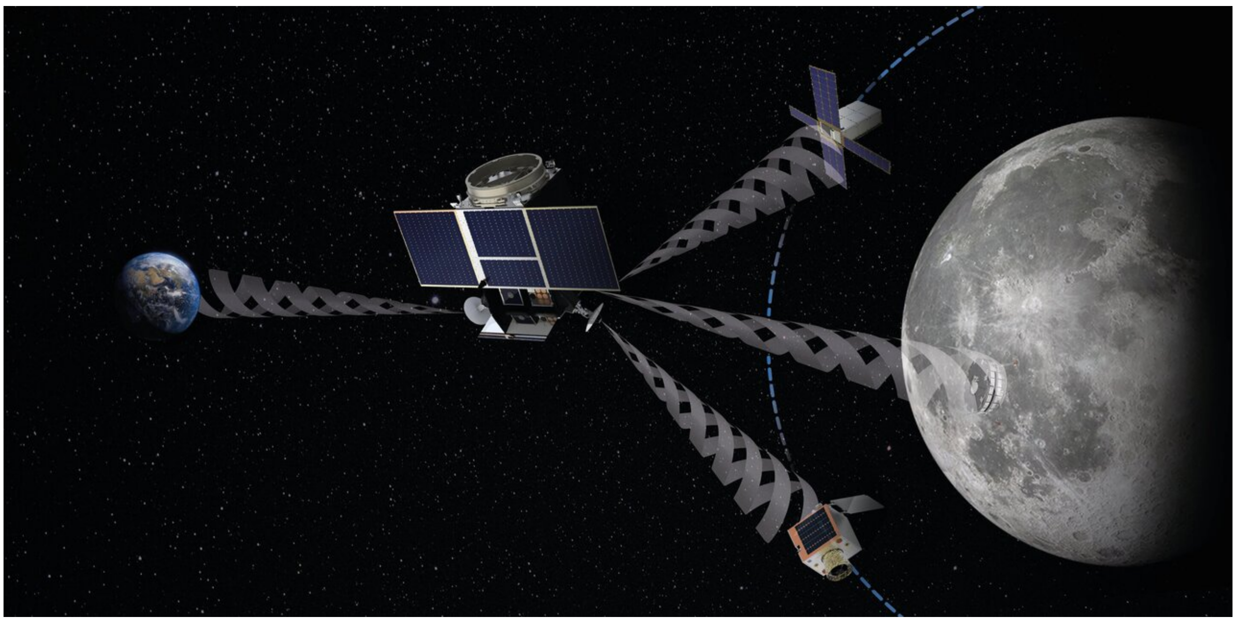
# Galileo will help Lunar Pathfinder navigate around moon

March 19 2021



Surrey Satellite Technology Ltd (SSTL), Goonhilly Earth Station (GES) and the European Space Agency (ESA) have signed a collaboration agreement for Commercial Lunar Mission Support Services at the Space Symposium in Colorado Springs today. This innovative commercial partnership for exploration aims to develop a European lunar telecommunications and navigation infrastructure, including the delivery of payloads and nanosats to lunar orbit. Credit: SSTL

