Galileo Spacecraft Modeling for Orbital Operations

ABSTRACT

by

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The Galileo Jupiter orbital mission using the Low Gain Antenna (LGA) requires a higher degree of spacecraft state knowledge than was anticipated in the primary mission. Kcy elements of the revised design include onboard buffering of science and engineering data and extensive processing of data prior to downlink. In order to prevent loss of data resulting from overflow of the buffers and to allow efficient usc of the spacecraft resources, ground based models of the spacecraft processes will be implemented. These models will be integral tools in the development of satellite encounter sequences and the cruise/playback sequences where recorded data is retrieved.

The changes to the Galileo flight software design are driven by the requirement to match the high data acquisition rates and the desires for continuous data acquisition with the reduced ability of the spacecraft to relay that data to the ground. Key features of that design arc switching to an optimized packet telemetry system to eliminate the inherent data redundancy of Time Division Multiplexed (TDM) telemetry, implementation of prioritized onboard data buffering schemes to allow efficient storage and return of the data, sophisticated data compression and editing to reduce downlink data volume and implementation of a flexible and partially autonomous process to control the playback and editing of recorded data, The complexity of the implementation and the interrelationship of the data collection, playback, editing, buffering and downlink requires selected modeling capabilities to predict the state of the data system at any given time. Additional modeling complexity is added given uncertainties in the data compression efficiencies, positional accuracies oft hc Dat a Memory System (DMS - Tape recorder) and spacecraft telecommunications link performance.

This ground based modeling will provide necessary tools to allow planners to control the data acquisition and editing processes on the spacecraft. The flight software design provides no onboard autonomous adjustment ofrcal-time data acquisition rates or playback data editing/selection. As a result, all real-tirnc data acquisition rates and data editing/compression must be controlled via stored sequence. The desire is to have data acquisition respond to science opportunities independent of the concurrent telecommunications link capability. This decoupling of data acquisition and downlink has resulted in the buffering scheme now being implemented. Balancing the data input flow resulting from observation opportunities and the data output flow dictated by telecommunications link capability requires control of the spacecraft resources in novel (for Galileo) ways. Thus the data flow on the spacecraft must be modeled carefully to assure efficient usc of the buffer resources, avoiding overflow or underflow of the buffers. The ground modeling will also provide an efficient method of understanding changes in capabilities which arc likely to arise throughout the mission, and allow analysts to rapidly find solutions to data flow problems that may result. These solutions may then be implemented on the spacecraft, either by modifying a planned sequence prior to its being sent to the spacecraft, or by changing an existing sequence as it is being executed.