Spacecraft-Initiated Operations with the Deep Space Network

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The Deep Space Network (DSN) has traditionally supported missions using a predefined schedule that is negotiated up to six months in advance. Each project requests DSN time based on operational plans and activity forecasts, and a well-defined scheduling and deconfliction process is then followed to generate a viable DSN seven-day schedule. During any day of operations, the DSN follows this seven-day schedule as a master plan indicating which spacecraft would be enabled by each antenna, at what time, and the services and equipment that will be used for mission support.

Motivated by a combination of two factors: an increase in popularity of CubeSats and SmallSats, both in near-Earth, cis-lunar, and deep space; and the desire to reduce mission operations costs, the DSN has been exploring new technologies and operational concepts to increase the number of supportable missions with the available ground infrastructure. We describe one such effort, which focuses on prototyping the necessary capabilities to enable spacecraft-initiated operations via a DSN demand access service. In spacecraft-initiated operations, time on DSN antennas is not provided based on the seven-day schedule; rather, it is requested by the spacecraft based on decisions made on board by its autonomy engine. The request is placed by having the spacecraft transmit DSN beacon tones to a smaller antenna (e.g., 18-21 meters in diameter), known as the queuing antenna, which provides frequent but short contacts with all spacecraft utilizing the demand access service. Once received, the request is automatically forwarded to both mission operations and to the DSN scheduling service. If needed, time on larger DSN 34 m or 70 m antennas is then allocated in near-real time, with a lead-time of 30 minutes to 2 hours.

We describe the results of the prototyping efforts conducted at JPL to deploy and operationalize the DSN demand access service, including the results of a flight demonstration conducted in 2023 with the BioSentinel spacecraft. To flight-validate the request mechanism, we describe the first attempt to send DSN beacon tones from a JPL Iris radio on board a CubeSat to the 21 m antenna at Morehead State University (affiliated with the DSN, also known as DSS-17). We also demonstrate the ability to automatically forward the received requests from the station to the DSN network operations center and the DSN Scheduling Service (SSS), both located at JPL.

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