ASAM | Association for standardisation of automation and measuring systems

Release Presentation

ASAM AE XIL-MA 2.0.1

Generic Simulator Interface for Simulation Model Access

2015 / 02 / 25

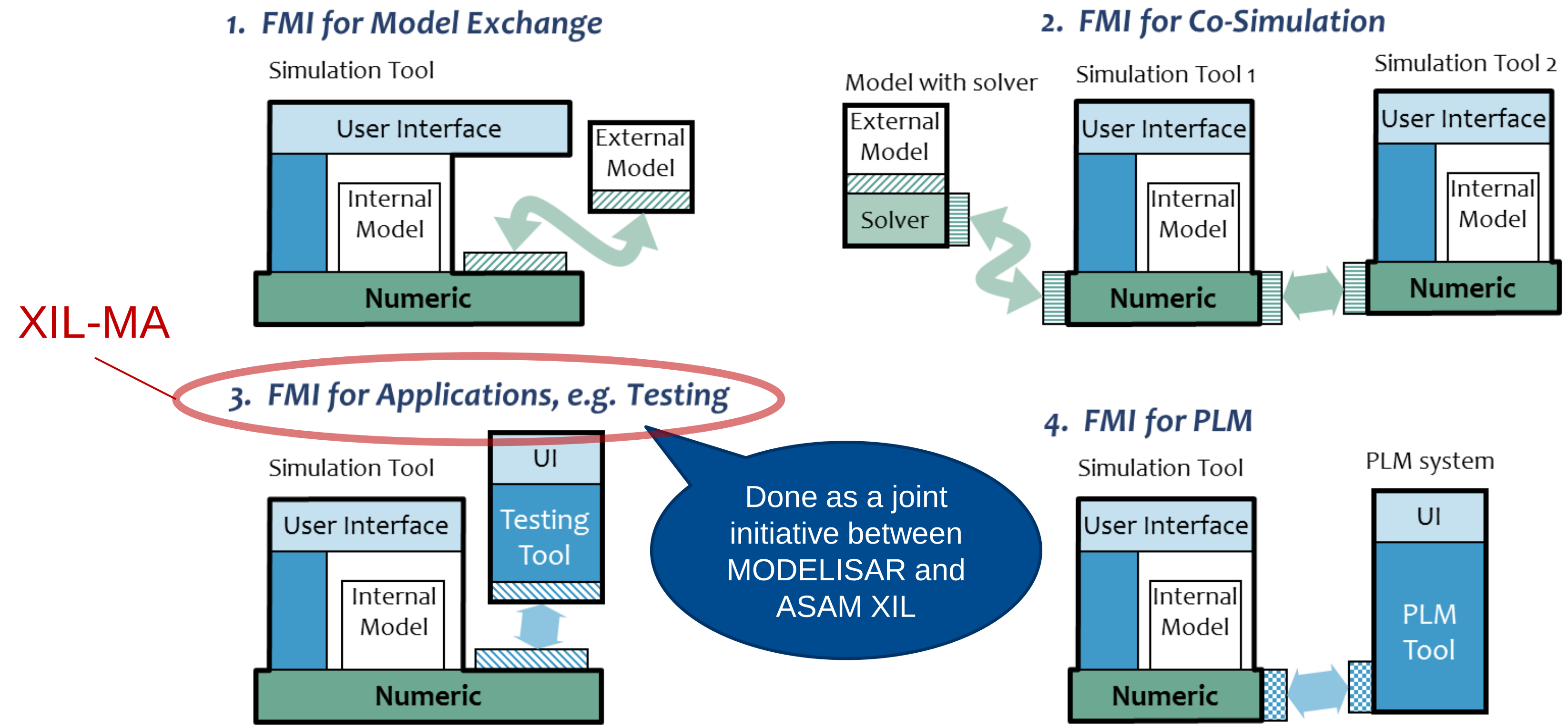
Agenda

- Motivation and Background of XIL-MA
- Introduction and General Concepts
- What’s New?
- Deliverables
- Compatibility

Motivation for XIL-MA

Cooperation of ASAM XIL and ITEA 2 Project MODELISAR

- European Project MODELISAR (2008 – 2011)
  was setup to develop a set of open interface standards for simulators



