

Enabling System Design and Analysis Integration using a SysML Parametrics-based Solver Manager

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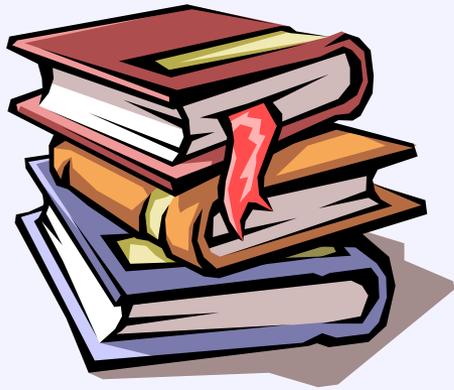
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Abstract

Collaborative design & analysis of complex systems requires an open standards-based framework that: (1) provides flexible control & fine-grained integration of multiple analysis models to system design models and databases, and (2) enables system & domain engineers to plug-and-play their design & analysis models formulated in COTS tools. OMG SysML is rapidly emerging as the open standard for representing & integrating system design and analysis models. Parametrics (subset of SysML) provides the constructs to model fine-grained relationships between model parameters. In this presentation, a conceptual model of such a framework—founded on SysML & other open standards—will be presented. A Parametrics-based Solver Manager (SM) is presented as the first tool in this framework. SM interfaces SysML modeling tools (e.g. MagicDraw) with math solvers (e.g. Matlab/Simulink & Mathematica) and spreadsheets thereby enabling requirements verification and system validation.

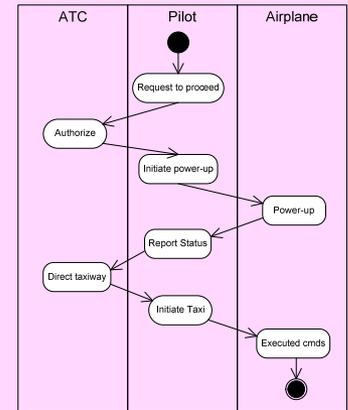
Model-based Systems Engineering

Past



- ◆ Specifications
- ◆ Interface requirements
- ◆ System design
- ◆ Analysis & Trade-off
- ◆ Test plans

Future



Moving from Document-centric to Model-centric

SysML for Model-based Systems Engineering

- ◆ A graphical modelling language in response to the UML for Systems Engineering RFP developed by the OMG, INCOSE, and AP233
 - a UML Profile that represents a subset of UML 2 with extensions
- ◆ Supports the specification, analysis, design, verification, and validation of systems that include hardware, software, data, personnel, procedures, and facilities
- ◆ Supports model and data interchange via XML Metadata Interchange (XMI®) and the evolving AP233 standard (in-process)

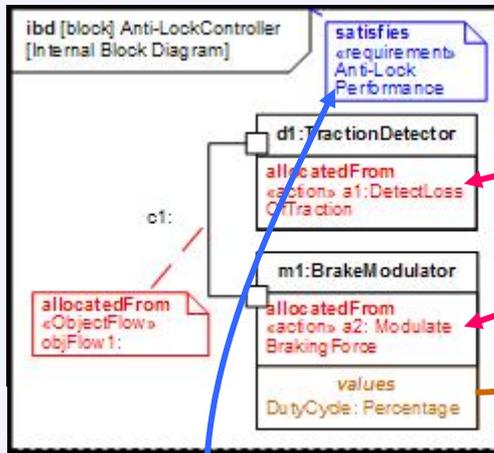
SysML is Critical Enabler for Model Driven SE

What is SysML?

