

## TECHNOLOGY SOLUTION

### Robotics, Automation and Control



# Lunar Surface Navigation System

[Reverse-ephemeris approach enables low-cost lunar navigation solution](#)

#### BENEFITS

- Minimal investment needed to develop and validate
- Low-cost of implementation; only 3 smallsats needed
- Effective and robust navigation for lunar surface missions

Scientists at NASA's Langley Research Center have developed a novel concept for a lunar navigation system based on the reverse-ephemeris technique. Typically, range related signal measurements from the earth's surface are used to locate and track orbital objects (satellites) and establish the ephemeris describing their orbits. For this reverse-ephemeris lunar navigation concept, the process is reversed to give lunar surface position fixes using the known ephemeris of a satellite in lunar orbit. Only a few inexpensive smallsats are required in order to implement a lunar navigation system based on this concept.

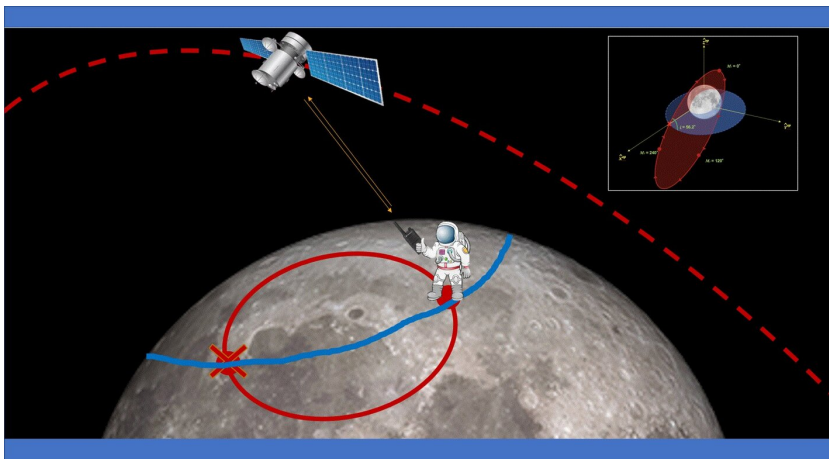
Lunar navigation systems will be needed for future moon missions, including for example for rover navigation, mining operations, exploration, etc. The inventors have conducted analytical simulations to demonstrate the versatility of this innovation when used to support route determination for various autonomous or manned lunar surface operations.



## THE TECHNOLOGY

NASA's reverse-ephemeris lunar navigation system is a concept for determining position on the lunar surface based on known orbits of satellites. In conventional GPS navigation systems, the GPS satellite transmits ephemeris data to a receiver on earth for determining position at the receiver location. Whereas for the reverse-ephemeris approach the receiver becomes the transmitter, and the satellite instead serves more as a fixed reference position with a known ephemeris. This simplifies the satellite requirements and also mitigates potential navigational disruptions that can otherwise arise in navigation systems that utilize satellite-based communications, for example from interference, jamming, etc.

The design consists of lunar surface S-Band (2,400 – 2,450 MHz) 10 W transceivers ranging with analog translating transponders on a three-satellite constellation in frozen elliptical orbits to provide continuous coverage with service to 300 simultaneous users over 1.8 MHz of bandwidth at the transponder. Digital bases systems are possible too. As compared to GPS-based navigation requiring four or more satellites costing 100's of millions of dollars, the new NASA concept is based on using only three smallsats.



Reverse Ephemeris Navigation uses range and range rate measurement to obtain lunar surface position fixes and navigation using a known ephemeris of an orbiting object or satellite.

## APPLICATIONS

The technology has several potential applications:

- Lunar: Navigational support for exploration, construction, mining, and other lunar surface activities.

## PUBLICATIONS

Patent Pending

More Information

National Aeronautics and Space Administration

**Agency Licensing Concierge**

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