

FMI experience at ZF – Progress in MAP „System Structure and Parameterization“

Jochen Köhler, Michael Kübler

ZF Friedrichshafen AG



1. Introduction ZF
2. Use-cases for FMI in ZF
3. Applications in ZF
4. FMI becomes ZF-Standard
5. Motivation / Planning MAP System Structure and Parameterization
6. Defined Use-cases
7. The SSD approach
8. First prototypes

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Corporate Structure ZF Friedrichshafen AG



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Commercial Steering Systems

Occupant Safety Systems

Electronics

Body Control Systems

Engineered Fasteners & Components

Parts & Service

Electronic Systems

ZF Services

THE POWER OF²

Key figures



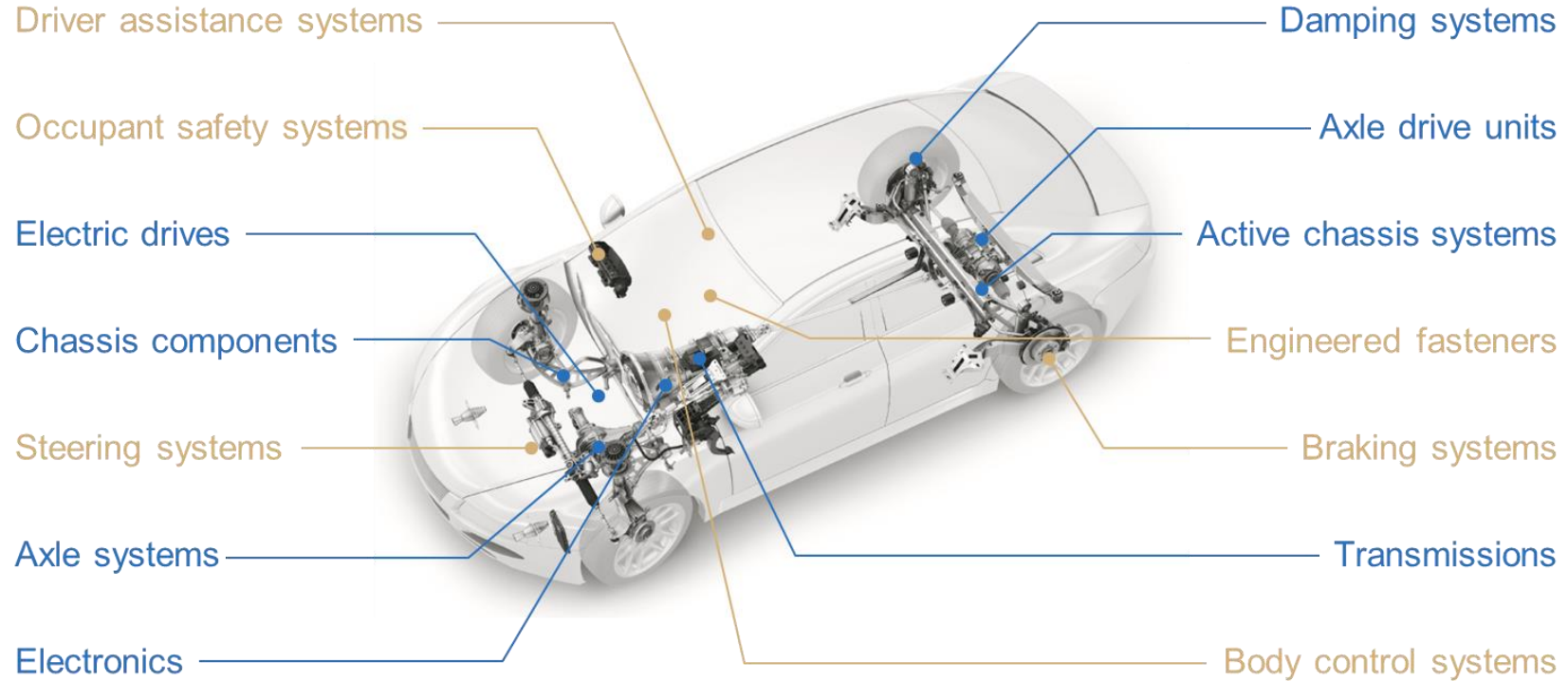
The new ZF Group – An Overview

	ZF (incl. TRW)	ZF	TRW
Sales	> € 30 billion	€ 18.4 billion	€ 13 billion
Employees	134,000	71,000	63,000
R&D expenditure	€ 1.6 billion	€ 891 million	€ 720 million