- ◆ ***Is*** a visual modeling language that provides
 - Semantics = meaning
 - Notation = representation of meaning
- ◆ ***Is not*** a methodology or a tool
 - SysML is methodology and tool independent
- ◆ Provides a language to express the information and knowledge generated and processed during the application of a systems development methodology

SysML: Integrating Different Aspects of Systems

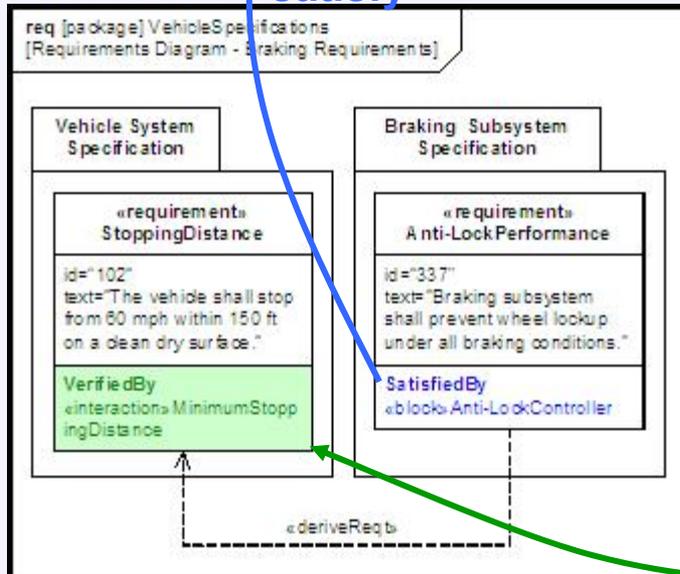
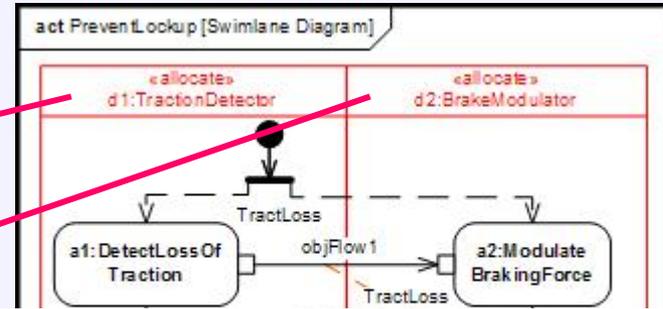
1. Structure



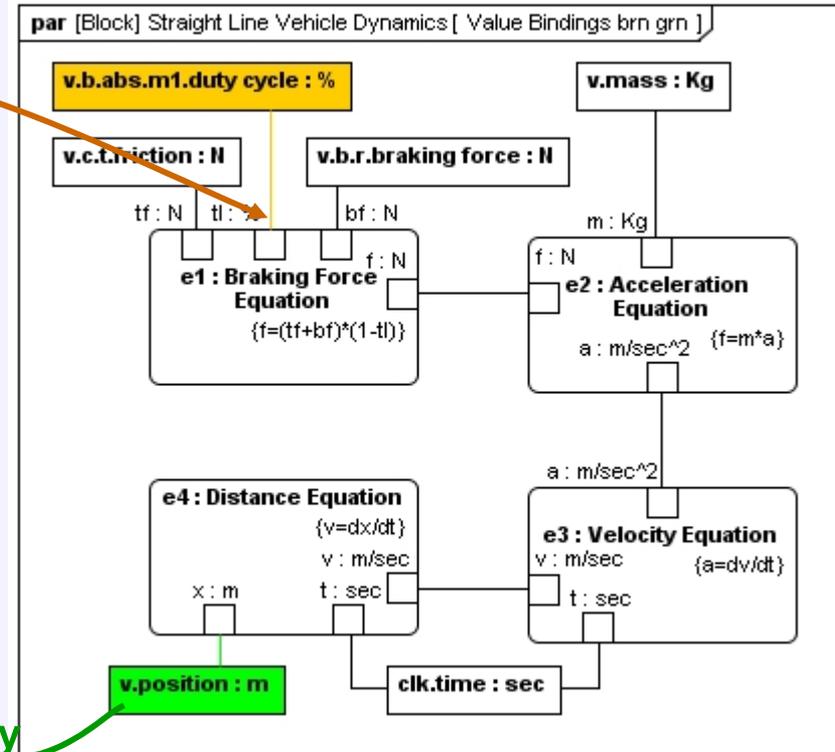
allocate

value binding

satisfy



Verify
(via interaction)



