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

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Agenda

- Motivation

- Challenges induced by model exchange

- Solution: automotive block library (ASAM-MBFS)

- Further proceeding

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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**
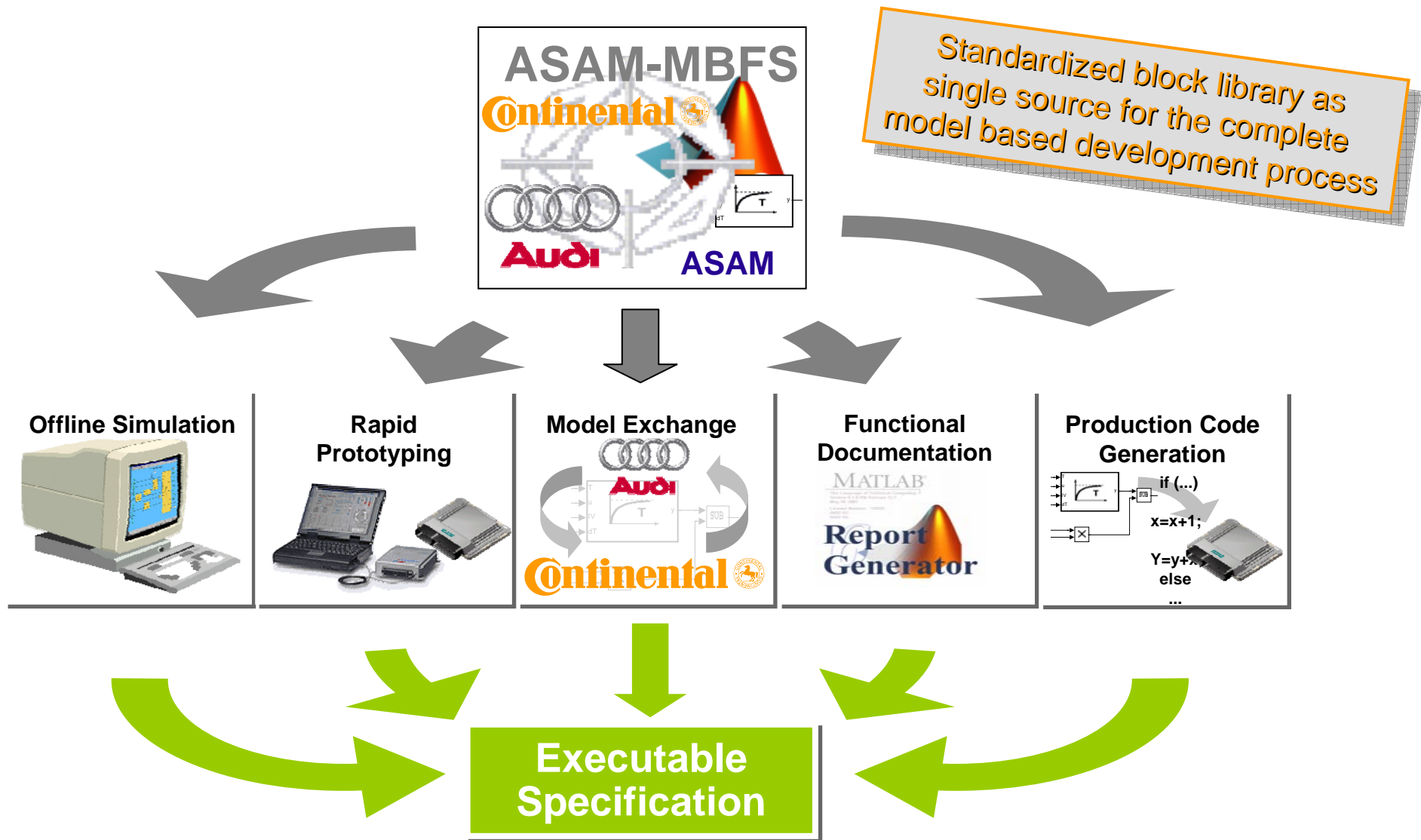
caused by "model translation"

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

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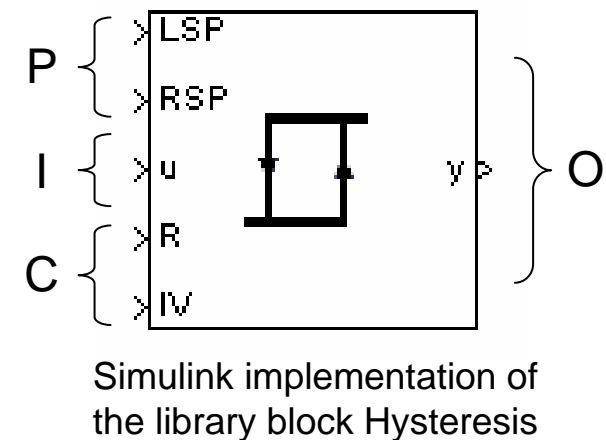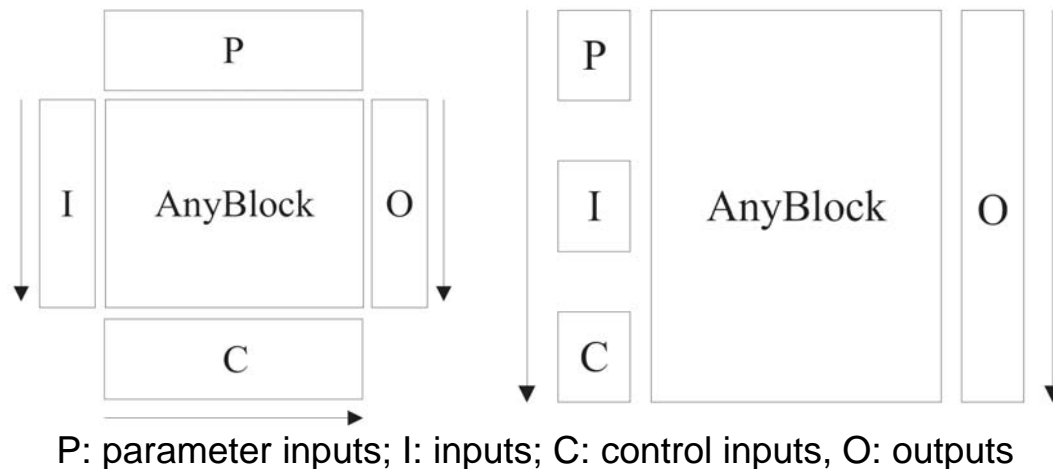
Solution: automotive block library (ASAM-MBFS)