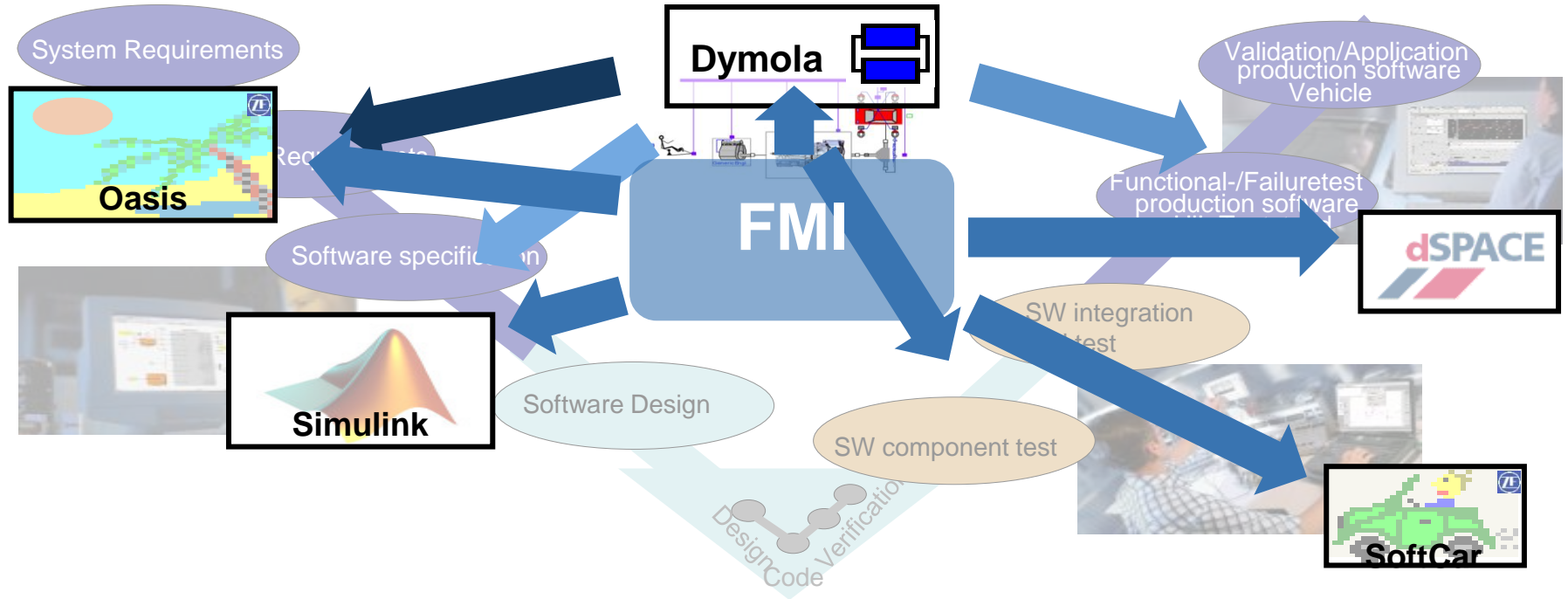
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Product Portfolio



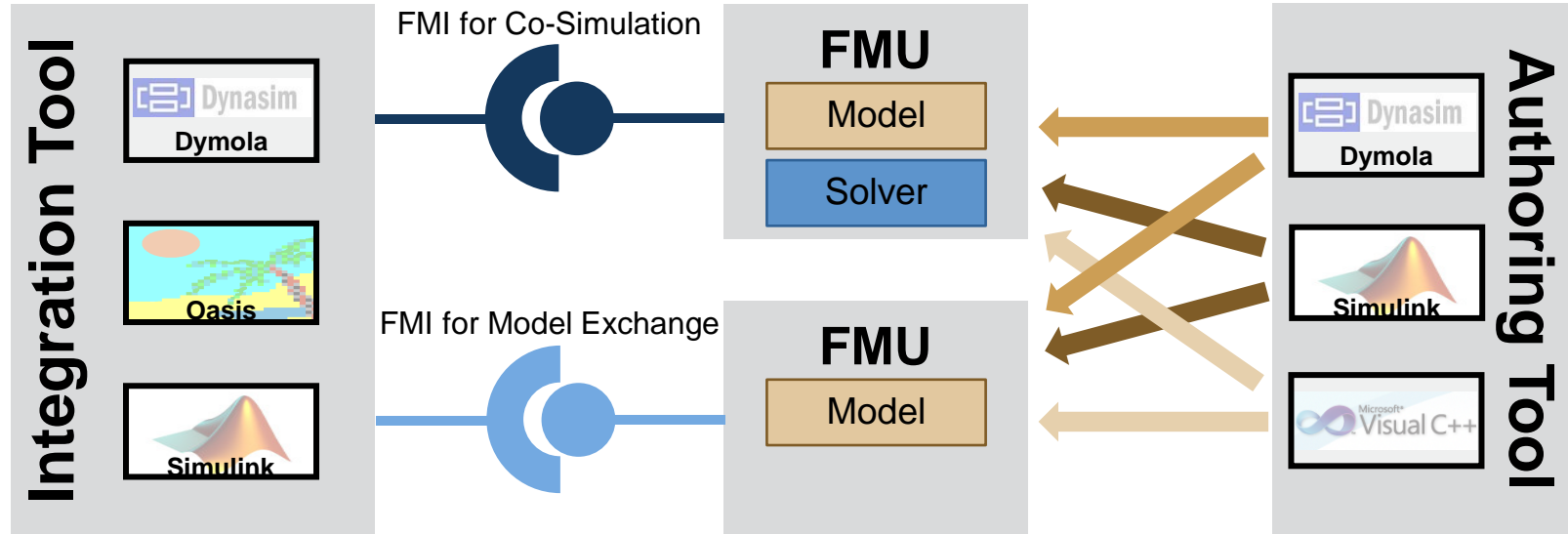
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How to test ECU Software with Modelica-Models

