National Aeronautics and Space Administration

L C R D

LASER COMMUNICATIONS RELAY DEMONSTRATION

NASA'S NEXT STEP IN OPTICAL COMMUNICATIONS

The Laser Communications Relay Demonstration (LCRD) is poised to revolutionize the way NASA communicates with spacecraft. Since NASA's inception in 1958, the agency has solely relied on radio waves to transmit information between spacecraft and Earth. From the Apollo missions to more modern feats such as the James Webb Space Telescope, the principles and methods of space communications have evolved and advanced. But to communicate effectively and efficiently with astronauts at the Moon and beyond, as well as support next-generation science missions, NASA will need a more robust communications system than ever before.

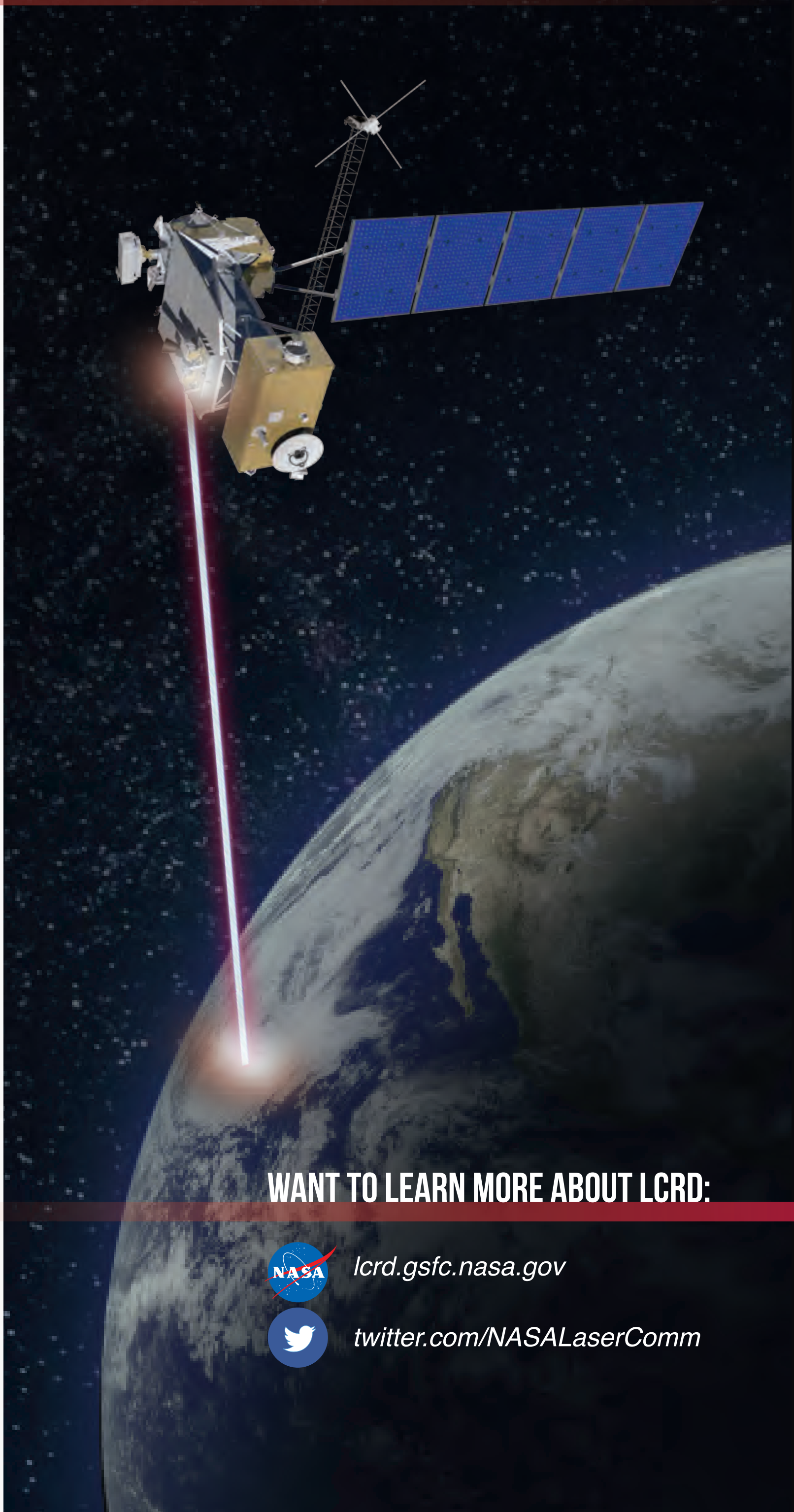
LCRD is pioneering operations for a new space communications system using lasers to encode and transmit data at rates 10 to 100 times better than radio systems.

