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Modelica within Simcenter Amesim

Combining causal & a-causal paradigms

David ALMER - Siemens PL CoE

All Siemens Divisions are driving digitalization technologies

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Digital Factory	Energy Management	Wind Power	Power and Gas, Power Generation Services
			
Process Industries and Drives	**Healthineers**	**Building Technologies**	**Mobility**
			

Our business – Digital Factory

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Digital Factory	Energy Management	Wind Power	Power and Gas, Power Generation Services
			
Process Industries and Drives	**Healthineers**	**Building Technologies**	**Mobility**
			

The Digital Factory business follows a long-term strategy with the systematic expansion of our portfolio

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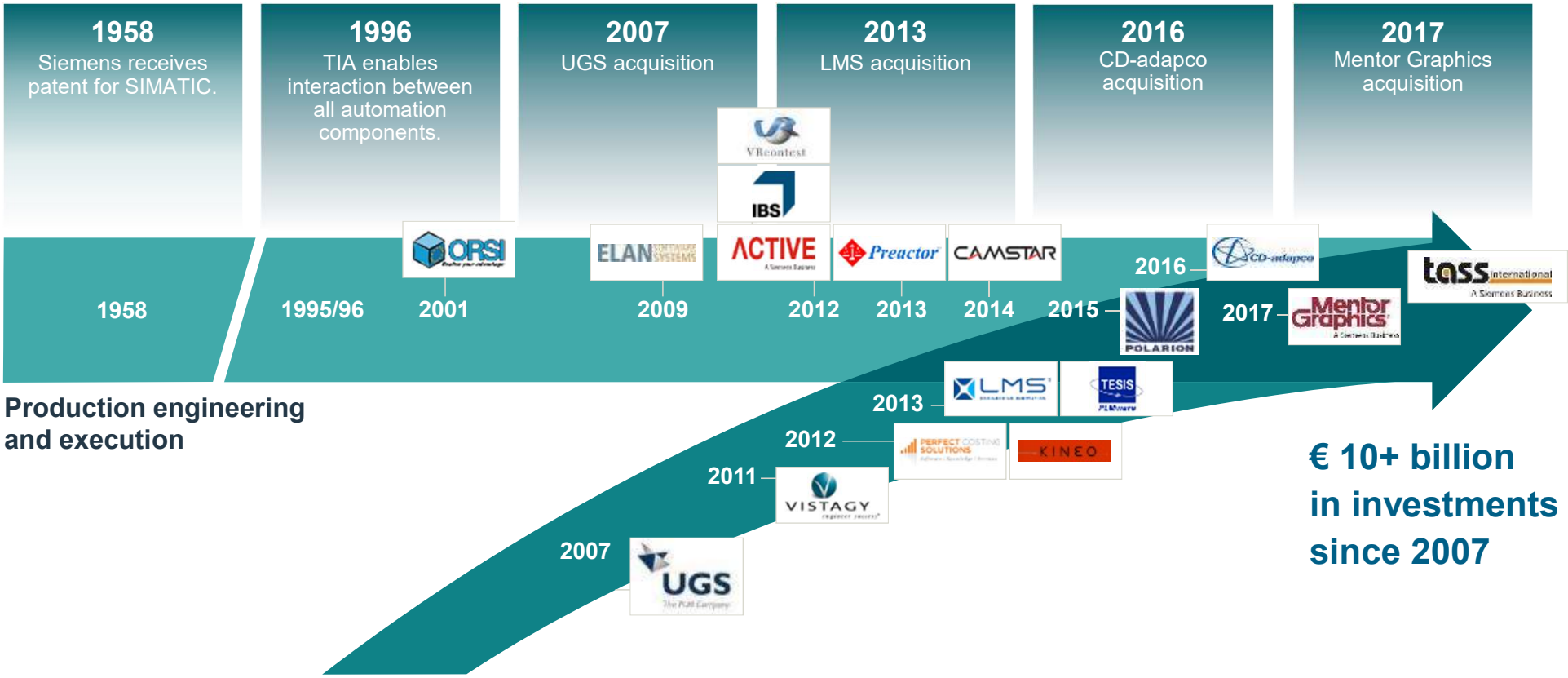