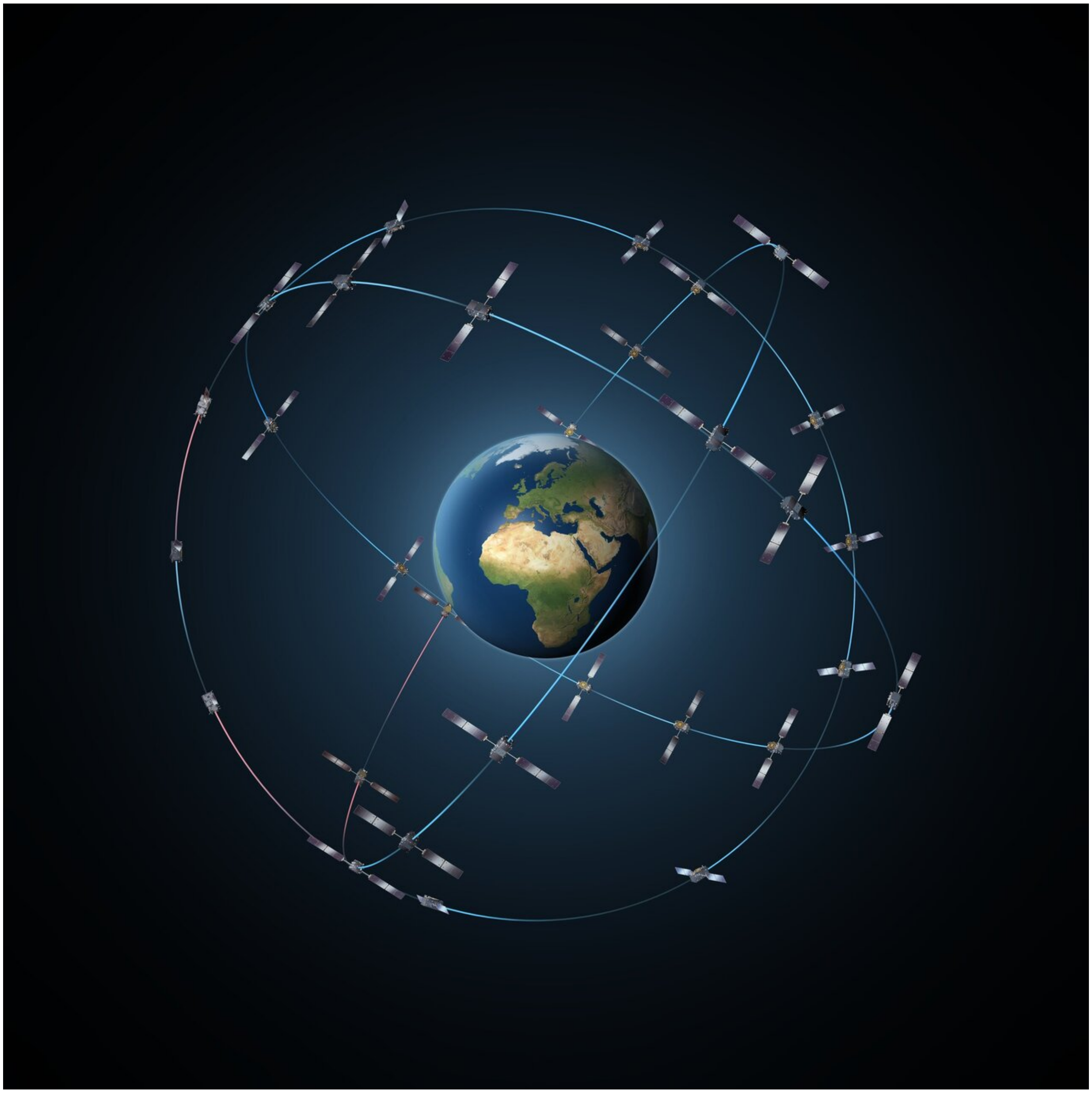
ESA's Lunar Pathfinder mission to the moon will carry an advanced satellite navigation receiver, in order to perform the first ever satnav positioning fix in lunar orbit. This experimental payload marks a preliminary step in an ambitious ESA plan to expand reliable satnav coverage—as well as communication links—to explorers around and ultimately on the moon during this decade.

Due for launch by the end of 2023 into lunar orbit, the public-private Lunar Pathfinder comsat will offer commercial data relay services to lunar missions—while also stretching the operational limits of satnav signals.

Navigation satellites like Europe's Galileo constellation are intended to deliver positioning, navigation and timing services to our planet, so most of the energy of their navigation antennas radiates directly toward the Earth disc, blocking its use for users further away in space.

"But this is not the whole story," explains Javier Ventura-Traveset, leading ESA's Galileo Navigation Science Office and coordinating ESA lunar navigation activities. "Navigation signal patterns also radiate sideways, like light from a flashlight, and past testing shows these antenna 'side lobes' can be employed for positioning, provided adequate receivers are implemented."

Just like people or cars on the ground, satellites in low-Earth orbit rely heavily on satnav signals to determine their orbital position, and since ESA proved higher-orbit positioning was possible, a growing number of satellites in geostationary orbit today employ satnav receivers.



