ASAM-MBFS: A Standardized Block Library as Enabler of Efficient Model Based Collaboration

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2008-06-03
Agenda

- Motivation
- Challenges induced by model exchange
- Solution: automotive block library (ASAM-MBFS)
- Further proceeding
Motivation

- **Model-based design more and more used** for automotive function development

- Model-based development **supports efficient**
  - requirements engineering
  - handover of requirements & executable specifications
  - early validation
  - early generation of prototype control units

- **Re-use of base algorithms** via block libraries leads to strongly reduced development time

**But:** Many effective degrees of freedom for model design

→ Problem potential in case of model exchange
Challenges induced by model exchange

- **Executable models** linked to different use cases (concept, implementation, …)
- **Many requirements** for each single functional base element (represented by blocks)
- **No automotive block library** delivered by tool suppliers
- Development of *specific block libraries* driven by several companies adapted to company-specific needs
- Model exchange means exchange of different block libraries
  - Very time consuming
  - Very error-prone
  - Different forming could lead to misunderstandings
  - 1 to 1 mapping not possible in general (e.g. due to functional details)

*Large overhead for model exchange due to integration and rework efforts caused by "model translation"*
Solution: automotive block library (ASAM-MBFS)

- Standardized block library **eases model exchange** and **reduces integration time**
- Improved **model comprehensibility**
- **Avoidance of misunderstandings**
- Reduction of **transfer efforts**

**ASAM** (Association for Standardization of Automation and Measuring Systems) as **right base** for establishing standardized block library

- **provides standards** for data models, interfaces and syntax specifications for a variety of applications (testing, evaluation, simulation, …)
- **has wide range of members**: OEMs, tier one suppliers, suppliers, universities, individuals

**ASAM-MBFS** (Model Based Function Specification) as successor of former MSR-MEGMA working group already defined
Solution: automotive block library (ASAM-MBFS)

- Creation of **ASAM standard** discussed and agreed by **ASAM-MBFS working group**
  - based on **MSR specification**
  - considering **experiences** from existing library implementations in function development environments, such as
    - **SDA** (System Design Automation) by Continental's Powertrain division and
    - **ASD** (AUDI system design) by AUDI for Powertrain functionalities
  - covering
    - **tool-independent specification** as enabler of model exchange across different modeling tools
    - **Simulink based specification** and **reference implementation** based on Continental's MEGMA-related block library implementation – **driven by Continental and AUDI AG**
Solution: automotive block library (ASAM-MBFS)

ASAM-MBFS

Offline Simulation
Rapid Prototyping
Model Exchange
Functional Documentation
Production Code Generation

Executable Specification

Standardized block library as single source for the complete model based development process

if (...) 
  x=x+1;
  Y=y+x;
else
  ...

ASAM
Solution: automotive block library (ASAM-MBFS)

- The MBFS specification includes
  - general definitions valid for all blocks

<table>
<thead>
<tr>
<th>P</th>
<th>AnyBlock</th>
<th>O</th>
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<tbody>
<tr>
<td>I</td>
<td></td>
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<tr>
<td>C</td>
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- General recommendations for **port placement** for different port classifications
- All blocks represent **discrete time blocks**
- Clearly defined block names
- Variables/parameters classified as external interface variables, internal variables, internal constants, applicable parameters

Simulink implementation of the library block Hysteresis

P: parameter inputs; I: inputs; C: control inputs, O: outputs
Solution: automotive block library (ASAM-MBFS)

- The MBFS specification includes
  - detailed specifications of each single block

<table>
<thead>
<tr>
<th>Icon</th>
<th>Variables</th>
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<tbody>
<tr>
<td>Inputs</td>
<td>Outputs</td>
</tr>
<tr>
<td>1 LSP: real</td>
<td>1 y: logic</td>
</tr>
<tr>
<td>2 RSP: real</td>
<td></td>
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<tr>
<td>3 u: real</td>
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<tr>
<td>4 R: logic</td>
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</tr>
<tr>
<td>5 IV: logic</td>
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- Simulation data types specified for all variables and parameters
- Optional variables explicitly defined
- Graphical representation of each block specified

- definitions for default setup of blocks, rounding function, reset functionality, …
Solution: automotive block library (ASAM-MBFS)

- The MBFS specification includes
  - test cases together with **simulation results**

![Graphs showing parameter input, control/reset input, and input/output relationship]
Solution: automotive block library (ASAM-MBFS)

- **Successful applications**
  - ASAM-MBFS library used at Continental's and AUDI's Powertrain division for modeling and simulating ECU functionalities
  - ASAM standard *integral part* of model-based function development environments including simulation, testing, rapid prototyping, automatic production code generation, documentation
  - Exchange of models using the same block library much more efficient – mapping and transformation of different block implementations not necessary anymore
  - Continental's and AUDI's Powertrain division pushed further development of library for production code generation: standard allows to use same software routines independent of modeling or code generation tool used
  - Model-based specifications and **documentations** of control algorithms show **very good comprehensibility** based on standardized graphical element
Further proceeding

- ASAM-MBFS represents a **standard for model-based development** enabling a very efficient exchange of functional models and the comprehensibility of documentations.

- **Very important topics for the future:**
  - **maintenance** of standard and reference implementation
  - **very close link** to up-to-date **tool releases**
  - **direct support by tool suppliers** for ensuring high optimum efficiency for all steps in model-based function development process

- **Block library to be provided by tool suppliers**
  - could be **highly integrated** into tooling & would be available for all customers
  - would further establish the standard block library as **common platform**

  → **Tool suppliers should take over the implementation of the ASAM standard and perform further refinements**