National Aeronautics and Space Administration

Commercial Lunar Payload Services

Firefly Blue Ghost Mission One

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Contents

QUICK FACTS

As part of its Artemis campaign, NASA is working with multiple U.S. companies to deliver science and technology to the lunar surface. These companies are eligible to bid on task orders to deliver NASA payloads to the Moon.

Existing CLPS contracts are indefinite-delivery, indefinite-quantity contracts with a cumulative maximum contract value of $2.6 billion through 2028.

The CLPS vendor is responsible for payload integration and operations and launching from Earth and landing on the surface of the Moon.

Under the CLPS model, NASA is investing in commercial delivery services to the Moon to enable industry growth and support long-term lunar exploration. As a primary customer for CLPS deliveries, NASA aims to be one of many customers on future flights.

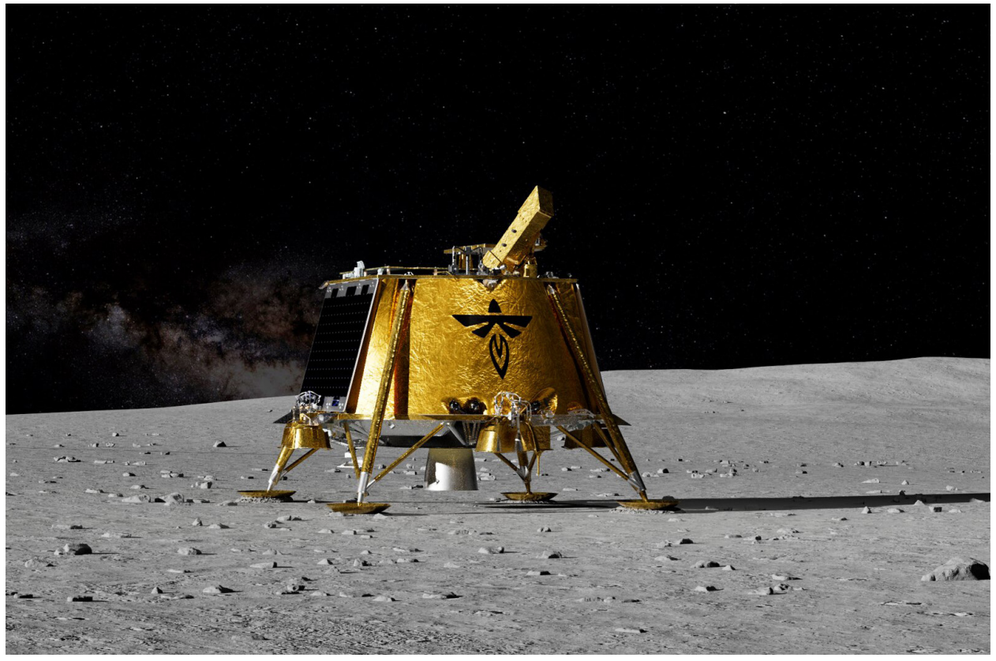
There are currently 13 American companies eligible to bid on CLPS contracts. To date, five vendors have been awarded 11 lunar deliveries under CLPS, sending more than 50 instruments to various locations on the Moon, including the lunar South Pole.

MISSION OVERVIEW

About Firefly's Blue Ghost Mission 1

Firefly was selected to be part of the CLPS vendor pool in 2018 and has been awarded four task orders to complete three deliveries to the lunar surface. Firefly's Blue Ghost Mission 1 will deliver 10 NASA science investigations and first-of-their-kind technology demonstrations to the lunar surface to further our understanding of the Moon's environment and help prepare for future human missions to the lunar surface supporting the agency's Moon to Mars exploration approach.

The company's Blue Ghost lunar lander is targeted to launch on January 15, 2025 and land in early March 2025. After an approximately 45-day transit to the Moon, Blue Ghost will land near a volcanic feature called Mons Latreille within Mare Crisium, a large basin located in the northeast quadrant of the Moon's near side. The lander will operate on the Moon's surface for a lunar day (about 14 Earth days) and for several hours into the lunar night. Firefly will aim to capture images of the lunar sunset which could provide insight on how lunar regolith reacts to solar influences during lunar dusk conditions.