Siemens PLM Software Business Segments

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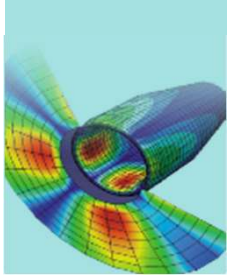
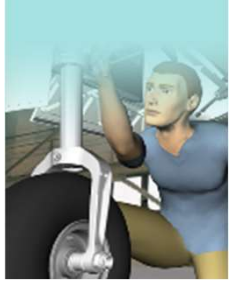
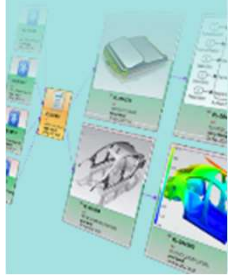
Product Engineering	Mainstream Engineering	Specialized Engineering	Simulation and Test Solutions	Manufacturing Engineering	Lifecycle Collaboration	Manufacturing Operations Management	Digital Services
NX	**Solid Edge** **Femap**	**Fibersim** **Syncrofit** **Mastertrim**	**Simcenter** **STAR-CCM+ & HEEDS**	**Tecnomatix** **NX CAM**	**Teamcenter** **Polarion**	**SIMATIC IT** **IBS QMS** **Camstar** **WinCC** **Preactor**	**MindSphere** **Omneo**
End-to-end design and engineering	Product design, simulation and manufacturing	Composites, air frame assembly and seat design	Simulation, test and systems engineering	Process design and simulation; NC programming	Collaboration, Process, Change and BOM Management	MES, Quality, HMI and Production	IoT operating system and analytics
							
Design & engineer better products faster	Product design and engineering for the mainstream market	Rich domain and industry driven solutions	Enabling closed-loop Systems Driven Product Development	Build & support products more efficiently	Collaborate & innovate more intelligently	Realize products faster and increase quality	Collect and analyze data to optimize plants, products, and machine

Business Ready Cloud Solutions

Product-driven Services

Simcenter system simulation solutions

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Industry Sector

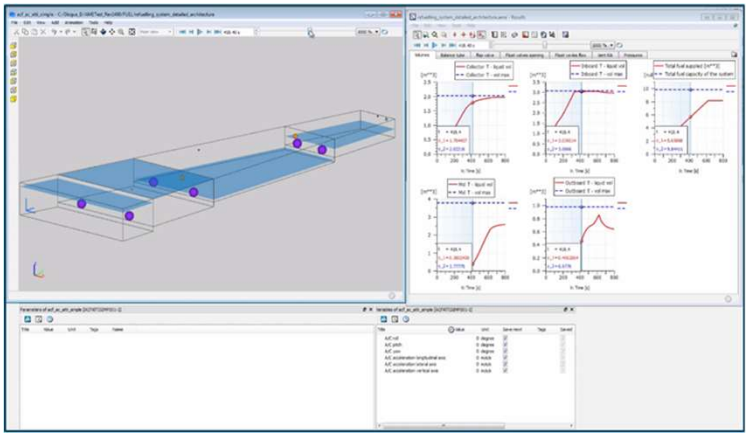
- Automotive & Transportation
- Aerospace & Defense
- Heavy Equipment
- Industrial Machinery
- Marine
- Energy & Utilities

Pre-design

Performance analysis

Design Optimization

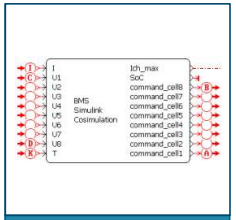
Controls validation



Scalable simulation

Connecting "mechanical" – "controls"

Multi-physics

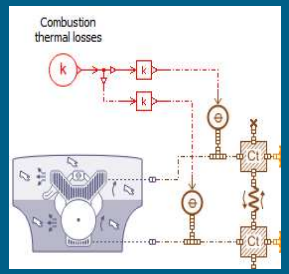


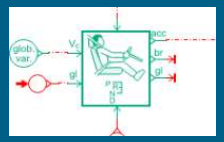
Co-simulation

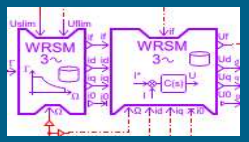
Open and customizable

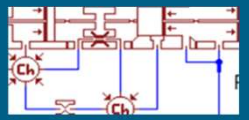
>40 libraries

>5,000 models

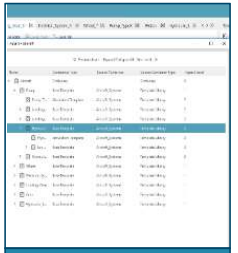








Mechanical
Hydraulics/Pneumatics
Thermal
Electrical
Magnetic
Chemical



Model Architecture

Applications in auto & aero industries

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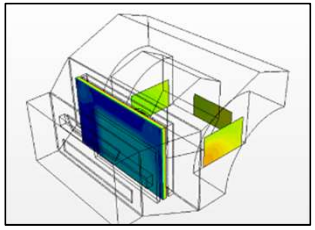
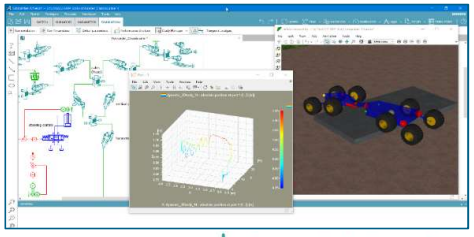