1. *FMI for Model Exchange*

Simulation Tool

User Interface

Internal Model

Numeric

External Model

2. *FMI for Co-Simulation*

Model with solver

External Model

Solver

Simulation Tool 1

User Interface

Internal Model

Numeric

Simulation Tool 2

User Interface

Internal Model

Numeric

XIL-MA

3. *FMI for Applications, e.g. Testing*

Simulation Tool

User Interface

Internal Model

Numeric

UI

Testing Tool

Done as a joint initiative between MODELISAR and ASAM XIL

4. *FMI for PLM*

Simulation Tool

User Interface

Internal Model

Numeric

PLM system

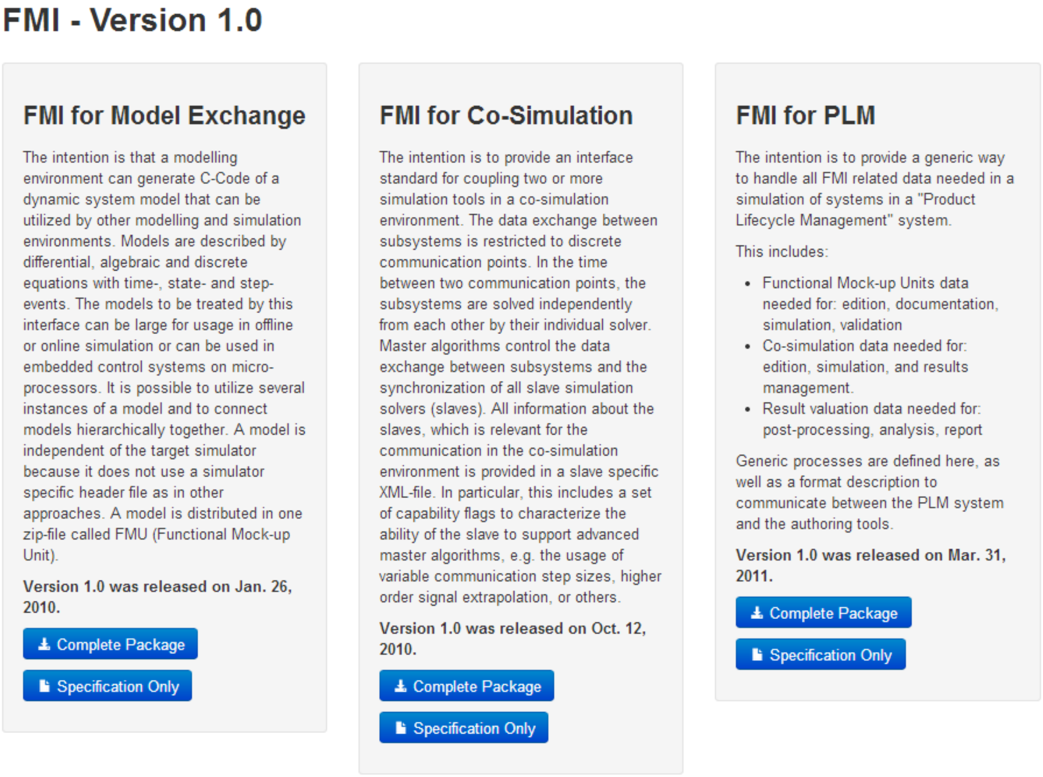
UI

PLM Tool

Background on FMI (1)

Result of MODELISAR: Functional Mockup Interface FMI

- Open standard
  - Free downloads on FMI web page: https://www.fmi-standard.org/downloads



FMI - Version 1.0

FMI for Model Exchange

The intention is that a modelling environment can generate C-Code of a dynamic system model that can be utilized by other modelling and simulation environments. Models are described by differential, algebraic and discrete equations with time-, state- and step-events. The models to be treated by this interface can be large for usage in offline or online simulation or can be used in embedded control systems on micro-processors. It is possible to utilize several instances of a model and to connect models hierarchically together. A model is independent of the target simulator because it does not use a simulator specific header file as in other approaches. A model is distributed in one zip-file called FMU (Functional Mock-up Unit).

Version 1.0 was released on Jan. 26, 2010.

FMI for Co-Simulation

The intention is to provide an interface standard for coupling two or more simulation tools in a co-simulation environment. The data exchange between subsystems is restricted to discrete communication points. In the time between two communication points, the subsystems are solved independently from each other by their individual solver. Master algorithms control the data exchange between subsystems and the synchronization of all slave simulation solvers (slaves). All information about the slaves, which is relevant for the communication in the co-simulation environment is provided in a slave specific XML-file. In particular, this includes a set of capability flags to characterize the ability of the slave to support advanced master algorithms, e.g. the usage of variable communication step sizes, higher order signal extrapolation, or others.

Version 1.0 was released on Oct. 12, 2010.

FMI for PLM

The intention is to provide a generic way to handle all FMI related data needed in a simulation of systems in a "Product Lifecycle Management" system.