Artist's concept of Firefly's Blue Ghost lander on the lunar surface. *Credit: Firefly Aerospace*

CLPS: Firefly Blue Ghost Mission One

Blue Ghost's Landing Site

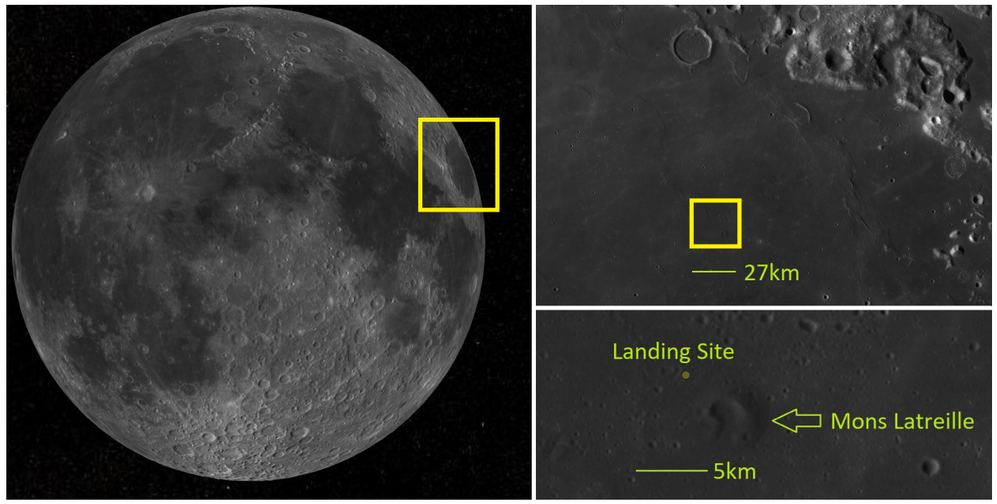
The Mare Crisium basin is approximately 340 miles wide (550 kilometers) and was formed by an asteroid impact flooding the basin with basaltic lava, a dark lava commonly found on Earth. The landing site is located near an ancient volcanic feature called Mons Latreille. This unique landing site will allow the science payloads and instruments to gather data about the Moon's regolith, geophysical characteristics, and the interaction of solar wind and Earth's magnetic field.

About NASA'S CLPS Initiative

Through the **Commercial Lunar Payload Services** or CLPS initiative, NASA is purchasing lunar delivery services from American companies to carry science investigations and technology demonstrations to the Moon. The CLPS initiative aims to conduct science on the Moon for the benefit of all, improving our understanding of the lunar environment and surface characteristics, in advance of future crewed missions to the Moon as part of the agency's broader **Artemis** campaign.

Under this innovative model, NASA is one of many customers, along with commercial companies, universities and international partners, all sending payloads to the Moon. With CLPS, NASA is embracing a higher level of risk tolerance by leveraging commercial solutions to send rapid, low-cost deliveries to the Moon, fostering a growing lunar economy and enabling a long-term presence on the lunar surface.

In 2018, NASA started the CLPS initiative and announced an initial **nine eligible U.S companies** to bid on CLPS contracts. A year later, NASA added **five more CLPS providers** to the vendor pool, bringing the total number of eligible vendors to 14.

