Advanced Simulation System Design Process for LunarSat

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The classic approach for developing the attitude control system separates the simulation tools used for the different phases of a space mission is:

- During Phase 0 to A normally static calculations are done to choose the basic configuration of the ADCS and to asses its performance parameters. A selection of the most probable options for the layout is presented.
- During Phase B to C design tools like Matlab/SIMULINK or MatrixX are used for dynamic simulations of the spacecraft, development of the control algorithms and for obtaining the performance of the system.
- In later phases the information from the design stage of the mission is used for real-time operations simulators like ROSE, EuroSim or SimSat. They are used to provide information for the mission operations team and to allow for training of the operations staff.

Unfortunately the models used in these 3 development stages are separated from each other. In this presentation a proposal for an advanced approach to this problem is presented which provides a tool chain to support the mission from its start to the end. No information would be lost between the different phases and no information needs to be transferred to the different tools manually. It would be even possible to have a basic dynamic satellite simulator from the very beginning of a mission initialised with the design data from the tools used during phase 0 to A.

The proposed software infrastructure features the following components:

- The core of the whole infrastructure is MuSSAT which is a concurrent engineering tool developed at the Division of Astronautics for Dornier Satellite Systems that supports teams to create spacecraft configurations during Phase 0 to mid-Phase B. At the backend, a database stores all information gathered. The tool only provides capabilities for static simulations.
- For dynamic simulations Matlab/SIMULINK is used. A link between the two software tools needs to be developed to allow for a creation of a basic dynamic simulator configuration for Matlab/SIMULINK. In a first approach the information flow will only be supported from the lower to the higher phases of a mission. In future versions a feedback mechanism from the dynamic simulation to the design tools will be provided. All necessary information is stored in the centralised database backend of MuSSAT.

- For the real-time simulations the Matlab/SIMULINK simulations will be compiled and downloaded on a target environment with specialised real-time hardware. This real-time hardware can be enhanced with a variety of interfaces to be able to connect most of the currently available space hardware to the simulator. While this step is not automated the consistent tool chain would allow a much easier and faster development of the real-time simulator.

This paper provides an overview of the suggested new approach and presents the advantages of this solution, including:

- Much faster development cycle of the simulators needed for a space mission
- One iteration step takes significantly less time and therefore costs
- Consistent tool chain reduces information losses during the transition from one phase to the next
- Feedback from dynamic simulations are already possible in very early stages of the development and prevents errors that otherwise might be discovered very late in the development process
- Lessons learned during the development cycle can be reused for future missions