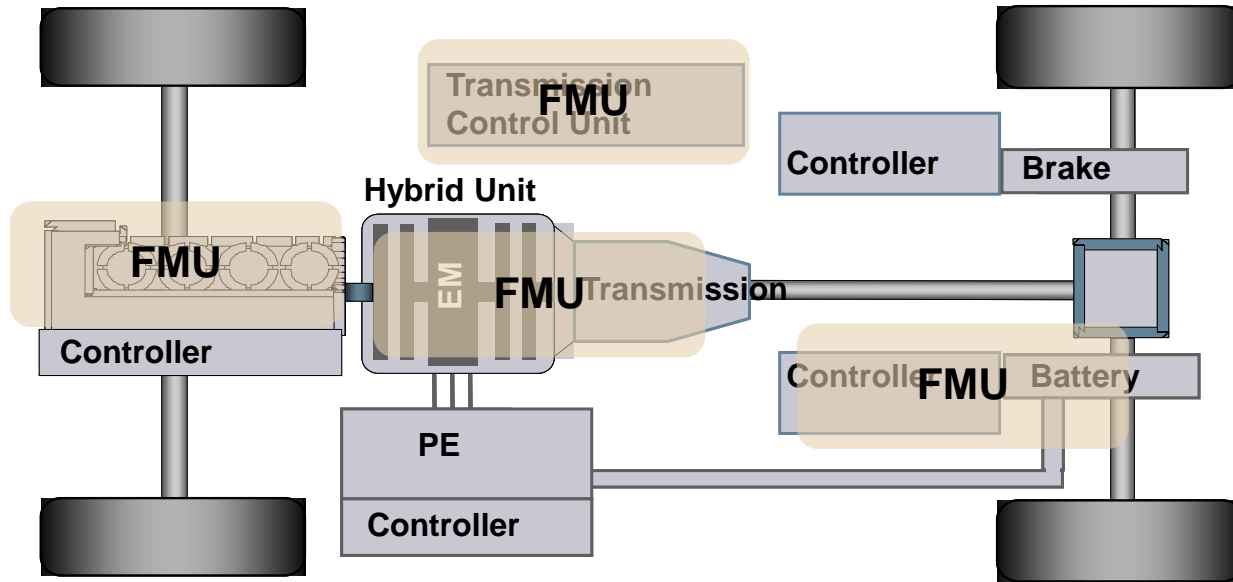


FMI is standardizing model exchange !

Generating FMUs only once for several Targets



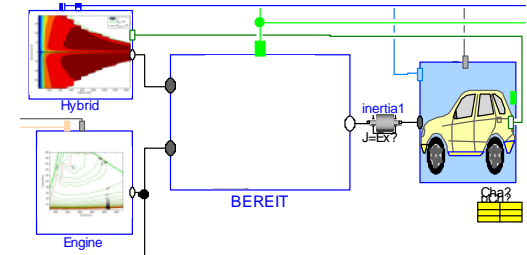
Modularization on cycle-simulations



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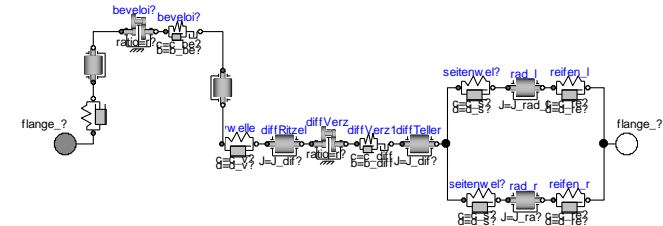
■ **Software model** RangeExtender for PKW

- Modeling with Modelica
- Import as co-simulation-FMU in Softcar



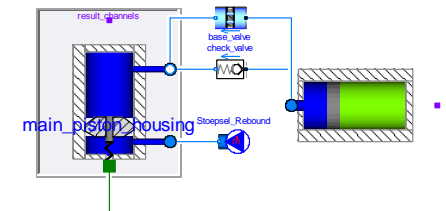
■ **Oscillation model 8HP for SIL**

- Software development for shifting 3-2
- Rebuild of DRESP-models in Modelica
- Import as co-simulation-FMU in Softcar



■ **Damper model for racing car application**

- Detailed model in Modelica
- Export as co-simulation-FMU for external customers



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Making FMI being a ZF-Standard



Proceeding

- Validation of FMI (2013-2014)
- Including FMI functionality into in house tools (Softcar, OASIS)
- Evaluation of FMI (2015-2016)
 - High level of experience in central research with very good results
 - Finding other teams that want to evaluate FMI
- Developing a Directive for FMI as ZF Standard (2016)



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Motivation for initiating MAP System Structure and Parameterization (SSP)

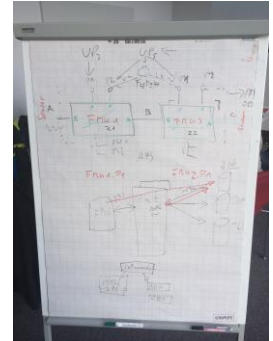


Origin of SSP

- Workshop with BMW, Bosch, ZF 02/2014 – Collecting “missing” features around FMI standard
- Presentation “Proposal for a standardized parameterization of FMUs / Models” and “FMI Mapping” on Modelica-Conference (2014, Lund)
- Initiating the Modelica-Association Project “System Structure and Parameterization”

Purposes of MAP-SSP

- Define a standardized format for the connection structure for a network of components.
- Define a standardized way to store and apply parameters to these components.
- The developed standard / APIs should be usable in all stages of development process (architecture definition, integration, simulation, test in MiL, SiL, HiL).
- This work in this project shall be coordinated with other standards and organizations (FMI, ASAM, OMG).



