TBIRD

TERABYTE INFRARED DELIVERY

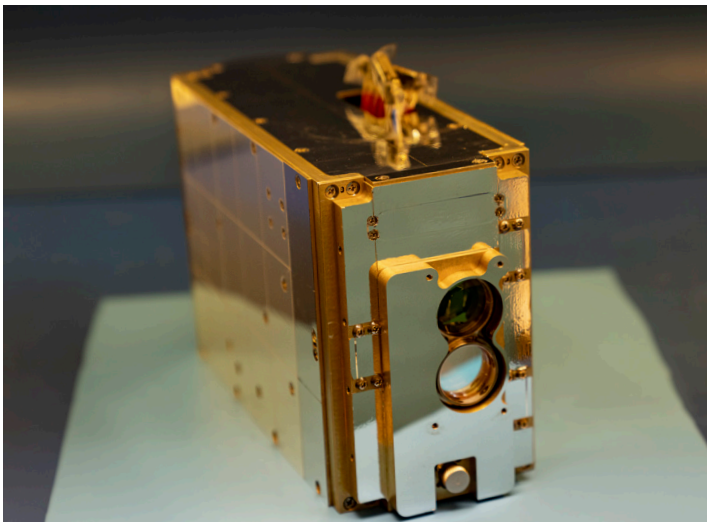
NASA's TeraByte InfraRed Delivery (TBIRD) system is showcasing unprecedented communications capabilities that will enhance the way future science and exploration missions communicate data to and from Earth.

Big Data Rates…

As science instruments evolve to capture larger amounts of high-resolution data, and as astronauts journey to the Moon and Mars, missions will need more efficient ways to transmit information to Earth. TBIRD will demonstrate a laser communications downlink at 200 gigabits per second (Gbps) – one of the fastest the aerospace industry has ever seen.

Traditionally, space missions have used radio frequencies to send data to and from space. The infrared light used for laser communications differs from radio waves because the infrared light packs the data into significantly tighter waves, meaning ground stations on Earth can receive more data at once.

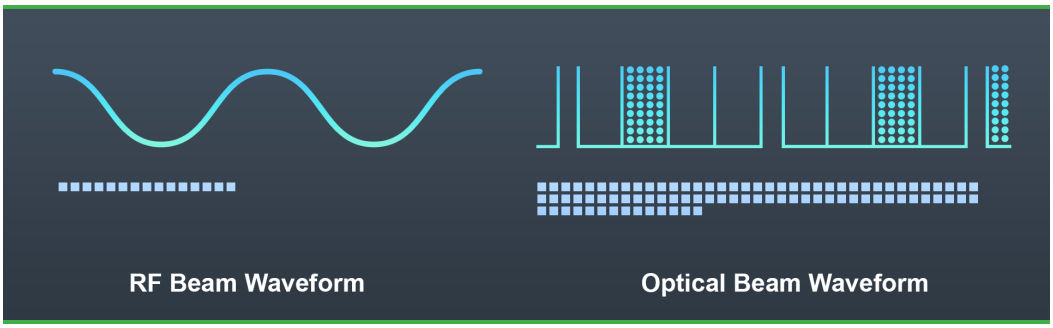
At 200 Gbps per pass, TBIRD will send back terabytes of data and give NASA more insight into the capabilities of lasers for transmitting science and exploration data back to Earth. The addition of laser communications to spacecraft is similar to humanity's transition from dial-up to high-speed internet.



NASA's TeraByte InfraRed Delivery (TBIRD) payload.
Credit: MIT Lincoln Laboratory

…In a Small Package

TBIRD is intended to operate for at least six months in low-Earth orbit, approximately 1,200 miles from Earth's surface. CubeSats, such as the one that will carry TBIRD, provide a cost-effective way to test technologies and capabilities in space, and their miniaturized size enables cost savings in areas like fuel and hardware development.



Optical communications enables more data in a single downlink than comparable radio systems. This is represented by the blocks.
Credit: NASA

CubeSats are measured in ten centimeter cubes, roughly four inches. TBIRD is a three-unit or "3U" payload, meaning it is three ten centimeter cubes put together – about the size of a tissue box. TBIRD is hosted on a "6U" CubeSat called Pathfinder Technology Demonstrator-3 (PTD-3), which is comprised of six, ten centimeter cubes. In total, the spacecraft is the size of two stacked cereal boxes.

SpaceX's Falcon 9 rocket launching from Cape Canaveral.
Credit: NASA

In addition to being small, TBIRD is built from commercial terrestrial telecommunications technology. The team took commercial, off-the-shelf hardware, and redesigned it for space operations. Leveraging existing components also introduces cost savings.

Launch and Operations

PTD-3 is launching from Cape Canaveral Space Force Station on SpaceX's Transporter-5 Rideshare mission, which will use a Falcon 9 rocket to launch multiple CubeSats like TBIRD. The rocket will follow a sun-synchronization launch so that TBIRD enters a "fixed" position relative to the Sun and can pass over the same place on Earth at the same time each day.

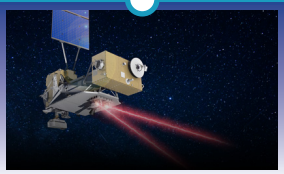
That spot is Optical Ground Station – 1 in Table Mountain, California. The location was chosen for its clear weather conditions and remote, high altitude. Most of the weather there takes place below the summit of the mountain, leaving relatively clear skies perfect for laser communications. TBIRD shares this ground station with NASA's Laser Communications Relay Demonstration, which launched in 2021 and is demonstrating the benefits of an optical relay through numerous experiments and assessing the impact of clouds and weather on laser communications.

Optical Ground Station-1 at NASA's Jet Propulsion Laboratory in California.
Credit: NASA

The Future of Laser Communications

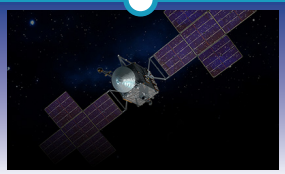
The TBIRD payload is a joint partnership between NASA and the Massachusetts Institute of Technology – Lincoln Laboratory, who are working together to infuse laser communications into multiple spacecraft. Planned future missions using laser communications include a laser terminal on the International Space Station, a mission headed toward a deep-space asteroid, and Artemis II – a crewed mission to the lunar region.

Timeline of Current and Future Laser Communications Missions



Laser Communications Relay Demonstration (LCRD)

TeraByte InfraRed Delivery (TBIRD)



Deep Space Optical Communications (DSOC)

Integrated LCRD LEO User Modem and Amplifier Terminal (ILLUMA-T)

Orion Artemis II Optical Communications System (O2O)

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