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UPLINK AND DOWNLINK ELECTRONICS UPGRADES FOR THE NASA DEEP SPACE NETWORK APERTURE ENHANCEMENT PROJECT (DAEP)

Abstract

The NASA Deep Space Network (DSN) has a new requirement to build additional 34-meter beam waveguide antennas at all 3 of the existing complexes: Goldstone, Canberra and Madrid. For the new project, called the DSN Aperture Enhancement Project(DAEP)χ, the long-term plan is to have 4 34m BWG antennas at each complex. The new antennas are part of NASA's Integrated Space Communication Architecture. The 4 antennas will allow simultaneous X/Ka-band tracking of additional spacecraft. The 4 antennas can also be arrayed to provide a downlink G/T performance equivalent to a 70m antenna. For the uplink EIRP, a 70m equivalent capability will be provided by the addition of a 100 kW high-power amplifier (HPA) in 2 new antennas per complex. The uplink and downlink electronics upgrades are driven by several considerations, including parts obsolescence, cost reduction, improved reliability and maintainability, and capability to meet future performance requirements. Several technologies have made it possible to meet the performance requirements as well as the cost, reliability and maintainability improvements. The use of high-density FPGAs has allowed a flexible, software defined radio approach to be used for both the uplink and downlink electronics. For the 70m EIRP equivalent capability, some developments in high-power (100 kW) waveguide components have been key. The use of high-speed (2.4 GHz) digital design in the Exciter has made it possible to eliminate some upconversions and therefore eliminate several RF assemblies in the uplink chain. The key new features of the Uplink and Downlink electronics design are: - addition of new high-power waveguide and feed components, to accommodate the new 100 kW X-band high-power amplifier (HPA) - design of a new Uplink Signal Generator (USG), which does all of the exciter signal generation digitally within an FPGA - smaller X/Ka-band cryostat, relative to the existing DSN LNA systems for improved reliability and ease of maintenance - implementation of telemetry processing and downlink ranging functions in 2 FPGAs, with increased flexibility for adding new telemetry capabilities and improved reliability. The future expansion possibilities that are enabled by this upgrade are: - addition of new telemetry capabilities such as LDPC coding - wider ranging bandwidth (12 MHz) for 10 cm ranging resolution - higher command modulation rates for large software uploads to a spacecraft - capability to add carrier phase control for future uplink arraying - capability to economically add S-band uplink, S-S and S-X test translation, Ka-band uplink and K-K test translation