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LARGE ANTENNA MECHANICAL NOISE CALIBRATION (LANC) SYSTEM FOR THE NASA DEEP SPACE NETWORK (DSN)

Abstract

In the most sensitive Radio Science measurements carried out by the NASA Deep Space Network (DSN) (Allan deviations 4 1015 at 1000 sec), the intrinsic mechanical instability of the large (34m) antennas emerges as the leading noise contributor since other contributions to the noise budget can be mitigated by thermal stabilization or phase compensation. A task is underway to improve the measurement precision by providing in-situ calibration for phase variations due to antenna mechanical noise on received spacecraft signals. The objective of the new system is to provide a factor of 5 reduction in the amount of antenna mechanical noise in Radio Science experiments. This is referred to as the Large Antenna Noise Calibration (LANC) system. In the real-time approach for this task, phase stable calibration signals, at Ka-band, will be transmitted from 3 small, patch, injection antennas, at 3 different frequencies, placed on the DSN antenna's main reflector. The calibration signals from the injection antennas will follow the same RF path as the spacecraft signal through the antenna, feed and downlink electronics. The receiver will record both the calibration signals and spacecraft downlink signal in parallel. Tracking software will then be used to extract signal phase information from both the spacecraft signal and the calibration signals. The phase data from the calibration signals will be combined and used to correct variations in the spacecraft signal thereby reducing antenna mechanical errors in the overall observation. For calibration tone processing, the approach for this system is to make use of the existing Open Loop Receiver (OLR) subsystem to record the calibration signals. A key challenge to this approach is the development of the phase stable reference distribution system. This system will use single-mode fiber optic links to 3 small patch antenna and microwave electronics assemblies (Remote boxes) mounted behind the surface of the main 34m dish. The fibers will be routed through the azimuth and elevation cable wraps, and will connect to the Remote Boxes mounted behind the dish surface, where the optical signals will be received and converted back to RF signals. Patch antennas, mounted on the dish surface, will radiate the Ka-band signals toward the sub-reflector while the dish is tracking the spacecraft Ka-band downlink signal. This paper describes the design of the LANC system along with preliminary results from testing done on an experimental 34m antenna at the Goldstone tracking station.