Powertrain & Chassis Controls
Plant model for MiL-SiL-HiL validation
Pre-calibration

Vehicle Performance
Fuel Economy/Performance
Emissions, Drivability

IC Engine
Air path management
Fuel injection & Valvetrain
After-Treatment

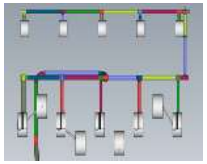
Chassis Systems
Ride & Handling
Braking
Steering
Suspension and anti-roll

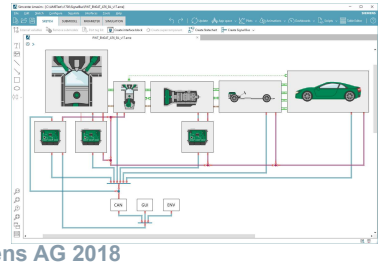
Thermal Management
Engine/Transmission
Battery cooling
Lubrication
HVAC

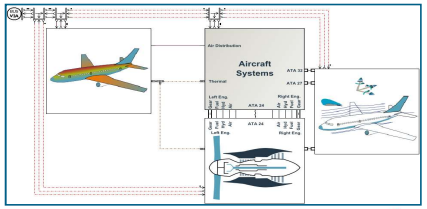
Transmission
AT, MT, CVT, DMF, DCT
Actuators & components

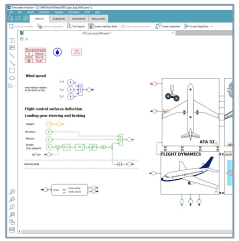
Electric/Electronics
E-Motor
Battery
Electrical board

Power Systems
Hydraulic systems sizing
Mechanical-hydraulic integration
Architectures assessment









Aircraft integration
Aircraft systems integration

ATA 27 Flight controls

ATA 21
Environenment Control Systems

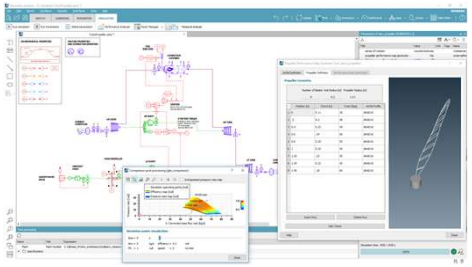
ATA 28
Fuel system

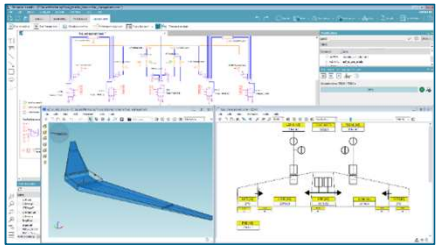
ATA 29
Hydraulic Power

ATA 24
Electrical power

ATA 32
Landing gear

ATA 71 – 72 - 73 – 79 – 76 - 83
Powerplant – Turbine
Engine fuel and control
Engine oil and engine controls
Engine accessory gearbox





Simcenter Amesim: an open platform

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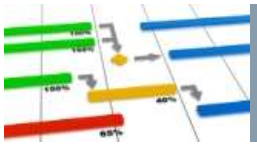
Platform facilities:
Data management, pack, libraries, supercomponents…

Analysis tools:
Eigenvalues, Modal shapes, Bode plots, …

Optimization, robustness, design of experiments:
NLPQL, Parameter sweep, Monte Carlo, Genetic Algorithms



Simulator scripting & APIs:
C/C++, python, VBA, matlab, scilab, console…

Customization:
App designer, customized components…

Solvers and numerics:
Solver technology, Parallel computing, HPC, ..

