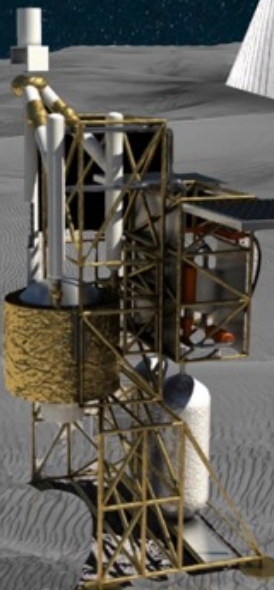


Lunar Dust
Mitigation



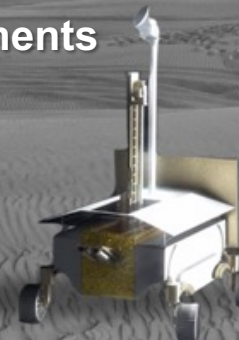
Surface
Excavation/Construction

In Situ
Resource
Utilization



Extreme Environments

Extreme Access



Lunar Surface
Power



Lunar Surface Innovation Initiative



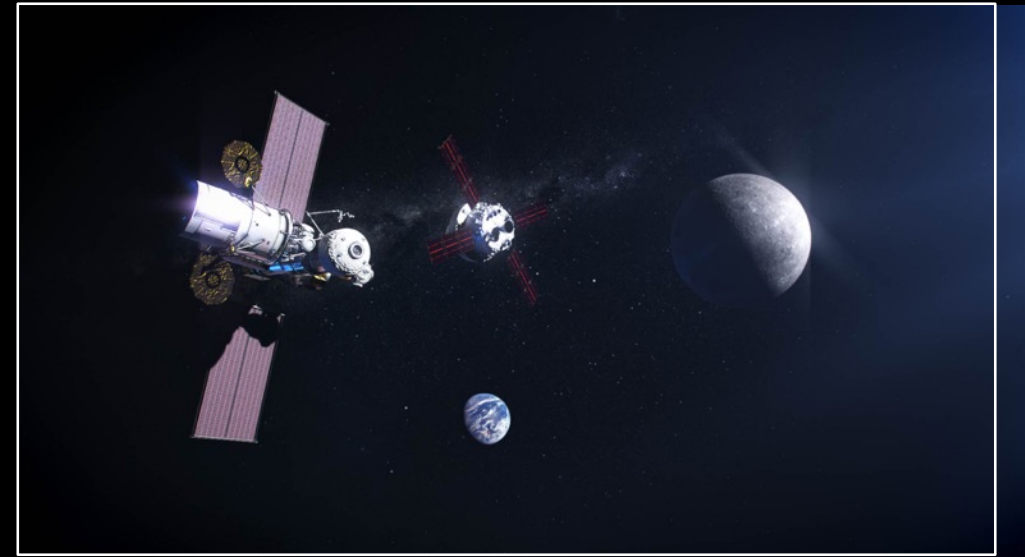
THE ARTEMIS PROGRAM

**PHASE 2:
Sustainability at the Moon
and on to Mars**



Sustainability at the Moon and on to Mars

- The U.S. leading in exploration and setting the standards for the Moon
- Unbound potential for partnerships and collaboration
- Meaningful, long-duration human missions
- Testing impacts on human performance and exploration operations to be used for Mars
- Repeatable operations traveling from Earth to the Gateway to the surface with reusable systems
- Unprecedented science outside of Earth's influence
- Maintains strategic presence as a deep space port and refueling depot around the Moon
- Increases international and commercial partnership opportunities, fostering healthy competition



Integrated Artemis Manifest: 2025-2028



	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	
Sustainable Low-Earth Capability	ISS MCB (transition) LEO Commercialization Studies		Commercial Crew Test Flights and Certification			Other LEO Commercialization Activities (in work): <ul style="list-style-type: none"> Multi-Agency Working Group (through NSpC) ISS Capabilities Pricing Policy Government LEO Research Policy (through NSpC) LEO Commercial Capabilities Solicitation 					
Development/Procurement Starts Now (2019)	(Timeline arrow starting from 2019 and extending to 2028)										
Sustainable Lunar Orbit Staging Capability	AA-2 NextSTEP Hab ground prototypes complete	Artemis 1 uncrewed test flight + 13 CubeSats, 7 lunar (under review)	Artemis 2 crewed test flight (under review)	CLV PPE	CLV w/tug Mini-Hab	Artemis 3 Crew + Surface Logistics	Artemis 4 Crew + HAB Augmentation	Artemis 5 Crew + Surface Logistics	Artemis 6 Crew + Gateway Logistics + Robotic Arm	Artemis 7 Descent + Surface Asset	Artemis 8 Crew + Surface Logistics
Sustainable Lunar Surface Exploration	CLPS opportunity Candidate Tech Insertion Opportunities	CLPS opportunity NDL	CLPS opportunity NDL, ISRU	CLPS opportunity	CLPS opportunity NDL, ISRU, & HPSC	CLPS opportunity HPSC, NDL, ISRU, haz. detection, CFM, & TRN	CLPS opportunity ISRU & Nuclear Surface Power	CLPS opportunity	CLPS opportunity ISRU	CLPS opportunity	CLPS opportunity Lunar Surface Asset Deployment
					Enhanced Science and Exploration Capability	Human Lunar Landing	Human Lunar Landing Ascent Module and TV return to Gateway	Human Lunar Landing Ascent Module and TV return to Gateway	Human Lunar Landing Ascent Module and TV return to Gateway	Human Lunar Landing Ascent Module and TV return to Gateway	Human Lunar Landing