Enabling Exploration and Discovery through Better Data Rates
Laser communications uses a different wavelength of light than radio waves, which is where the benefits of laser technology are realized. Laser, which uses invisible infrared light, has a shorter wavelength than radio waves. This allows it to transmit more data at a time, enabling scientists to get their data back from space more quickly. Transmitting a map of Mars to Earth might take nine years with current radio systems, but as little as nine weeks with laser communications.

Additionally, laser communications systems transmitting at the same rate as radio systems take up less space, weight and power on a spacecraft. Because spacecraft have limited room and power on board, minimizing the requirements of communications systems can allow mission managers to include more science instruments.

LCRD is not NASA's first laser communications mission. In 2013, NASA launched the Lunar Laser Communications Demonstration (LLCD) in partnership with the Massachusetts Institute of Technology (MIT) Lincoln Laboratory. This was the first high-rate demonstration of laser communications in space. LCRD leverages the pioneering developments of LLCD with the goal of readying them for mission-critical, long-term operations.

This leap in technology will allow NASA to support all phases of future exploration, from scouting for knowledge to further human exploration to enabling manned deep-space missions themselves. Laser communications will enable spacecraft to send high-resolution



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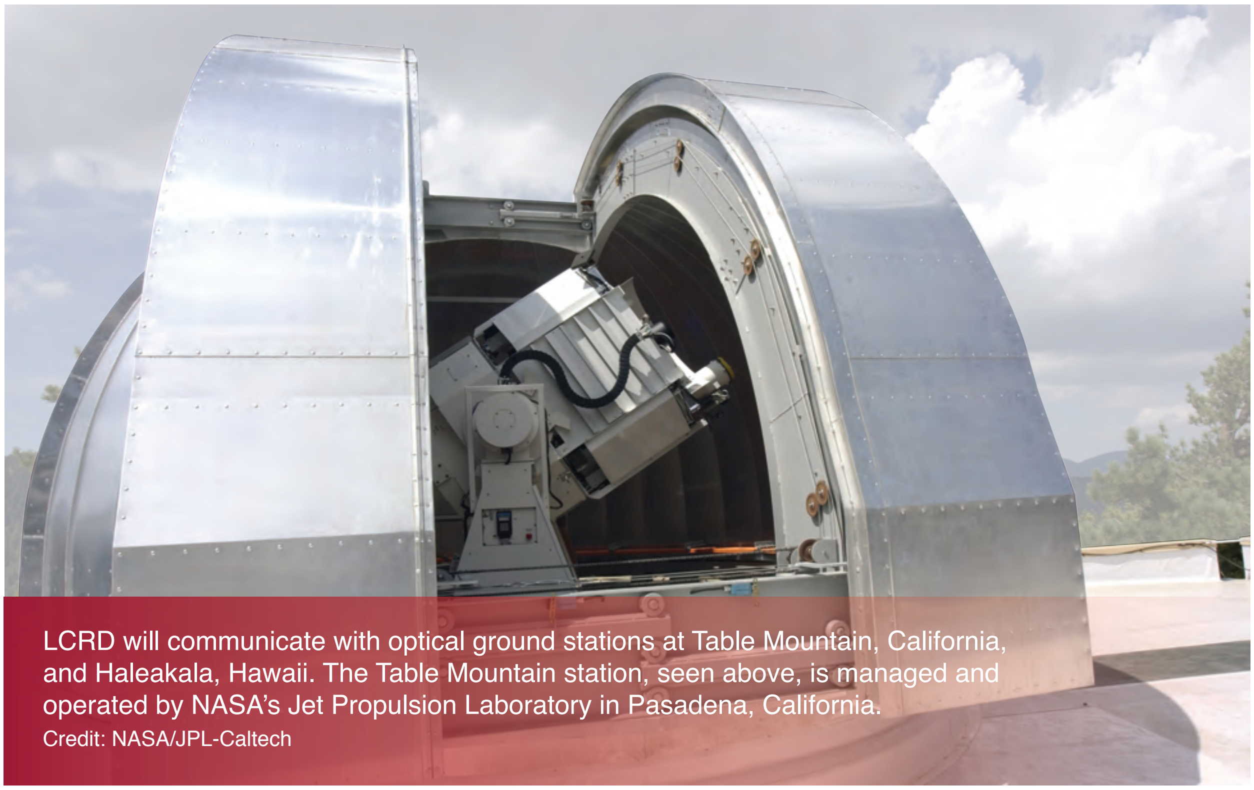
science data across the solar system to scientists on Earth, affording researchers the opportunity to study other planets at the same level of depth as they study our own.