MIL/SIL/HIL and real-time:
Blackbox, RT FMUs,
Precompiled objects for RT targets…

Software interfaces:
FMI export/import 1.0-2.0
dedicated interfaces (Simulink,etc…), Excel import, in-house codes…

1D/3D CAE:
CAD import, FE import, CFD coupling,…

MODELICA

Modelica platform

Modelica within Simcenter Amesim

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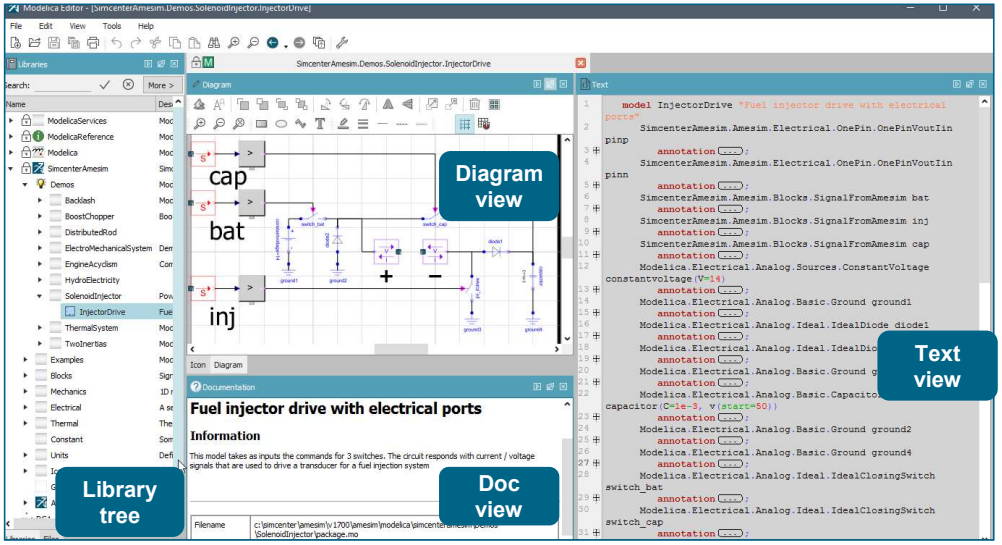
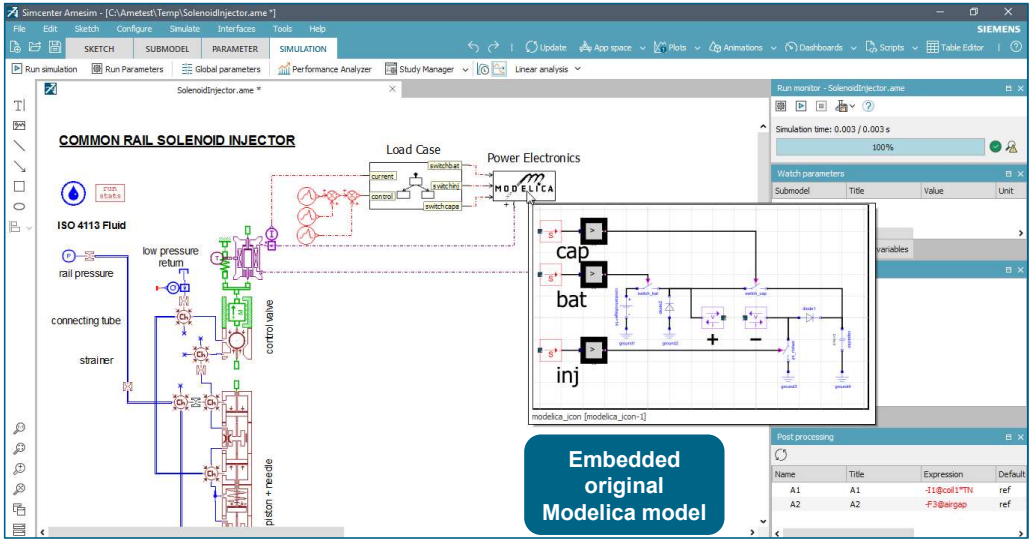
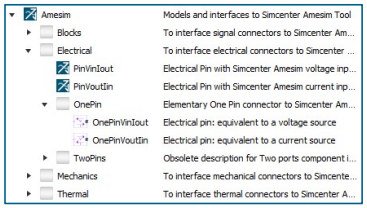


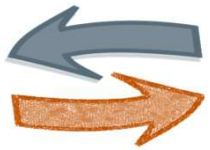


Modelica Editor

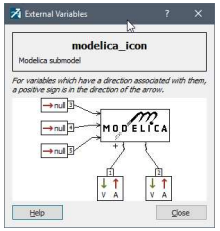
Simcenter Amesim

Dedicated Simcenter connector libraries





Two worlds in a **same environment** require a translator able to ease integration and interactions



Physical ports

Siemens partners with Modelon

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NA Modelica Conference, Boston, October 9th, 2018

Siemens partners Modelon to use Optimica's Compiler Toolkit as its Modelica engine starting from Simcenter Amesim 17

Siemens & Modelon signed an agreement to integrate Modelon's OCT compiler within next Simcenter Amesim release (*). This agreement will allow Simcenter users **develop**, enhance and reuse **Modelica** libraries to describe dynamic multi-physics systems, and **combine** them seamlessly with the Simcenter Amesim **native libraries**.

