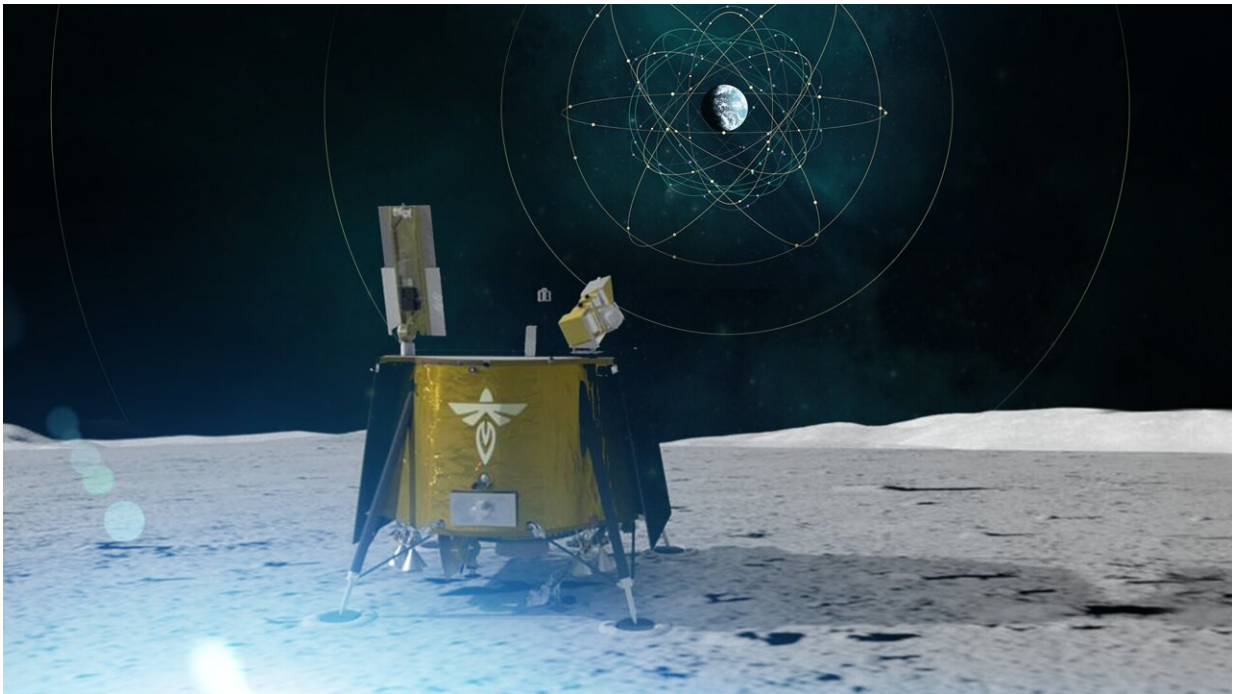


NASA moon mission set to break record in navigation signal test

June 2 2022, by Danny Baird



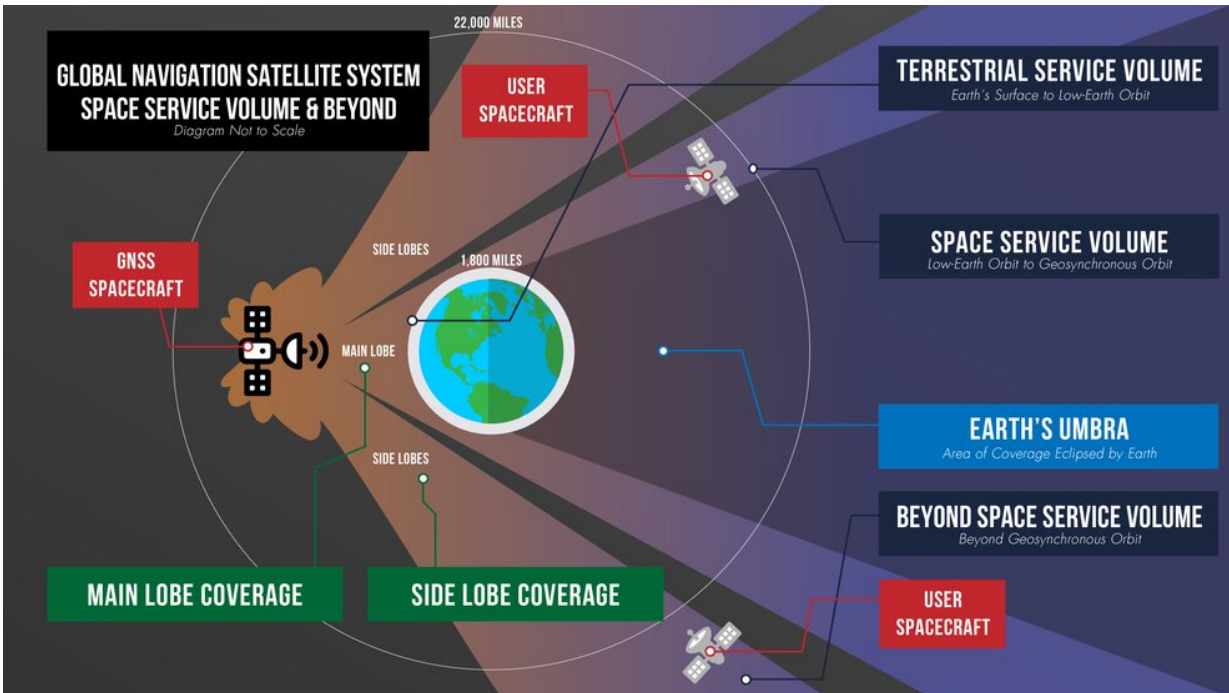
Artistic rendering of LuGRE and the GNSS constellations. In reality, the Earth-based GNSS constellations take up less than 10 degrees in the sky, as seen from the Moon. Credit: NASA/Dave Ryan