This includes:

- Functional Mock-up Units data needed for: edition, documentation, simulation, validation
- Co-simulation data needed for: edition, simulation, and results management.
- Result valuation data needed for: post-processing, analysis, report

Generic processes are defined here, as well as a format description to communicate between the PLM system and the authoring tools.

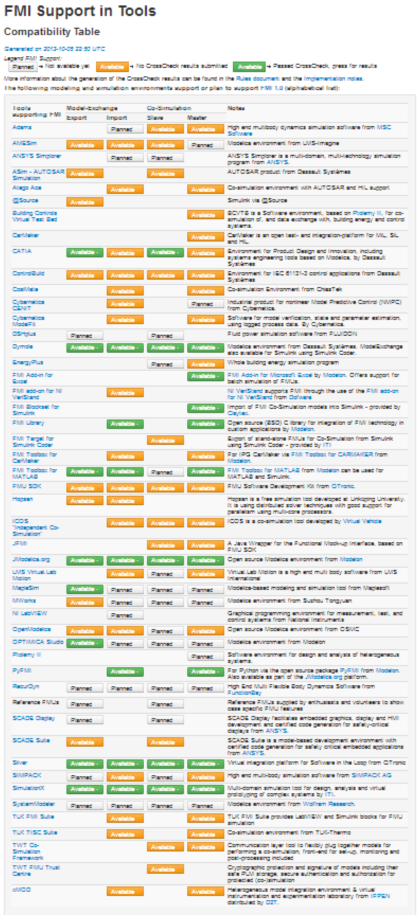
Version 1.0 was released on Mar. 31, 2011.

Background on FMI (2)

Functional Mockup Interface standard is going its way

- Broadly supported by simulation tools, see FMI web page: https://www.fmi-standard.org/tools

- Continuous development on future releases by a group as a Modelica Association Project
  - Members include Dassault Systems, Siemens, dSPACE, ETAS, Bosch, Daimler
- ProSTEP project to utilize FMI as standard exchange format between OEMs and suppliers
  - Members include BMW, Bosch, Conti, Daimler, Ford, MAN, several tool vendors
- Global Automotive Advisory Group for PLM support the ProSTEP initiative
  - OEM Members include BMW, Chrysler, Daimler, FIAT, Ford, GM, Nissan, Renault, VW,



FMI Support in Tools

Compatibility Table

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

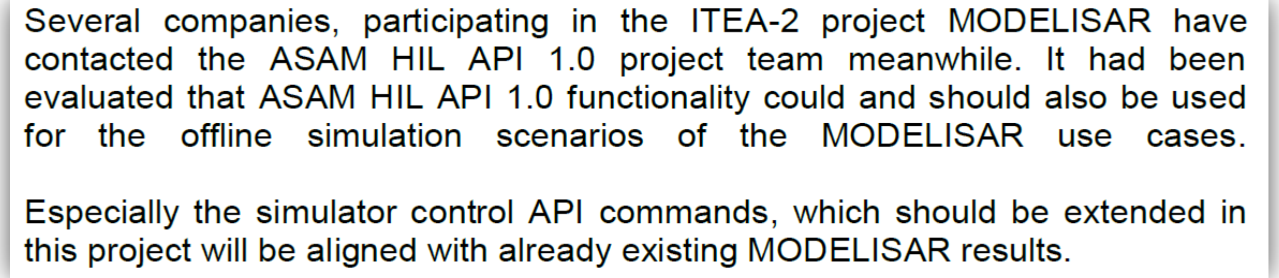
More information about the generation of the CrossCheck results can be found in the Rules document and the Implementation notes.

