

**Audi**

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

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# Agenda

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

# Motivation

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▶ **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

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- ▶ **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)

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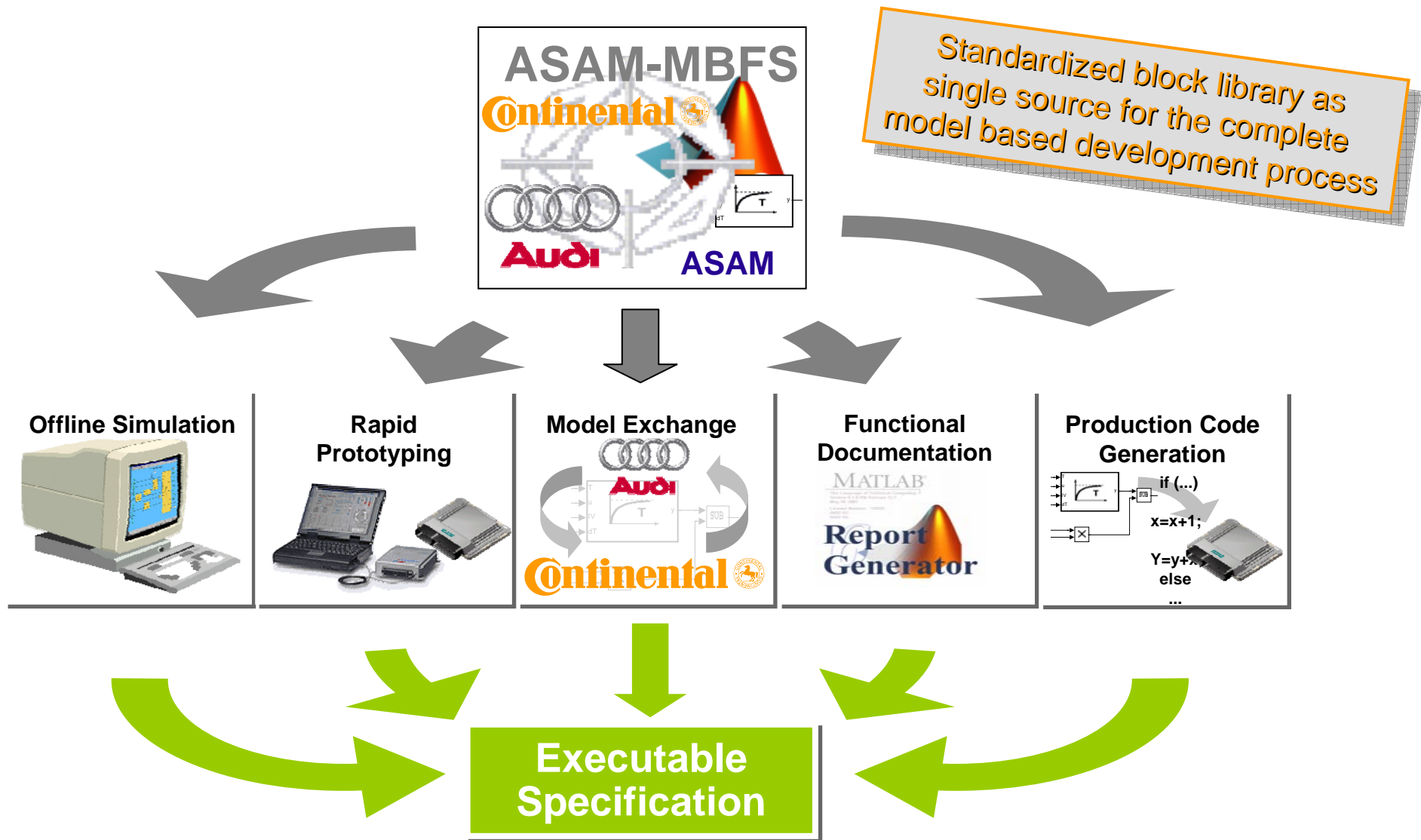
- ▶ Standardized block library **eases model exchange** and **reduces integration time**
- ▶ Improved **model comprehensibility**
- ▶ **Avoidance of misunderstandings**
- ▶ Reduction of **transfer efforts**
- ▶ **ASAM** (Association for Standardization of Automation and Measuring Systems) as **right 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)

