

Release Presentation

ASAM AE XIL-MA 1.0.0

Generic Simulator Interface for Simulation Model Access

2014 / 02 / 27

Agenda

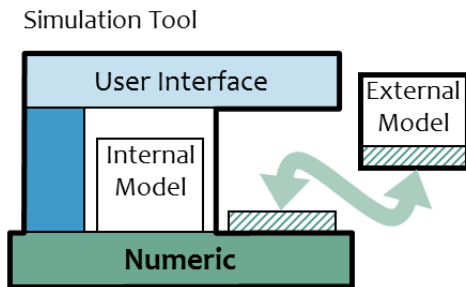
- ▶ **Motivation and Background of XIL-MA**
- ▶ **Introduction and General Concepts**
- ▶ **What's New?**
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- ▶ **Compatibility**

Motivation for XIL-MA

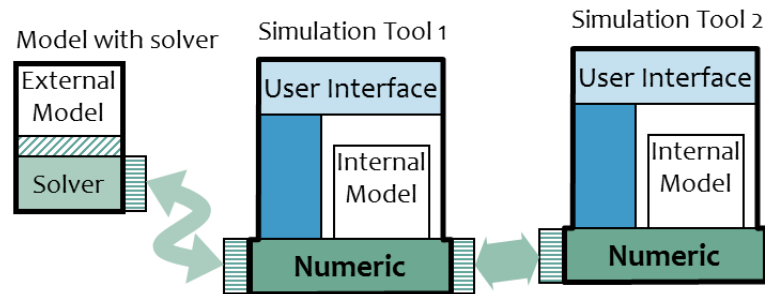
Cooperation of ASAM XIL and ITEA 2 Project MODELISAR

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

1. FMI for Model Exchange

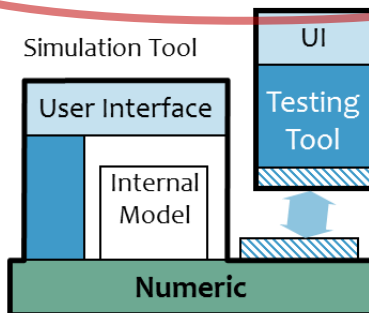


2. FMI for Co-Simulation



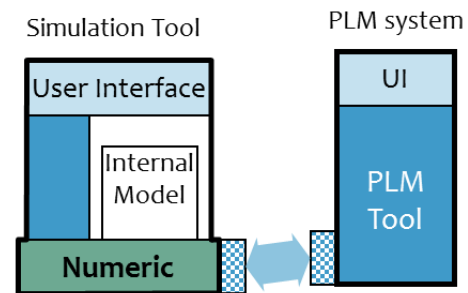
XIL-MA

3. FMI for Applications, e.g. Testing



Done as a joint initiative between MODELISAR and ASAM XIL

4. FMI for PLM



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.

📄 Complete Package

📄 Specification Only

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.

📄 Complete Package

📄 Specification Only

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.

📄 Complete Package

📄 Specification Only

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

Generated on 2015-10-22 20:17 UTC
 Legend: FMI Support: Planned, Available, Not CrossCheck results submitted, Available, Pre-Tested CrossCheck, press for results
 More information about the generation of the CrossCheck results can be found in the [Rules document](#) and the [Implementation rules](#).
 The following modeling and simulation environments support or plan to support FMI 2.0 (operational):