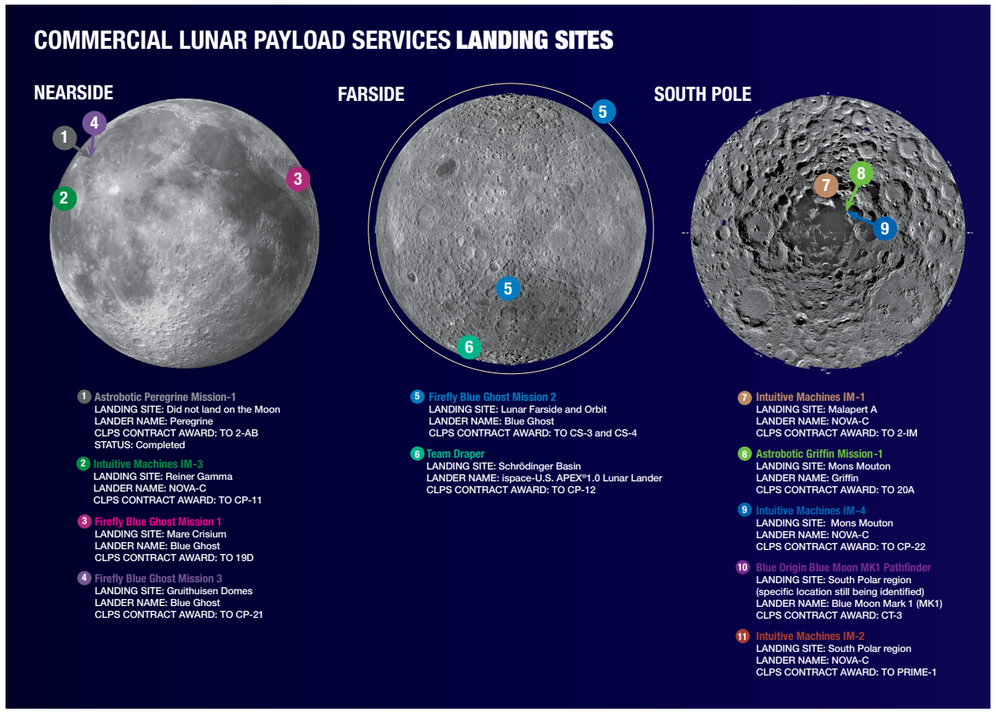


Mare Crisium is seen near the top of this topographic map of the Moon's Near Side.
Credit: NASA/Lunar and Planetary Institute Regional Planetary Image Facility

CLPS contracts are indefinite delivery, indefinite quantity contracts with a combined maximum contract value of $2.6 billion through November 2028.

Individual CLPS contract awards cover end-to-end commercial payload delivery services, including payload integration, mission operations, launch from Earth, and landing on the surface of the Moon. In addition to the NASA payloads aboard, CLPS vendors are also encouraged to fly commercial payloads.

The first two CLPS deliveries launched in early 2024. While one devliery experienced an anomaly which prevented the spacecraft from reaching the Moon, the other landed on the lunar South Pole region and operated for approximately seven Earth days. In addition to Blue Ghost Mission 1, another CLPS flight is scheduled to launch in early 2025. Additional CLPS deliveries are planned through 2028 at a cadence of around two per year. Future CLPS payloads will be selected through a call for proposals for PRISM (Payloads and Research Investigations on the Surface of the Moon).



This graphic depicts the landing sites for CLPS deliveries on the near side, far side, and South Pole of the Moon. LROC (Lunar Reconnaissance Orbiter Camera) Wide Angle Camera base maps.
Credit: NASA/GSFC/Arizona State University

CLPS: Firefly Blue Ghost Mission One

Current Timeline of all CLPS Deliveries

2024

- **Astrobotic's Peregrine Mission One** – Following a successful launch, the spacecraft experienced an anomaly preventing it from landing on the Moon.
- **Intuitive Machines' IM-1 Mission** – Completed, delivered six NASA payloads to **Malapert A** in the South Pole region of the Moon.

2025

- **Firefly's Blue Ghost Mission 1** will carry 10 NASA payloads to Mare Crisium, a basin on the Moon's near side.
- **Intuitive Machines' IM-2 mission** will deliver the **PRIME-1** (Polar Resources Ice Mining Experiment-1) instrument suite and lunar retroreflector to the Moon's South Pole region.
- **Intuitive Machines' IM-3 mission** will deliver four payloads to Reiner Gamma.
- Astrobotic's Griffin Mission One will deliver their lunar lander to the Moon's South Pole region.
- Blue Origin's Blue Moon Mark 1 lander will deliver NASA's **Stereo Cameras for Lunar Plume-Surface Studies (SCALPSS)** payload to the lunar South Pole.

