MA-Project “System Structure and Parameterization” – Current Status and Plans

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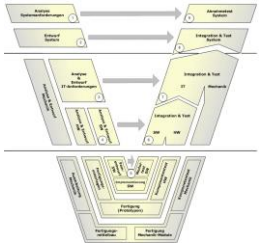
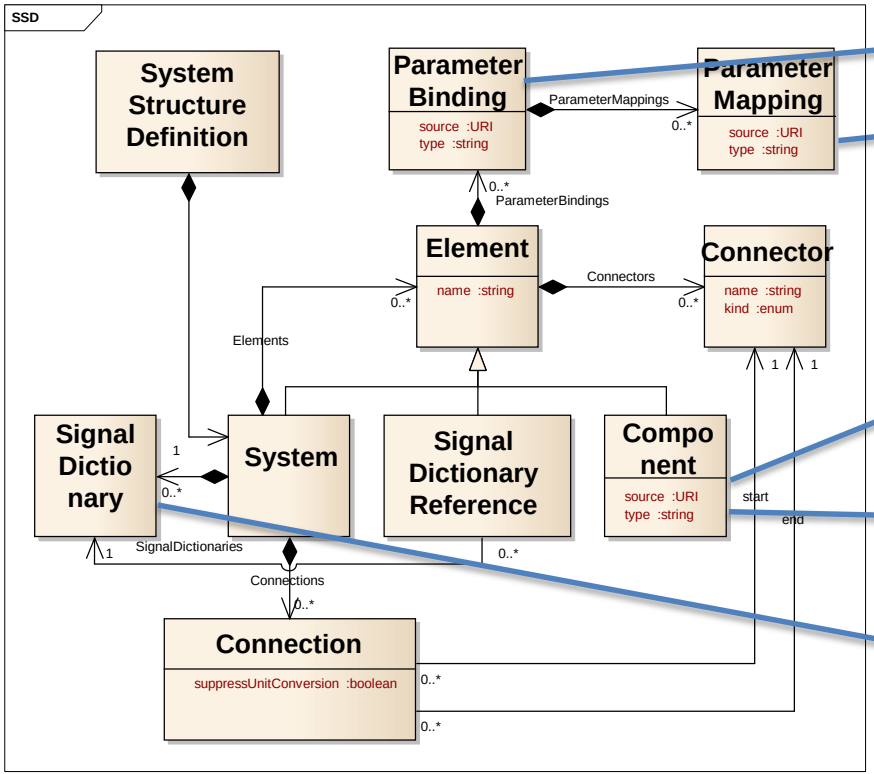
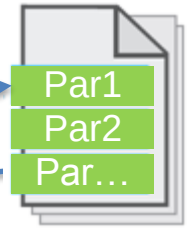
Main Purposes of SSP – Based on FMI standard

- Define a standardized format for the connection structure of a network of components (FMUs in particular).
- 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).
- The work in this project shall be coordinated with other standards and organizations (FMI, ASAM, OMG).