The following modeling 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	Planned	Modelica environment from LMS-Imagine
ANSYS Simplorer		Planned	Planned		ANSYS Simplorer is a multi-domain, multi-technology simulation program from ANSYS.
ASim - AUTOSAR Simulation	Available		Available		AUTOSAR product from Dassault Systèmes
Atego Ace		Available		Available	Co-simulation environment with AUTOSAR and HIL support
@Source	Available				Simulink via @Source
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 Systèmes
ControlBuild	Available	Available	Available	Available	Environment for IEC 61131-3 control applications from Dassault Systèmes
CosiMate		Available		Available	Co-simulation Environment from ChiasTek
Cybernetica CENIT		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		Planned		Fluid power simulation software from FLUIDON
Dymola	Available -	Available -	Available -	Available -	Modelica environment from Dassault Systèmes. ModelExchange also available for Simulink using Simulink Coder.
EnergyPlus			Planned	Available	Whole building energy simulation program
FMI Add-in for Excel				Available -	FMI Add-in for Microsoft Excel by Modelon. Offers support for batch simulation of FMUs.
FMI add-on for NI VeriStand		Available			NI VeriStand supports FMI through the use of the FMI add-on for NI VeriStand from Dofware
FMI Blockset for Simulink				Available -	Import of FMI Co-Simulation models into Simulink - provided by Claytex.
FMI Library		Available -		Available -	Open source (BSD) C library for integration of FMI technology in custom applications by Modelon.
FMI Target for Simulink Coder			Available		Export of stand-alone FMUs for Co-Simulation from Simulink using Simulink Coder - provided by ITI
FMI Toolbox for CarMaker		Available		Available	For IPG CarMaker via FMI Toolbox for CARMAKER from Modelon.
FMI Toolbox for MATLAB	Available -	Available -	Planned	Available -	FMI Toolbox for MATLAB from Modelon can be used for MATLAB and Simulink.
FMU SDK	Available	Available	Available	Available	FMU Software Development Kit from QTronic.
Hopsan	Available	Available			Hopsan is a free simulation tool developed at Linköping University. It is using distributed solver techniques with good support for parallelism using multi-core processors.
ICOS "Independent Co-Simulation"		Available	Available	Available	ICOS is a co-simulation tool developed by Virtual Vehicle
JFMI			Available	Available	A Java Wrapper for the Functional Mock-up Interface, based on FMU SDK
JModelica.org	Available -	Available -	Available -	Available -	Open source Modelica environment from Modelon
LMS Virtual.Lab Motion		Available	Planned	Available	Virtual.Lab Motion is a high end multi body software from LMS International
MapleSim	Available -	Planned	Planned	Planned	Modelica-based modeling and simulation tool from Maplesoft
MWorks	Available	Planned	Planned	Planned	Modelica environment from Suzhou Tongyuan
NI LabVIEW		Planned			Graphical programming environment for measurement, test, and control systems from National Instruments
OpenModelica	Available	Available	Planned	Available	Open source Modelica environment from OSMC
OPTIMICA Studio	Available -	Planned	Planned	Planned	Modelica environment from Modelon
Ptolemy II				Planned	Software environment for design and analysis of heterogeneous systems.
PyFMI		Available -		Available -	For Python via the open source package PyFMI from Modelon. Also available as part of the JModelica.org platform.
RecurDyn	Planned	Planned	Planned	Planned	High End Multi Flexible Body Dynamics Software from FunctionBay
Reference FMUs	Planned		Planned		Reference FMUs supplied by enthusiasts and volunteers to show case specific FMU features
SCADE Display	Planned		Planned		SCADE Display facilitates embedded graphics, display and HMI development and certified code generation for safety-critical displays from ANSYS.
SCADE Suite	Available		Available		SCADE Suite is a model-based development environment with certified code generation for safety critical embedded applications from ANSYS.
Silver	Available -	Available -	Available -	Available -	Virtual integration platform for Software in the Loop from QTronic
SIMPACK	Planned	Available	Planned	Available	High end multi-body simulation software from SIMPACK AG
SimulationX	Available -	Available -	Available -	Available -	Multi-domain simulation tool for design, analysis and virtual prototyping of complex systems by ITI.
SystemModeler	Planned	Planned	Planned	Planned	Modelica environment from Wolfram Research.
TLK FMI Suite		Available		Available	TLK FMI Suite provides LabVIEW and Simulink blocks for FMU simulation
TLK TISC Suite		Available		Available	Co-simulation environment from TLK-Thermo
TWT Co-Simulation Framework			Available	Available	Communication layer tool to flexibly plug together models for performing a co-simulation; front-end for set-up, monitoring and post-processing included
TWT FMU Trust Centre			Available		Cryptographic protection and signature of models including their safe PLM storage, secure authentication and authorization for protected (co-)simulation
xMOD		Available		Available	Heterogeneous model integration environment & virtual instrumentation and experimentation laboratory from IFPEN distributed by D2T.

Basic idea of the joint initiative between MODELISAR and the ASAM XIL group

- Don’t develop competing standards
  - Bring together the HIL and MIL/SIL environments
  - Project proposal addresses the idea



Several companies, participating in the ITEA-2 project MODELISAR have contacted the ASAM HIL API 1.0 project team meanwhile. It had been evaluated that ASAM HIL API 1.0 functionality could and should also be used for the offline simulation scenarios of the MODELISAR use cases.

