STRATEGIC PRINCIPLES OF HUMAN SPACE EXPLORATION

- Fiscal Realism
- Commercial 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
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

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MARS & BEYOND
THE ARTEMIS PROGRAM

PHASE ONE: South Pole by 2024
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
Gateway Phase 1

- Supports the acceleration of landing Americans on the surface of the Moon in 2024, while preserving the ability to evolve for a longer-term human presence.
  - Provides power, propulsion, and communication for surface landing systems
  - Accessible for many rockets currently on the market
  - Port for landing system vehicle aggregation and safe haven for crew
- Open architecture and interoperability standards provide building blocks for partnerships and future expansion.
- Serves as a reusable command module and port for logistics delivery and landing system aggregation.
- Provides a temporary home for the crew who remain in orbit during the surface expedition.
- During Phase 1 operations, without a U.S. or international habitat module at the Gateway, the crew is limited to surface expeditions of no more than four days.
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 module delivered to Gateway

Artemis 3: Crewed mission to Gateway and lunar surface

Commercial Lunar Payload Services
- CLPS delivered science and technology payloads

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

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

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.

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.

CREW
NASA Programs SLS and Orion

PPE
Power and Propulsion Element arrives at NRHO via commercial rocket

Pressurized Module
Small area for crew to check out systems prior to lunar transfer and decent

Transfer
Transfers lander from Gateway to low lunar orbit

Descent
Descends from Transfer Vehicle to lunar surface

Ascent
Ascends from lunar surface to Gateway

Human Landing System

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

**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

**Sustainable Low-Earth Capability**

- **2019**: Commercial Crew Test Flights and Certification (ISS MCB transition)
- **2020**: LEO Commercialization Studies
- **2024 onwards**: Other LEO Commercialization Activities (in work)
  - 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)**

**Sustainable Lunar Orbit Staging Capability**

- **2019**: AA-2
- **2020**: Artemis 1 uncrewed test flight, 13 CubeSats, 7 lunar lander reviews
- **2021**: CLV PPE
- **2022**: CLV w/ tug, Mid-life
- **2023**: 3 CLVs T/V, Descent, and Ascent Modules
- **2024**: 1 CLV T/V, Descent, and Ascent Modules

**Sustainable Lunar Surface Exploration**

- **2019**: CLPS opportunity
- **2020**: Candidate Tech Insertion Opportunities
- **2021**: CLPS opportunity
- **2022**: CLPS opportunity
- **2023**: CLPS opportunity
- **2024**: CLPS opportunity

**Artemis 1**
- Crew + Surface Logistics

**Artemis 2**
- Crew + Surface Logistics

**Artemis 3**
- Crew + Surface Logistics

**Artemis 4**
- Crew + HAB Augmentation

**Artemis 5**
- Crew + Surface Logistics

**Artemis 6**
- Crew + Gateway Logistics

**Artemis 7**
- Descent + Surface Asset

**Artemis 8**
- Crew + Gateway Logistics

**Human Lunar Landing**
- Human Lunar Landing

**Enhanced Science and Exploration Capability**
- Assumes Ascent and Transfer Vehicle Module Reuse

**ISRU & Nuclear Surface Power**
- ISRU & Nuclear Surface Power
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
Space Technology for 2024 and Beyond

- Cryofluid Management
- High Performance Spaceflight Computing
- Precision Landing
- Solar Electric Propulsion
- Surface Excavation/Construction
- Extreme Environments
- Extreme Access
- Lunar Dust Mitigation
- In Situ Resource Utilization
- Lunar Surface Power
- Lunar Surface Innovation Initiative
THE ARTEMIS PROGRAM

PHASE 2:
Sustainability at the Moon and on to Mars
Gateway Phase 1 and Phase 2

Phase 1:  
**Initial deep space vehicle by 2024**  
The essential hardware and systems required to land the first woman and next man on the lunar South Pole in 2024 – power and propulsion, communication, minimum habitation to support 2024 human surface expedition, and docking ports for surface asset delivery, human landing system, and Orion.

Phase 2:  
**Sustainable deep space vehicle by 2028**  
Building on Phase 1, the addition of robotics, habitation volume, and airlock will allow development and operation of Mars-forward tests, deep space science, and extend lunar surface expeditions.
Gateway Phase 2

- Testing of systems and operational procedures for Mars-class missions.
- Additional habitation volume and Mars-class ECLS and avionics systems can extend lunar vicinity missions to beyond 30 days, allowing for longer surface expeditions with supporting assets on the lunar surface.
- Expanded infrastructure supports landing system reusability.
- Longer stays at the Gateway will enhance human and robotic missions on the surface and support deep space science activities.
- Increased volume and addition of robotics, communications, docking ports, and airlock will support a new era of deep space science.
Global Commitment

Long-term international partnerships provide political resilience. Open architecture invites meaningful contributions from international and industry partners. Standardized interfaces make it possible for non-traditional contributors to develop Gateway-compatible spacecraft or payloads.

15 International Space Agencies documented their support for a lunar Gateway in the 2018 Global Exploration Roadmap and through published statements:

- March 2019: Multilateral Coordination Board Joint Statement
- Feb. 2019: NASA Secures First International Partnership for Moon to Mars Lunar Gateway
Preparation for Mars

To get to Mars, we will need a transit vehicle capable of conducting complex orbital maneuvers and sustaining human life for up to three years (roundtrip). The Gateway is NASA’s first opportunity to test and operate the systems of a long-duration, crewed vehicle in the deep space environment.

• The habitation volume, functional distribution, and ECLS systems are at the crux of deep space human exploration – particularly when the travel time is 2-3 years roundtrip, as it is for Mars. The Phase 2 Gateway will comprise multiple habitation volumes, informing form, fit, and function of different approaches and allowing NASA and its partners years of testing in deep space before embarking on missions to Mars or other destinations.

• A Mars transit vehicle cannot be launched on a single rocket, nor can it travel direct from Earth to Mars. The transit vehicle needs a location outside of Earth’s gravity well to aggregate, perform operational checkout procedures, and refuel before beginning its journey to the Red Planet. The Gateway can serve as this critical aggregation and refueling depot.
Sustainability at the Moon and on to Mars

- The U.S. leading in exploration and setting the standards for the human exploration of the solar system
- 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
Let's go. *The time is now.*

We have the capability

We have the purpose

We have the charge

We have the responsibility