Recent Features Added to the Iris Deep-Space Transponder

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Abstract

In 2013, the Jet Propulsion Laboratory (JPL) developed the Iris Deep Space transponder, a CubeSat compatible software-defined radio (SDR), intended to support the first CubeSat deep space mission: the Interplanetary NanoSpacecraft Pathfinder In Relevant Environment (INSPIRE). The Iris Transponder is a reconfigurable SDR designed for missions requiring interoperability with NASA's Deep Space Network (DSN) on X-band frequencies (7.2 GHz uplink, 8.4 GHz downlink). The transponder provides radiometric tracking support with the DSN to provide navigation products for precise orbit determination while performing standard uplink and downlink communications in a CubeSat/SmallSat-applicable package size.

In 2015, JPL developed the second version of the Iris transponder to be used on the Mars Cube One (MarCO) mission. The second version has, in addition to X-Band transmit and receive functionality, the capability to receive in the UHF band. On MarCO, Iris successfully performed bent-pipe relay direct-to-Earth during entry, descent, and landing (EDL) of the InSight lander, providing the first confirmation of successful landing, including relay of InSight's first image from the surface of Mars.

JPL, in partnership with Utah State University Space Dynamics Lab (SDL) continues to improve and enhance Iris. The latest version of Iris (2.1) is slated to be the main transponder on each of seven secondary payload CubeSat missions of the upcoming Space Launch System Artemis-1 Mission. In this version, several updates to Iris were made. The power supply board (PSB) was redesigned to increase the radiation tolerance, and further miniaturization was performed to reduce the overall SwaP (Size, Weight, and Power) of the unit. In addition, the firmware/software on Iris was updated with two enhanced navigation and ranging techniques: Pseudo-random Noise (PN) Delta-Difference-of-Ranging (DDOR) technique and PN Regenerative Ranging. Also, Over-the-Air Update (OTAU) capability of the Iris firmware/software was added. The last feature will allow future mission to make updates to Iris's firmware and software in flight, if needed. This enhanced version of the Iris firwm/software by updated on three Artemis-1 CubeSat missions: Lunar Flashlight, Lunar IceCube, and LunaHMap.

This presentation focuses on the recent updates that were made to Iris in 2020-2021 and presents some results from recent compatibility testing at the DSN Test Facility (DTF-21) in September of 2020 and beyond. These features include, the Beacon Transmit Mode, LDPC channel coding, Higher Data Rates on both Trasnmsit & Receive modes to enable relay applications, 1-way

ranging, and Carrier Sweep/Acquisition & Doppler Compensation schemes to enable Multiple Uplink Per Antenna (MUPA).