2026

- **Firefly's Blue Ghost Mission 2** will deliver two NASA payloads to the far side of the Moon and deliver a communications and data relay satellite into lunar orbit, which is an ESA (European Space Agency) collaboration with NASA. As part of Blue Ghost Mission 2, Firefly will also provide a radio frequency calibration service to LuSEE-night (Lunar Surface Electromagnetics Experiment – Night) from lunar orbit.
- **Draper's first mission** will deliver PRISM science investigations to Schrödinger Basin

2027

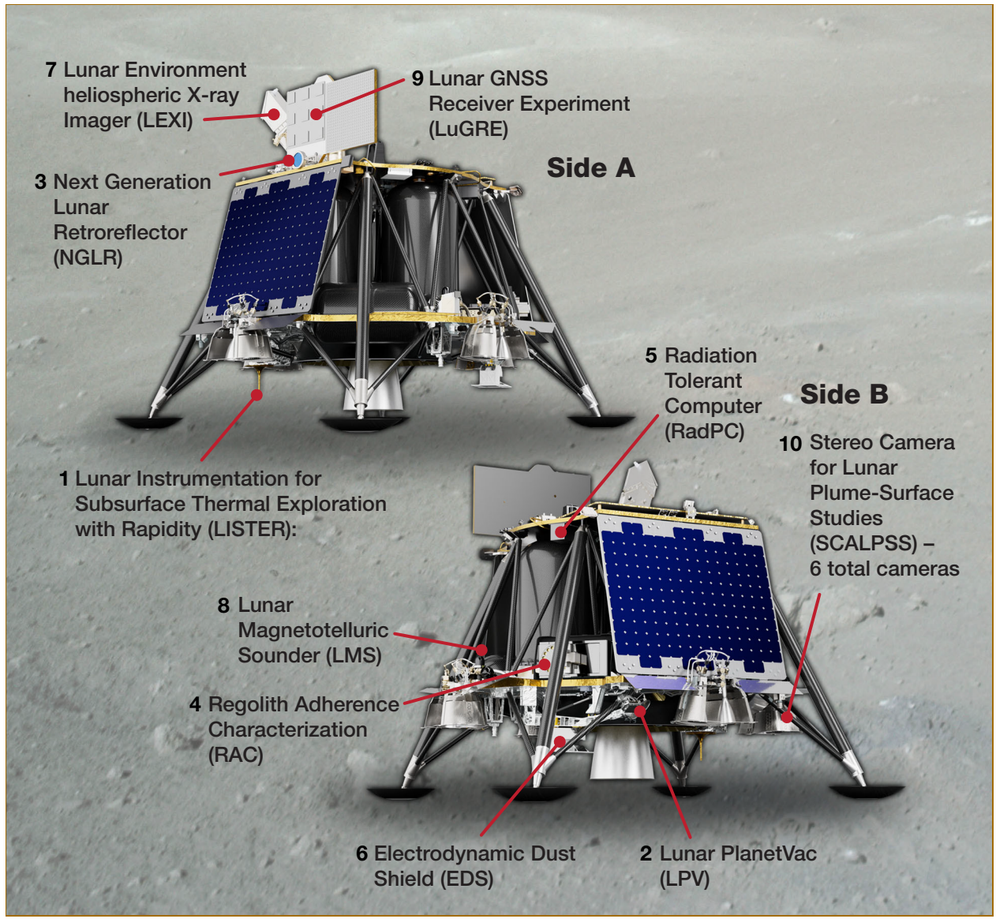
- **Intuitive Machines' IM-4 mission** will carry six NASA payloads to the lunar South Pole.

2028

- **Firefly's third mission** will deliver six NASA payloads to Gruithuisen Domes on the near side of the Moon.

WHAT'S ON BOARD

The NASA payloads on this flight will help advance lunar research and conduct several first-of-their-kind technology demonstrations, strengthening our understanding of the Moon's environment and helping prepare for human missions to the lunar surface. This includes testing a regolith sampling technology, the ability to use Earth-based global navigation satellite systems (such as GPS) enroute to and on the Moon, radiation tolerant computing, and mitigation of lunar dust. The data captured may also benefit humanity by providing insights into how space weather and other cosmic forces impact Earth.



