Galileo Constellation Simulator

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The Galileo constellation is a European Global Navigation Satellite System that will provide an open service complementary to the Global Positioning System (GPS), giving high-accuracy real-time positioning to users world-wide. The first 4 Galileo satellites are planned to be launched in 2010, with the full deployment of 27 satellites plus 3 in-orbit spares planned for several years later.

The Galileo Constellation Simulator (CSIM) will be used to support the operations preparation, training and ground segment validation for the Galileo constellation. CSIM is required to support the initial In-Orbit Validation (IOV) constellation (4 spacecraft) and the full evolution of the constellation for the planned 20 year lifetime. This means it has to be scalable to support the simultaneous simulation of up to 6 spacecraft with high-fidelity onboard processor emulations, plus up to 45 spacecraft simulated at a lower fidelity (to cover replenishment and in-orbit spares, as well as the nominal constellation). It will also support up to 5 different ground stations supporting concurrent telecommand and telemetry links to up to 5 spacecraft at any one time. This scalability brings unique challenges to the design, development and end-use of CSIM.

The high-fidelity spacecraft models will be used for exercising operations procedures when the spacecraft is in ground contact. The lower fidelity spacecraft models are mainly intended to load the mission control system as they come into ground contact. They will accept uplinked telecommands and generate housekeeping telemetry, but will not be required to perform accurate modelling of AOCS functions. For a number of reasons, the lower fidelity spacecraft model is being developed based on the QERC block translation emulator of the ERC32 onboard processor, as opposed to functional models. This approach obviates the need to maintain a large number of different functional models, potentially a different functional model for each spacecraft in the constellation. In addition, the performance offered by QERC means that the hardware required to model the full constellation of 30+ spacecraft is minimized.

The performance required to run the onboard software in real-time within a processor emulator requires the satellite models to be distributed on several server machines, coordinated from a single workstation. Distribution solves the system performance issue, but brings its own challenges as far as managing and synchronizing the overall simulation, saving/restoring the simulation state quickly and efficiently, and logging events in the simulation. It is essential that the User sees a single coherent simulation and does not need to be concerned with the details of how the models are distributed.

In this paper, we discuss the progress in development of CSIM that been made to date, addressing the technical challenges outlined above.