

Von der DSHplus-STC zum FMI

Erweiterung durch Standardisierung

FLUIDON Konferenz 2014
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Was hat es mit der DSHplus-STC auf sich?

- **Motivation**

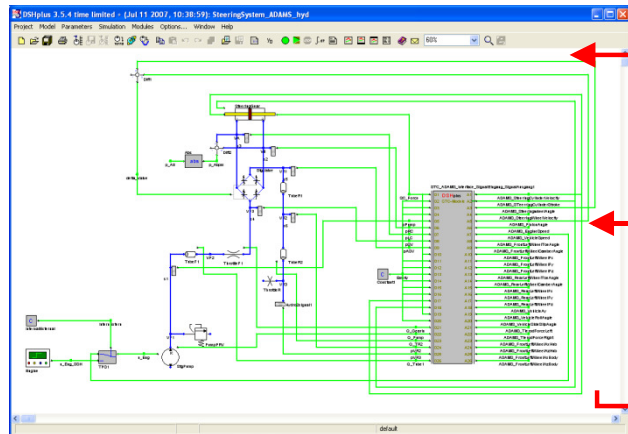
- Aufgrund steigender Anforderungen an Realitätsnähe und Berechnungsgenauigkeit ist es immer erforderlicher, die Interaktionen unterschiedlicher technischer Teilsysteme bei simulationstechnischen Untersuchungen detailliert zu berücksichtigen.
- Durch die Kopplung von Programmen mit unterschiedlichen Stärken können die Vorteile aller Programme durch eine Simulation im Softwareverbund genutzt werden.

- **Umsetzung**

- Die DSHplus-STC ist eine Knopfdruck-Lösung zur nahtlosen Kopplung und Integration von eindimensionalen domänen-übergreifenden DSHplus-Modellen mit beliebigen CAx-Werkzeugen.
- Neben klassischen Co-Simulationslösungen bietet die DSHplus-STC ECoSim - Embedded Co-Simulation - ein gekapseltes und geschütztes Stand-Alone-Modul, welches sowohl das eindimensionale DSHplus-Modell, als auch die Co-Simulations-Schnittstelle sowie den DSHplus-Berechnungskern beinhaltet.
- Als dritte Art wird eine Kopplung auf Gleichungsebene unterstützt. Die Differential- und algebraischen Gleichungen des DSHplus-Modells werden vom Solver des Mastersimulators berechnet.

Das Prinzip der DSHplus-STC

Step 1: Initial simulation of the fluid power system in **DSH^{plus}**



Step 2: Optimization and Verification of the fluid power System by means of a co-simulation