This graphic highlights the location of each NASA payload aboard Firefly's Blue Ghost lander.
Credit: NASA, Firefly

CLPS: Firefly Blue Ghost Mission One

NASA Payloads on Board

1. **Lunar Instrumentation for Subsurface Thermal Exploration with Rapidity (LISTER)**

   LISTER will characterize heat flow from the interior of the Moon by measuring the thermal gradient and conductivity of the lunar subsurface. It will take several measurements to a 2–3-meter final depth using its pneumatic drilling technology with a custom heat flow needle instrument at its tip.

   Lead organization: Texas Tech University

2. **Lunar PlanetVac (LPV):**

   LPV is designed to collect regolith samples from the lunar surface using a burst of compressed gas to drive the regolith into a sample chamber (sieving) for collection and analysis by various instruments. Additional instrumentation will then transmit the results back to Earth.

   Lead organization: Honeybee Robotics

3. **Next Generation Lunar Retroreflector (NGLR)**

   NGLR serves as a target for lasers on Earth to precisely measure the distance between Earth and the Moon by reflecting very short laser pulses from Earth-based Lunar Laser Ranging Observatories (LLROs). The laser pulse transit time to the Moon and back is used to determine the distance. Data from NGLR could improve the accuracy of our lunar coordinate system and contribute to our understanding of the inner structure of the Moon and fundamental physics questions.

   Lead organization: University of Maryland

4. **Regolith Adherence Characterization (RAC)**

   RAC will determine how lunar regolith sticks to a range of materials exposed to the Moon's environment throughout the lunar day. RAC will measure accumulation rates of lunar regolith on the surfaces of several materials (e.g., solar cells, optical systems, coatings, and sensors) through imaging to determine their ability to repel or shed lunar dust. The data captured will allow the industry to test, improve, and protect spacecraft, spacesuits, and habitats from abrasive regolith.

   Lead organization: Aegis Aerospace

5. **Radiation Tolerant Computer (RadPC)**

   RadPC will demonstrate a computer that can recover from faults caused by ionizing radiation. Several RadPC prototypes have been tested aboard the International Space Station and Earth-orbiting satellites, but we'll provide the biggest trial yet by demonstrating the computer's ability to withstand space radiation as it passes through Earth's radiation belts, while in transit to the Moon, and on the lunar surface.

   Lead organization: Montana State University

6. **Electrodynamic Dust Shield (EDS)**

   EDS is an active dust mitigation technology that uses electric fields to move and prevent hazardous lunar dust accumulation on surfaces. EDS is designed to lift, transport, and remove particles from surfaces with no moving parts. Payload scientists will run multiple tests to demonstrate the feasibility of the self-cleaning glasses and thermal radiator surfaces on the Moon. In the event the surfaces do not receive dust during landing, EDS has the capability to re-dust itself using the same technology.

   Lead organization: NASA's Kennedy Space Center

7. **Lunar Environment heliospheric X-ray Imager (LEXI)**

   LEXI will capture a series of X-ray images to study the interaction of solar wind and the Earth's magnetic field that drives geomagnetic disturbances and storms. Deployed and operated on the lunar surface, this instrument will provide the first global images showing the edge of Earth's magnetic field for critical insights into how space weather and other cosmic forces surrounding our planet impact Earth.

   Lead organizations: Boston University, NASA's Goddard Space Flight Center, Johns Hopkins University

8. **Lunar Magnetotelluric Sounder (LMS)**

   LMS will characterize the structure and composition of the Moon's mantle by measuring electric and magnetic fields. This investigation will help determine the Moon's temperature structure and thermal evolution to understand how the Moon has cooled and chemically differentiated since it formed.

   Lead organization: Southwest Research Institute

9. **Lunar GNSS Receiver Experiment (LuGRE)**

   LuGRE will demonstrate the possibility of acquiring and tracking signals from GNSS (Global Navigation Satellite System) constellations — specifically GPS and Galileo — during transit to the Moon, during lunar orbit, and on the lunar surface. If successful, LuGRE will be the first pathfinder for future lunar spacecraft to use existing Earth-based navigation constellations to autonomously and accurately estimate their position, velocity, and time.