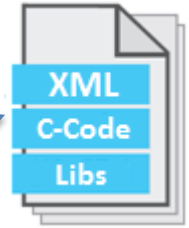
Overview of File Definitions





*.SSV

*.SSM



*.FMU

*.SSP

*.SSB

List of features

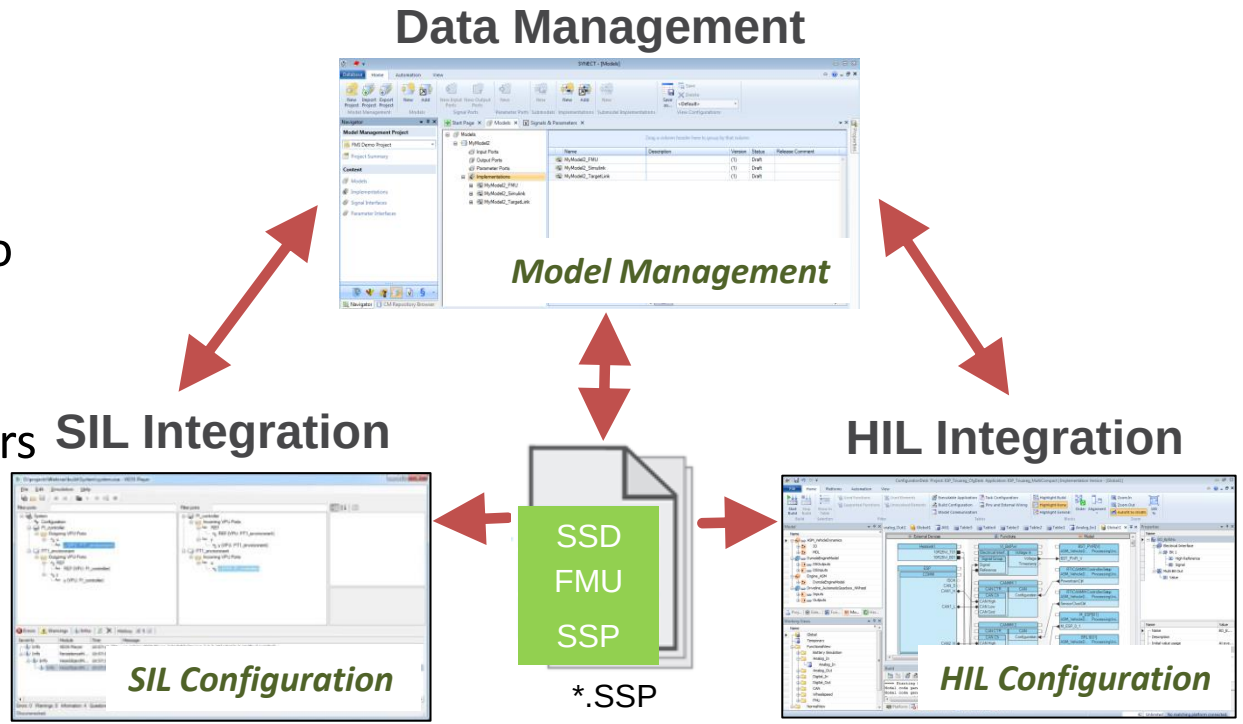
- Hierarchical description of systems of connected components
- Components: FMUs and external SSPs/SSDs, extensible to models, …
- Parameter bindings both at component and system-level, including transformations and name/unit-mapping
- Signal dictionaries support cross-hierarchical data pools (e.g for busses)
- Packaging of SSDs, FMUs, Parameters, … into one bundle (SSP)
- Light-weight support for variant handling at SSP level (multiple SSDs sharing components, parameters, resources)
- Optional exchange of graphical information (similar display across tools)
- URI references to all resources: Integration with other systems via URIs

Parameter Handling with Simulation Data Management Systems and Authoring Tools

- Results from workshop with SDM vendors:
  - Direct connection between SDM and authoring tools is not the preferred way
  - Parameter and system structure exchange could be done via file transfer (SSP standard)
  - Further measures will be taken to make a proof of concept

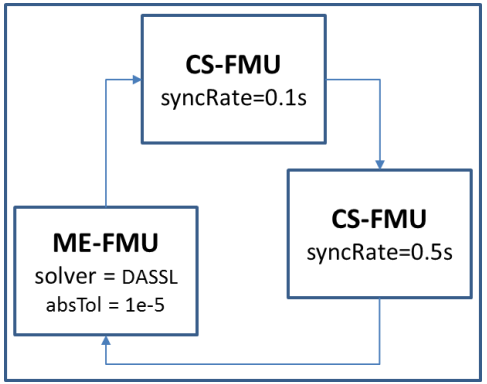
Integration of FMUs for SIL & HIL with SSP: Reuse of the System Structure

- The System Structure defined for SIL can be reused for HIL testing
- It becomes possible to reuse more models, configurations, tests, layouts and parameters
- A Data Management tool controls the lifecycle of the SSP



Potential further work

- Components can support more than FMUs/SSPs:
  - New ADAS Sensor Interfaces currently in development (Object Lists)
- Open Issues in SSP
  - Start values for Inputs
    - Subsystems / t=0
  - Initial state of the system
  - Experiment setup
    - Start time, stop time, selected results
    - Selection of solver, -settings, subsystem handling
  - FMU-instance specific settings
    - e.g. Sync rate, (Co-)Simulation mode, Import Settings
- Reliability check
  - Similar to FMI Crosschecks



Existing prototypes with support of SSP

- Model.CONNECT™ by AVL – Scope
- Integration Tool FMI Bench by PMSF
- Co-Simulation Player” (Cybernet)
- TLK MoBA Lab by TLK
- FMI Composer by Modelon
- FMI Kit – FMI Library for Simulink by Dassault
- SSP support by solidThinking Activate® by Altair

Requested Features from FMI

- Nice support of vectors / arrays for parameters and signals

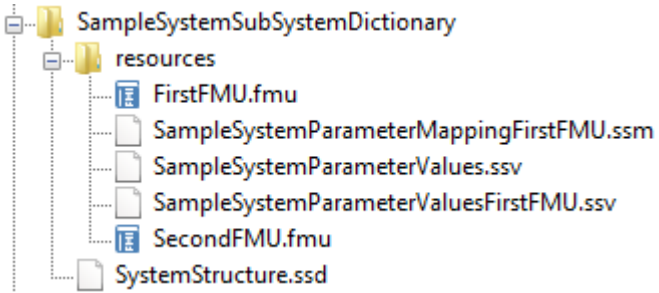
Current Roadmap for First Release

Topic	Due Date
Presenting on Modelica Conference	2017-05-15/17
End of Beta test phase	2017-09-30
Initiate website	2017-05-31
Review of existing documents	2017-05-31
Release Beta version	2017-06-01
Review of existing documents	2017-10-14
Release version 1.0	2017-11-30