Science After 2024

Human and Robotic Missions Provide Unique Science Opportunities

On Gateway

- Deep space testing of Mars-forward systems
- Hosts groundbreaking science for space weather forecasting, full-disc Earth observation, astrophysics, heliophysics, lunar and planetary science
- Mars transit testbed for reducing risk to humans

Surface Exploration

- Understanding how to use in-situ resources for fuel and life
- Revolutionizing the understanding of the origin and evolution of the Moon and inner solar system by conducting geophysical measurements and returning carefully selected samples to Earth
- Studying lunar impact craters to understand physics of the most prevalent geologic process in the solar system, impact cratering
- Setting up complex surface instrumentation for astrophysics, heliophysics and Earth observation
- Informing and supporting sustained human presence through partial gravity research in physical and life sciences, from combustion to plant growth

Surface Telerobotics to Provide Constant Science

- Sending rovers into areas too difficult for humans to explore; rovers can be teleoperated from Earth to maximize the scientific return



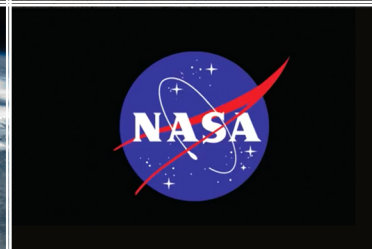
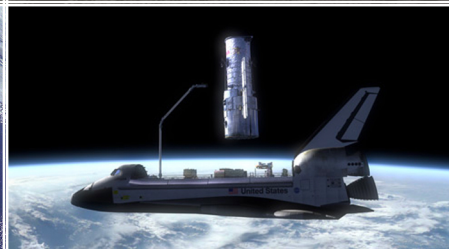
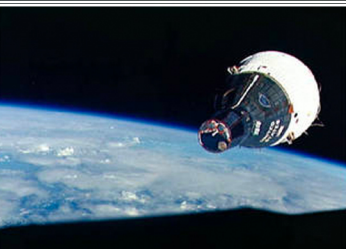
Lets go. *The time is now.*

We have the capability

We have the purpose

We have the charge

We have the responsibility





*Concept image

Stay Connected Between Committee Meetings

Sign up to get Moon to Mars updates from NASA: <https://www.nasa.gov/specials/moon2mars/#five>

EXPLORE MOON to MARS

" President Donald Trump has asked NASA to accelerate our plans to return to the Moon and to land humans on the surface again by 2024. We will go with innovative new technologies and systems to explore more locations across the surface than was ever thought possible. This time, when we go to the Moon, we will stay. And then we will use what we learn on the Moon to take the next giant leap - sending astronauts to Mars "

—NASA Administrator Jim Bridenstine

Join us as we explore and go forward to the Moon and to Mars. Get the latest Moon to Mars updates from NASA in your inbox.

• Email

By submitting this form, you are consenting to receive marketing emails from: NASA, 300 E Street S.W., Washington, DC, 20546, US, <https://www.nasa.gov>. You can revoke your consent to receive emails at any time by using the SafeUnsubscribe® link, found at the bottom of every email. [Emails are serviced by Constant Contact.](#) [Our Privacy Policy.](#)

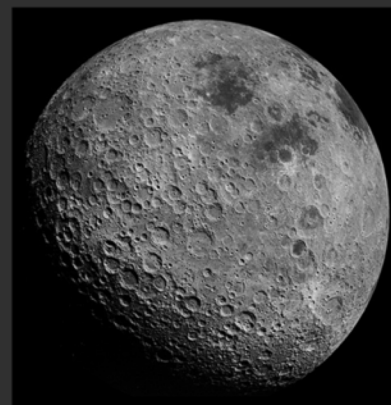
Get Updates

LATEST NEWS



[NASA Seeks US Partners to Develop Reusable Systems to Land Astronauts on Moon](#)

As the next major step to return astronauts to the Moon under Space Policy Directive-1, NASA announced plans on Dec. 13 to work with American companies to design and develop new reusable systems for astronauts to land on the lunar surface. [...]



[NASA Selects Experiments for Possible Lunar Flights in 2019](#)

NASA has selected 12 science and technology demonstration payloads to fly to the Moon as early as the end of this year, dependent upon the availability of commercial landers. These selections represent an early step toward the agency's long-term scientific study and human exploration of the Moon and, later, Mars. [...]



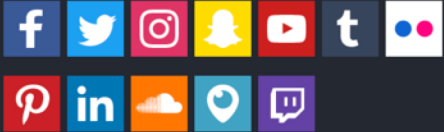
[NASA Announces New Partnerships for Commercial Lunar Payload Delivery Services](#)

Nine U.S. companies now are eligible to bid on NASA delivery services to the lunar surface through Commercial Lunar Payload Services (CLPS) contracts, as one of the first steps toward long-term scientific study and human exploration of the Moon and eventually Mars. [...]