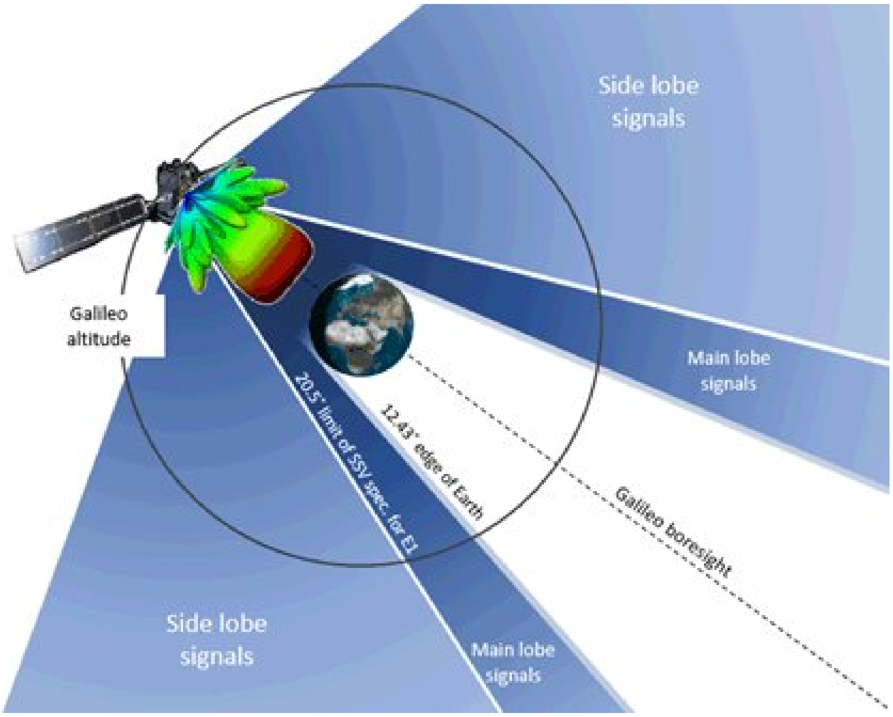
The complete Galileo constellation will consist of 24 satellites along three orbital planes, plus two spare satellites per orbit. The result will be Europe's largest-ever fleet, providing worldwide navigation coverage. Credit: ESA-P. Carril

But geostationary orbit is 35 786 km up, while the moon is more than ten times further away, at an average distance of 384 000 km. In 2019 however, NASA's Magnetospheric Multiscale Mission acquired GPS signals to perform a fix and determine its orbit from 187 166 km away, close to halfway the Earth-moon distance.

Javier adds: "This successful experimental evidence provides us high confidence since the receiver we will embark on Lunar Pathfinder will have a significantly improved sensitivity, employ both Galileo and GPS signals and will also feature a high-gain satnav antenna."

This high sensitivity receiver's main antenna was developed through ESA's General Support Technology Programme, with the receiver's main unit developed through ESA's Navigation Innovation and Support Programme, NAVISP.

The receiver project is led by ESA navigation engineer Pietro Giordano: "The high sensitivity receiver will be able to detect very faint signals, millions of times weaker than the ones received on Earth. The use of advanced on-board orbital filters will allow to achieve unprecedented orbit determination accuracy on an autonomous basis."