BACKUP

File Definitions - System Structure Package (*.SSP)

*.SSP



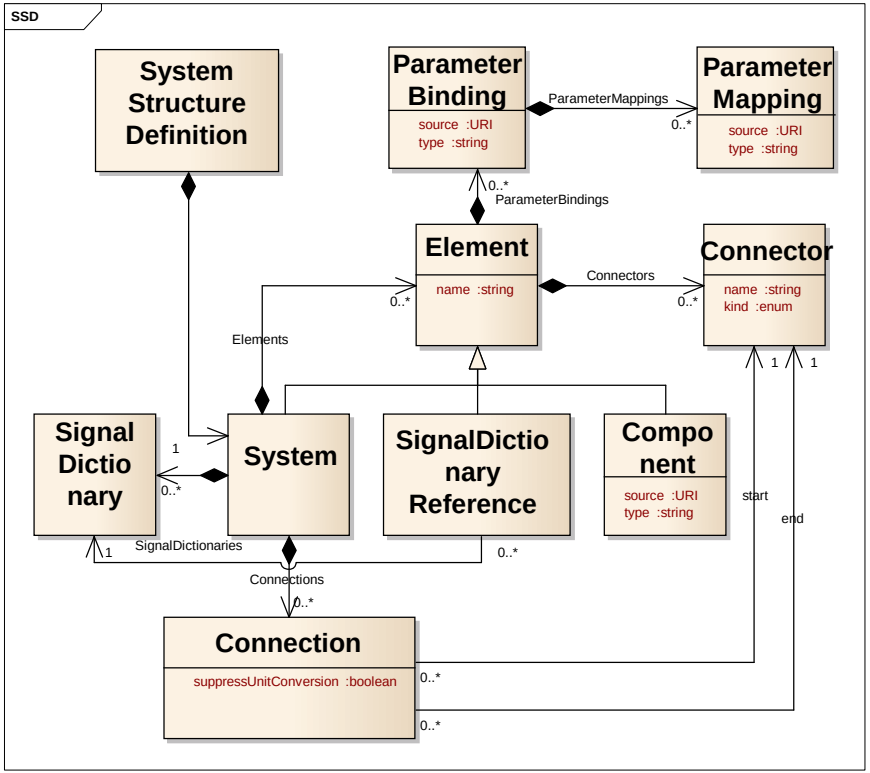
Use case

- Exchange of Complete Systems with Variants

Features

- All information (FMUs, system structure definition, parameters) can be stored in one archive (zip-file)
- Multiple SSDs in one SSP allows for variant modeling

File Definitions - System Structure Definition (*.SSD)



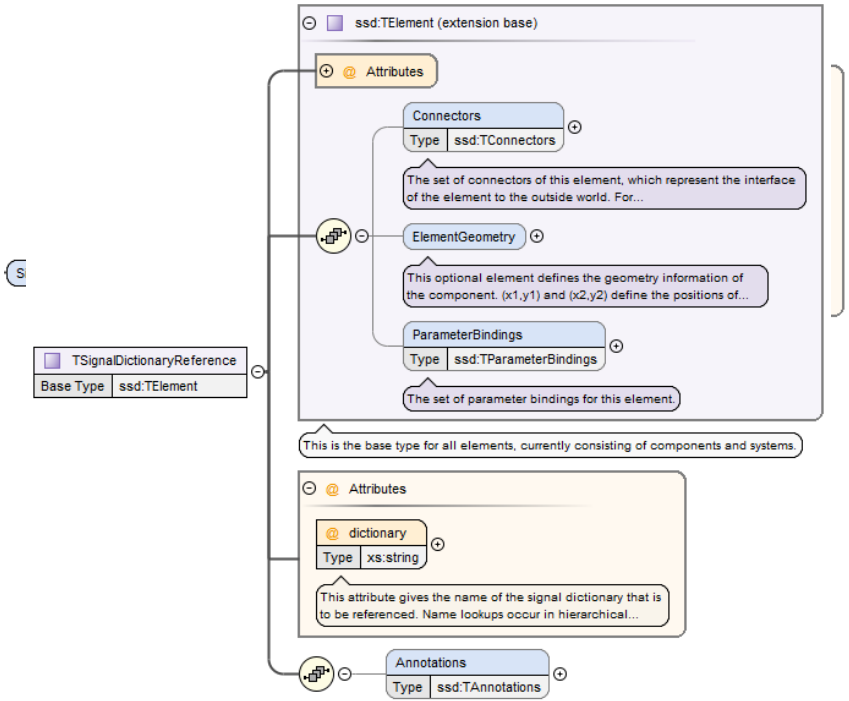
Use case

- Defining a Network of FMUs

Features

- Hierarchical sub-systems
- Empty components/FMUs as interface templates
- External resources via URIs: Both relative to SSD/SSP or absolute, e.g. via HTTP(S).
- Connections with unit conversions and optional linear/map transformations
- Optional: Diagram geometry

