SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Near-Earth and Interplanetary Communications (5)

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KA-BAND HIGH-RATE TELEMETRY SYSTEM UPGRADE FOR THE NASA DEEP SPACE NETWORK

Abstract

The NASA Deep Space Network (DSN) has a new requirement to support Category A (Cat A) missions (within 2 million kilometers of Earth) with simultaneous S-band uplink, S-band downlink and Ka-band downlink. The S-band links are required for traditional TTC support to the spacecraft, while the Ka-band link is intended for high-data-rate science returns. Several 34-meter DSN antennas have previously been upgraded to support the Category B (Cat B or deep space) Ka-band, at 31.8 - 32.3 GHz, referred to as Ka1. However, this upgrade task, referred to as Ka-band Phase 2 or Ka2, is the first time the DSN is being used to support the Cat A downlink band at 25.5 - 27.0 GHz. The initial Cat A support is required for the James Webb Space Telescope (JWST) in 2013 and possibly other missions. The upgrade has been implemented into 3 different 34-meter BWG antennas in the DSN, one at each of the complexes in Canberra (Australia), Goldstone (California) and Madrid (Spain). Demonstration tracks have already been done with the Lunar Reconnaissance Orbiter (LRO) spacecraft. The mission requirements for the Ka2 upgrade dictate a low-noise, cryogenic system for the front end and a high-data-rate system for the back end. The task has added a new dichroic reflector (M6A) and feed/LNA subsystem to enable simultaneous Cat A S-band transmit, S-band receive and Ka-band receive at 3 different 34-meter beam waveguide (BWG) antennas. The new mirror is required to be selectable using a shuttle mechanism, so that the antenna can operate in any of 3 modes (up/down/down): S/S/X, X/X/Ka1 or S/S/Ka2. The RF design is driven by both the dynamic range and bandwidth requirements. The system temperature requirement is met by using cryogenic low-noise amplifiers, cooled to 10K. The dynamic range requirement is achieved with a low-noise fiber optic link, to transport the X-band IF signals from the antennas to the Signal Processing Centers (SPC). Telemetry processing is done using a “2-box” commercial telemetry subsystem, consisting of a demodulator and telemetry processor. Software development was limited to modifications to the existing DSN monitor and control programs, to reduce development time and cost. The operator interfaces remain basically the same to allow a quick transition from development to transferred operations. System test data will be presented to show that the requirements were met and the DSN is ready for Cat A Ka-band operational support.