DSH^{plus} Co Simulation

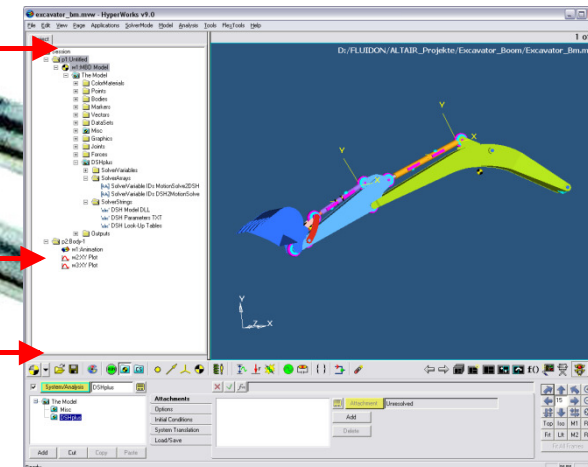
C++ Model
Source Code

C++ Auxiliary
Functions

C++ Numerical
Routines

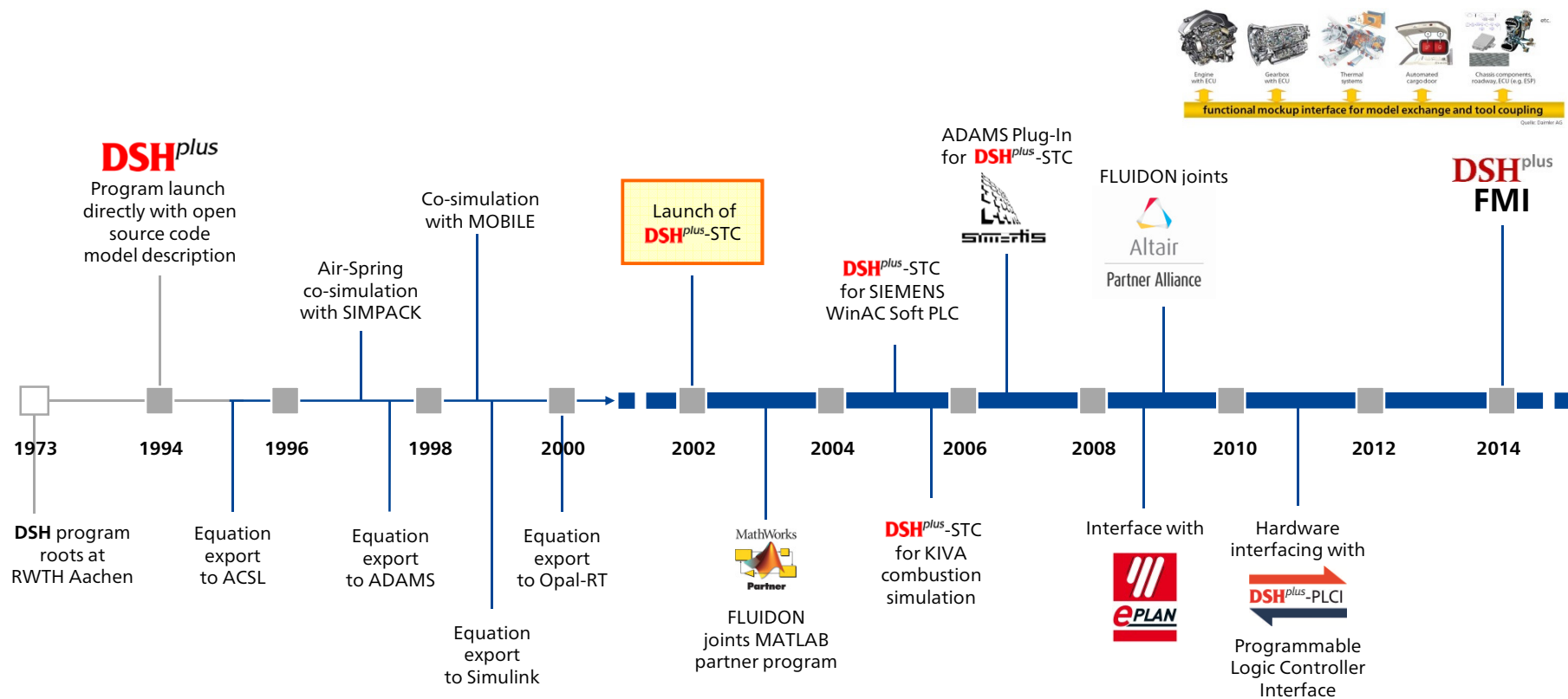
**DSH^{plus} Differential
Equation Export**