File Definitions - Signal Dictionaries (*.SSB)



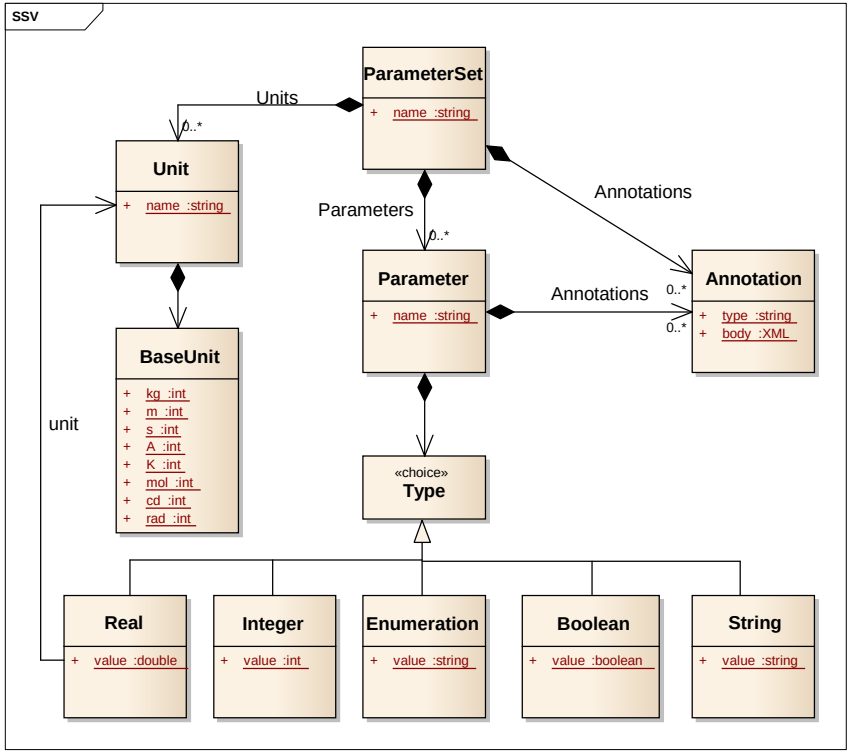
Use cases

- Collecting Control Signals in a Central Location

Features

- Causality is checked by tool automatically
- Crosses hierarchies without need for downward passing
- Well-suited for e.g. ECU control busses
- Can be inline or in external file

File Definitions – Parameter Values Data (*.SSV)



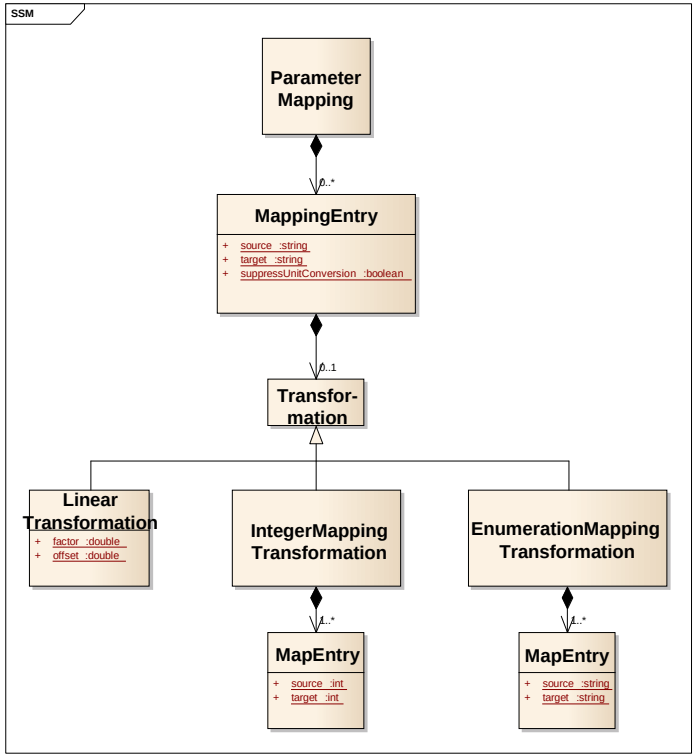
Use case

- Tool-independent Exchange of Parameter Data

Features

- Neutral exchange format between parameter sources
- Compatible to FMI standard
- Provides some meta data
- Access to param DBs via HTTP (-> Parameter API)

File Definitions - Parameter Mapping (*.SSM)