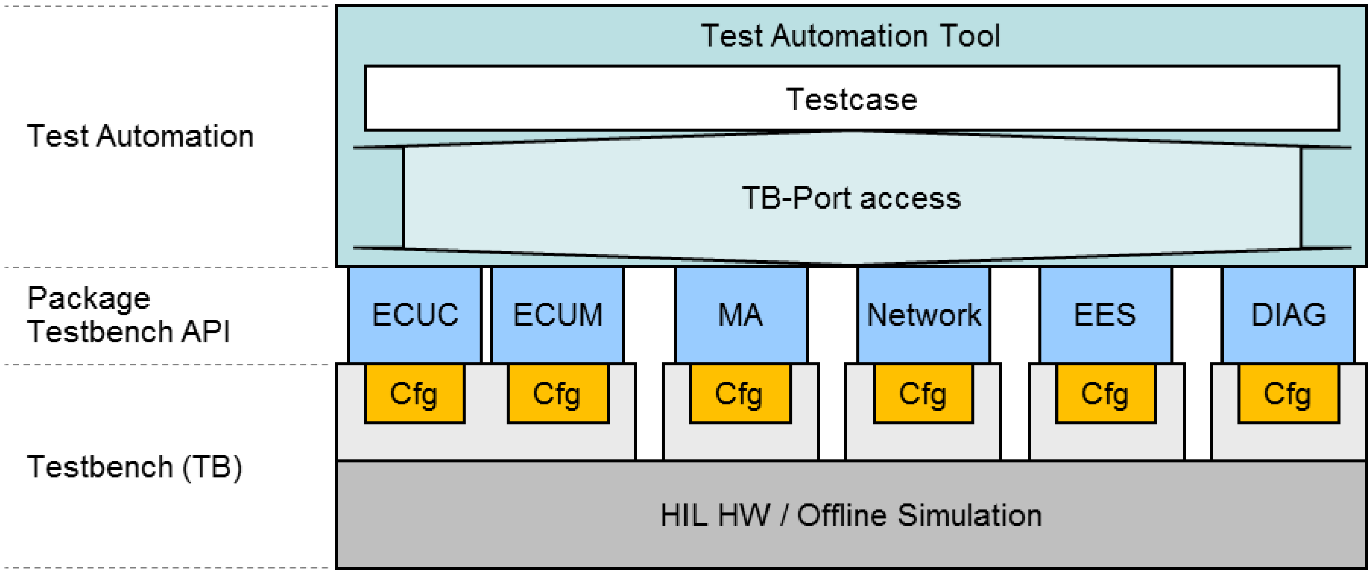
Especially the simulator control API commands, which should be extended in this project will be aligned with already existing MODELISAR results.

taken from project proposal ASAM HIL 2.0.0, 2011

  - Daimler entered the ASAM HIL API project to connect the two groups
  - No effort on FMI for Application within MODELISAR
- Common understanding that results concerning offline simulation can be released as FMI for Applications
  - freely available to non-ASAM-members

General Concepts of XIL (1)

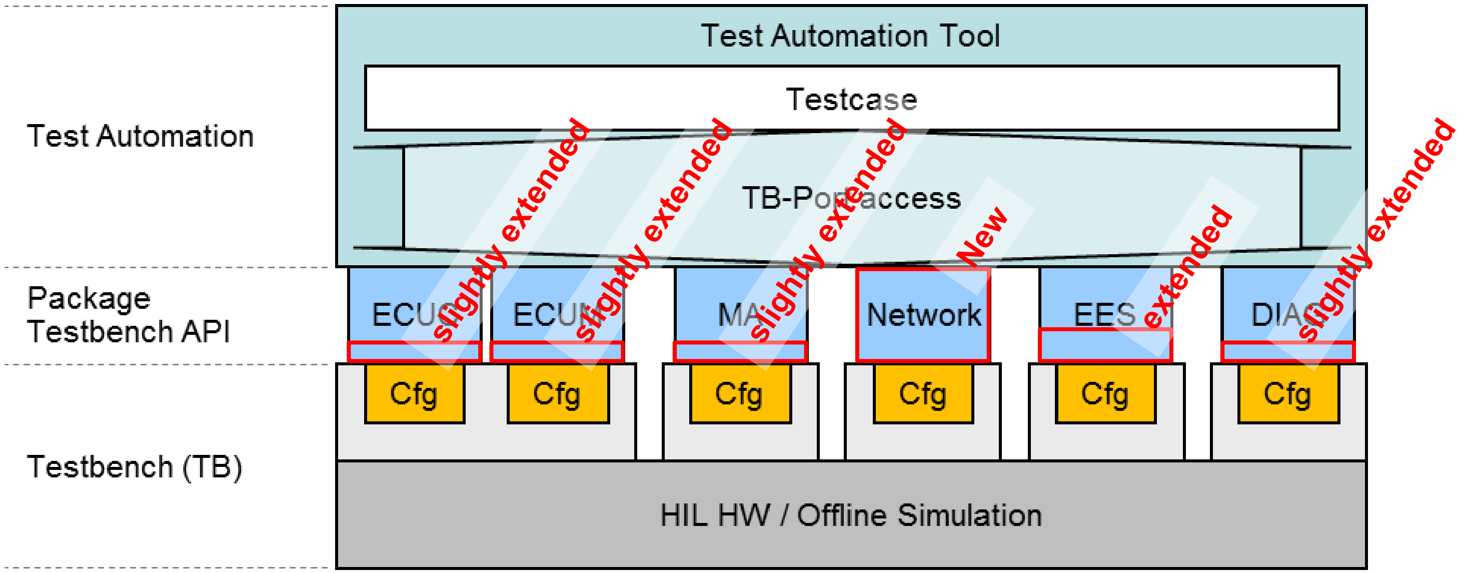
Testbench-based Access (as in HIL 1.0.2)