DSH^{plus} Solver Export



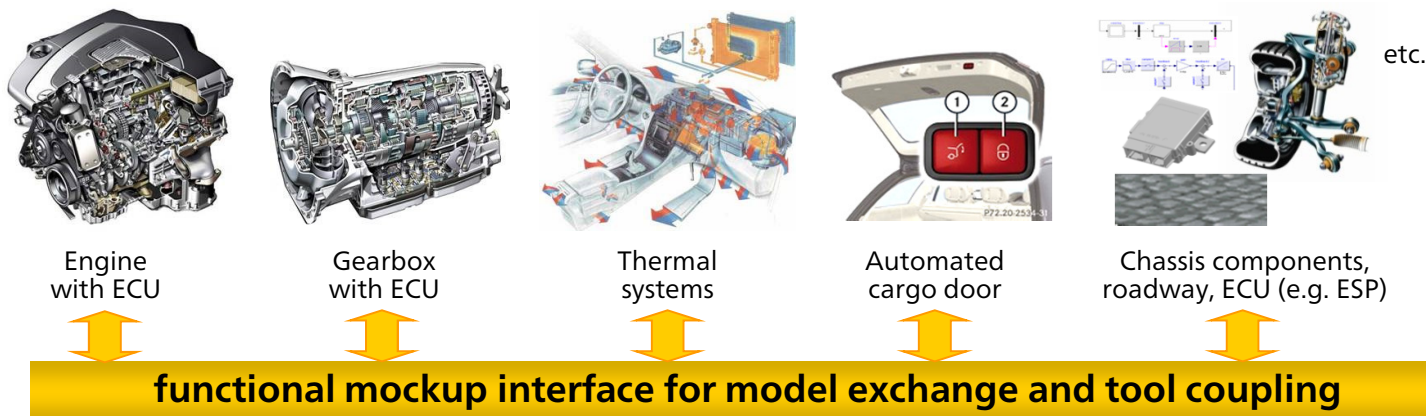
Step 3: Export of the fluid power system as embedded system in a different simulation domain or on a different hardware

Meilensteine der DSHplus-STC



Was hat es nun mit FMI auf sich?

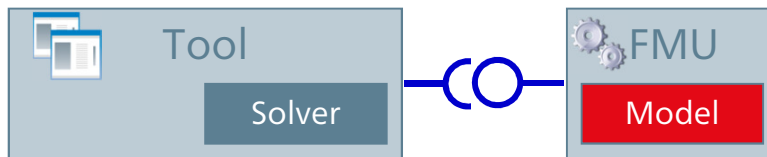
- grob zusammengefasst, setzt FMI die STC außerhalb der DSHplus-Grenzen fort
- zusätzliche Interfacefunktionen erweitern und verallgemeinern die Einsatzmöglichkeiten
- FMI ist Ergebnis des europäischen MODELISAR Forschungsprojektes, dessen Vorsitz in Deutschland bei Daimler AG lag.
- Folgende Folien stammen aus dem Vortrag „The Functional Mockup Interface for Tool independent Exchange of Simulation Models“, der am Ende des Forschungsvorhabens MODELISAR auf der Modelica Konferenz 2011 gezeigt wurde.



Quelle: Daimler AG

FMI – Main Design Idea

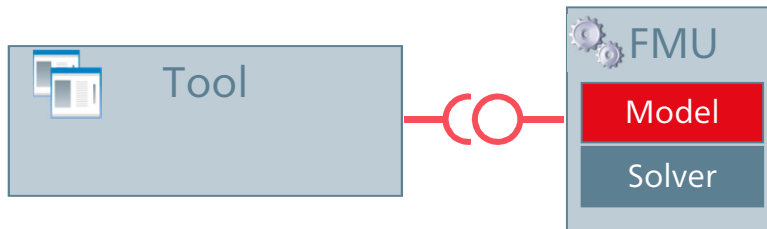
- FMI for Model Exchange:



- Version 1.0 released in January 2010

- FMI for Co-Simulation:

- Reuses as much as possible from FMI for Model Exchange standard



- Version 1.0 released in October 2010

Quelle: Modelica 2011: Functional Mockup Interface

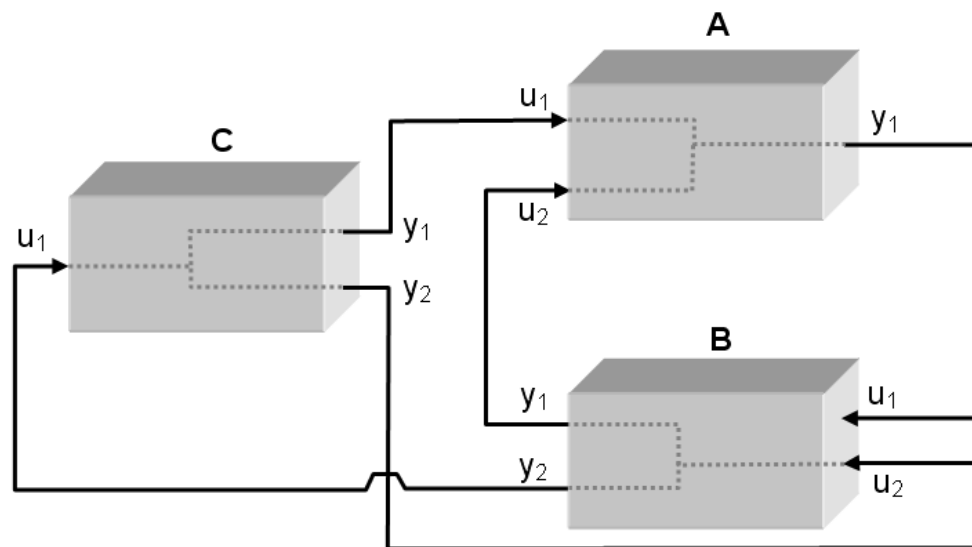
FMI - Main Design Idea

- A component which implements the interface is called Functional Mockup Unit (FMU)
- Separation of
 - Description of interface data (XML file)
 - Functionality (C code or binary)
- A FMU is a zipped file (*.fmu) containing
 - XML description file
 - implementation in source or binary form
 - Additional data and functionality
- Additional data and functionality can be included
- Interface specification: www.functional-mockup-interface.org

Quelle: Modelica 2011: Functional Mockup Interface

FMI for Model Exchange

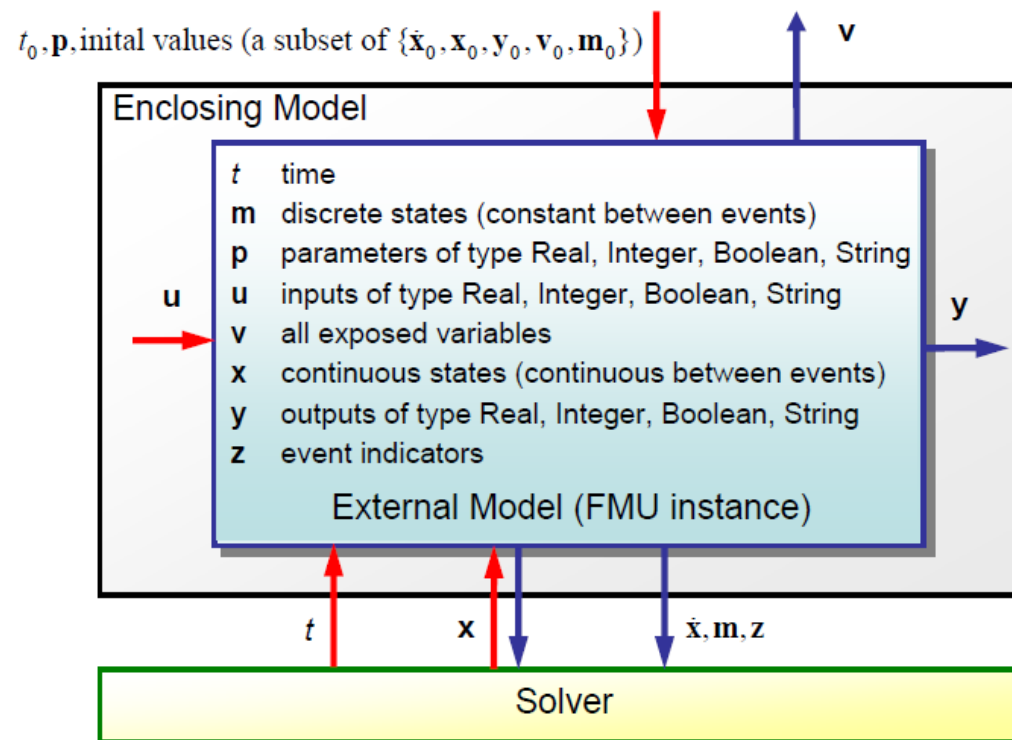
- Import and export of input/output blocks (FMU – Functional Mock-up Unit)
- described by
 - differential-, algebraic-, discrete equations,
 - with time-, state, and step-events
- FMU can be large (e.g. 100000 variables)
- FMU can be used in an embedded system (small overhead)
- FMUs can be connected together



