Historic demonstration proves laser communication possible

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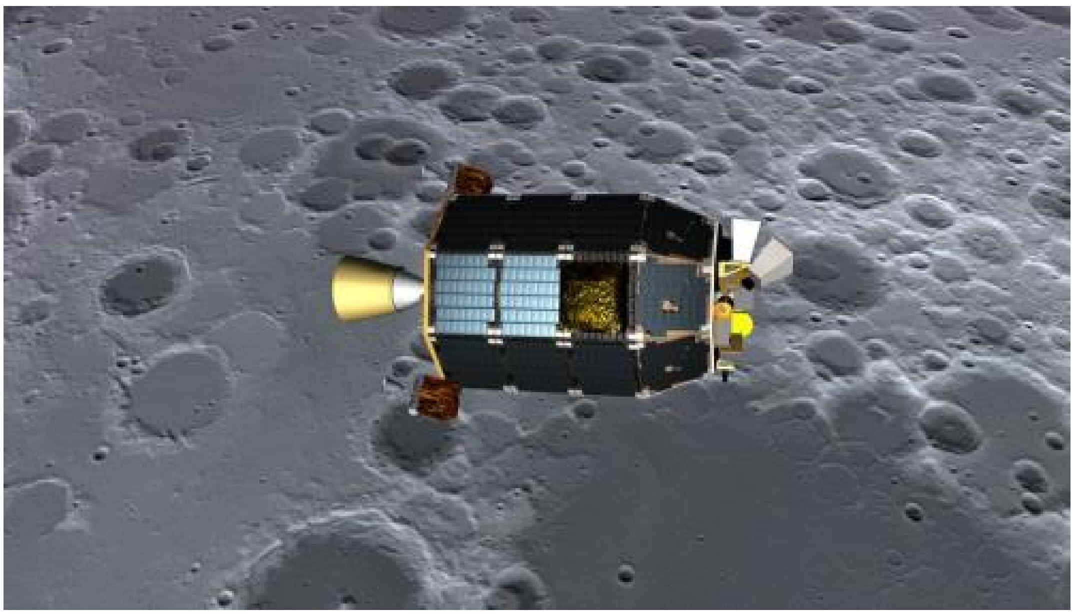

An artist's concept of NASA's Lunar Atmosphere and Dust Environment Explorer (LADEE) spacecraft seen orbiting near the surface of the moon. Credit: NASA/Ames/Dana Berry

In the early morning hours of Oct. 18, NASA's Lunar Laser Communication Demonstration (LLCD) made history, transmitting data from lunar orbit to Earth at a rate of 622 Megabits-per-second (Mbps). That download rate is more than six times faster than previous state-of-the-art radio systems flown to the moon.

"It was amazing how quickly we were able to acquire the first signals, especially from such a distance," said Don Cornwell, LLCD manager. "I attribute this success to the great work accomplished over the years by the Massachusetts Institute of Technology Lincoln Laboratory (MIT/LL) and their partnership with NASA."

LLCD is being flown aboard the Lunar Atmosphere and Dust Environment Explorer satellite known as LADEE, currently orbiting the moon. LADEE is a 100-day robotic mission designed, built, tested and operated by a team from NASA's Ames Research Center in Moffett Field, Calif. Its primary science mission is to investigate the tenuous and exotic atmosphere that exists around the moon.

LADEE, with LLCD onboard, reached lunar orbit 30 days after launch from NASA's Wallops Flight Facility on Wallops Island, Va., on Sept. 6. During the trip, the LADEE team provided an opportunity for LLCD to make post-flight calibrations of its pointing knowledge. "Being able to make those calibrations allowed us to lock onto our signal almost instantaneously when we turned on the laser at the moon," said Cornwell. "A critical part of laser communication is being able to point the narrow laser beam at a very small target over a great distance."

LLCD not only demonstrated a record-breaking download rate but also an error-free data upload rate of 20 Mbps. The laser beam was transmitted the 239,000 miles from the primary ground station at NASA's White Sands Complex in Las Cruces N.M., to the LADEE spacecraft in lunar orbit. This breakthrough technology has a laser-based space terminal that is half the weight of a comparable radio-based terminal while using 25 percent less power.

These first tests of the month-long demonstration have included the successful LLCD transmission, by pulsed laser beam, of two simultaneous channels carrying high-definition video streams to and from the moon. Proving the capability to communicate with multiple locations, LLCD successfully transmitted its beam several times to NASA's Jet Propulsion Laboratory's Optical Communications Telescope Laboratory in California. Soon testing will also include transmissions originating from the European Space Agency's (ESA) Optical Ground Station in Tenerife, Spain.

The tests also confirmed LLCD's capability of providing continuous measurements of the distance from the Earth to the LADEE spacecraft with an unprecedented accuracy of less than half an inch. "We hope this demonstration validates the capabilities and builds confidence in laser communication technology for consideration on future missions," said Cornwell.

LLCD has also transmitted large data files from the LADEE spacecraft computer to Earth. "These first results have far exceeded our expectation," said Cornwell. "Just imagine the ability to transmit huge amounts of data that would take days in a matter of minutes. We believe laser-based communications is the next paradigm shift in future space communications."

Future testing will include how well the system operates in optically stressed conditions such as daytime (all operations have been at night), full moon verses new moon, and different pointing positions for the ground terminals. "These series of tests will allow us to sample different conditions to demonstrate the flexibility of the technology," said Cornwell.

The LLCD system was designed, built and being operated by the MIT/LL team in Lexington, Mass. LLCD is managed by NASA's Goddard Space Flight Center in Greenbelt, Md. The LADEE spacecraft was built and operated by NASA's Ames Research Center in Moffett Field, Calif. Additional ground terminals have been provided by NASA's Jet Propulsion Laboratory in Pasadena, Calif., and ESA in Darmstadt, Germany.

NASA's laser communications between LLCD and Earth ground stations is the longest two-way laser communication ever demonstrated. It is the first step and part of the agency's Technology Demonstration Missions Program, which is working to develop crosscutting technology capable of operating in the rigors of space.

The Laser Communications Relay Demonstration (LCRD) is the follow-on mission, scheduled for launch in 2017. Also managed at Goddard, LCRD will demonstrate laser relay communications capabilities for Earth-orbiting satellites continuously over a period of two to five years.

"LLCD is the first step on our roadmap toward building the next generation of space communication capability," said Badri Younes, NASA's deputy associate administrator for space communications and navigation (SCaN) in Washington, which sponsored LLCD. "We are encouraged by the results of the demonstration to this point, and we are confident we are on the right path to introduce this new capability into operational service soon."

Provided by NASA's Goddard Space Flight Center

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