Use case

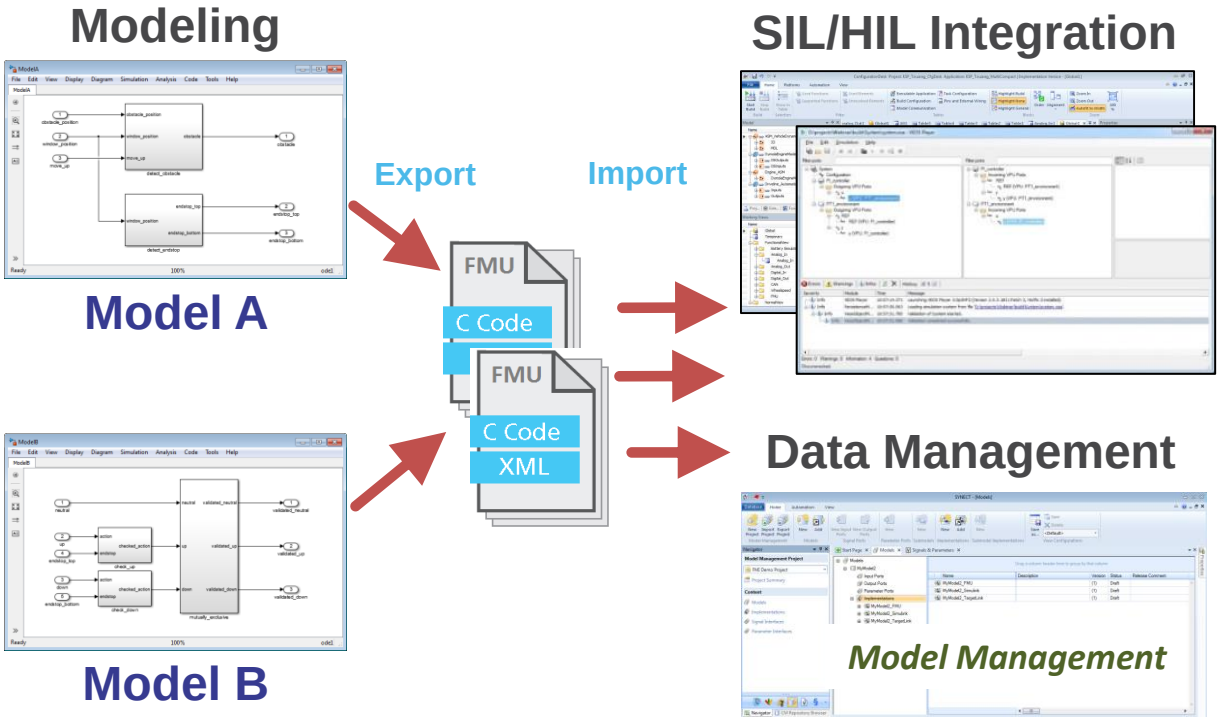
- Mapping Parameters to FMUs when the Parameter Names differ or Parameter Values require Transformations

Features

- Can be stored separately from System Structure and Parameter Data
- Can be inlined into SSD
- Optional manual linear and mapping transformations

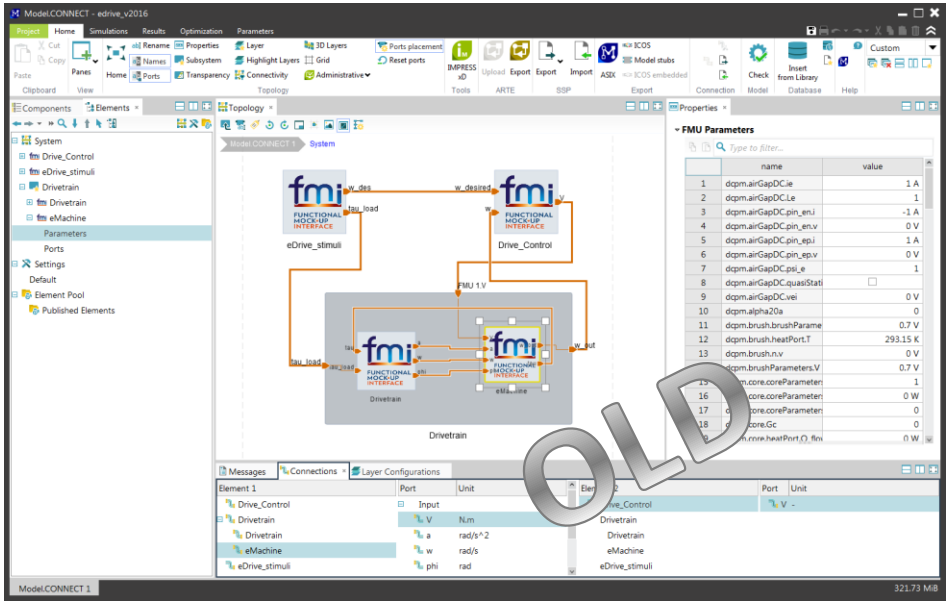
State of the Art: Integration of FMUs for SIL & HIL