Stay Connected Between Committee Meetings

See the latest NASA media releases: <https://www.nasa.gov/news/releases/latest>

Follow



Other NASA Social Media

Media Contacts

Media Resources

Latest NASA News Releases

NASA Live

Budgets/Plans

Reports/Transcripts

News Release Archive:1990-2017

Press Kits

Latest NASA News Releases

[NASA to Land in Mars, Pennsylvania to Celebrate Red Planet with STEAM](#)

May 23, 2019 - NASA returns to Mars, Pennsylvania Friday, May 31 to celebrate Mars exploration and share the agency's excitement about landing astronauts on the Moon in five years.

[NASA Administrator to Make Artemis Moon Program Announcement](#)

May 22, 2019 - NASA Administrator Jim Bridenstine will make a significant announcement about the Artemis program's lunar exploration plans at 1 p.m. EDT Thursday, May 23, at the Florida Institute of Technology. The remarks will be carried live on NASA Television and the agency's website.

[NASA Invites Public to Submit Names to Fly Aboard Next Mars Rover](#)

May 21, 2019 - Although it will be years before the first humans set foot on Mars, NASA is giving the public an opportunity to send their names — etched on microchips — to the Red Planet with NASA's Mars 2020 rover, which represents the initial leg of humanity's first round trip to another planet.

[Texas Students to Speak with NASA Astronaut on Space Station](#)

May 17, 2019 - Students in Texas will have an opportunity next week to speak with a NASA astronaut aboard the International Space Station.

[NASA Taps 11 American Companies to Advance Human Lunar Landers](#)

May 16, 2019 - NASA has selected 11 companies to conduct studies and produce prototypes of human landers for its Artemis lunar exploration program.



Tweets **934** Following **382** Followers **51.7K** Likes **929** Moments **2**

Following

Jim Bridenstine

@JimBridenstine

@NASA Administrator. Husband. Father. Veteran. nasa.gov/about/highligh...

Washington, DC

Joined January 2011

Tweet to Jim Bridenstine

4 Followers you know

Jim Bridenstine @JimBridenstine
 #Moon2024 News: While at @FloridaTech today, I will announce the commercial partner we selected to develop and build the first segment of @NASA's Gateway outpost – the power and propulsion element. Here's how you can watch starting at 1pm ET: go.nasa.gov/2HzesMx



10:45 AM - 23 May 2019
 222 Retweets 1,374 Likes

NASA, NASA Astronauts, Intl. Space Station and NASA Moon

Jim Bridenstine @JimBridenstine
 I joined Ali Velshi today on @MSNBC to talk about @NASA's #Moon2024 plans. Watch:



6:21 PM - 15 May 2019
 314 Retweets 1,610 Likes

Jim Bridenstine @JimBridenstine
 Want to supply the lunar Gateway? @NASA will work w/ US industry to deliver cargo (food/water/experiments/etc), critical supplies for orbital outpost to support astronauts on the surface for #Moon2024! Interested businesses can learn more: go.nasa.gov/2JSPBEX



1:11 PM - 20 May 2019
 279 Retweets 1,734 Likes

Jim Bridenstine @JimBridenstine
 Good news for #Moon2024! We just selected 11 American companies to conduct six-month studies and/or develop prototypes for our human landing system. Learn more: go.nasa.gov/2QGjkeN



1:20 PM - 16 May 2019
 458 Retweets 2,193 Likes

NASA, NASA Moon and NASA Astronauts



Back Up



Strategic Principles For Sustainable Exploration

- **FISCAL REALISM**

Implementable with the buying power of current budgets.

- **COMMERCIAL PARTNERSHIPS**

Leveraging the unique capabilities of NASA and the private sector, use partnerships to develop safe, reliable, and cost-effective space systems, while simultaneously developing a commercial LEO space economy.

- **SCIENTIFIC EXPLORATION**

Exploration enables science and science enables exploration; leveraging scientific expertise for human exploration of the solar system.

- **TECHNOLOGY PULL AND PUSH**

Application of high TRL technologies for near term missions, while focusing sustained investments on technologies and capabilities to address the challenges of future missions.

- **GRADUAL BUILD UP OF CAPABILITY**

Near-term mission opportunities with a defined cadence of compelling and integrated human and robotic missions, providing for an incremental buildup of capabilities for more complex missions over time.

- **ARCHITECTURE OPENNESS AND RESILIENCE** Resilient architecture featuring multi-use, evolvable space infrastructure, minimizing unique developments, with each mission leaving something behind to support subsequent missions.

- **GLOBAL COLLABORATION AND LEADERSHIP**

Substantial new international and commercial partnerships, leveraging current International Space Station partnerships and building new cooperative ventures for exploration.

- **CONTINUITY OF HUMAN SPACEFLIGHT**

Uninterrupted expansion of human presence into the solar system by establishing a regular cadence of crewed missions to cis-lunar space during ISS lifetime.