Quelle: Modelica 2011: Functional Mockup Interface

FMI for Model Exchange

- Signals of an FMU



Quelle: Modelica 2011: Functional Mockup Interface

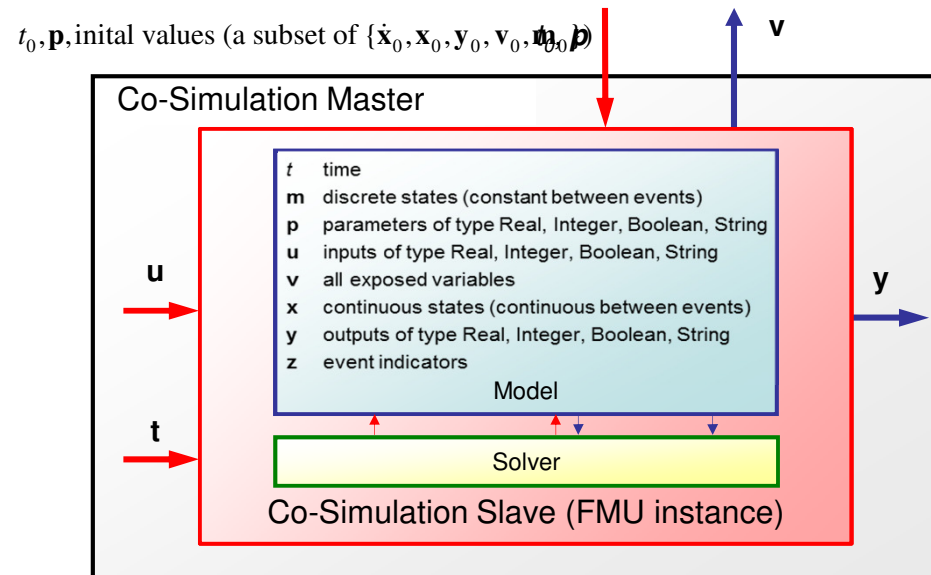
FMI for Co-Simulation

- Master/slave architecture
 - Considers different capabilities of simulation tools
 - Support of simple and sophisticated coupling algorithms:
 - Iterative and straight forward algorithms
 - Constant and variable communication step size
 - Allows (higher order) interpolation of continuous inputs
 - Support of local and distributed co-simulation scenarios
-
- FMI for Co-Simulation does not define:
 - Co-simulation algorithms
 - Communication technology for distributed scenarios

Quelle: Modelica 2011: Functional Mockup Interface

FMI for Co/Simulation

- Signals of an FMU for Co-Simulation



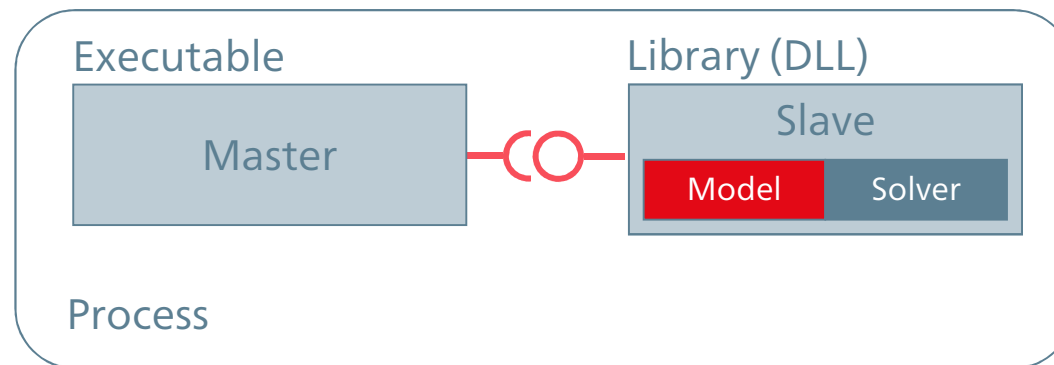
- Inputs, outputs, and parameters, status information
- Derivatives of inputs, outputs w.r.t. time can be set/retrieved for supporting of higher order approximation