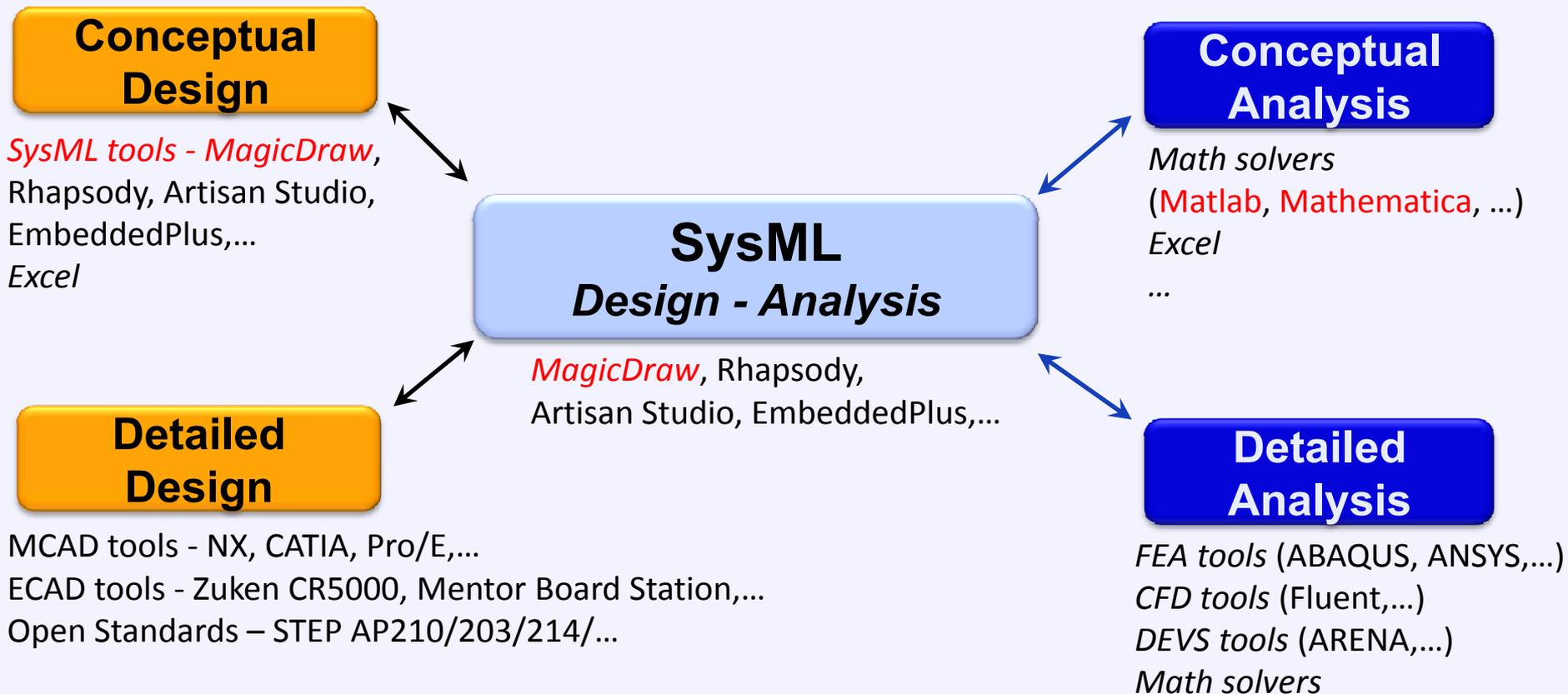
2. Behavior

4. Parametrics

I have a SysML model, what next?