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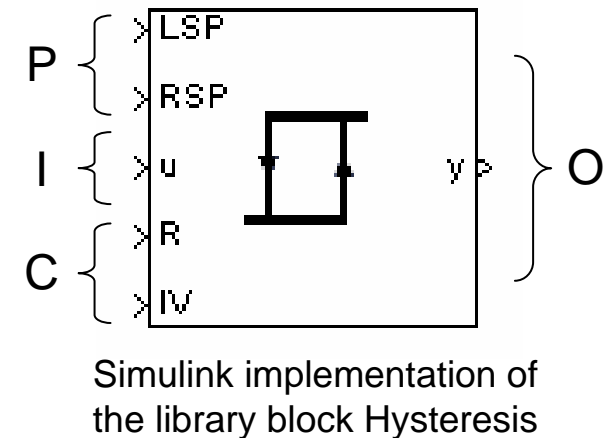
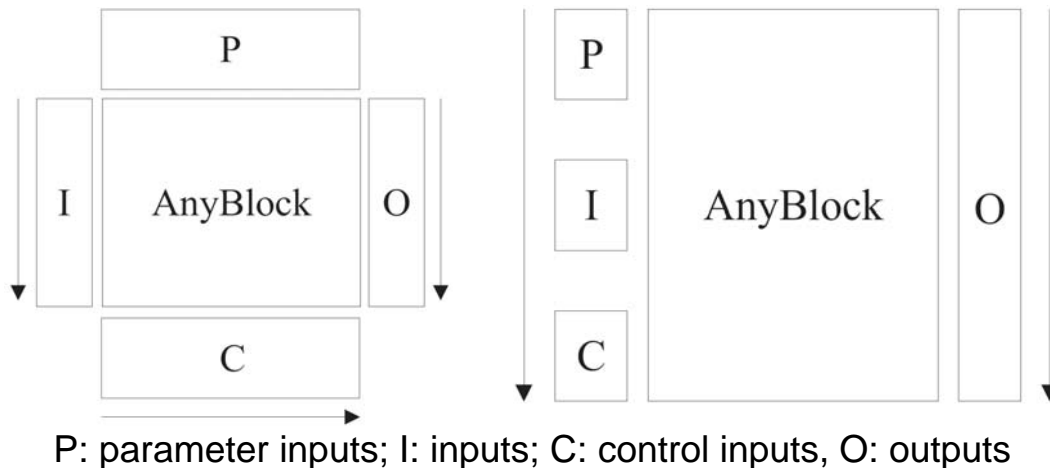
- ▶ Creation of **ASAM standard** discussed and agreed by **ASAM-MBFS working group**
  - ▶ based on **MSR specification**
  - ▶ considering **experiences** from existing library implementations in function development environments, such as
    - ▶ **SDA** (System Design Automation) by Continental's 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)



# Solution: automotive block library (ASAM-MBFS)

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




- ▶ 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



# Solution: automotive block library (ASAM-MBFS)

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

Icon	Variables			
	Inputs	Outputs	States	Temporary
	1 LSP: real 2 RSP: real 3 u: real 4 R: logic 5 IV: logic	1 y: logic	1 x: logic	

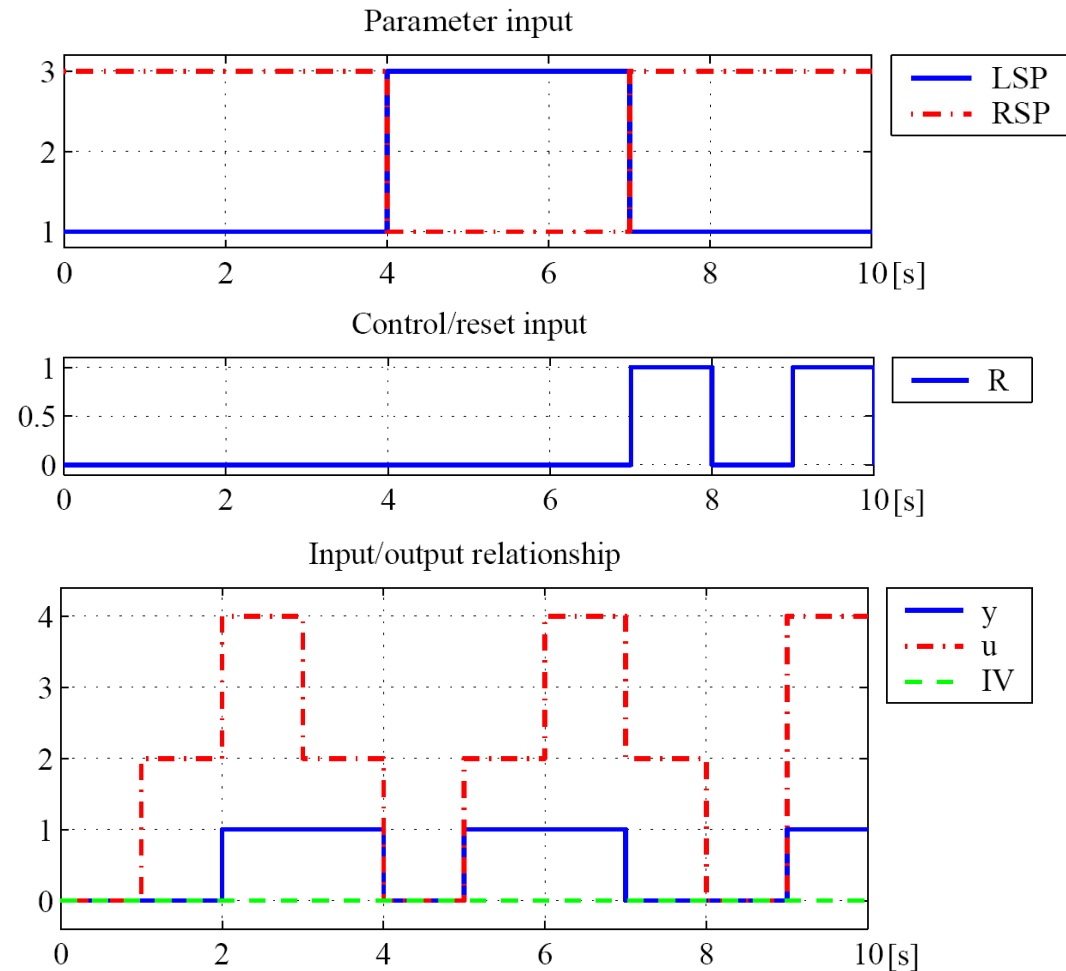
System init code	Runcode
x = 0;	<pre> if (R) {     x = IV; } if (u &gt; RSP) {     x = 1; } else if (u &lt; LSP) {     x = 0; } y = x;                     </pre>

- ▶ **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**



# Solution: automotive block library (ASAM-MBFS)

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## ▶ 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

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- ▶ 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**