Galileo System Design for Orbital Operations

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ABSTRACT

In April 1991, Galileo's X-band high gain antenna failed to deploy. An alternate approach which utilizes the spacecraft's S-band low gain antenna was conceived and is in development. This approach will enable the accomplishment of at least **70** percent of Galileo's original scientific objectives.

Implementation is to be accomplished in two steps, called Phase 1 and Phase 2, each of which requires Changes to the Galileo Spacecraft software, the supporting ground data system, and mission operations scenarios and procedures. This paper presents an overview of the Galileo mission, briefly describes the changes required to implement the orbital phase (Phase 2) of the Galileo mission, and describes the functional model of the end to end system which was developed to support the systems design effort.

The short development period dictates that the spacecraft system design, the ground data system design, and the operational system scenarios and procedures necessary to conduct the mission be developed concurrently, and places a premium on validating the system designs as early as possible. Additional design complexities introduced by 1) one way light times approaching one hour, which requires much autonomous data handling on the spacecraft, 2) the disparate science data acquisition and telemetry downlink rates, which requires extensive, data buffering on the spacecraft, and 3) the uncertainties introduced by data dependent compression, which results in data volume uncertainties of approximately 2:1, make the performance of the system designs non deterministic.

The validation of the system designs was accomplished with the aid of a commercial simulation product used to implement an end to end functional systems model. The model focuses on the spacecraft instrument data sources, the spacecraft data system, and the tape recorder, the elements of the end to end design that contribute most significantly to the non deterministic nature of the data flow. Questions addressed by the functional model included 1) the performance of the three major rate buffering mechanisms on the spacecraft; the tape recorder, and two random access memory buffers, the multiuse buffer and the priority buffer, 2) the extent of data loss due to buffer over or underflow, discontinuities in the downlink telemetry capability, and ground based science tradeoffs made during the buffer management process, 3) the impact of bit errors, especially on compressed data, in the presence of error containment strategies, 4) data latency, especially of the engineering telemetry data Stream, and 5) identification of the specific elements of the design that could benefit from the development of additional ground based tools to be used in the conduct of the mission.

The functional systems model provided an early means to validate that the approach conceived to meet existing science objectives was indeed feasible within the schedule, spacecraft, and ground resources available to implement the approach.