Such model will benefit from **full Modelica standard support** and **optimized code** generated by Modelon compiler, and will be simulated by Simcenter **Amesim solver** while being **compatible** with all useful **Simcenter Amesim platform capabilities** such as e.g. analysis tools, ... Support of Modelon industrial libraries through this workflow will come in future releases.

*"Do not choose between causal & acausal approach: get the **best of both worlds in a same environment**!"*

(*): available on demand in Simcenter Amesim 17

Modelon inside

Value proposition

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- **Modelica well suited for some physical domains**
  - Usable to extend Simcenter Amesim capabilities

- **Unique causal and a-causal execution platform**
  - Unique value of solution
  - Compatibility with popular libraries (full MSL 3.2.2 support, Modelon → support to be implemented in future release)

- **Integration into Simcenter Amesim**
  - Modelica Editor calls OCT (Optimica Compiler Toolkit) and generates a 2.0 Model Exchange FMU behind the scenes,
    extended with physical ports
    ► Tight coupling & compatibility with Simcenter Amesim analysis tools (e.g. Performance Analyzer, Linear Analysis)

- **CAE portfolio consolidation opportunity (one tool supports both)**

A new FMI specification being advocated by Siemens

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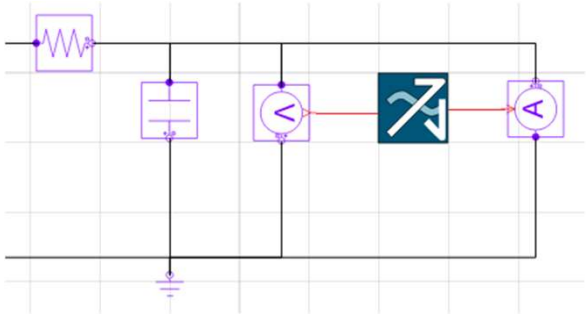
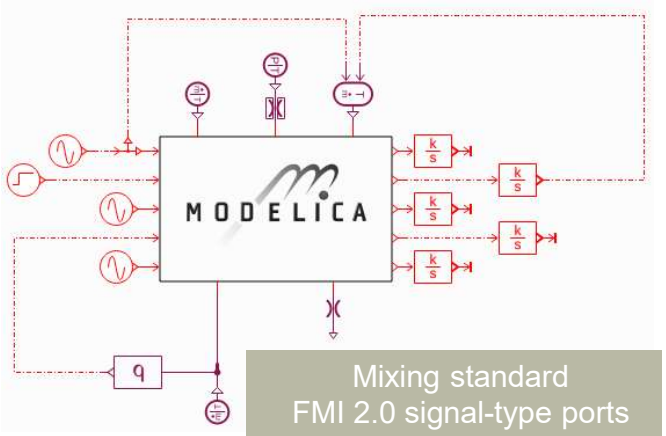
Modelica external connectors are translated to …



… FMI 3.0-like physical terminals that are converted into …

… Simcenter Amesim physical ports



Mixing standard FMI 2.0 signal-type ports with FMI 3.0 physical connectors

The FMI import tool is enhanced with the new FMI 3.0 "Terminals and Icons" FCP feature. Its first application is the import of FMUs produced by Modelon's Optimica Compiler Toolkit

A streamlined workflow

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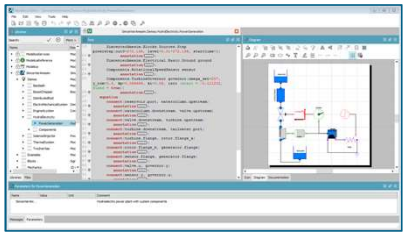
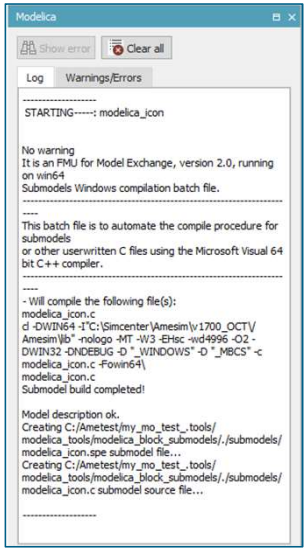
Create