The game-changing technology will also allow missions to use instruments that collect larger-than-usual amounts of data, including those that take high-definition images and video. Once the agency is ready to begin sending humans to distant destinations, laser communications will provide high-bandwidth transmissions that will enable high-definition streaming or the return of high volumes of science data during missions. It will also help astronauts stay connected with their families and society on Earth.

Not only can laser communications advance missions into deep space, but it can enable new capabilities on low-Earth-orbiting satellites. The needs for modern near-Earth missions are growing and require high data volumes comparable to those necessary for deep-space missions. LCRD is considered a critical next step toward the next-generation near-Earth communications architecture, which currently employs a fleet of communications satellites in geosynchronous orbit. These satellites relay mission data to ground stations via radio signals; the next-generation architecture will add laser communications capabilities.



LCRD will communicate with optical ground stations at Table Mountain, California, and Haleakala, Hawaii. The Table Mountain station, seen above, is managed and operated by NASA's Jet Propulsion Laboratory in Pasadena, California.
Credit: NASA/JPL-Caltech

Minimizing Size to Bolster Science and Increase Efficiency
Just as data rates have steadily increased over time, the communications systems employed both in space and on the ground have been shrinking in size. During the early days of human spaceflight, NASA flew antennas that were 7 feet in diameter aboard the Apollo spacecraft to communicate back to Earth. When NASA launched the Lunar Reconnaissance Orbiter (LRO) in 2009, its antenna was 2.5 feet in diameter. With the advent of laser communications, terminals aboard spacecraft can be as small as 4 inches. That is a staggering reduction in area, freeing up valuable spacecraft real estate for science instruments.

The same principle also applies to the ground-based laser communications receivers. During the Apollo program, NASA used 180-foot diameter ground antennas to send and receive data during trips to the moon. LRO uses a 55-foot diameter antenna at White Sands, New Mexico, to transmit data to the ground. The precursor to LCRD, LLCD, demonstrated laser communications from lunar orbit using four 15-inch ground receivers. This technology makes ground systems more cost-effective and efficient for NASA's many critical missions. These efficiencies will enable humans to travel back to the Moon and beyond to the many destinations in our solar system!

The LCRD team is led by NASA's Goddard Space Flight Center in Greenbelt, Maryland. Partners include NASA's Jet Propulsion Laboratory in Pasadena, California, and the MIT Lincoln Laboratory. LCRD is funded through NASA's Technology Demonstration Missions (TDM), part of the Space Technology Mission Directorate at NASA Headquarters, and the Space Communications and Navigation (SCaN) program, which is part of the Human Exploration and Operations Mission Directorate. The LCRD payload will be hosted aboard the U.S. Air Force's Space Test Program Satellite-6 (STPSat-6) and will launch from the Cape Canaveral Air Force Station in Florida. Ground stations in California and Hawaii will test LCRD's invisible, near-infrared lasers, beaming data to and from the satellite as the mission refines the transmission process, studies different operational scenarios and perfects tracking systems. They also will study the effects of clouds and other disruptions on communications, seeking to identify solutions including relay operations in orbit or backup receiving stations on the ground.

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