RFP/RFC for Platform-independent Integration of SysML with Physical Interaction and Signal Flow Simulation Tools

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Overview

- Review
  - Motivation and approach
  - Physical interaction and signal flow simulation overview
  - RFP/RFC summary
- Recent updates
- Questions / Discussion
- Summary
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Physical Interaction and Signal Flow Simulation Language Integration

- Covers multiple engineering disciplines.
- Fewer languages involved.

SysML

PI & SF simulation languages & tools
Cruise Control Example

- Signal flow:
  - Desired speed
  - Fuel intake control
  - Wheel rotation rate

- Physical interaction:
  - Between air & car (linear momentum)
  - Between gravitational field & car (linear momentum)
  - Between wheel and car (angular momentum converted from/to linear via road)
  - To rolling resistance (angular momentum converted to heat)

- All flows modeled with rate & potential, regardless of what is flowing.
Reduce Specialized Mappings

- Extend SysML with a general simulation profile.
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RFP: Objectives and Other Specs

- **Objective**
  - Extension of SysML supporting tool-independent integration with physical interaction and signal flow simulation models.

- **Relationship to other specifications**
  - **Modelica** is a simulation platform. OMG SysML-Modelica is a PSM.
  - **FMI** is for integrating executable simulation code, rather than system models and simulation models.
RFP: Mandatory Requirements

- Stereotypes, textual equation syntax, and model libraries.
- Bidirectional mappings.
- Examples for widely-used simulation languages.
RFC: Stereotypes

```
«metaclass»
Property

«stereotype»
SimProperty
referTo : FlowProperty

«stereotype»
SimConstant
isContinuous : Boolean = true
isConserved: Boolean = false
changeCycle: Real = 0

«stereotype»
SimBlock

«stereotype»
Block
```
RFP: Optional & Evaluation

- **Optional features**
  - Stereotypes for simulation inputs, solver directives, mappings for additional SysML constructs.

- **Evaluation**
  - More widely used simulation platforms.
  - More concepts from these platforms.
  - Textual equation syntax close to those platforms.
  - Fewer and less complicated stereotypes.
  - Provide more optional features.
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Updates: RFP / RFC

- **RFP**
  - Small refinements.

- **RFC / Submission**
  - Brief tutorial
  - Signal flow example in Simscape.
  - Array / matrix support.
  - Fixes from testing (see implementation)
  - XMI files

Updates: Implementation

- Automated translation based on RFC
  - OMG-compliant SysML XMI to Modelica and Simulink / Simscape input files.
- MagicDraw plugin for running it.
- Brief MD-specific tutorial.
- This is not a recommendation regarding systems or simulation modeling tools.
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Question: RFP or RFC?

- **RFP**: Vendors develop their own submissions in coordination with supporters.
  - NIST would contribute its work.

- **RFC**: Comment on draft RFC until it’s ready to vote on.

- **Timeline**: Either way, vote in March is feasible.

- **Recommendation?**
Discussion: Mapping Formality

- Formal mappings (eg, QVT), require standard simulation models.

- SysML-Modelica’s has only UML diagrams
  - MOF metamodel is non-normative and not used in the transformations.

- Proprietary platforms (Simulink / scape).
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Summary

▪ SysML extension for physical interaction and signal flow simulation.
  – Including equation syntax and libraries.
  – Simulation platform-independent.
▪ Platform-dependent mappings and examples of their application.
▪ Mapping implementation available.
▪ RFP or RFC?
More Information

- Draft RFP, RFC, implementation:
- OMG SysML Portal
  - SysML Extension for Dynamic Simulators
- Conference paper available (draft journal paper on request).
- Followup telecon TBD.