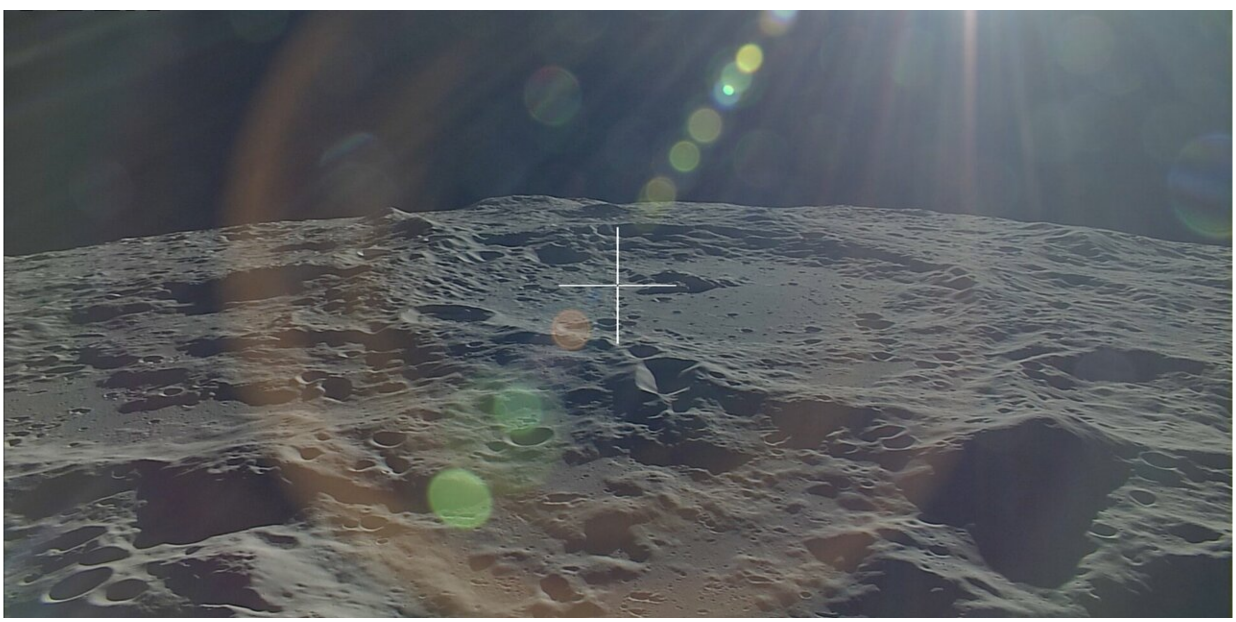

Navigation satellites – such as Europe's Galileo, the US GPS, Russia's Glonass or their Japanese, Chinese and Indian counterparts – aim their antennas directly at Earth. Any satellite orbiting above these constellation can only hope to detect signals from over Earth's far side, but the majority are blocked by the planet. For a position fix, a satnav receiver requires a minimum of four satellites to be visible, but this is most of the time not possible if based solely on front-facing signals. Instead, satnav receivers in higher orbits can make use of signals emitted sideways from navigation antennas, within what is known as 'side lobes'. Just like a flashlight, radio antennas shine energy to the side as well as directly forward. Credit: ESA

Lunar Pathfinder's receiver is projected to achieve positioning accuracy of around 100 m—more accurate than traditional ground tracking.

The availability of satnav will allow the performance of 'Precise Orbit Determination' for lunar satellites, notes Werner Enderle, Head of ESA's Navigation Support Office: "Traditional orbit determination for lunar orbiting satellites is performed by radio ranging, using deep space ground stations. This Lunar Pathfinder demonstration will be a major milestone in lunar navigation, changing the entire approach. It will not only increase spacecraft autonomy and sharpen the accuracy of results, it will also help to reduce operational costs."

While lunar orbits are often unstable, with low-orbiting satellites drawn off course by the lumpy mass concentrations or 'mascons' making up the moon , Lunar Pathfinder is planned to adopt a highly-stable 'frozen' elliptical orbit, focused on the lunar south pole—a leading target for future expeditions.

Earth—and its satnav constellations—should remain in view of Lunar Pathfinder for the majority of testing. The main challlenge will be overcoming the limited geometry of satnav signals all coming from the same part of the sky, along with the low signal power.



A high-definition image of the Mars Australe lava plain on the moon taken by

Japan’s Kaguya lunar orbiter in November 2007. Credit: JAXA/NHK

Lunar Pathfinder's demonstration that terrestrial satnav signals can be employed to navigate in lunar orbits will be an important early step in ESA's moonlight initiative. Supported through three ESA Directorates, moonlight will go on to establish a Lunar Communication and Navigation Service.

"Over this coming decade, ESA aims to contribute to building up a common communications and navigation infrastructure for all lunar missions based on dedicated lunar satellites," explains Bernhard Hufenbach, managing commercialisation and innovation initiatives for space exploration at ESA.

"moonlight will allow to support missions that cannot use Earth satnav signals, such as landers on the far side and is planning to cover the current gap towards the needs expressed by the Global Exploration community, targeting positioning accuracy below 50 metres."

As well as facilitating lunar exploration, these satnav signals might one day become a tool for science in their own right, used, for example, to perform reflectometry across the lunar surface; sounding the scant dusty 'exosphere' that surrounds the moon or by providing a common time reference signal across the moon, to be used for fundamental physics or astronomy experiments.

So as well as marking a first in the history of satellite navigation, Javier notes that Lunar Pathfinder's satnav experiment will have larger consequences: "This will become the first ever demonstration of GPS and Galileo reception in lunar orbit, opening the door to a complete way to navigate spacecraft in deep space, enabling human exploration of the moon."

Provided by European Space Agency

Citation: Galileo will help Lunar Pathfinder navigate around moon (2021, March 19) retrieved 26 April 2024 from https://phys.org/news/2021-03-galileo-lunar-pathfinder-moon.html