| Tool | Model-Exchange Support | Co-Simulation Support | Notes |
|---------------------------------------|------------------------|-----------------------|---|
| Adams | Planned | Available | High and multi-body dynamics simulation software from MSC Software |
| ANSYS | Available | Available | Modelica environment from LMS Imagine |
| ANSYS Smpower | Planned | Planned | ANSYS Smpower is a multi-domain, multi-technology simulation program from ANSYS |
| Asim - AUTOSAR Simulation | Available | Available | Modelica environment from Dassault Systèmes |
| Aspen HYSYS | Available | Available | Simulation environment with AUTOSAR and HIL support |
| Autodesk | Available | Available | Software for 3D design |
| Building Controls Visual Test Bed | Available | Available | SCADA is a software environment, based on ProStep II, for co-simulation of, and data exchange with, building energy and control systems |
| CarSim | Available | Available | CarSim is an open-look and integration platform for HIL, SIL, and MIL |
| CATIA | Available | Available | Environment for Product Design and Innovation, including systems engineering tool based on Modelica, by Dassault Systèmes |
| ControlDesk | Available | Available | Environment for IEC 61131-3 control applications from Dassault Systèmes |
| ControlExpert | Available | Available | Co-simulation Environment from Chartwell |
| Cybernetica | Available | Available | Industry product for nonlinear flexible Control (NLFC) from Cybernetica |
| Cybernetica Modelica | Available | Available | Software for model verification, reuse and operational execution, using Modelica (see also: DSpace) |
| dSPACE | Planned | Planned | Full power simulation software from FluidCAD |
| Dynas | Available | Available | Modelica environment from Dassault Systèmes, Modelica/Modelica is available for Simulink using Simulink-Coder |
| Energysim | Available | Available | Whole building energy simulation program |
| FMI-Adapter for Simscape | Available | Available | FMI-Adapter for Simulink: Full support for Simulink. Other support for each simulation of FMI |
| FMI-Adapter for MATLAB | Available | Available | FMI-Adapter for MATLAB: Full support for MATLAB. Other support for each simulation of FMI |
| FMI-Adapter for Simulink | Available | Available | Support of FMI Co-Simulation modes into Simulink - provided by Daimler |
| FMI-Target for Simulink-Coder | Available | Available | Code source (SBC) library for integration of FMI technology in custom applications by MathWorks |
| FMI-Target for MATLAB | Available | Available | Support of external FMI for Co-Simulation from Simulink using Simulink-Coder - provided by IT |
| FMI-Target for MATLAB/Simulink | Available | Available | Full FMI Co-Simulation modes into Simulink - provided by Daimler |
| FMI-Tool | Available | Available | FMI-Toolbox for MATLAB from MathWorks can be used for MATLAB and Simulink |
| FMI-Toolbox | Available | Available | FMI-Toolbox Development Kit from Chartwell |
| Hopsan | Available | Available | Hopsan is a free simulation tool developed at Linköping University, which supports and implements full FMI support for performing multi-scale processes |
| IEC 61131-3 Independent Co-Simulation | Available | Available | IEC is a communication tool developed by Visual Informatics |
| JPLSI | Available | Available | A Java Controller for the Functional Mockup Interface, based on FluidCAD |
| Modelica.org | Available | Available | Open source Modelica environment from Ipsocon |
| NI LabVIEW | Available | Available | Visual LabVIEW is a high and multi-body software from NI |
| OpenModelica | Available | Available | Modelica-based modeling and simulation tool from Ipsocon |
| OptiModelica | Available | Available | Modelica environment from Sinopec Tongshan |
| PLM | Planned | Planned | Optical programming environment for measurement, test, and control systems from National Instruments |
| ProSTEP | Available | Available | Open source Modelica environment from Chartwell |
| ProSTEP II | Available | Available | Modelica environment from Ipsocon |
| ProSTEP III | Available | Available | Modelica environment from Ipsocon |
| ProSTEP IV | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP V | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP VI | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP VII | Available | Available | Software environment for design and analysis of heterogeneous systems |
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| ProSTEP XVI | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP XVII | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP XVIII | Available | Available | Software environment for design and analysis of heterogeneous systems |
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| ProSTEP XXVII | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP XXVIII | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP XXIX | Available | Available | Software environment for design and analysis of heterogeneous systems |
| ProSTEP XXX | Available | Available | Software environment for design and analysis of heterogeneous systems |

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.

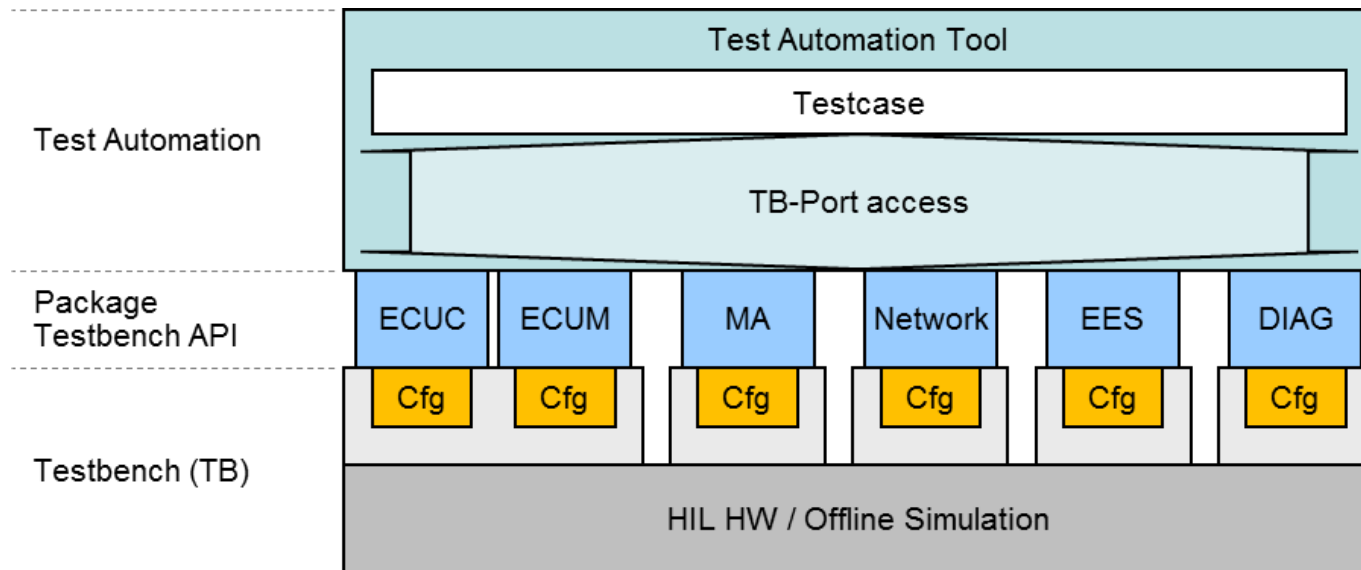
Especially the simulator control API commands, which should be extended in this project will be aligned with already existing MODELISAR results.

