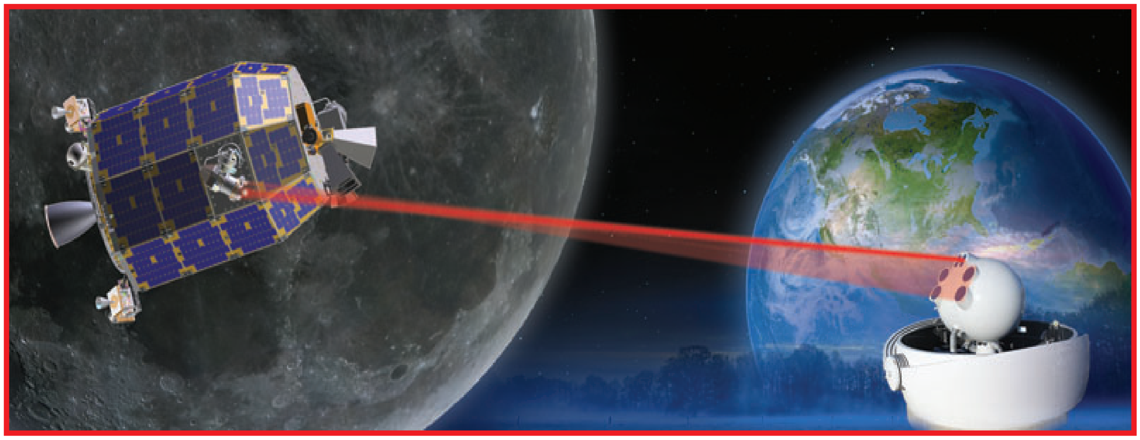
National Aeronautics and Space Administration

NASA facts

Lunar Laser Communication Demonstration

NASA's First Space Laser Communication System Demonstration



When it comes to communicating in space, NASA has set the standard for connecting data-gathering satellites with ground stations on Earth, through global communication networks. Since its inception, the agency has relied on radio frequency (RF)-based communications to meet its data transmission and navigation needs.

Over the years, these global networks, comprised of ground stations and space-based relay satellites, have expanded, drastically improving the communication services NASA provides. Future mission communication service demands for higher and faster data rates are expected to increase. Furthermore, today's mission communication requirements have begun to stress the current communication networks' capabilities. As NASA works to upgrade and enhance current network assets, the search has begun for more capable and effective solutions for future space communication.

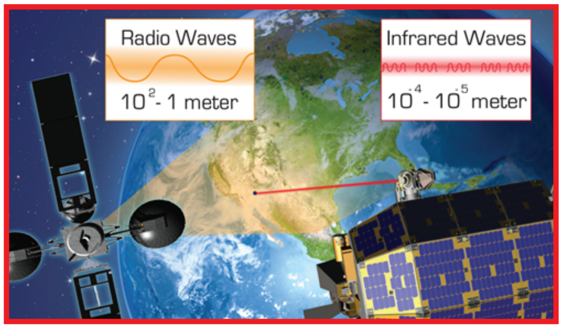
One solution for NASA is to look beyond the radio and microwave portions of the electromagnetic spectrum towards the near-infrared and in the realm of light photons. Light photons are small packets of electromagnetic waves, and when many are transmitted together "in synch," they form what is commonly known as a LASER beam. NASA is venturing into a new era of space communications using lasers, beginning with the Lunar Laser Communications Demonstration (LLCD).

LLCD will establish the ability to encode data onto a beam of laser light and, if successful, will validate a new form of communications from space, "optical communications." The term "optical communications" refers to the use of light as the medium for data transmission. The main goal of LLCD is to use highly reliable infrared lasers, similar to those used to bring high-speed data over fiber-optic cables into our workplaces and homes. LLCD has the capability to transfer data at a rate of up to 622 megabits per second (Mbps). It will demonstrate two-way, high-rate laser communications from lunar orbit aboard the Lunar Atmosphere Dust Environment Explorer (LADEE). It is scheduled to launch aboard a Minotaur-V Rocket from NASA's Wallops Flight Facility on Wallops Island, Va., .

Why Laser Communications?

During the past several decades, the volume of data from NASA's missions has increased exponentially and is expected to continue at even greater rates. Although RF-based communications currently are the most reliable form of space communications, the radio and microwave portions of the electromagnetic spectrum are getting close to capacity. Laser communications will enable NASA to work within a new, less crowded section of the electromagnetic spectrum.

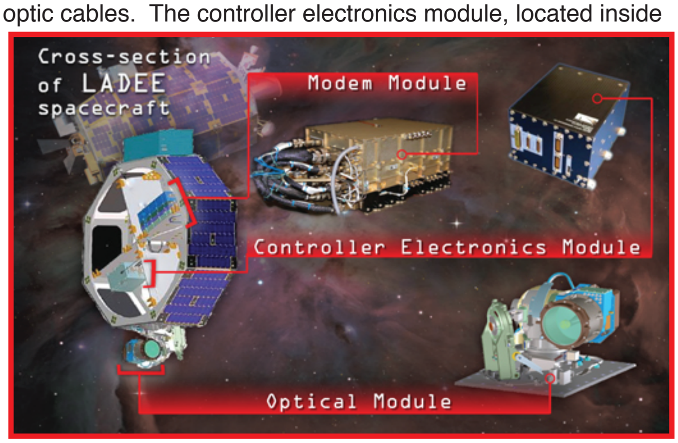
Another motivation for exploring laser communications is the development of more efficient, cost-effective space communications equipment. Because RF wavelengths are longer, the size of their transmission beam covers a wider area (about 100 miles); therefore, capture antennas for RF data transmissions must be very large. Laser wavelengths are 10,000 times shorter, allowing data to be transmitted across narrower, tighter beams. The smaller wavelengths of laser-based communications are more secure, delivering the same amount of signal power to much smaller collecting antennas.