Working schedule

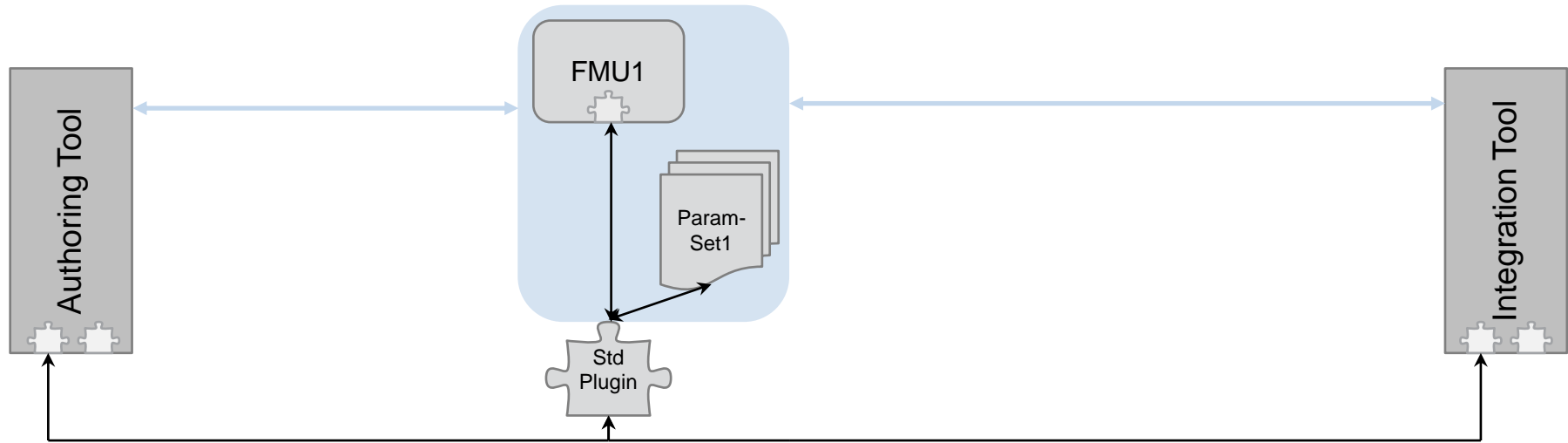
- Draft definition of data model for system structures exists (as XML schema). ✓
- Representative reference system structure is defined. (✓)
- FMUs are exported from different generators.
- At least two running prototypes (with co-simulation) exist for exchanging application packages in a round trip use-case based on the draft definition.
- Draft definition of data model for parameter sets exists. ✓



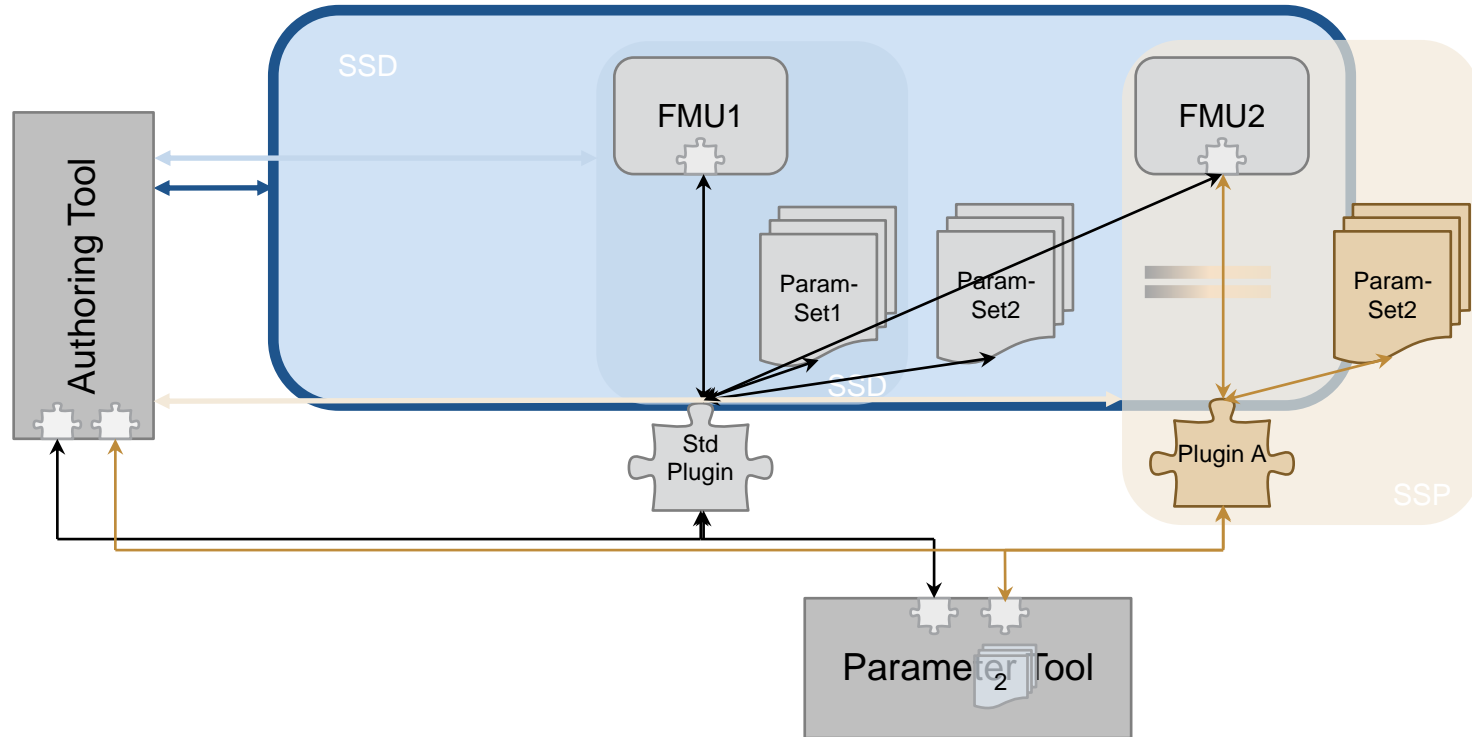
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- ■ **UC 01 Exchange of one FMU / Model with multiple different Parameter Sets**
- UC-03 Exchange of Parameter Sets with Restricted Visibility / Changeability of Parameters
- UC-04 Encryption and Authentication of Parameter Sets
- **UC-05 Describing parameter sets for system architecture**
- UC-06 Handling parameter sets independently from FMUs/Models
- UC-07 Use of one parameter set for parameterization of several FMUs
- UC-08 Meta information for parameters
- ✓ ■ **UC-09 Describing a system structure**
- **UC-10 Handling different parameter set formats**
- ■ **UC-11 Handling parameters within an authoring tool**
- UC-12 Providing parameters sets for simulation
- UC-13 Standard parameter handling plugin
- ■ **UC-14 System architectures with signal-adoption-layers**
- ■ UC-15 Parameter Data Model