- Integration tools are importing FMUs, Simulink-based models and ECU code
- A Data Management tool controls the lifecycle of all models
- The SIL/HIL integration results (System Descriptions) can not be exchanged easily among the tools



Prototypes – Integration Tool

- Model.CONNECT™ by AVL – Scope:
  - Simulation architecture set-up
  - Model integration
    (FMI and dedicated interfaces)
  - Execution
    (office and lab)
  - Model management
  - Handling system structure and parameter variants

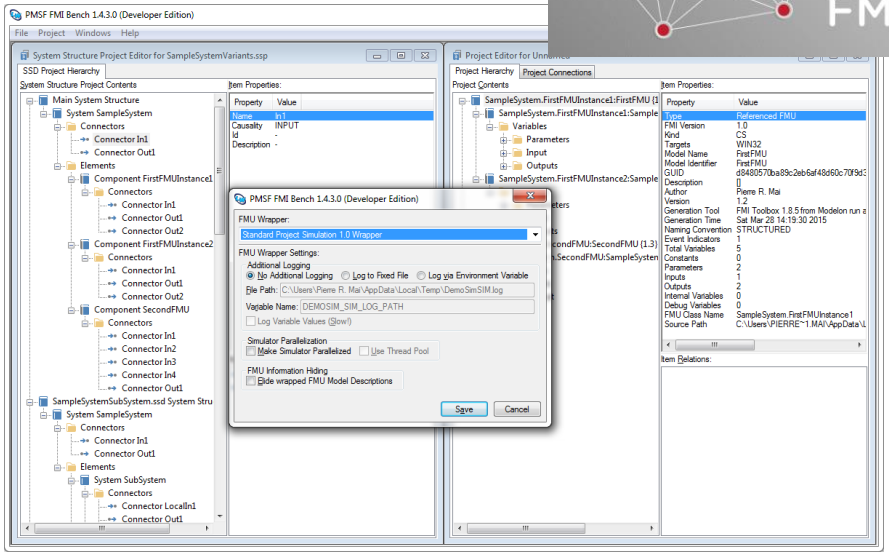


Prototypes – Integration Tool

- Model.CONNECT™ by AVL – SSP prototype:
  - Import and export of system structure (SSP packages)
    - Prototype supports multiple structure variants in the package
    - Mapping between the SSP variant handling and the tool-specific variant handling had to be implemented
    - Import-export roundtrip does not re-produce original ssp content
    - This is a consequence of the deliberately simple SSP variant handling concept
  - Import and export of graphical information
    - Overall layout information can be transferred via SSP.