- ◆ Can I execute it?
- ◆ Can I automatically verify my requirements?
- ◆ Can I perform trade studies and optimization?
- ◆ Does it connect to domain models?
 - Math models (Excel, Matlab, Mathematica,...)
 - CAD/CAE models (NX, Zuken, ABAQUS,...)
 - Simulation models (ARENA, STK,...)
 - Cost models
 - Project planning and scheduling

Collaborative Modeling and Simulation



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InterCAX Proprietary Information

ParaMagic™

- ◆ Available as a plugin for MagicDraw (SysML tool)
- ◆ Makes SysML models executable
 - Structure and Parametrics (focus in first generation)
 - Connects to [Mathematica](#), [Matlab/Simulink](#), [Excel](#)
- ◆ ParaMagic™ releases
 - [16.0 \(Apr 2009\)](#)
 - 15.x series (Jul 08 – Jan 09)
- ◆ ParaMagic™ download
 - www.magicdraw.com/paramagic
 - 30-day free evaluation period
 - Mathematica test server available during evaluation

- Product Info
 - What is MagicDraw
 - New and Noteworthy
 - Features
 - MagicDraw Online Tutorials
 - What Edition Do I Need?
 - Screenshots
 - System Requirements
 - Samples
 - MagicDraw Add-ons
 - Teamwork Server
 - DoDAF Plugin
 - SysML Plugin
 - Cameo DataHub
 - Cameo SOA+
 - UPDM Plugin
 - EA Importer Plugin
 - MagicRQ Plugin
 - MagicDraw RSXConverter
 - MagicDraw PCConverter
 - ParaMagic Plugin**
 - Merge Plugin
 - Methodology Wizards
 - SPEM Plugin
 - MARTE Profile
 - Data Modeling Notations Plugin
 - CSV Import Plugin
 - Other Products
 - Cameo Suite
 - Cameo Requirements+
 - Cameo Business Modeler
 - Third Party Add-ons
 - UML4ODP Plugin
 - What's New
 - Key Benefits



MagicDraw UML Training

Maximize your MagicDraw potential!

Our instructional courses quickly get your team up to speed on dynamic MagicDraw functionalities... [Learn more >>>](#)

ParaMagic® Plugin

ParaMagic(TM) plugin makes MagicDraw SysML models come alive! Using the quantitative information and constraint relationships displayed in SysML diagrams, model-builders can run simulations from the earliest stages of system design. In traditional domains of system engineering like aerospace and transportation, users can explore system performance, estimate cost and allocate resources. Developers leveraging MagicDraw's DoDAF and business modeling capabilities can add parametric simulation using SysML submodels for defense planning, business process analysis and computational finance.

ParaMagic® 16.0 Release

ParaMagic™ 16.0 offers a dramatic expansion of the power of SysML parametric simulation, allowing users to integrate Microsoft Excel®, MATLAB®/Simulink® (The MathWorks, Inc.) and Mathematica® (Wolfram Research, Inc.) into their MagicDraw SysML models. With these new capabilities, users can

- Incorporate existing simulation models created in MATLAB and Simulink
- Automate data transfer between Excel spreadsheets and MagicDraw models
- Add powerful Mathematica graphing functions to their simulations.

Building parametric models for simulation and requirements checking is easier than ever, now that legacy models and data, created and validated with many man-years invested, can be exploited within a modern systems engineering framework.

ParaMagic and MATLAB

The ParaMagic-MATLAB connection wraps MATLAB script and function M-files as constraint blocks for use in ParaMagic's parametric solving process. This includes wrapping and executing Simulink models that are invoked using script M-files. Now existing Simulink models can pull inputs from the SysML model, execute the Simulink model at the correct stage in the parametric solving process, and output results back into the MagicDraw model.