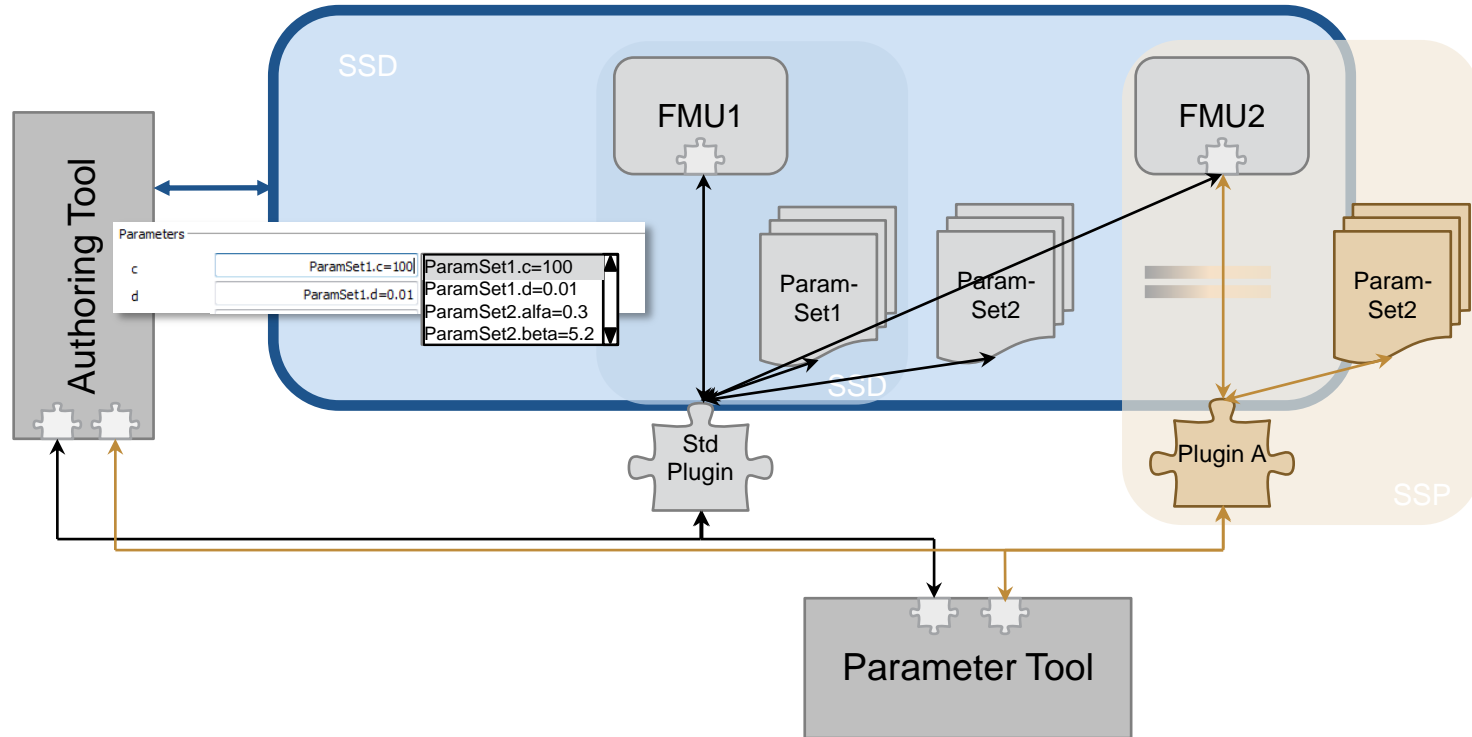
Exchange of one FMU / Model with multiple different Parameter Sets



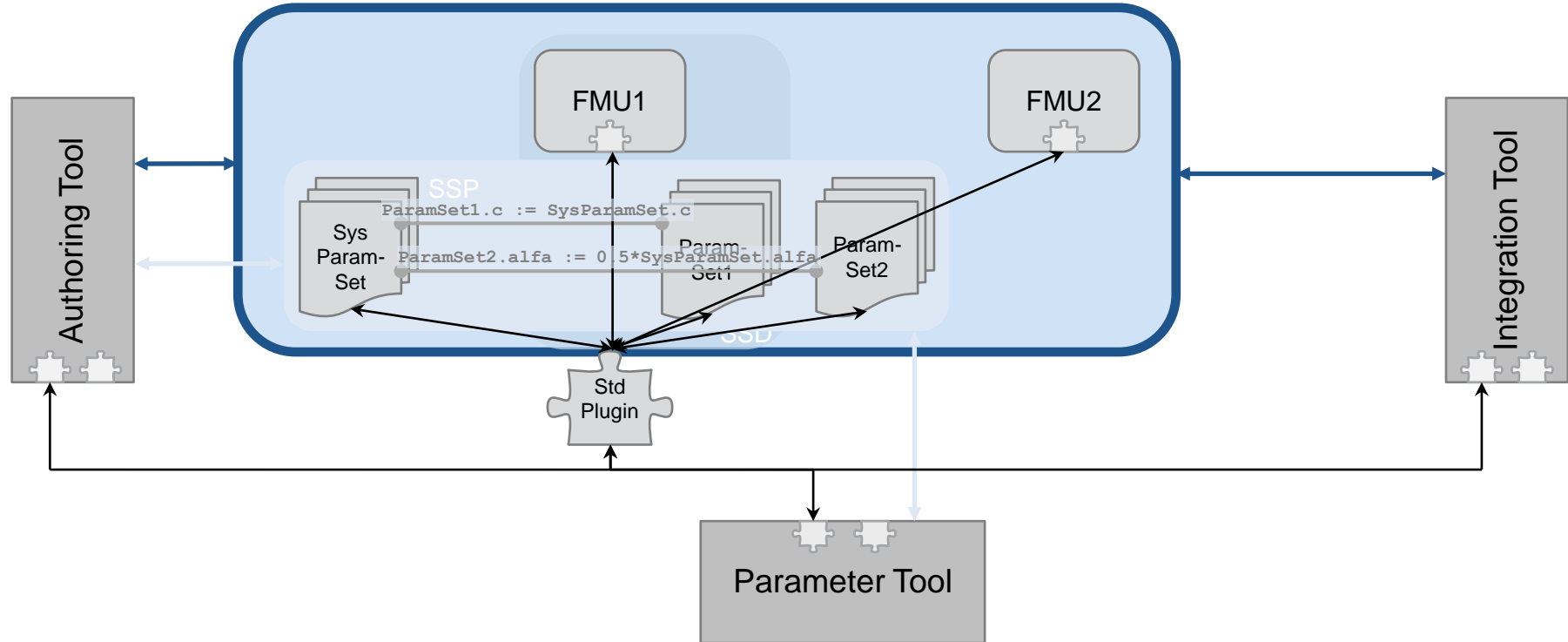
Handling different parameter set formats



