



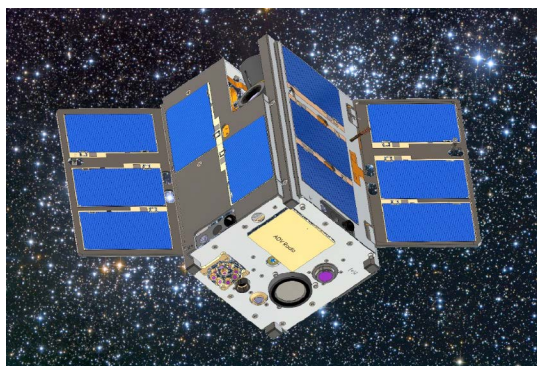
# Optical Communications and Sensor Demonstration

## Technologies for Proximity Operations and Data Transmission

The Optical Communications and Sensor Demonstration (OCSD) project addresses two cross-cutting capabilities of value to many future small spacecraft missions: high-speed optical transmission of data and small spacecraft proximity operations. Optical data rates demonstrated by OCSD are expected to reach 200 megabits per second (Mb/s), a factor of 100 increase over current high-end CubeSat communications systems. The proximity sensors developed for this mission enable relative position measurement between two small satellites - a capability not previously demonstrated.

The OCSD project will produce three 1.5-unit (1.5U) CubeSats that will be launched as secondary payloads on two separate missions. Each CubeSat is about 4 inches x 4 inches x 6.7 inches (10 centimeters x 10 centimeters x 17 centimeters) and weighs approximately 5 pounds (2.5 kilograms). The first OCSD mission, with one satellite, launched on Oct. 8, 2015 aboard an Atlas rocket from Vandenberg Air Force Base in California. This first OCSD flight was a risk reduction mission that allowed some checkout of the star trackers and important subsystems to include power, camera, GPS, radio and deployment mechanisms. It also allowed calibration and tool refinements to support the operational second flight of OCSD.

The second OCSD mission, with two satellites, is scheduled to launch in late 2017. The satellites have been modified to incorporate the lessons learned during the first mission. For this second mission, laser communications system will be demonstrated in addition to the proximity operations demonstration, which will involve relative position measurements using cameras, beacons, laser



*OCSD Spacecraft Configuration*

rangefinders, and relative maneuvering using variable drag and propulsion. The novel propulsion system on OCSD uses water as a propellant, exhausted as steam.

The optical communications system on OCSD differs from other space-based laser communication systems because the laser is hard-mounted to the spacecraft body. The beam is pointed by controlling the orientation of the entire spacecraft. This makes the laser system much more compact than anything previously flown in space. The attitude control system developed for these satellites includes a pair of miniature star trackers, which are cameras that measure the position of stars for navigational purposes. These star trackers are expected to enable pointing to an accuracy of 0.05 degrees, which is 20 times the precision previously demonstrated in a satellite of this size.

The OCSD mission addresses the need for low-cost sensors that small spacecraft can use to assist in maneuvering and operating safely in close proximity to other spacecraft or objects in space. Capabilities in proximity operations will enable multiple small spacecraft to operate cooperatively

during science or exploration missions, to approach another spacecraft or object for in-space observation or servicing, or to connect small spacecraft together to form larger systems or networks in space.

The potential for optical communications technology will not reach its limit with OCSD; it is anticipated that relatively simple upgrades, primarily to the attitude control system, will enable download rates of 2.5 gigabits per second (Gb/s) or higher. This would open the possibility of using small satellites in applications, such as synthetic aperture radar or hyperspectral Earth imaging, that produce volumes of data far beyond the capacity of radio-frequency downlink systems. It is also possible to use these satellites

as data relay nodes in low-Earth orbit; a modest constellation of small satellites has the potential to provide low-latency, high-rate communications as a service for other satellites in orbit around Earth.

The OCSD satellites are developed and operated by The Aerospace Corporation of El Segundo, California.

The OCSD mission is managed and funded by the Small Spacecraft Technology Program (SSTP) within the Space Technology Mission Directorate. The SSTP expands U.S. capability to execute unique missions through rapid development and in space demonstration of capabilities for small spacecraft applicable to exploration, science, and the commercial space sector. The SSTP will enable new mission architectures through the use of small spacecraft with goals to expand their reach to new destinations, and challenging new environments.

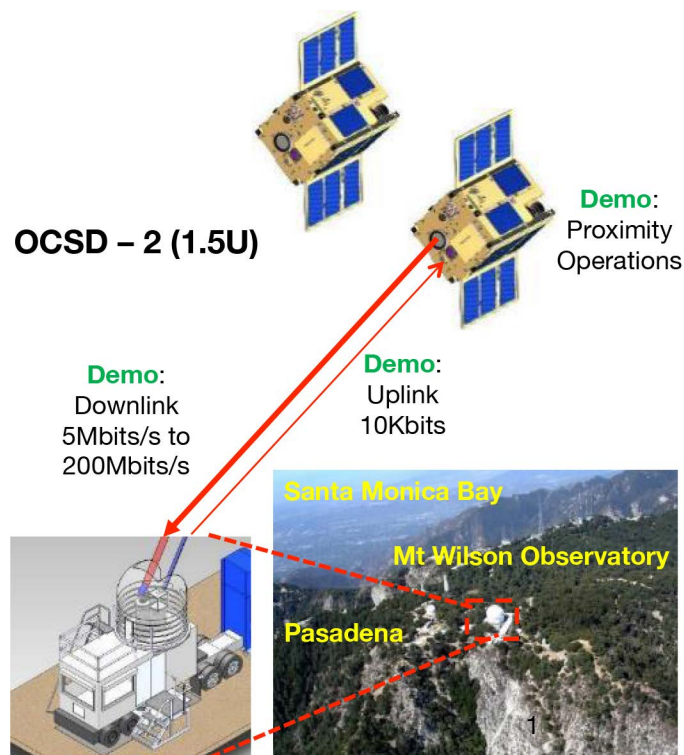
**For more information about the SSTP, visit:**  
[www.nasa.gov/directorates/spacetech/small\\_spacecraft/](http://www.nasa.gov/directorates/spacetech/small_spacecraft/)

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*The OCSD 1.5U CubeSat Transmits Data Via Laser from Space to Ground.*

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NASA Facts