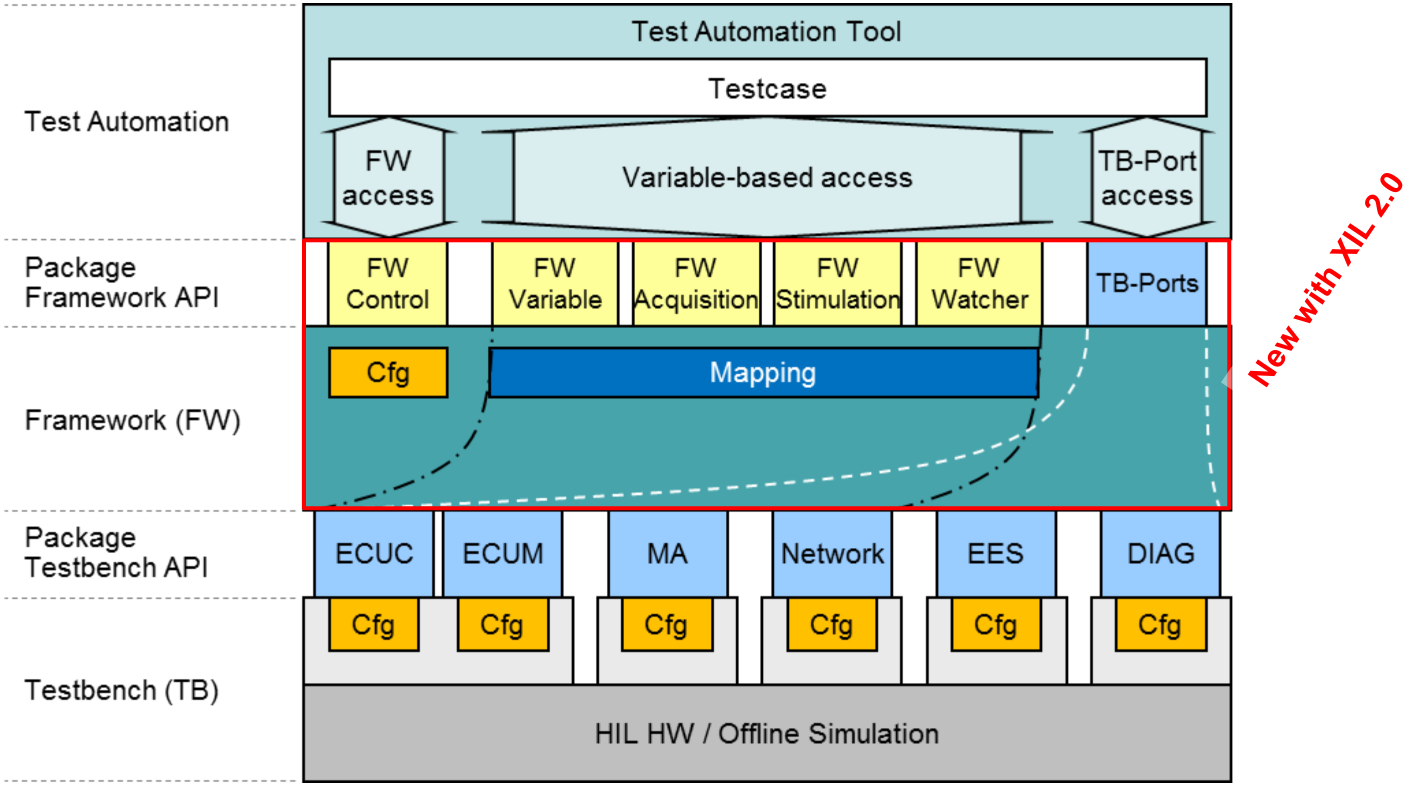
- Drawbacks of HIL 1.0.2:
  - Testcase has to implement start and shutdown of ports
  - Dealing with vendor-specific start and shutdown methods (not standardizedin 1.0.2)
  - Port-specific variable identifiers and data types
  - Missing overall concepts for measuring and stimulating accross different ports