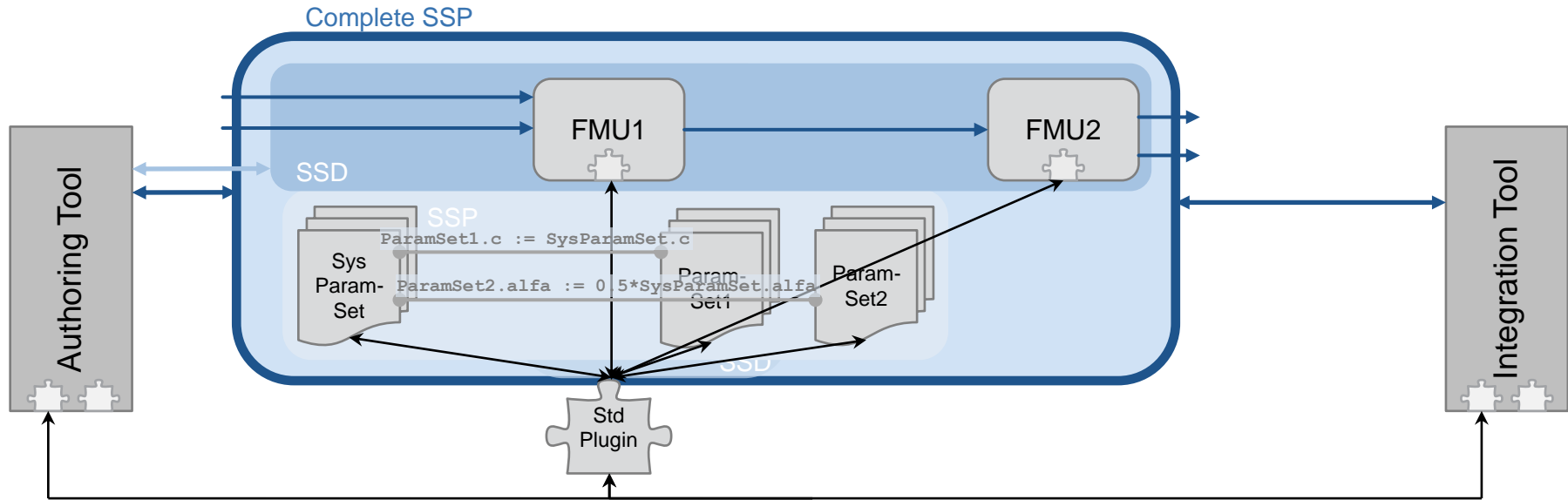
Handling parameters within an authoring tool



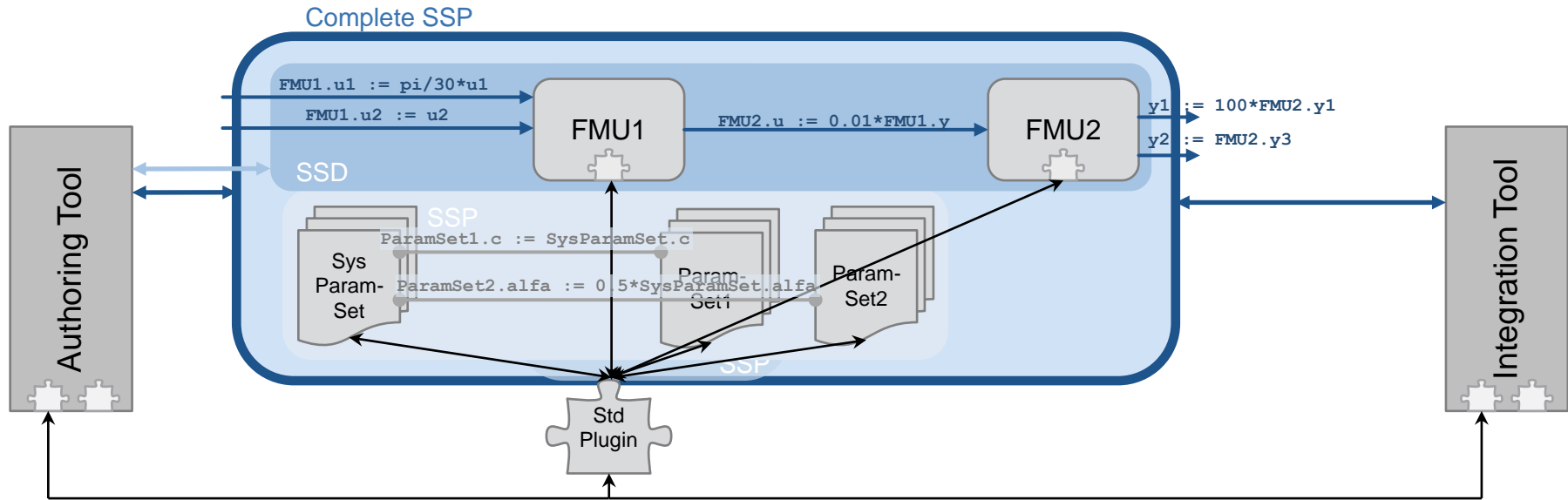
Describing parameter sets for system architecture