This reduction in antenna size applies for both ground and space receivers, which reduces satellite size and mass. Laser communication terminals can support higher data rates with lower mass, volume and power requirements, a cost savings for future missions. For laser communications to become standard, NASA first must prove the concept is a viable option. NASA's LLCD mission will test this concept.

Flight Terminal

Data, transmitted in the form of hundreds of millions of short pulses of light every second, will be sent by the Lunar Lasercomm Space Terminal (LLST), aboard the LADEE spacecraft. These data transmissions will be downlinked to any one of three ground telescopes in New Mexico, California or Spain. The LLST, developed by the Massachusetts Institute of Technology's (MIT) Lincoln Laboratory in Lexington, Mass., is comprised of three modules: the optical module, the modem module and the controller electronics module. The entire system weighs about 65 pounds. The optical module is mounted to the exterior of the LADEE spacecraft and consists of a 4-inch diameter telescope on a two-axis gimbal. This position allows LLCD to precisely point its laser beam back to Earth over a variety of spacecraft orientations. The modem is mounted inside LADEE and contains the 0.5-watt infrared laser transmitter that will transmit data at a rate of 622 Mbps from the Moon to Earth. The modem also contains the highly sensitive receiver that deciphers the light pulses of data sent from the ground telescopes at up to 20 Mbps. The optical module telescope transmits and collects the signals transmitted to and from Earth to the modem module by fiber-optic cables. The controller electronics module, located inside

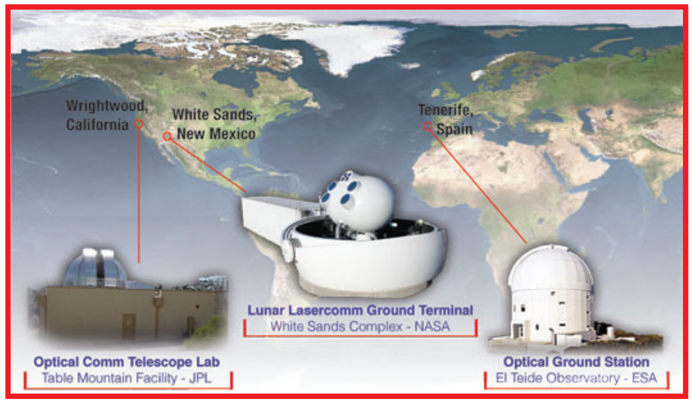


the LADEE spacecraft, is the brain of the LLST, providing fine, closed-loop pointing-and-tracking control of the optical module to Earth. It also provides the command and telemetry interfaces between the LLST and the LADEE spacecraft.

Ground Terminal

The Lunar Lasercomm Ground Terminal (LLGT), also developed by MIT/Lincoln Laboratory, consists of an array of eight transceiver and receiver telescopes mounted on a single gimbal. The telescopes and gimbal are connected to the control room where ground-based optical transmitters, receivers and associated electronics reside. The four, 6-inch refracting telescopes are used to send both a beacon and data to the LLST. Four, 17-inch reflective telescopes collect and focus the faint optical data signals from the LLST to optical fibers leading to detectors in the control room. All eight telescopes are housed in a fiberglass enclosure for stability to maintain their alignment and operation. The control room houses the electronics to control the gimbal and telescopes, as well as the ground terminal modem electronics and optics. Four optical transmitters generate the signals for the optical uplink. Each transmitter is connected to a transceiver telescope through an optical fiber.

The ground terminal is transportable, enabling it to move to a location near MIT/Lincoln Laboratory in Mass., for calibration and performance characterization. Several months before the LADEE spacecraft launches, the ground terminal will be transported to its operational location in White Sands, N.M.



Engineers expect future space missions to benefit greatly from the use of laser communications technology. This new ability will provide increased data transmission for real-time communication and 3-D high-definition video, while taking advantage of its lower on-orbit mass and power requirements. For example, using S-band communications, the LADEE spacecraft would take 639 hours to download an average-length HD movie. Using LLCD technology, download times will be reduced to less than eight minutes.

LLCD is a cooperative effort led by NASA's Goddard Space Flight Center in Greenbelt, Md., which is managing the LLCD payload. Management oversight and funding is provided by NASA's Space Communication and Navigation Program within the Human Exploration and Operations Mission Directorate.The LADEE mission is being overseen by the agency's Ames Research Center, Moffett Field, Calif., and is responsible for managing the mission, building the spacecraft and performing mission operations. Wallops Flight Facility has the responsibility for launch vehicle integration, launch services and launch range operations. Flight and ground station hardware for LLCD was designed and built at MIT/Lincoln Laboratory. NASA's Jet Propulsion Laboratory in Pasadena, Calif., and the European Space Agency are developing the ground stations in California and Spain, respectively.

Through these partnerships, NASA and LLCD will introduce the use of laser communications as the future of space communications.

For more information on the LLCD project please visit: http://llcd.gsfc.nasa.gov

For media inquiries please contact Dewayne Washington at 301-286-0040.

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