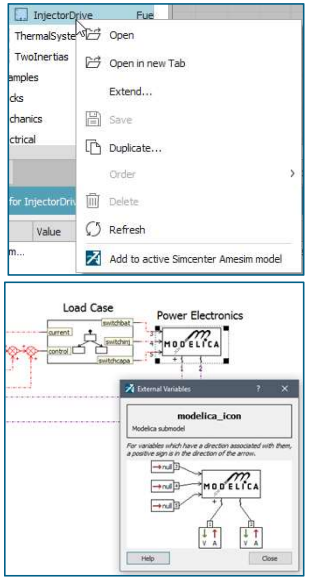
- Full-featured, configurable IDE
- **Source code editor**
- Graphical component assembly
- MSL v3.2.1
- Easy library loading

Compile



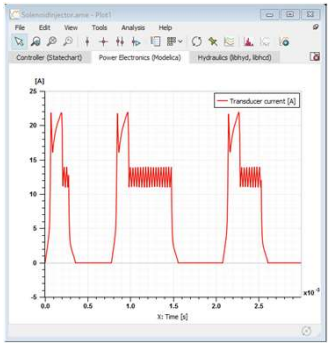
Automated compiling when model added to Simcenter Amesim

Connect



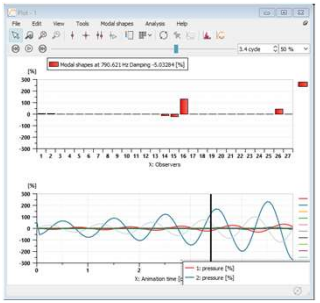
Connection with native libraries through dedicated physical connectors

Simulate



Solved as whole system, **no cosimulation**. Compatible with Simcenter Amesim **simulation** capabilities: Batch/Design Exploration, HPC, MIL/SIL/HIL…

Analyze



Compatible with Simcenter Amesim platform capabilities: Performance analyzer, linear **analysis** (eigenvalues, modal shapes, frequency response, root locus…), dashboards, scripting,…

Demo: heterogeneous modelling of an injector

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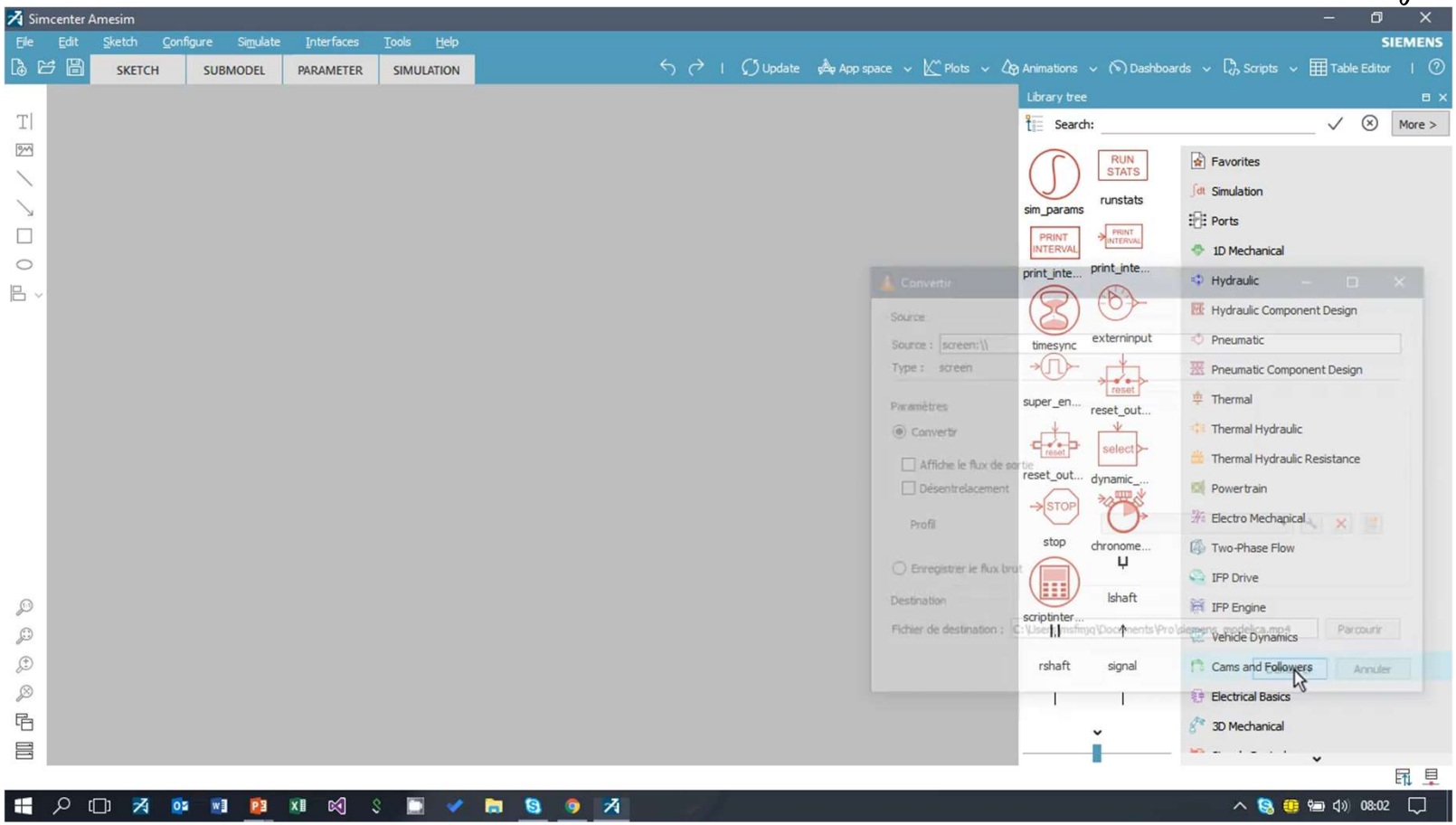