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)

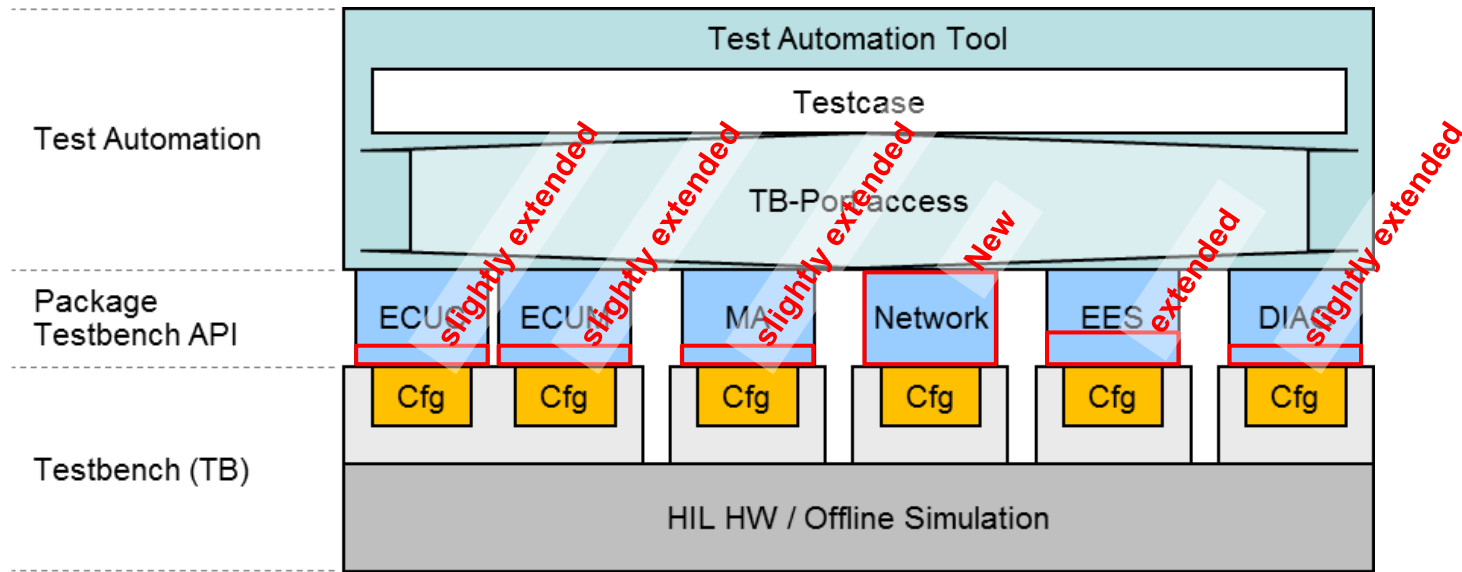


► Drawbacks of HIL 1.0.2:

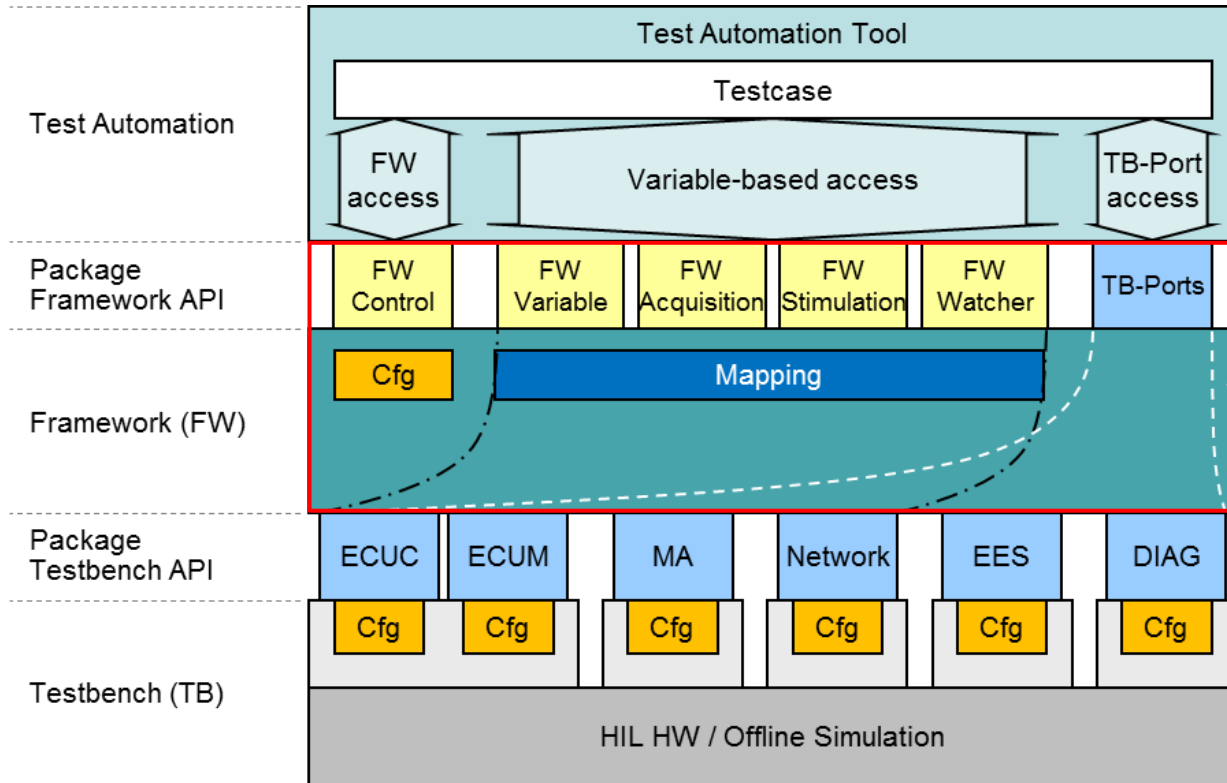
- Testcase has to implement start and shutdown of ports
- Dealing with vendor-specific start and shutdown methods (not standardized in 1.0.2)
- Port-specific variable identifiers and data types
- Missing overall concepts for measuring and stimulating across different ports

General Concepts of XIL (2)

Testbench Extensions with XIL 2.0



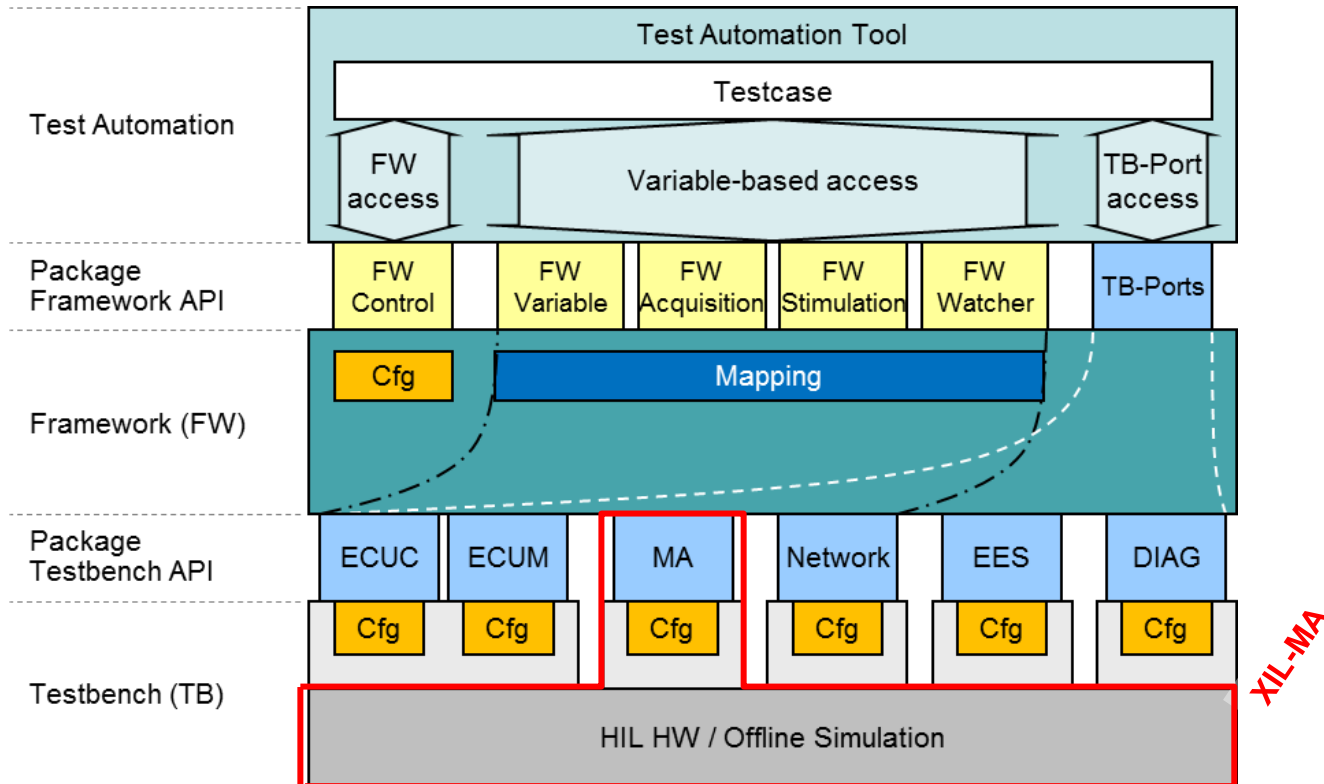
Framework-based Access (with XIL 2.0.0)