Describing a system structure



System architectures with signal-adoption-layers



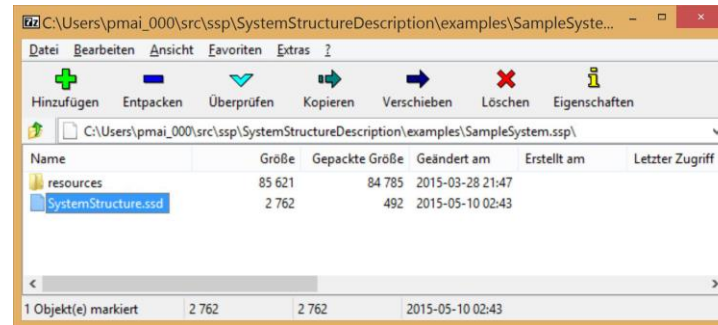
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Design Goals

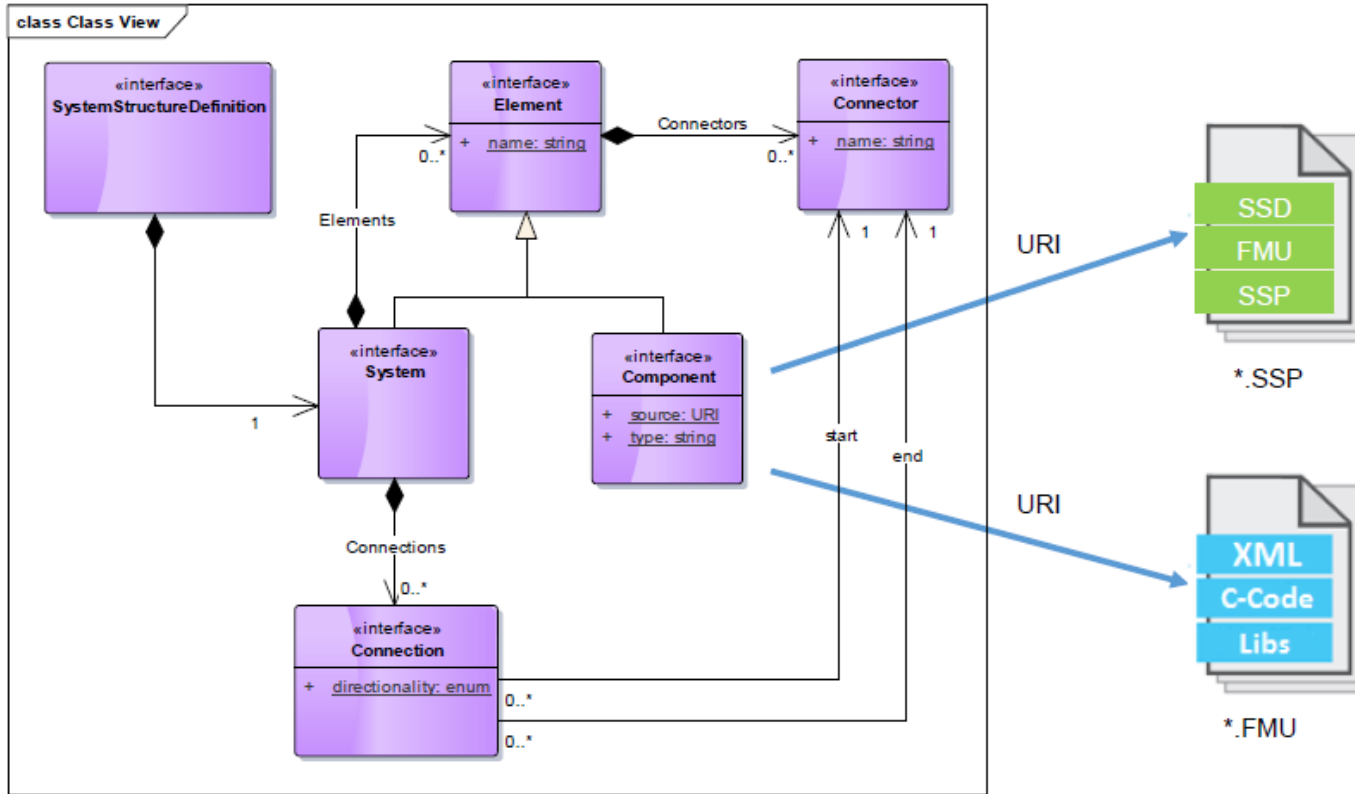
- Minimize additional semantics, rely on FMI as far as possible
- Fit into FMI world (use FMI-like design choices where reasonable)

System Structure Package (SSP)

- SSP is a „ZIP“ container with standardized content (**S**ystem **S**tructure **P**ackage)
- 'SystemStructure.ssd' is main system structure description file
- Referenced FMUs, SSPs, etc. packaged in resources directory



Basic Data Model (UML)



