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Strategies for Rapid Implementation of Interstellar Missions: Precursors and Beyond (4)

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ON BOARD VIRTUAL SOC: AN ENABLING DESIGN FOR SCIENCE OPERATIONS ON DEEP SPACE MISSIONS

Abstract

We present a design that enables missions utilizing today's complex instruments with large data output to return high-quality scientific measurements even when telemetry bandwidth is severely constrained, as would be the case for a mission to interstellar space. Instrument flight software must be stable and, ideally, simple to allow for rigorous verification and validation. Traditionally a selection of flight data is telemetered to the ground and the science operations center (SOC) and instrument teams analyze the data and then uplink instrument configuration data, such as look-up tables, to optimize performance. The challenge of this approach, particularly with low telemetry rates, is that it is difficult to collect enough data, or the right data, to make these decisions and analysis in a timely manner. A possible approach is to make the instrument flight software perform more complicated analysis tasks, but this introduces worrisome complexity that could compromise essential instrument functions.

We answer these challenges by breaking the task into two nearly independent components: the flight software remains simple and robust; the virtual SOC software can become complex with minimal risk since it can function like a human staffed, ground-based SOC in the sense that it can perform its tasks and produce "science output" without impacting instrument health and safety since it only generates information in the form of science data files. For interstellar missions, this approach has the additional attraction that procedures and products can be developed and refined during commissioning and early cruise when bandwidths and solar particle count rates are high.

Spacecraft software developed at the Johns Hopkins University Applied Physics Laboratory uses Goddard's core Flight Executive (cFE) framework and is currently being flown on NASA's Van Allen Probes. The cFE framework supports application level development to schedule and perform software tasks. A new application was integrated with the spacecraft software on Van Allen Probes after launch to increase downlink telemetry volumes with data compression routines. A similar approach would be followed to integrate a virtual SOC application for interstellar missions.