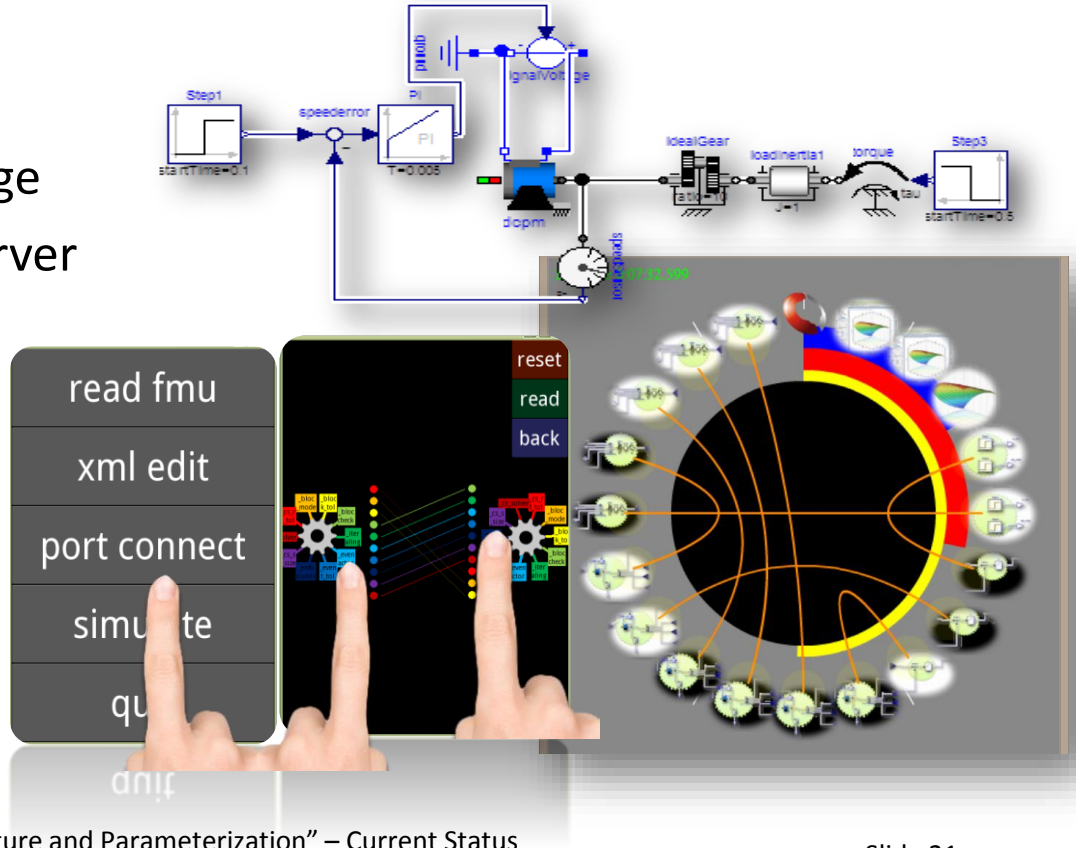
Prototypes: Integration Tool FMI Bench

- FMI Bench by PMSF: Workbench for FMUs
  - FMU Inspector & Editor, Integration, Automation
  - Export Integrated FMUs, Simulators, Remote FMU Execution, FMU-internal Parallelization, IP-Protection
- FMI Bench SSP Prototype
  - Direct Editing of SSDs, SSPs, incl. Variants
  - Generation of Native FMI Bench Projects from SSP Projects
  - Generation of FMU or Stand-alone Sim. from SSP
  - Parallelization
  - IP Protection



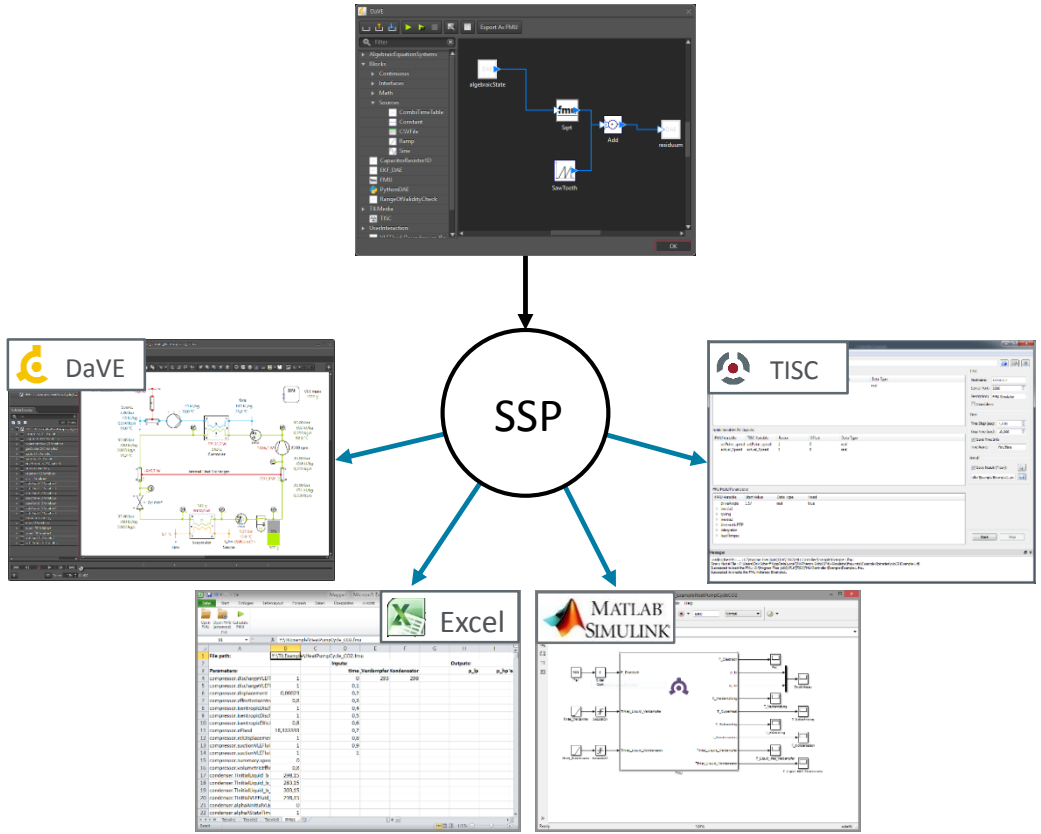
Prototypes – “Co-Simulation Player” (Cybernet)

- For Mobile Co-Simulation
  - SSP as an Online AP Package
  - Flash client and Python server
- Natural Interface
  - Ring connection geometry
  - Flexible 2D/3D Layout
- Parameter repository
  - Load sqlite.DB as a FMU
  - URI online access



