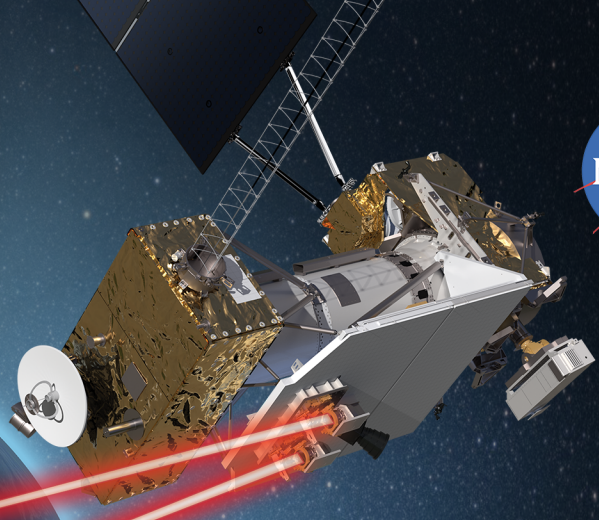
# LASERS LIGHT THE WAY

## LASER COMMUNICATIONS MISSIONS



As NASA journeys to the Moon, Mars and beyond, the communications needs of NASA missions are growing and changing. Rising to the challenge, laser communications will infuse NASA networks with the capabilities we need to explore ever further. Laser communications uses infrared light to transmit data, similar to the way we currently use radio frequency. However, with laser communications supplementing radio, missions will have unprecedented flexibility.

### LASER COMMUNICATIONS

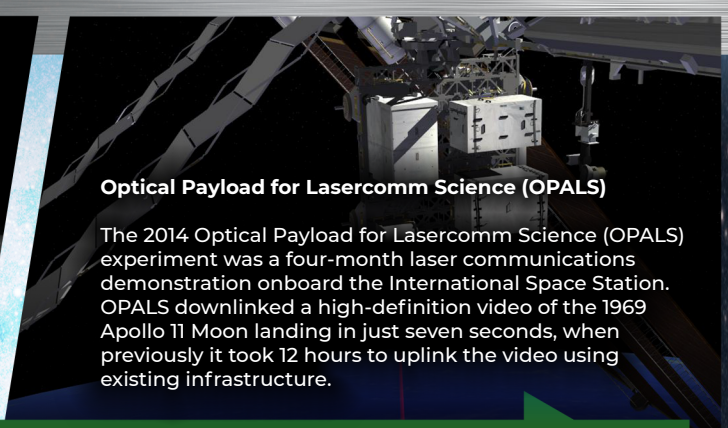
NASA is developing laser communications to supplement the capabilities of current radio frequency systems, including: bandwidth, spectrum and overall size of frequency packages and power used.

### ELECTROMAGNETIC SPECTRUM

Laser communications use light as a means of transmitting information over long distances. Within the context of NASA, laser communications technology sends data across space using lasers instead of radio frequencies.

**Lunar Laser Communication Demonstration (LLCD)**

In 2013, LLCD demonstrated laser communications at 622 megabits per second from and 20 megabits per second to lunar orbit. The mission validated the use of laser communications at the Moon and set the stage for further research and development.

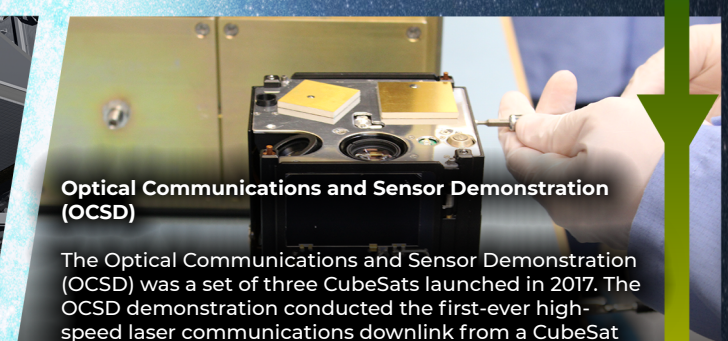


**Optical Payload for Lasercomm Science (OPALS)**

The 2014 Optical Payload for Lasercomm Science (OPALS) experiment was a four-month laser communications demonstration onboard the International Space Station. OPALS downlinked a high-definition video of the 1969 Apollo 11 Moon landing in just seven seconds, when previously it took 12 hours to uplink the video using existing infrastructure.