FMI 2.0 model exchange export

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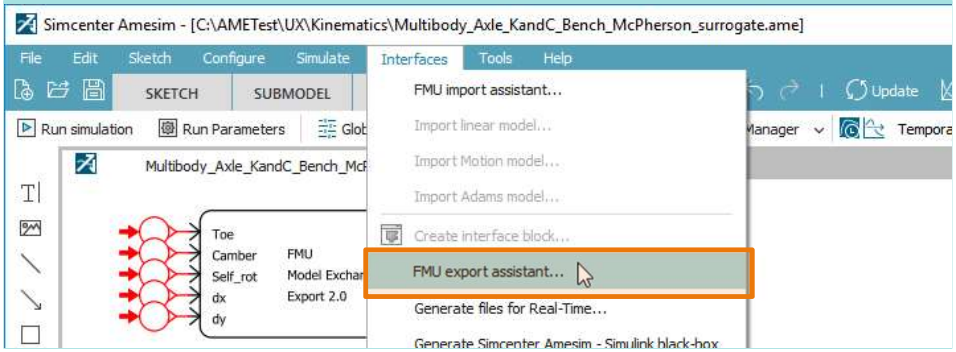
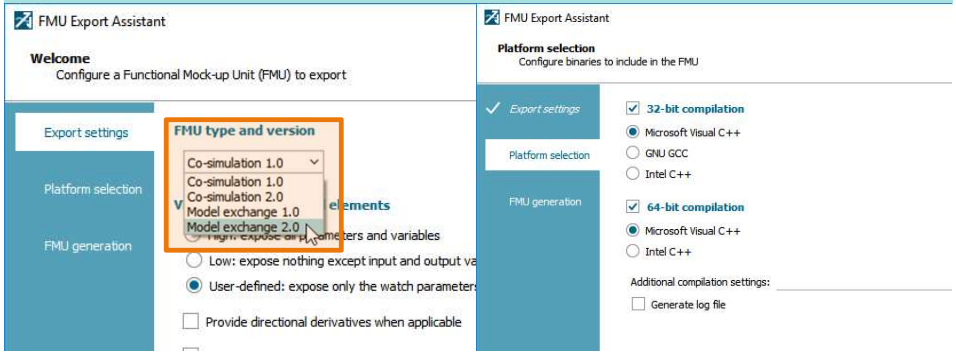
Software interfaces

- Export Simcenter Amesim models as 2.0 Functional Mock-up Units (FMUs) for model exchange and simulate the coupled system in various Functional Mock-up Interface (FMI) compatible tools