   Lead organizations: NASA's Goddard Space Flight Center; Italian Space Agency (ASI)

10. **Stereo Camera for Lunar Plume-Surface Studies (SCALPSS)**

    SCALPSS will use stereo imaging photogrammetry to capture the impact of rocket plume on lunar regolith as our lander descends on the Moon's surface. The high-resolution stereo images will aid in creating models to predict lunar regolith erosion – an important task as bigger, heavier payloads are delivered to the Moon in close proximity to each other. This instrument also flew on Intuitive Machine's first CLPS delivery.

    Lead organization: NASA's Langley Research Center

CLPS: Firefly Blue Ghost Mission One

MAJOR MISSION MILESTONES AND TIMELINE

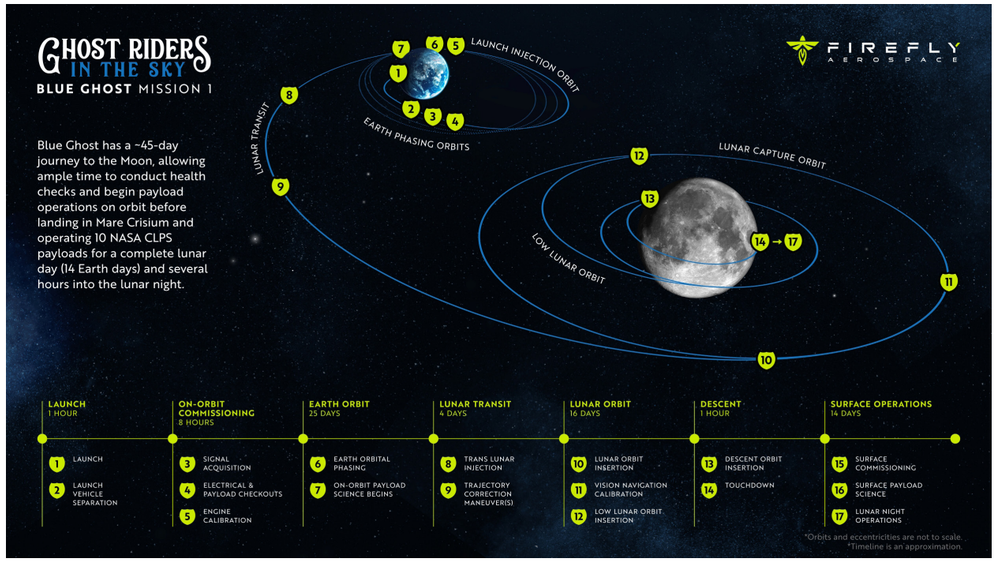
Launch Information

Firefly's Blue Ghost Mission1 is scheduled to launch on a SpaceX Falcon 9 rocket on Wednesday, January 15, 2025. Liftoff will be from Launch Complex 39A at NASA's Kennedy Space Center in Florida. Firefly will conduct all mission operations through their mission control based at Firefly's headquarters in Austin, Texas.

- Launch site: **KSC Launch Complex 39A**
- Target Launch Date: **January 15, 2025**
- Cruise Phase: **45 days**
- Surface operations: **14 days**
- Landing Site: **Mare Crisium**
- Lander Name: **Blue Ghost**
- Task Order: **TO19D**
- Launch vehicle: **SpaceX Falcon 9**