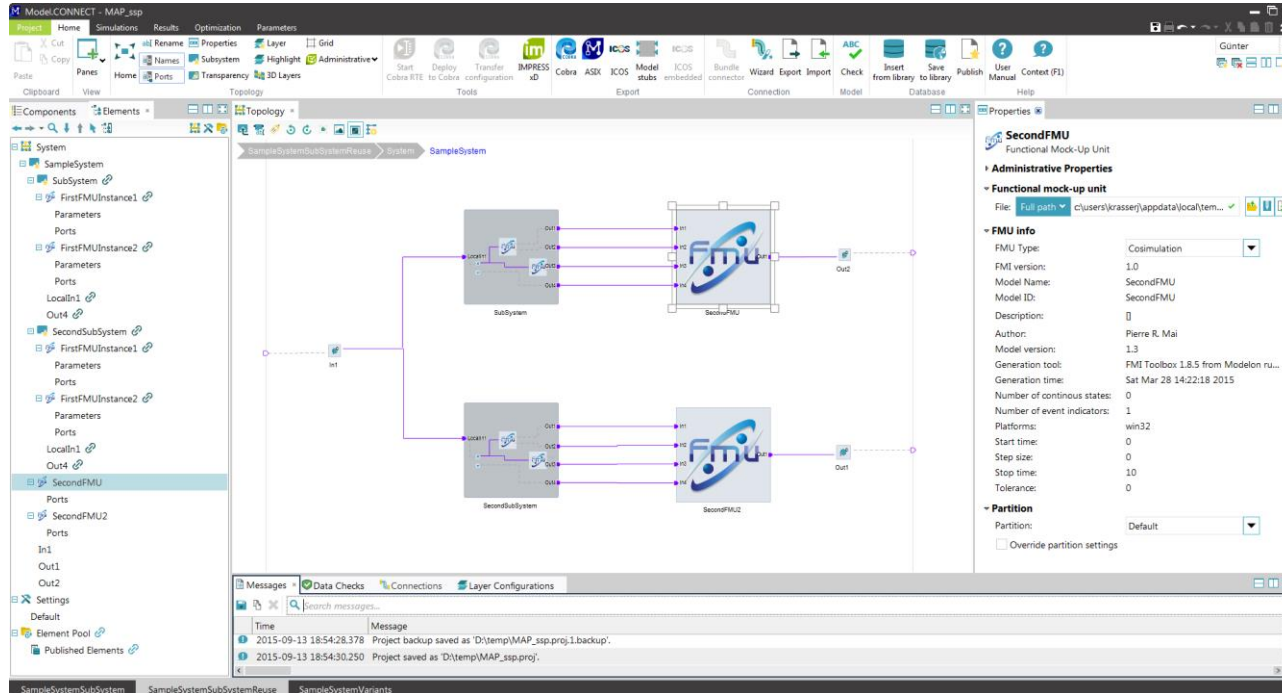
<https://svn.modelica.org/projects/ssp/trunk/SystemStructureDescription/SystemStructureDescription.xsd>

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Prototype from AVL – in Model.CONNECT™



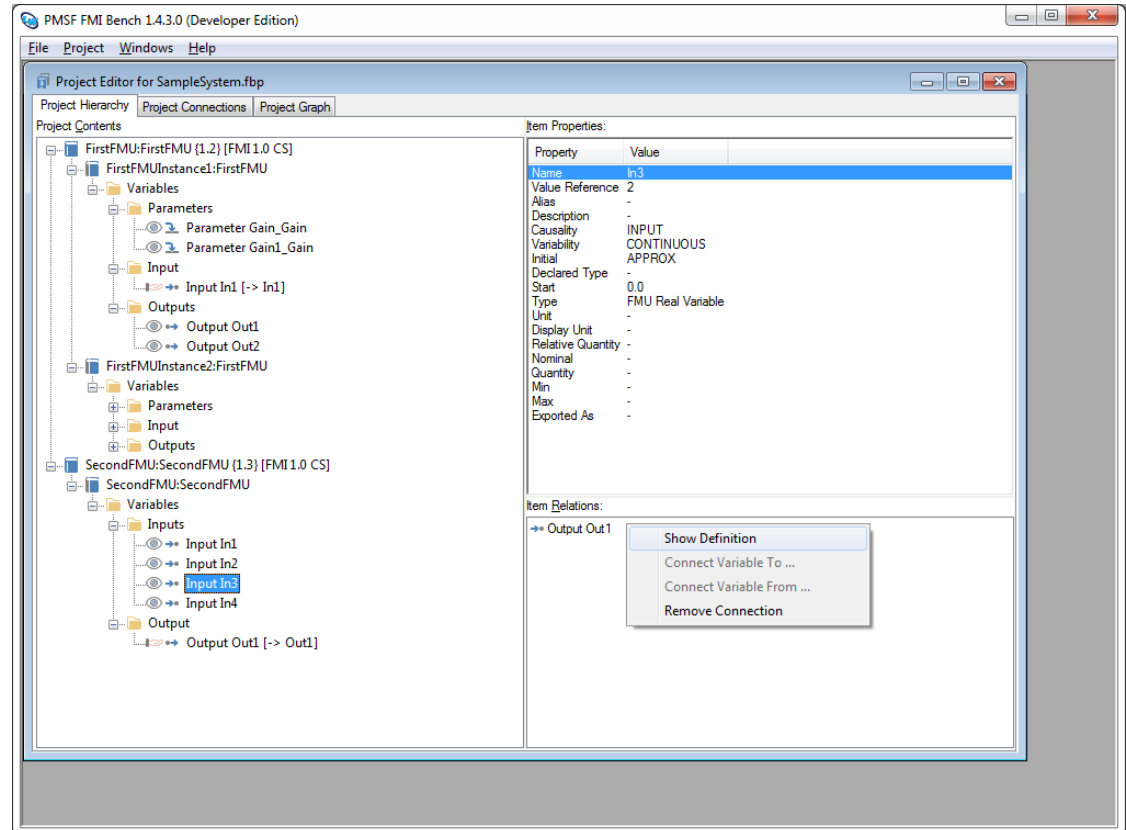
- Model.CONNECT™ is a platform to set up and execute system simulation models which are composed of subsystem and component models from multiple model authoring environments.



Prototype PMSF FMI Bench: Workbench for FMUs



- FMU Inspector
- FMU Pre-Integration
- FMU Debugging
- FMU Customization



Thank you

