

IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Advances in Space-based Communication Systems and Services, Part 3 (3)

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NEW TECHNOLOGY INNOVATIONS FOR THE FRONTIER RADIO FROM THE EMIRATES MARS
MISSION, EUROPA CLIPPER, DART, AND MORE

Abstract

The Johns Hopkins University Applied Physics Laboratory's Frontier Radio (FR) is a TRL-9 software-defined radio (SDR) platform which targets low power, high reliability, and performance for near and deep space applications. Continually evolving new features and even expanding into new hardware configurations, the FR family remains a compelling choice for demanding missions. This is supported by the heritage of a number of successful missions such as NASA's Van Allen Probes (VAP) mission through the Van Allen radiation belts, NASA's Parker Solar Probe (PSP) mission through the sun's corona, the UAE Space Agency's Emirates Mars Mission (EMM) Hope spacecraft currently orbiting Mars, delivery to NASA's first planetary defense mission, the Double Asteroid Redirection Test (DART), to study the kinetic impactor technique for asteroid redirection, and multiple deliveries of its single-board variant as a spaceflight global navigation solution to the DoD community. Currently in test and nearing delivery is the X/Ka-band variant for NASA's Europa Clipper mission to explore that ocean world in a high-radiation environment. Through all of this development, the radio platform incorporates new features and advancements that will be valuable to future missions including the NASA Interstellar Mapping and Acceleration Probe (IMAP) to understand the boundaries of our heliosphere and the Dragonfly mission to explore Saturn's moon Titan by rotorcraft and repeated landings. These advancements include developing in a cost-constrained paradigm for EMM, bringing a large amount of functionality of the S-Band variant from VAP to a single board, and redesigning the X-band platform into a flat panel with a single board computer based on a new reconfigurable FPGA (the Microsemi RTG4). For DART, ESA compatibility, higher bandwidth downlink rates of 3 Mbps, modulation of QPSK Turbo 1/2, and a high data rate instrument bus are supported in firmware for the first time. Firmware updates for integrated encryption are also supported. For the Europa Clipper mission, unique radiation challenges and a Level 1 parts program led to extensive screening and qualification efforts, planetary protection considerations for a potentially extraterrestrial life-harboring world drove new processes for cleanliness, and the potential for a future

lander mission led to the development of relay link support and an open-loop record feature. This paper details the newest aspects of the Frontier Radio platform and their applications in current and future missions.