- 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**

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Solution: automotive block library (ASAM-MBFS)

ASAM-MBFS

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

Offline Simulation

Rapid Prototyping

Model Exchange

Functional Documentation

Production Code Generation

if (...)

x=x+1;

Y=y+x
else
...

Executable Specification

Solution: automotive block library (ASAM-MBFS)

▷ The MBFS specification includes

    ▷ **general definitions** valid for all blocks

P: parameter inputs; I: inputs; C: control inputs, O: outputs

Simulink implementation of the library block Hysteresis

    ▷ 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

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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;	if (R) {
	    x = IV;
	}
	if (u > RSP) {
	    x = 1;
	}
	else if (u < LSP) {
	    x = 0;
	}
	y = x;

        ▷ **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, …

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Solution: automotive block library (ASAM-MBFS)

▷ The MBFS specification includes

　　▷ test cases together with **simulation results**
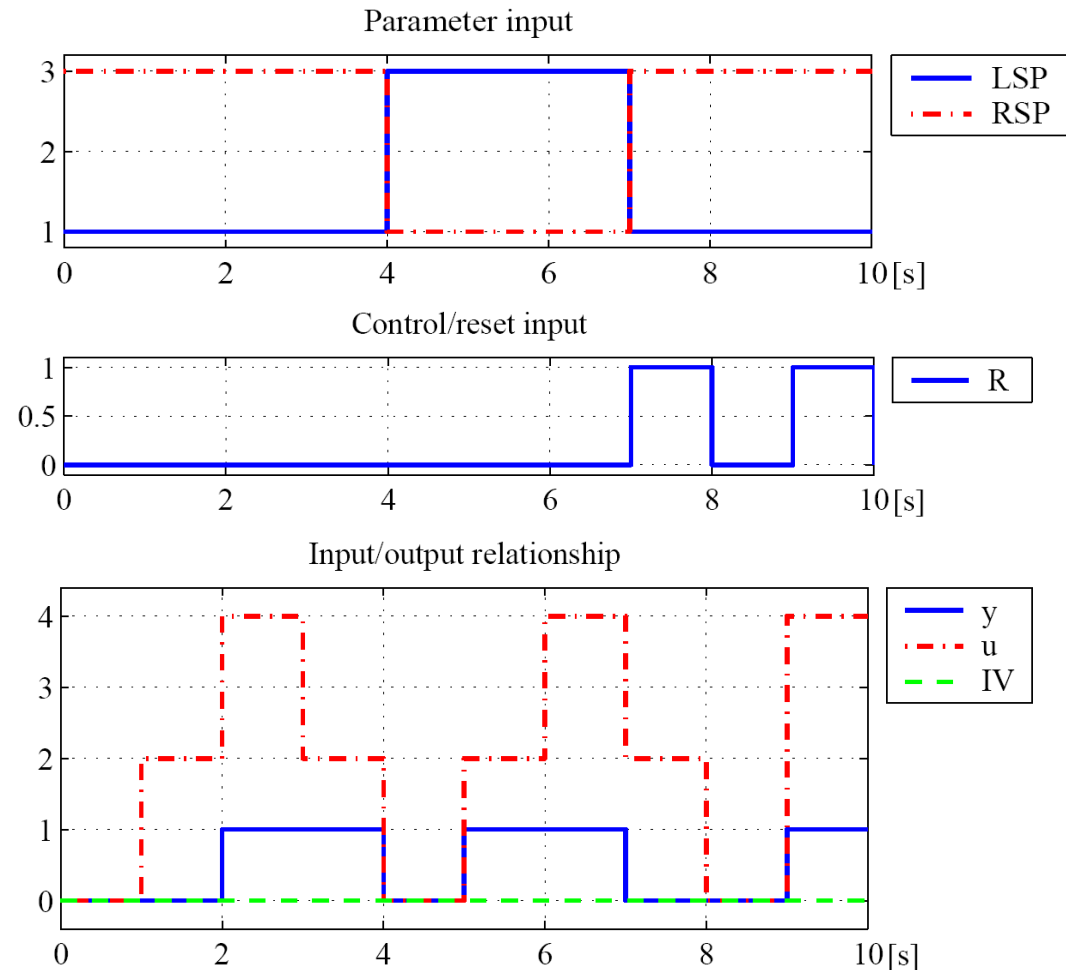
Solution: automotive block library (ASAM-MBFS)

▶ **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

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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*

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