ParaMagic and Excel

The ParaMagic-Excel connection enables users to read and write SysML instance slot values from MS Excel spreadsheets. Data from multiple workbooks and worksheets can be written in to a single SysML model before parametric calculations are executed and the parametric results can be written back to the spreadsheets. Engineers and analysts used to working on individual spreadsheets now have a collaborative tool to synchronize their efforts using the best model-based systems

Demos

◆ Satellite

- Power and weight budget for a satellite
- Basic illustration of using ParaMagic & SysML Parametrics

◆ Home Heating

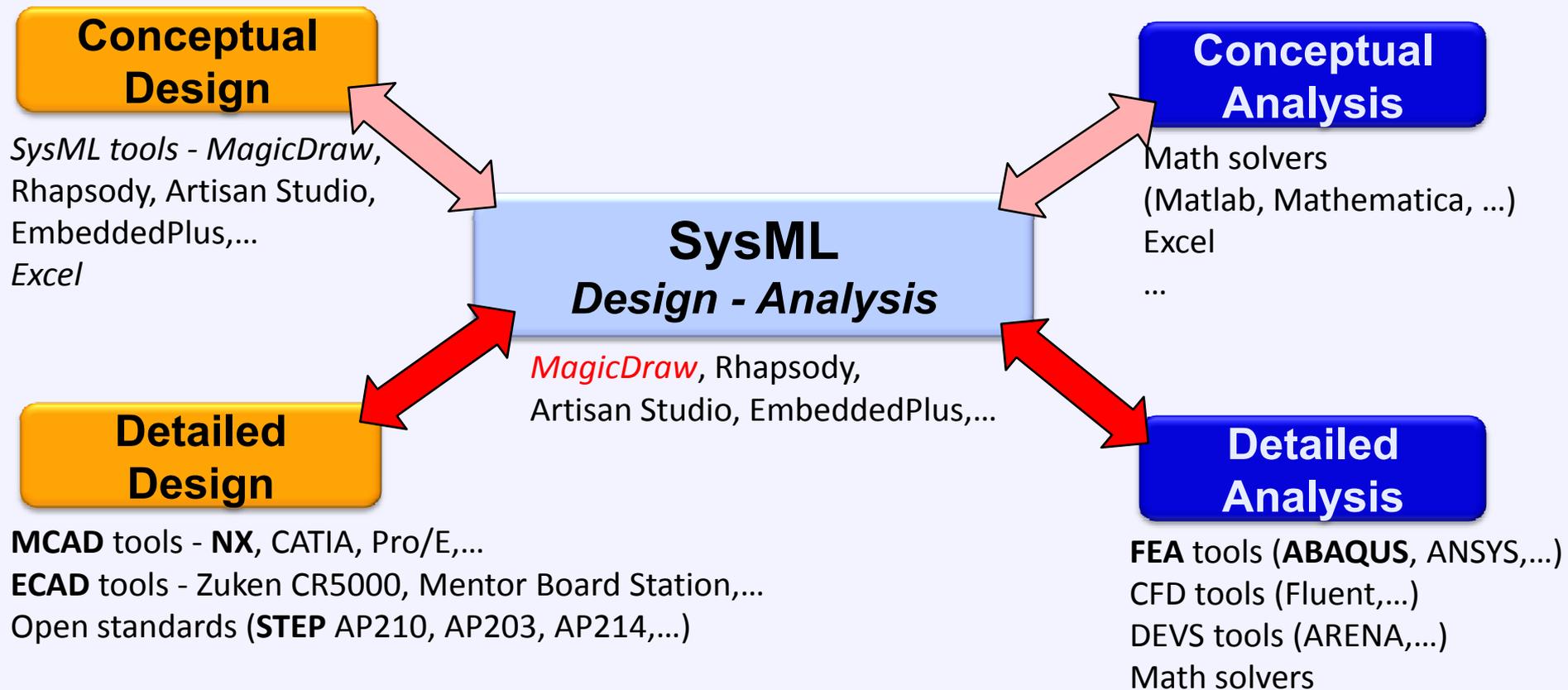
- Cost of heating a home over time
- Connection to Matlab/Simulink models

◆ Examples/Tutorials with ParaMagic 16.0

- Orbital, UAV, Mechanical Parts, Circuits, ...
- Banking, Trade Finance, Project Planning, ...

NASA SBIR Phase 1

End-to-End Mission Design & Analysis



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InterCAX Proprietary Information

Questions / Comments

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