First In-flight demonstration of Psuedo-noise Delta-Differential One-way Ranging

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Spacecraft requiring high-precision deep-space navigation use Differential One-way Ranging (DOR) tone signals to perform DDOR measurements. So far, these DOR tones are narrowband signals which differ greatly from the broadband quasar signals used in Delta-DOR (DDOR) measurements. This introduces a potential leading error term into the DDOR error budget. For the next-generation deep-space missions, which require higher precision measurements, this potential error can be reduced by transforming the narrowband spacecraft signals to broadband spacecraft signals. Recent CubeSat missions to the moon have launched with the latest Iris CubeSat Deep Space Transponder firmware capable of modulating the narrowband DOR tones with a pseudo-noise (PN) spread spectrum Gold Code sequence. Use of these PN spread spectrum signals during DDOR are referred to as PN DDOR. This presentation reports on the initial results from these lunar CubeSats, including the operational impact of PN DDOR, the received waveform qualities at the Deep Space Network (DSN), and the resulting PN DDOR performance.