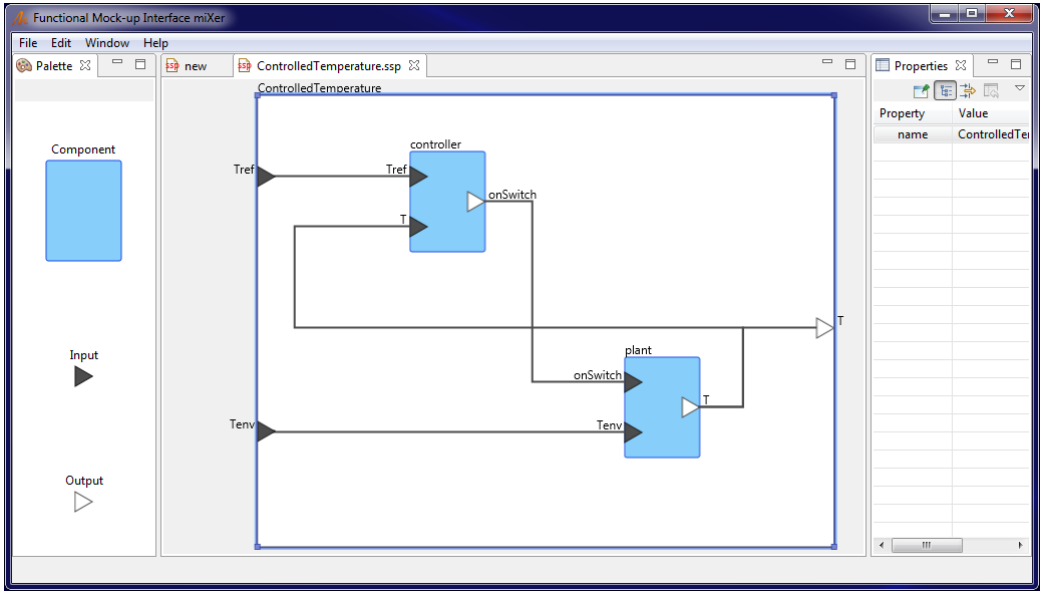
Prototypes – TLK MoBA Lab

- Focus:
  - FMI-based models
  - physical connections
  - thermodynamic environment
- Features
  - System Design & Model management
  - Simulation & virtual test bench
  - Optimization & parameter fitting
- Prototype for im-/export support of SSP in development



fMIXer by Modelon

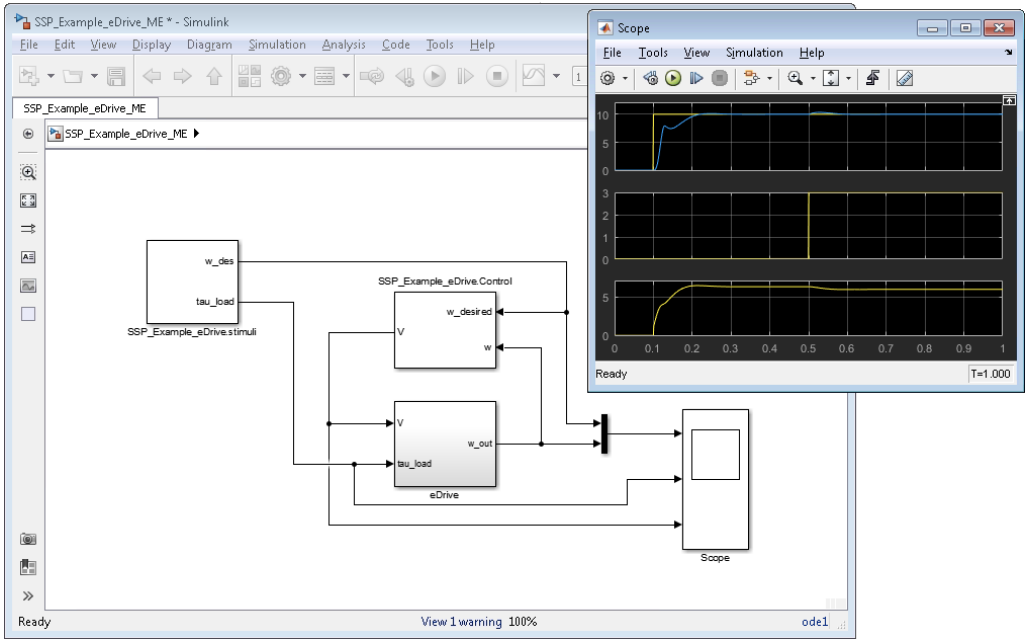
- Connect FMUs graphically
- Save as .ssp or export to FMU for simulation in any FMI-compliant tool
- View FMU information
- Manage parameters
- Convert ME to CS FMUs



FMI Kit – FMI Library for Simulink

FMI Kit by Dassault Systèmes

- Export models as FMUs
- Import of FMUs into Models
- Initial support of SSP



SSP support by solidThinking Activate®

- Leverage complete FMI 2.0 support (import/export, ME and CS)
- Simulation of connected FMUs, with handling of parameters
- Support of SSP format for both import and export (WIP)