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THE FRONTIER SOFTWARE-DEFINED RADIO: MISSION-ENABLING, MULTI-BAND, LOW-POWER PERFORMANCE

Abstract

Demanding mass and power requirements across many low-cost, competed, NASA mission sets (Discovery, New Frontiers, Mars Scout, SMEX, MIDEX, and others) place a premium on lightweight, efficient, and versatile radios. A low power, low mass, modular, multi-band software-defined radio (SDR) has been developed by JHU/APL, for NASA, for use in spaceborne communications, navigation, radio science, and sensor applications, with terrestrial and airborne applications as well. It's software-defined functionality and performance facilitates a variety of standard or unique applications via firmware and software uploads. The use of modular hardware and firmware blocks within this SDR further enable flexibility in reconfiguring for new applications or infusion of new technology with minimal non-recurring engineering (NRE). Current configurations operate within the NASA S, X (under development), and Ka-bands (26 and 32 GHz). The SDR is capable of transmit data rates up to 100 Mbps (QPSK, higher with 8/16 PSK/QAM) and receive data rates up to 1.3 Mbps (QPSK). Compatibility with NASA's STRS architecture helps promote the wide use of this transceiver throughout the NASA community. The transceiver's modular and software-definable architecture reduces potential development and implementation cost and risk for a broad mission set encompassing unique mission configurations and new/future capabilities. The current firmware set includes communications and Doppler navigation modes, with provisions for future advanced communications, navigation, radio science, and sensor functions. In-band channel assignment, bit rate, modulation format, turnaround ratio, loop bandwidths, coding formats, and other features are reconfigurable in flight. Several mission-enabling features make this SDR a powerful platform to continue to build upon. Flexible turnaround ratio capability enables shared uplink and two-way radiometric tracking services. DSP-based carrier tracking enables the use of narrow and high-order loop filter implementations required for low loss implementation of uplink error correction codes; this enables a reduction in ground station aperture sizes during emergency or critical communications scenarios, among other benefits. Flexible DSP-based I/Q modulation enables high order modulation schemes for high bit rate transmissions, and advanced pulse shaping and waveform linearization/predistortion for improved power and spectral efficiency. An integrated general purpose processor provides smart or autonomous functionality and the ability to adapt performance to the unique requirements of different mission phases (e.g. early ops, cruise, or orbit insertion). Along with its low power (5 W receive mode w/internal ovenized oscillator and 28V bus power) and low mass (1.8/2.1 kg, single/dual band configuration), this SDR offers

missions an attractive combination of capabilities and efficiency.