Blue Ghost Trajectory

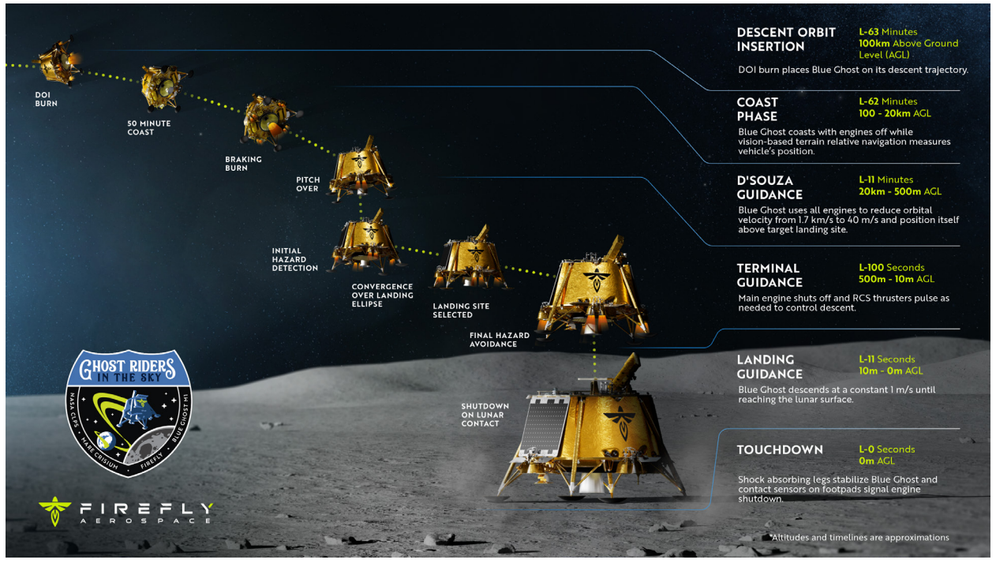
Shortly after launch, the Blue Ghost lander will separate from the rocket and begin it's approximately 45-day cruise to the Moon. The lander will first orbit Earth for 25 days during which payloads teams will conduct health checks and perform transit operations. The lander will then continue its lunar journey and orbit the Moon for approximately 16 days before descending to the landing site on the near side of the Moon.



This graphic depicts Blue Ghost's trajectory from launch through descent to touchdown on the lunar surface. *Credit: Firefly Aerospace*

Blue Ghost Descent Profile and Timeline

During the final hour of descent, Blue Ghost will use vision-based terrain relative navigation and hazard avoidance to measure the lander's position and identify craters, slopes, and rocks before selecting the final hazard-free target within the landing zone. Blue Ghost's Reaction Control System thrusters pulse as needed throughout the descent for a soft landing.



This illustration depicts Blue Ghost's descent from lunar orbit insertion to touchdown on the lunar surface. *Credit: Firefly Aerospace*

CLPS: Firefly Blue Ghost Mission One

Completed and Upcoming CLPS Milestones

2018

- November: **First nine CLPS vendors announced**

2019
First CLPS Contracts Awarded

- February: **NASA announces first payloads for early CLPS flights**
- May: **NASA selects Astrobotic, Orbit Beyond, and Intuitive Machines to deliver payloads to Moon**
- July: **NASA announces 12 new lunar investigations for CLPS flights**
- November: **NASA awards five more CLPS contracts**

2020

- October: **NASA selects Intuitive Machines to deliver PRIME-1**

2021

- November: **NASA awards Intuitive Machines to deliver four payloads**

2023

- May: **Intuitive Machines lunar landing site moves to south pole**

2024
First CLPS flights launched to the Moon

- January: **Astrobotic's Peregrine Mission One launched** Jan. 8, 2024
- February: **Intuitive Machine's IM-1 Mission launched** Feb. 15, 2024
- February: **IM-1 lander lands on the Moon's South Pole region** Feb. 22, 2024
- August: **NASA awards Intuitive Machines lunar south pole research delivery**
- December: **More NASA science, tech will Fly to Moon aboard future Firefly flight**

2025

- January: Firefly's Blue Ghost Mission One scheduled to launch in mid-January 2025
- Intuitive Machines IM-2 mission targeting a Q1 2025 launch
- Intuitive Machines' IM-3 Mission targeting launch in 2025
- Astrobotic's Griffin Mission One targeting launch in 2025
- Blue Origin's Blue Moon Mark 1 targeting launch in 2025

WHAT'S COMING UP

To date, Firefly has been awarded four task orders to complete three lunar deliveries as part of NASA's CLPS initiative. Firefly's **second lunar mission**, scheduled in 2026, includes two task orders: the first consists of a lunar orbit drop-off of a satellite and a surface delivery to the far side of the Moon.

The second task order consists of providing an orbiting calibration service for one of the surface payloads. Firefly's **third lunar mission** will aim to deliver six NASA payloads to the Gruithuisen Domes on the Moon's near side in 2028.

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