

## Study on validity of distributed simulation techniques for spacecraft simulations

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We have been developing a spacecraft simulation environment(SPLISE) based on object-oriented design. The simulator consists of models of the hardware components, numerical solvers for dynamics, thermal, communication and power analysis, and simulation environment including DB and GUI. The simulator should be useful to optimize satellite concept designs, verify the designs and reuse the simulation models as well as to shorten development cycles. Moreover, on-board models verification (on-board software, hardware-in-the-loop) can be performed using the system. One of the functions of the system enables distributed simulations for distributed parallel developments between the core bus system models and the mission system models, to distribute the CPU load of the solver, and for the hardware-in-the-loop simulation.

We have examined a distributed computing middleware, HLA/RTI(High-Level Architecture/Run-Time Infrastructure) and HORB(Hirano's Object Request Broker), to evaluate the functions and performance for using in SPLISE. HLA/RTI was proposed by DMSO(Defense Modeling and Simulation Office), USA, which has been achieved satisfactory results also by ESA(European Space Agency) and the related enterprises. HORB is a Java based middleware which has been successively used in embedded real-time systems as robotics. The middleware should be equipped the functions of synchronized as well as asynchronous data transfer for our spacecraft simulations. Very short delay time by the middleware is important for real-time hardware-in-the-loop simulations. It is required a little modification on the simulation codes or on-board software for applying the middleware. We discuss the validity of the middleware on the results of benchmark tests and sample applications.