Quelle: Modelica 2011: Functional Mockup Interface

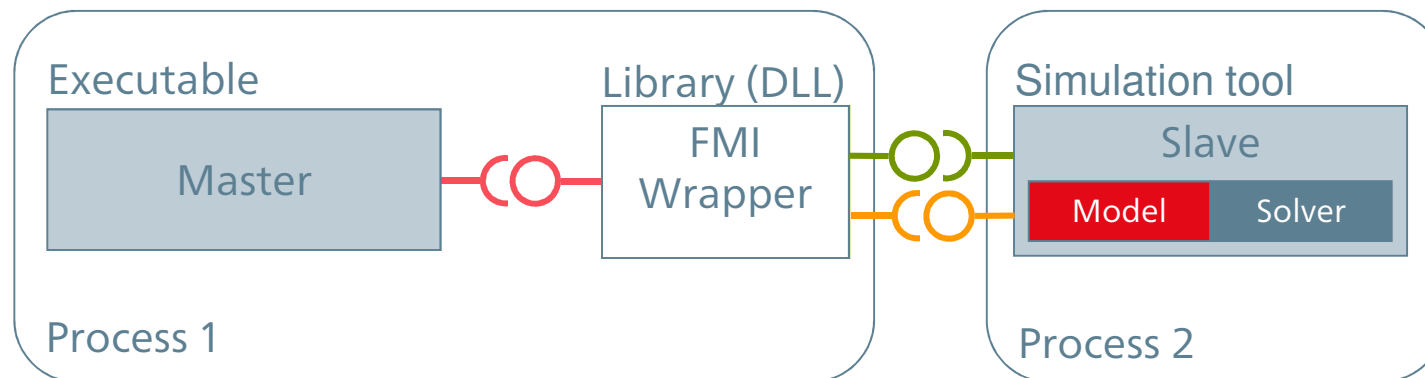
FMI for Co/Simulation

Use Case

- Co-Simulation stand alone:



- Co-Simulation tool:

