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New Operations Concepts, Advanced Systems and Commercial Space Operations (2)

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LUNAR LASER COMMUNICATIONS DEMONSTRATION OPERATIONS ARCHITECTURE

Abstract

Radio waves have been the standard method for deep-space communications since the Apollo Mission. However, the recent success of the Lunar Laser Communications Demonstration (LLCD) program will clearly revolutionize the way data is sent and received from deep space. LLCD demonstrated record-breaking optical up/downlinks between Earth and the Lunar Lasercom Space Terminal (LLST) payload on NASA's Lunar Atmosphere Environment Explorer (LADEE) satellite orbiting the Moon. A space-to-ground optical downlink of up to 622 Mb/s was demonstrated with three ground terminals: the Lunar Lasercom Ground Terminal (LLGT) located in Las Cruces, NM, built /operated by MIT Lincoln Laboratory; the Lunar Lasercom OCTL Terminal (LLOT) at NASA's Table Mountain Facility in Wrightwood, CA, operated by NASA Jet Propulsion Laboratory (JPL); and Lunar Lasercom Optical Ground System (LLOGS), located at Teide Observatory in Tenerife, Spain (Canary Islands) and operated by the European Space Agency (ESA). A ground-to-space uplink of up to 20 Mb/s was also demonstrated with the LLGT. The LLST, developed and built at MIT Lincoln Laboratory, consisted of a 10-cm inertially-stabilized telescope, produced up to 1 Watt of pulse-position modulated downlink signal, and processed acquisition beacon and uplink comm signals.

The Lunar Lasercom Operations Center (LLOC), located at MIT Lincoln Laboratory in Lexington, MA was the hub for LLCD mission planning. The LLOC and ops architecture were developed and tested over the year prior to the demonstration. The ops architecture was designed to support a wide range of operation conditions, multiple terminals with varying designs and capabilities, short contact times (sometimes as little as 10 minutes) with energy and thermal constraints, and limited viewing opportunities. Each lasercom ops required collaboration between the LADEE Mission Operations Center (MOC) at NASA Ames Research Center in Mountain View, CA, the LADEE Science Operations Center (SOC) at NASA Goddard Research Center in Greenbelt, MD, the three ground stations (LLGT, LLOT, and LLOGS), as well as the LLOC. This paper will explore the ops architecture used in the LLOC as well as present ideas on how best to make laser communications ops routine and more suitable for wide-scale deployment.

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