As the Artemis missions journey to the moon and NASA plans for the long voyage to Mars, new navigation capabilities will be key to science, discovery, and human exploration.

Through NASA's Commercial Lunar Payload Services initiative, Firefly Aerospace of Cedar Park, Texas, will deliver an experimental payload to the [moon](#)'s Mare Crisium basin. NASA's Lunar GNSS Receiver Experiment (LuGRE) payload will test a powerful new lunar [navigation](#) capability using Earth's Global Navigation Satellite System (GNSS) signals at the moon for the first time. GNSS refers to satellite constellations commonly used for position, navigation, and timing services on Earth. GPS—the GNSS constellation operated by the U.S. Space Force—is the one many Americans are familiar with and use on a daily basis.

"In this case, we are pushing the envelope of what GNSS was intended to do—that is, expanding the reach of systems built to provide services to terrestrial, aviation, and maritime users to also include the fast growing space sector," said J.J. Miller, Deputy Director of Policy and Strategic Communications for NASA's Space Communications and Navigation (SCaN) program. "This will vastly improve the precision and resilience of what was available during the Apollo missions, and allow for more flexible equipment and operational scenarios."

LuGRE—developed in partnership with the Italian Space Agency (ASI)—will receive signals from both GPS and the European GNSS constellation, Galileo, and use them to calculate the first-ever GNSS location fixes in transit to the moon and on the lunar surface.



A graphic detailing the different areas of GNSS coverage. Credit: NASA/Danny Baird

"Space missions close to Earth have long relied on GNSS for their navigation and timekeeping," said Joel Parker, LuGRE principal investigator at NASA's Goddard Space Flight Center in Greenbelt, Maryland. "In recent years, NASA and the international community have pushed the boundaries of what was considered possible by using these techniques in the Space Service Volume and beyond."

Missions in the GNSS Space Service Volume—from about 1,800 miles to 22,000 miles in altitude—receive signals that spill past Earth's edge from GNSS satellites on the opposite side of the planet. The first Space Service Volume experiments occurred around the dawn of the new millennium. Since then, numerous missions in the Space Service Volume have reliably used GNSS to navigate.

In 2016, the NASA's Magnetospheric Multiscale Mission (MMS) employed GPS operationally at a record-breaking 43,500 miles from Earth. Then, in 2019, MMS broke its own record by fixing its location with GPS at 116,300 miles from Earth—nearly halfway to the moon.

At these extreme altitudes, missions need extremely sensitive GNSS receivers. The LuGRE mission will use a specialized weak-signal receiver developed by Qascom, an Italian company specializing in space cybersecurity and satellite navigation security solutions, and funded by ASI.

LuGRE teams are now testing the payload in preparation to deliver it for integration onto the Firefly "Blue Ghost" lander in November of this year. Launch is currently slated for no earlier than 2024 from Cape Canaveral, Florida, aboard a SpaceX Falcon 9 rocket.

During the multi-week flight to the moon, LuGRE will collect GNSS signals and perform navigation experiments at different altitudes and in lunar orbit. After landing, LuGRE will deploy its antenna and begin 12 days of data collection, with the potential for extended mission operations as well. NASA and ASI will process and analyze [data](#) downlinked to Earth and then share results publicly.

"LuGRE is the latest effort in a long line of missions designed to expand high-altitude GNSS capabilities," said Fabio Dovis, LuGRE co-principal investigator at the Italian Space Agency. "We've developed a cutting-edge experiment that will serve as the foundation for operational GNSS systems at the moon."

The LuGRE mission seeks to spark further development of GNSS-based navigation capabilities near and on the moon, even as NASA plans to begin using high-altitude GNSS operationally for future lunar missions. NASA and ASI will bring the results of this work forward to the space

community through the International Committee on GNSS, a United Nations forum focused on ensuring the interoperability of GNSS signals. These capabilities are also a key stepping stone towards building LunaNet, an architecture that will unify cooperative networks into seamless lunar communications and navigation services.

"The lunar deliveries we're sourcing from commercial vendors are providing a number of innovative new technologies and opportunities to conduct experiments with affordable access to the lunar surface," said Jay Jenkins, Commercial Lunar Payload Services Program Executive. "LuGRE is one example of the progress that government and industry can make when united in their exploration objectives."

Developing new uses of GNSS for emerging space operations is a priority for the SCan program at NASA headquarters, as the lead organization responsible for implementing guidance from Space Policy Directive-7, which directs NASA to develop requirements for GPS support of space operations and science in higher orbits and beyond into cislunar space.

Provided by NASA

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