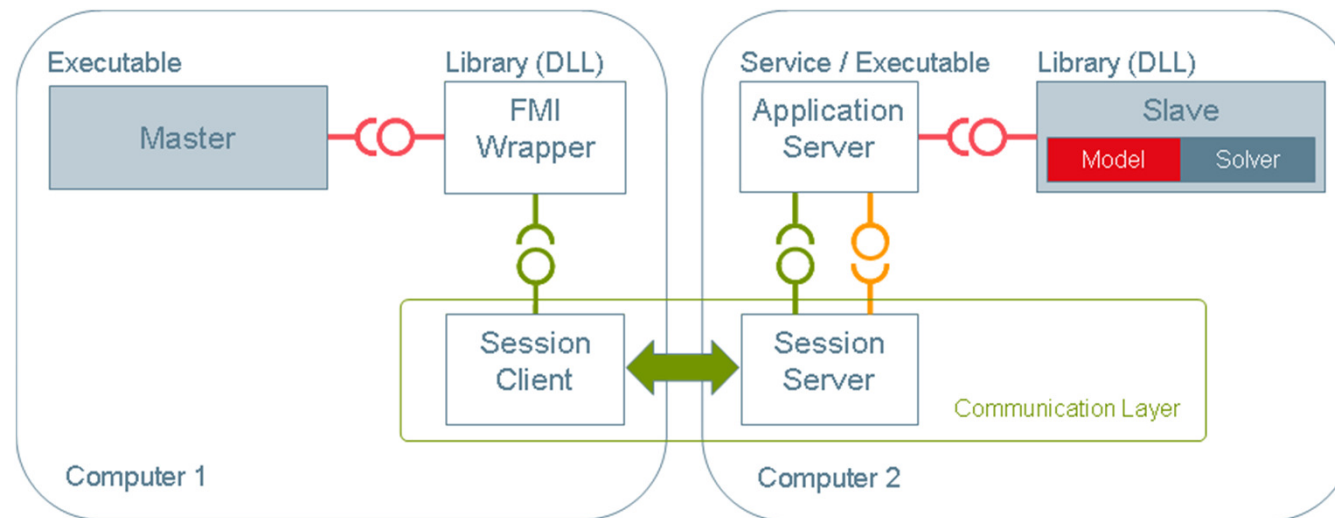


Quelle: Modelica 2011: Functional Mockup Interface

FMI for Co/Simulation

Use Case

- Distributed co-simulation scenario



- Data exchange is handled by a communication layer which is implemented by a special FMI wrapper
- Master and slave utilize FMI for Co-Simulation only

Quelle: Modelica 2011: Functional Mockup Interface

Wer unterstützt FMI?

Ein Standard ist natürlich nur so gut, wie er auch angewendet wird.

Seit dem Start von FMI umfasst die offizielle Liste der FMI-Supporter, die den Einsatz von FMI unterstützen oder planen, 58 Programme.

Die Liste wird auf www.fmi-standard.org geführt.

FLUIDON unterstützt zur Zeit FMI for Co-Simulation sowohl als klassische Co-Simulation (stand alone) als auch als ECoSim (embedded Co-Simulation) (tool) für Windows 32bit und 64bit.

Zukünftig werden auch FMI for Model Exchange und Linuxvarianten unterstützt.

FMI Support in Tools
Compatibility Table
Generated on 2014-05-15 11:18 UTC

Legend FMI Support:
Planned → Not available yet → Available → No CrossCheck results submitted → Available → Passed CrossCheck, press for results

More information about the generation of the CrossCheck results can be found in the [Rules document](#) and the [Implementation notes](#).

The following modelling and simulation environments support or plan to support FMI 1.0 (alphabetical list):

Tools supporting FMI	Model Exchange		Co-Simulation		Notes
	Export	Import	Slave	Master	
Adams		Planned	Available	Available	High end multibody dynamics simulation software from MSC Software
AMESim	Available	Available	Available	Available	Modelica environment from LMS-Imagine
ANSYS Smplicor		Available	Planned		ANSYS Smplicor is a multi-domain, multi-technology simulation program from ANSYS
ASIN - AUTOSAR Simulation	Available		Available		AUTOSAR product from Dassault Systems
Atago Ace		Available		Available	Co-simulation environment with AUTOSAR and HIL support
QSource	Available				Simulink via QSource
AVL Cruise		Available			Vehicle and Driveline System Analysis for Conventional and Future Vehicle Concepts from AVL
Building Controls Virtual Test Bed				Available	BCVTB is a Software environment, based on Ptolemy II, for co-simulation of, and data exchange with, building energy and control systems
CarMaker				Available	CarMaker is an open test-and integration-platform for MIL, SIL and HIL
CATIA	Available	Available	Available	Available	Environment for Product Design and Innovation, including systems engineering tools based on Modelica, by Dassault Systems
ControlBuild	Available	Available	Available	Available	Environment for IEC 61131-3 control applications from Dassault Systems
CoolMate		Available		Available	Co-simulation Environment from ChiasTex
Cybernetica CENT		Available		Planned	Industrial product for nonlinear Model Predictive Control (NMPC) from Cybernetica
Cybernetica ModelFit		Available		Available	Software for model verification, state and parameter estimation, using logged process data. By Cybernetica
DSHplus	Planned		Available		Fluid power simulation software from FLUIDON
Dymola	Available	Available	Available	Available	Modelica environment from Dassault Systems. Model exchange also available

Vielen Dank für Ihre Aufmerksamkeit.