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



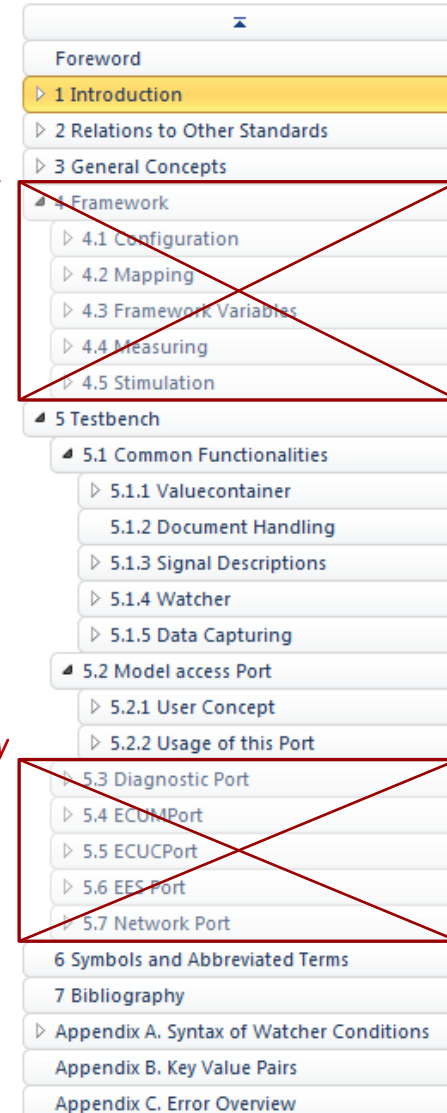
▶ MAPort for Simulation Model Access

- 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?

Not included in XIL-MA but in XIL

- ▶ 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)



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|--|
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| ▶ 1 Introduction |
| ▶ 2 Relations to Other Standards |
| ▶ 3 General Concepts |
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| ▶ 4.2 Mapping |
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| ▶ 5.1 Common Functionalities |
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| ▶ Appendix A. Syntax of Watcher Conditions |
| Appendix B. Key Value Pairs |
| Appendix C. Error Overview |

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
- ▶ Those parts, that are available in both standards are absolutely identical

Deliverables

Package Standard

Directory Specification

ASAM_AE_XIL-MA_AS_V1-0-0.pdf

Directory Generic UML Model

ASAM_AE_XIL-MA_AS_V1-0-0.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)

Directory Technology Reference Interfaces

Sub Directory Python contains

- Mapping_Rules

(ASAM_AE_XIL_Generic-Simulator-Interface_BS-3-4_Python-API-Technology-Reference-Mapping- Rules_V2-0-0)

- Python Interfaces (py files)

Sub Directory C# c contains

- Mapping_Rules (ASAM_AE_XIL_Generic-Simulator-Interface_BS-2-4_C#-API-Technology-Reference-Mapping-Rules_V2-0-0)

- Interfaces (cs files)