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FROM PROTOTYPE TECHNOLOGY TO FLIGHT: INFUSING THE FRONTIER RADIO INTO SPACE MISSIONS

Abstract

New technologies are constantly being developed at many space-related institutions. A significant challenge is to not only propose and develop these new technologies, but to infuse them into real space missions. The Johns Hopkins University Applied Physics Laboratory (JHU/APL) has a successful history of infusing such new technologies into NASA flight programs, including non-coherent navigation in the CONTOUR mission (launched 2002), a circularly-polarized phased-array antenna on the MESSENGER mission (2004), and a low-power receiver on the New Horizons mission (2006). Over the last several years, JHU/APL has developed a new line of software-defined radio, the Frontier Radio, to be used on flight missions. The Near-Earth version of this radio (Frontier NE), operating at S-band, is flying on the NASA Van Allen Probes (VAP) mission (launched in 2012). Subsequent Deep-Space versions of this radio (Frontier DS) are baselined for the NASA Solar Probe Plus Mission (launch 2018) and the Europa Multiple-Flyby Mission (launch 2022) using X- and Ka-band operation. Further, a streamlined version of the radio, Frontier LT, is in development for mass- and power-constrained missions, and a cross-link version of the radio, Frontier XL, is in development to support constellation architectures. This paper discusses how the first Frontier Radio was infused into the VAP mission. This work began with the NASA Communication, Navigation, and Networking reConfigurable Testbed (CoNNeCT) Program, in which a prototype S/Ka-Band software-defined radio was built and tested. To transition from prototype to flight for VAP, a technology development plan was implemented requiring the qualification of several new packaging technologies and the completion of a Qualification Model (QM) radio. The QM was built and tested as close to the intended flight configuration as possible with some compromises allowed for schedule constraints and parts availability. The technology development plan called for the QM radio to be qualified to a Technology Readiness Level (TRL) of 6, which requires a demonstration in a relevant environment exercising all interfaces. With the successful completion of the QM phase of the development, the Frontier Radio was deemed ready for flight infusion, and the flight models have enjoyed flawless operation in Earth's radiation belts since the Van Allen Probes launch in 2012. This mission paved the way for use of the Frontier Radio product line in future missions.