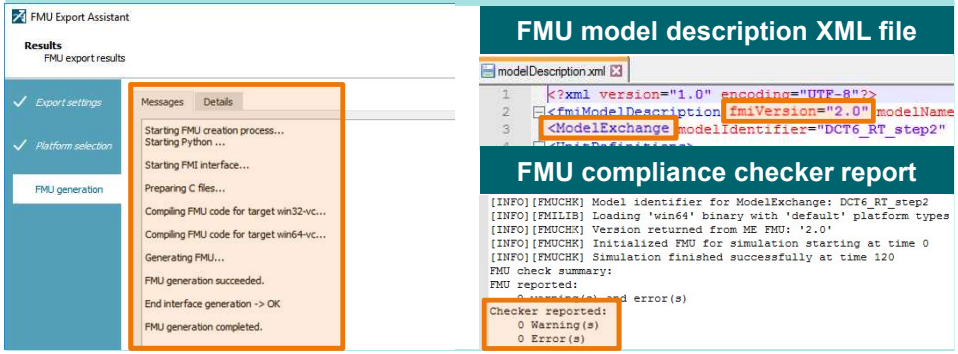
Start the FMU export assistant with an FMI interface block on the sketch



Select “model exchange 2.0” as export setting and select your platform



… generate your FMU and optionally test it with the compliance checker



Application: export a Simcenter Amesim model without its solver to any FMI 2.0 compliant importing tool for continuous or strong coupling applications

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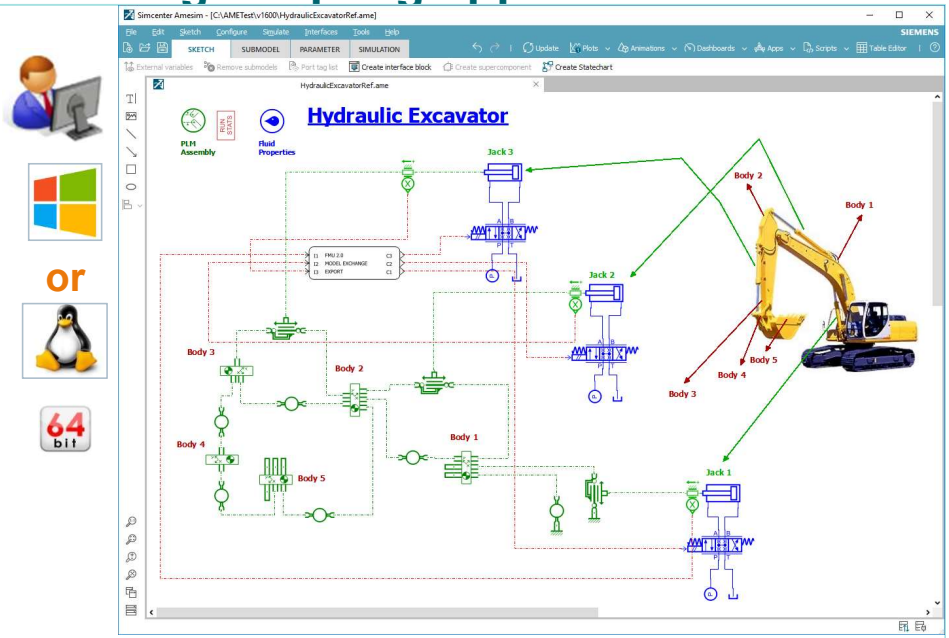
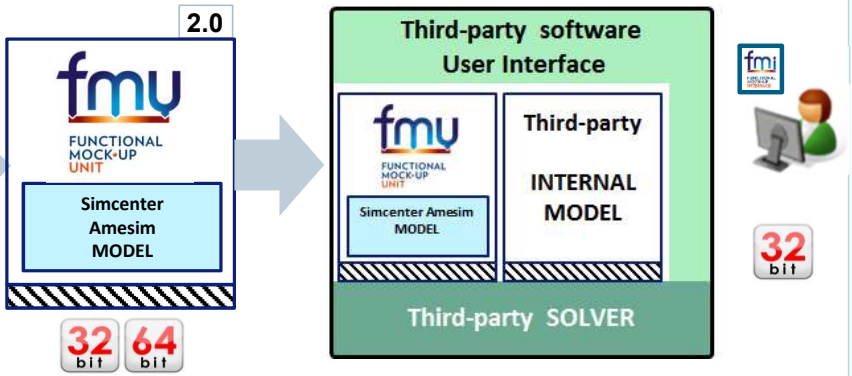


Under Windows or Linux, a Simcenter Amesim user exports his model as a 2.0 FMU for model exchange, i.e. without the solver embedded. The FMU is compiled for both the 32-bit and the 64-bit architectures and embeds all the tables used by the model

"1D" (Simcenter Amesim)	Any 3rd-party FMI tool	CFD	Control
X	X		

ME Import	ME Export	Cosim Master	Cosim Slave
	X		



A user of a 3rd party FMI 2.0 compliant tool imports the FMU and selects a solver suitable for solving both the 3rd party part of the assembled coupled model and the Simcenter Amesim part contained in the FMU

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Thank you.