General Concepts of XIL (2)

Testbench Extensions with XIL 2.0



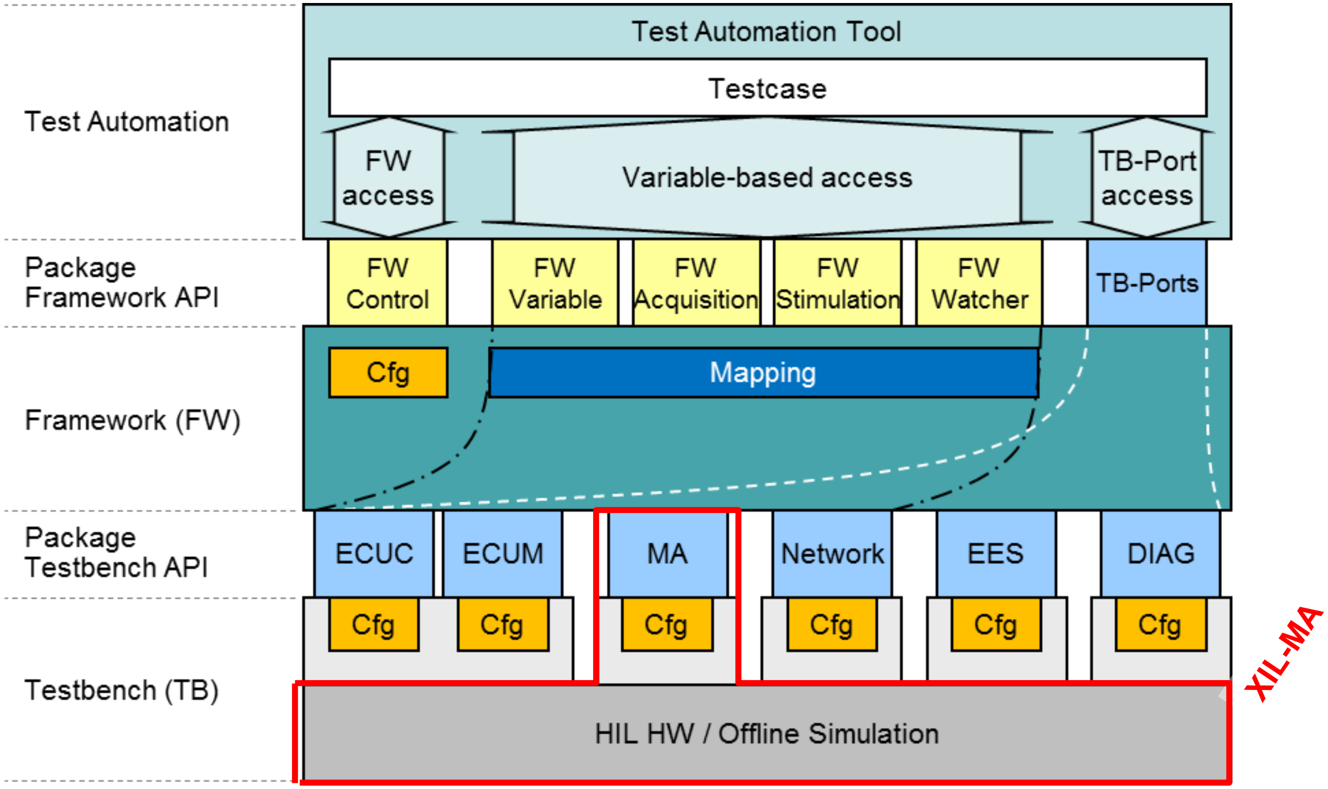
Framework-based Access (with XIL 2.0.0)



Major Benefits:

- Port independence of testcases by using an object-oriented access to variables
- Framework starts and shuts down ports in a configured order
- Test Developer can use both: Testbench Port access and Variable-based access
- FW Variables provide access to the underlying Testbench Port

