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DEEP SPACE STATION 17: A UNIVERSITY-OPERATED AFFILIATED NODE ON THE NASA DEEP SPACE NETWORK FOR INTERPLANETARY SMALL SATELLITE MISSIONS

Abstract

The era of interplanetary Small Satellites is here. CubeSats, in particular, have executed fly-by mission of Mars (MarCo in 2018) and are being launched to the Moon (Lunar IceCube, LunaH-Map, and CAPSTONE) and to nearby asteroids (NEAScout) in 2022. All of these activities require ground support for communications, navigation and tracking- support that requires significant infrastructure including ground stations with large apertures, full-motion antennas and specialized deep space ranging and telecommunication instrumentation. With an already high demand on mission support, the DSN, even with the expansion of the new antennas and with the implementation of new techniques to increase the antenna utilization (i.e., multiple spacecraft per aperture), will be challenged accommodate the large number of missions expected as the SmallSat revolution unfolds. To begin to address this challenge, partnership between JPL and Morehead State University was initiated in 2014 to enhance DSN capabilities by utilizing existing non-NASA assets. An enhanced DSN can be achieved by transferring DSN processes and techniques, precision timing standards, data formatting, handling and transfer protocol, and mission and ground operation processes to existing university-based large aperture antennas. The team used the Morehead State University 21 m Space Tracking Antenna as a case-study to prove the validity of the concept of adding non-NASA nodes to the DSN. The goal of this project has been to develop and implement a strategy to transfer DSN processes and protocol to the MSU 21 m antenna system to enable integration into the DSN as an auxiliary station to support small-sat missions. The program focused on the implementation of DSN capabilities with deep space communication and navigation tracking techniques, including Space-link Extension (SLE) protocol and CCSDS data standardization, and asset scheduling capabilities. The 21 m antenna system has been upgraded for DSN-compatibility and the station, designated DSS-17, became operational in 2021. DSS-17 is also serving as a pilot ground station for three emerging technologies with the potential to substantially lower CubeSat mission cost and risk, or even enable new types of deep space missions to be proposed. These new capabilities include Disruption Tolerant Networking (DTN), spacecraft-initiated operations utilizing a beacon tone service, and Opportunistic Multiple Spacecraft per Aperture (OMSPA). DTN and beacon operations will be flight validated for use on CubeSats by the Lunar IceCube mission, which will also certify these capabilities for operational use at DSS-17. An overview of the entire upgrade, status to date, and mission benefits will be provided.