IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Communication Technologies (7)

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KEYNOTE: UST-LITE, A SMALL-SAT MODULAR TRANSPONDER FOR LUNAR AND MARS COMMS

Abstract

Small satellites play a crucial role in developing flexible, cost-effective, and rapid solutions for the development of communication services on other celestial bodies. Thinking for instance at the Moon, recent initiatives such as Moonlight or LunaNet aim at using commercially developed platforms to provide a reliable infrastructure for communication and navigation, eliminating the need for direct-to-Earth links while utilizing Proximity-1 protocols. With growing interest in Mars exploration too, the need for relay satellites becomes essential due to the vast distances and power constraints. To address the need of high-performance telecommunication solutions, Argotec is developing and testing a multi-channel and multi-band transponder, called UST-Lite, as part of the Universal Space Transponders (UST) family. The UST-Lite features a modular design, advanced signal processing capabilities, high-reliability components while keeping a low size, weight and power [1].

This paper highlights the latest technological advancements of UST-Lite: a new revision of the Digital Processor Module (DPM) offers exceptional computational capabilities, supporting up to four simultaneous independent full-duplex channels and direct synthesis up to the X-band; the Radio Frequency Module has been redesigned for improved scalability; a newly designed Power Supply Module (PSM) is capable of distributing power to all internal boards and of providing a stable clock reference from either an internal TCXO or an external ultra-stable oscillator, thus enabling radio science applications. Electrical and functional tests on the prototype demonstrate the radio's ability to meet the demands of deep space small satellite missions, both for telecom and for scientific applications. being capable of processing signals at 150—MHz bandwidth and achieving a short-term clock stability (1 s) as precise as 1 ppb.

The industrialization of the UST-Lite is part of Argotec's plans towards offering end-to-end communication and navigation services on the Moon, on Mars and beyond [2]. The design's flexibility and modularity also allow the radio to be used, alternatively, as a transponder, as a relay asset or as a user terminal with minimal design modifications. The goal is to achieve TRL7 for the PSM and TRL6 for the overall radio by Q3 2025.

[1] M. M. Kobayashi et al., "UST-Lite Direct Waveform Sampling Software-Defined Radio for Spaceflight Applications," 2023 IEEE Aerospace Conference, Big Sky, MT, USA, 2023. [2] A. Balossino and Faramaz Davarian, "The Plan to Give the Moon Decent Wireless Coverage", IEEE Spectrum, Jan 2022.