An Efficient Modeling and Execution Framework for Space System Development
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Abstract
In this paper, we present different modeling and execution frameworks that allow us to efficiently analyze, design and verify Low earth orbit satellite space systems, mainly to cope with the specific concerns of the Real-time and embedded systems (RTE) domain. First we depict a Simulink based methodology for executable RTE systems modeling with a framework and its underlying model transformations required to execute SysML models conforming to the ECSS standard. The advantages of adopting a more generic action language with formal features are highlighted, in order to raise the level of abstraction with formal features. Then, we investigate how it can be made to represent faithfully SysML periodic/aperiodic tasks communicating through event or data ports, in an approach to end-to-end flow latency analysis. An analytical framework allows us to optimize port-based communication by generating a run time executive that utilizes shared data areas where appropriate, while ensuring the timing semantic assumed by the control application. We show how a SysML model transformation provides a formal model for model checking activities and we suggest that model transformation provides useful support to improve the integration of formal verification in a space engineering process. As a case study we use an implementation of a satellite attitude determination algorithm.

Introduction
SysML is a language of System Engineer Figure 1 shows the basic diagrams: Requirement, Structure and Behavior which are reflected to satellite function tree, product tree and requirement.

ECSS Standard
ECSS standard is used to define satellite system parameters in a simple parametric method. Parametric diagram in SysML can be used to make this implementation. Figure 2,3 shows the relation between function tree and product tree.

Concurrent Design Center software
Figure 4,5 below show CDC interface between Excel, Matlab, STK and embedded platform.

Case Study
Activity diagram by Figure 6,7 show how to interface with Thruster model AOCS algorithm as a case study. NADIR DEMOSAT PHASE AOCs THRUSTERX OFF NADIR DEMOSAT PHASE AOCS THRUSTERX ON

Results
Figure 9 shows the ability to trace the parameter as requirements diagram, parametric diagram, structure diagram and embedded model behavior in embedded X86 target platform.

Figure 10 shows the torque threshold needed to switch on the thruster against attitude error should be minimum to optimize the hydrazine volume.

Conclusion
A demonstration of SysML capability is presented and as a case study we use an implementation of a satellite attitude determination algorithm. Future work will demonstrate all satellite subsystems which is based about 1000 satellite system requirement parameters.

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