A Demand Access System for Deep Space Operations

Marc Sanchez Net, Nathaniel Richards, Jay E Wyatt, T. Joseph W. Lazio, Rebecca Castano, Mark Johnston, Tim Pham, Costin Radulescu
Jet Propulsion Laboratory
California Institute of Technology
4800 Oak Grove Dr.
Pasadena, CA 91109
first.last@jpl.nasa.gov

Benjamin K. Malphrus, Jeffrey A. Kruth, Chloe Hart, Emily Mattle, Emily Walters.
Space Science Center
Morehead State University,
Morehead, Kentucky, 40351
first.last@moreheadstate.edu

Using small spacecraft for deep space exploration is currently a topic of growing interest. This is exemplified by the success of the Mars Cubesat One (MarCO) spacecraft, as well as by other missions such as the Lunar Trailblazers, Janus, and the Escape and Plasma Acceleration and Dynamics Explorer (EscaPADE). While exploring deep space with smallsats offers scientific advantages, the prospect of having to operate and support a possibly (much) larger mission suite raises significant challenges. This motivates the need for innovative operational approaches to facilicate the coexistence of traditional large deep space missions with large fleets of new smallsats.

We summarize the efforts conducted at the Jet Propulsion Laboratory to define and prototype a new way of conducting mission operations, which we term “demand access”. In demand access, ground support is provided to missions in near real-time upon request from the spacecraft, including both the Deep Space Network (DSN) and the ground data system (GDS). This contrasts with the current way of performing operations, which entails long planning activities and contact opportunities with the ground that are scheduled weeks if not months in advance.

The demand access system is built around three core and fully integrated capabilities: (1) A queuing antenna that scans the sky looking for request from spacecraft operating in demand access mode; (2) a suite of flexible scheduling tools that reserve time on DSN antennas ahead of each day of operations and then allocate it to spacecraft in near real-time based on requests received via the queuing antenna; and (3), optionally, a cloud-based GDS that is spins up resources for real-time telemetry and science processing in response to newly scheduled demand access tracks. To demonstrate feasibility, we show results from several prototyping efforts and tests conducted over the last two years in conjunction with the Lunar IceCube (LIC) team at Morehead State University. These include, for instance, the use of DSS-17 as a queuing antenna, as well as tests conducted to demonstrate real-time delivery and processing of LIC telemetry in the cloud using Delay Tolerant Networking (DTN) and the Advanced Multi-Mission Operations System (AMMOS).

Finally, to illustrate the technology benefits, we discuss how demand access adds value during different mission phases, from cruise to science operations, using specific examples such as Venus Bridge Orbiter and LIC. Furthermore, we anticipate that the technologies and techniques described herein are applicable to most mission concepts int this workshop.

ACKNOWLEDGMENT
This work was carried out at the Jet Propulsion Laboratory, California Institute of Technology, under contract with the National Aeronautics and Space Administration.