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IN-FLIGHT PERFORMANCE OF THE VAN ALLEN PROBES RF TELECOMMUNICATIONS SYSTEM

Abstract

The NASA Van Allen Probes mission (previously called the Radiation Belt Storm Probes) successfully launched on 30 August, 2012. The twin spacecraft, designed, built, and operated by The Johns Hopkins University Applied Physics Laboratory (JHU/APL), have been successfully operating within Earth's radiation belts since then, returning critical science data revealing new insights into the physics of the radiation belts. Because of the extreme radiation environment, all spacecraft subsystems including the telecommunications system had to make special accommodations to withstand the effects of the radiation.

Each Van Allen Probes spacecraft's telecommunications systems includes an S-band version of the Frontier Radio, a solid-state power amplifier, RF routing components, and dual low-gain antennas. This mission marks the first flight of the Frontier Radio, which is baselined for use in the upcoming Solar Probe Plus and Europa Clipper missions. This paper will present an overview of the as-built telecommunications system and its ground station interfaces, discuss key communications flight hardware components, and then discuss in detail activities and performance in-flight, including launch and commissioning operations, performance enhancements since launch, and performance trending in flight. Post-launch telecommunications commissioning activities were driven by the requirement to verify both spacecraft's communication systems over multiple ground networks, including JHU/APL's own 18-m ground station, the Universal Space Network, and TDRSS. Enhanced science data downlink volume was enabled by expanding the usable field of view of the spacecrafts' antennas once in-flight calibrations of the antenna patterns were completed, as well as reducing downlink link margins to a bare minimum when downlinking via APL's 18-m dish, where the CFDP (CCSDS File Delivery Protocol) is used to guarantee file delivery. Radiation drove some of the hardware design; the radios have experienced several predicted fault conditions at the predicted rates, and have reacted autonomously as designed to minimize impact to the science downlink.

The communications system was originally designed to meet a 2-year minimum science campaign. Assuming the system and the rest of the spacecraft continue to operate as expected, this mission may be extended to enable the return of further science from the relatively ill-explored Van Allen Radiation Belts.