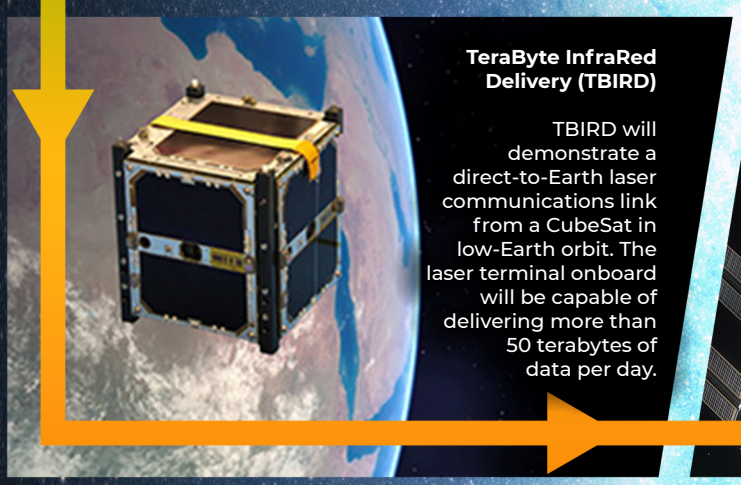
**Laser Communications Relay Demonstration (LCRD)**

LCRD will be NASA's first end-to-end laser relay system, demonstrating and testing NASA-developed laser technologies. LCRD will have two optical terminals, each capable of transmitting and receiving 1.2 gigabits per second. LCRD will spend two years relaying data for ground-based laser experiments before supporting missions in low Earth orbit.



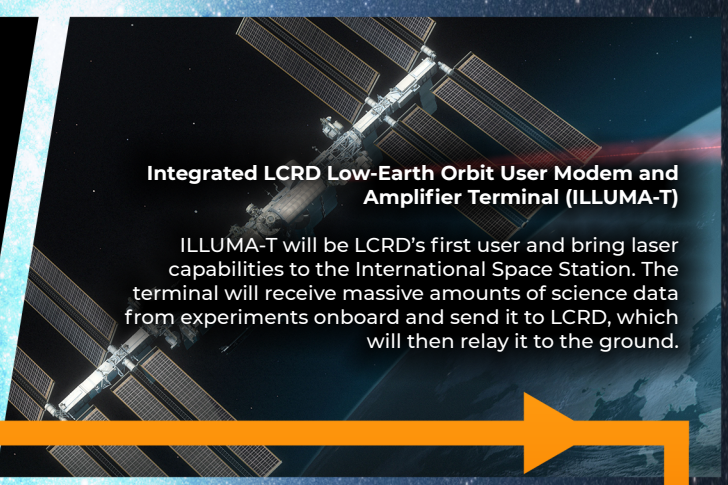
**Optical Communications and Sensor Demonstration (OCSD)**

The Optical Communications and Sensor Demonstration (OCSD) was a set of three CubeSats launched in 2017. The OCSD demonstration conducted the first-ever high-speed laser communications downlink from a CubeSat to a ground station, using data rates of 2.5 gigabits per second.



**TeraByte InfraRed Delivery (TBIRD)**

TBIRD will demonstrate a direct-to-Earth laser communications link from a CubeSat in low-Earth orbit. The laser terminal onboard will be capable of delivering more than 50 terabytes of data per day.

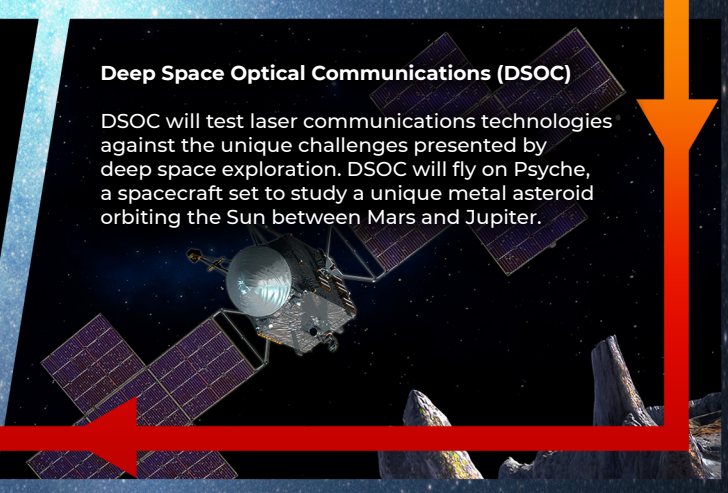


**Integrated LCRD Low-Earth Orbit User Modem and Amplifier Terminal (ILLUMA-T)**

ILLUMA-T will be LCRD's first user and bring laser capabilities to the International Space Station. The terminal will receive massive amounts of science data from experiments onboard and send it to LCRD, which will then relay it to the ground.

**Orion Artemis II Optical Communications System (O2O)**

O2O will leverage laser communications on Orion spacecraft, which will take humans to the Moon for the first time since the Apollo missions. O2O will enable live, ultra-high-definition video feeds between astronauts and Earth.



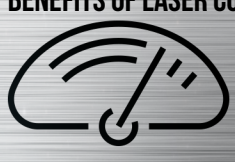
**Deep Space Optical Communications (DSOC)**

DSOC will test laser communications technologies against the unique challenges presented by deep space exploration. DSOC will fly on Psyche, a spacecraft set to study a unique metal asteroid orbiting the Sun between Mars and Jupiter.


**LunaNet**

LunaNet is NASA's plan for an internet on the Moon. Lunar orbiters or surface rovers using radio frequency or laser communications will be connected to LunaNet and receive services such as networking, navigation, and detection.

### BENEFITS OF LASER COMMUNICATIONS



Faster, lighter, flexible, and secure.

### CHALLENGES OF LASER COMMUNICATIONS

A need for precise laser beam accuracy and Earth's atmosphere interference, such as clouds.