XIL-MA

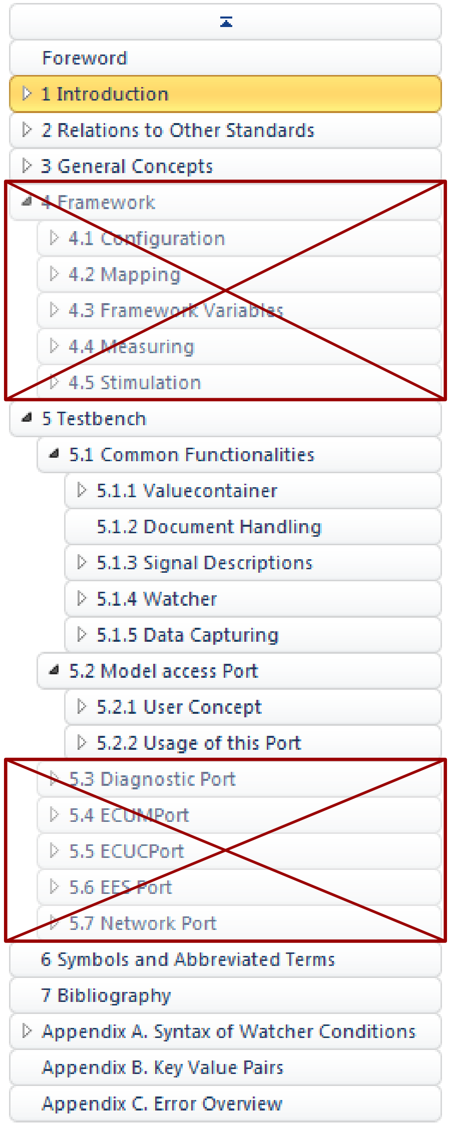


- MAPort for Simulation Model Access
  - can be used in single testautomation applications
  - can be integrated into the XIL Framework together with other ports to benefit from the full Framework functionality.

XIL-MA: What’s New?

- ASAM releases an additional document:
“Generic Simulator Interface for Simulation Model Access”
  - Contains only relevant parts **for implementation of MAPort**
  - **Freely available** for anyone as a download
  - **ASAM XIL standard remains “master”** description, Testbench Model Access Port and Common Functionalities
- Future releases of ASAM XIL
  - Extract the same scope of content
  - The **FMI group** should be invited to **send representatives** into XIL to contribute their experience (also non ASAM members)

Not included in XIL-MA but in XIL



Benefits of XIL-MA

- Open ASAM Document
  “Generic Simulator Interface for Simulation Model Access
  - Broadens scope of XIL standard to non-ASAM / non-HIL vendors
  - Consistency of specification is maintained by XIL group
  - ASAM ownership and copyright

Compatibility

- XIL-MA is a subset of XIL.
- The parts that are available in both standards are absolutely identical.

Deliverables

Package Standard

Directory Specification

ASAM_AE_XIL-MA_AS_V2-0-1.pdf

Directory Generic UML Model

ASAM_AE_XIL-MA_AS_V2-0-1.EAP (view of test case developer)

Package Implementation Support (ASAM software parts)

Directory Templates and Directory Template Example

- Stimulus Signal Description (*.xsd, *.sti and *.stz example)
- ImplementationManifest (ImplementationManifest.xsd; xml example)

Directory Technology Reference Interfaces

Sub Directory Python contains

- Mapping_Rules (ASAM_AE_XIL_Generic-Simulatior-Interface_BS-3-4_Python-API-Technology-Reference-Mapping- Rules_V2-0-1)
- Python Interfaces (py files)

Sub Directory C# c ontains

- Mapping_Rules (ASAM_AE_XIL_Generic-Simulatior-Interface_BS-2-4_C#-API-Technology-Reference-Mapping-Rules_V2-0-1)
- Interfaces (cs files)
- Sample Code (restricted for MA-Port)

Changes in Maintenance XIL-MA 2.0.1

based on XIL-MA 1.0.0

- Bugfixing of some workblockers, that have been detected during implementation phase, such as scalar was returned instead of a list of scalars;
  Signal generator factory now returns the correct ISignalGeneratorSTZWriter instead of ISignalGeneratorSTZReader;
  added missing value 'eDATAFILE' to SegmentTypes enum.
- Definition of Initial values to avoid invalid object creation of the new DataFileSegment class.
- Added some missing error codes and post conditions
- Added a new MAPort method GetTaskInfos to get information about existing tasks (eTimerDriven, eEventDriven, Sample Period)
- Added some functionality for simultanious read access of multiple clients and threads to the Testbench Manifest File (contains vendor-specific information about the Testbench)
- Capture now derives from Interface IDisposable to enable explicit instance destruction of Capture (to free system resources, e. g. real-time service code)
- Correction of errors in documentation (Guide and UML Model, e. g. SetStartTriggerCondition)
- Introduction of the correct short name in all documents:
  "XIL - Generic Simulator Interface" instead of “XIL - API for ECU Testing via XIL“