



Markus Maier / ETAS GmbH

Development of AUTOSAR SW Components

Tools and Methods

Development of AUTOSAR Software

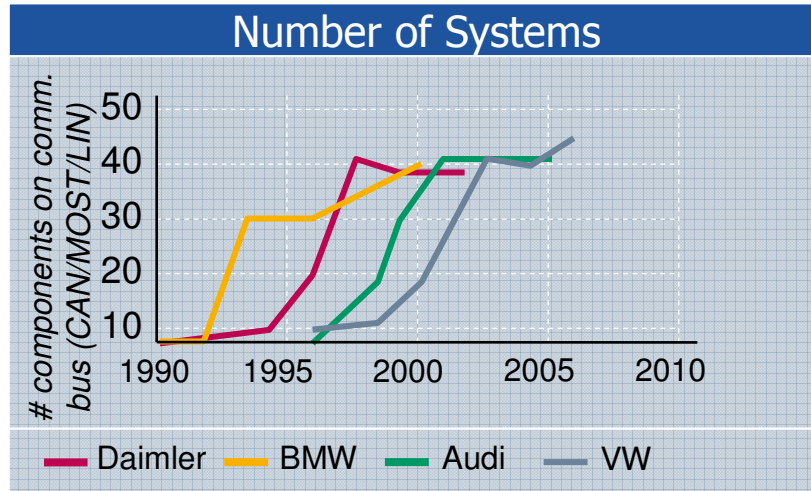
Agenda

- Status Quo
- ECU Software and System Architecture
 - Today and Tomorrow
- Development of AUTOSAR Application Software
- Conclusion

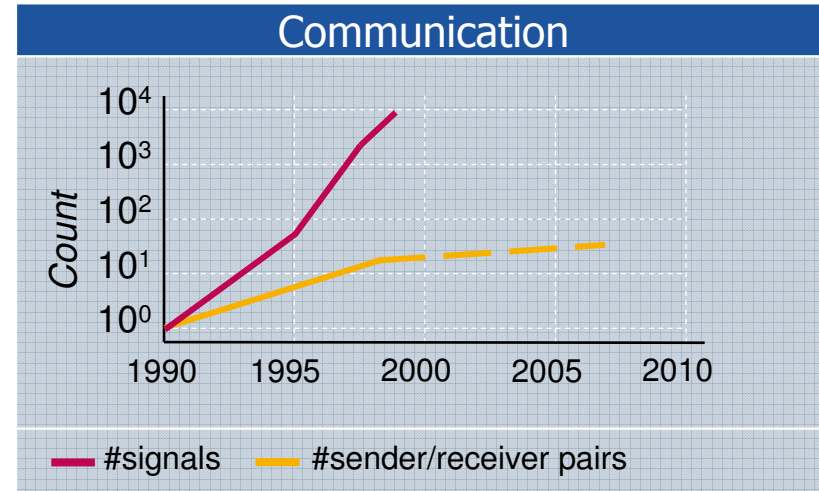


Status Quo

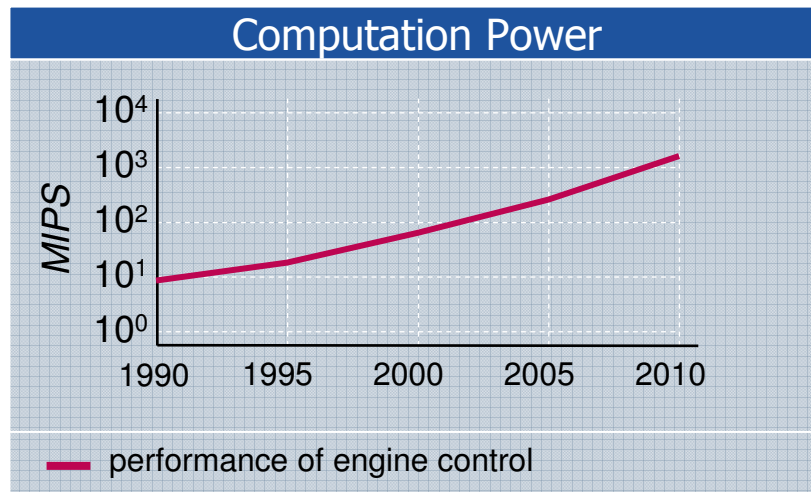
The Complexity of E/E Systems in Automotive increases exponentially



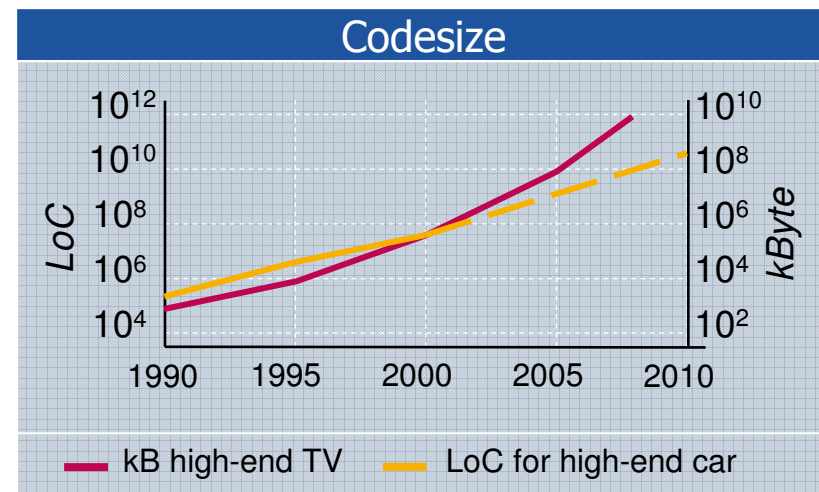
Source: VW 2005, Fachkongreß Automobil-Elektronik



Source: BMW, Frischkorn, BoCSE 2002



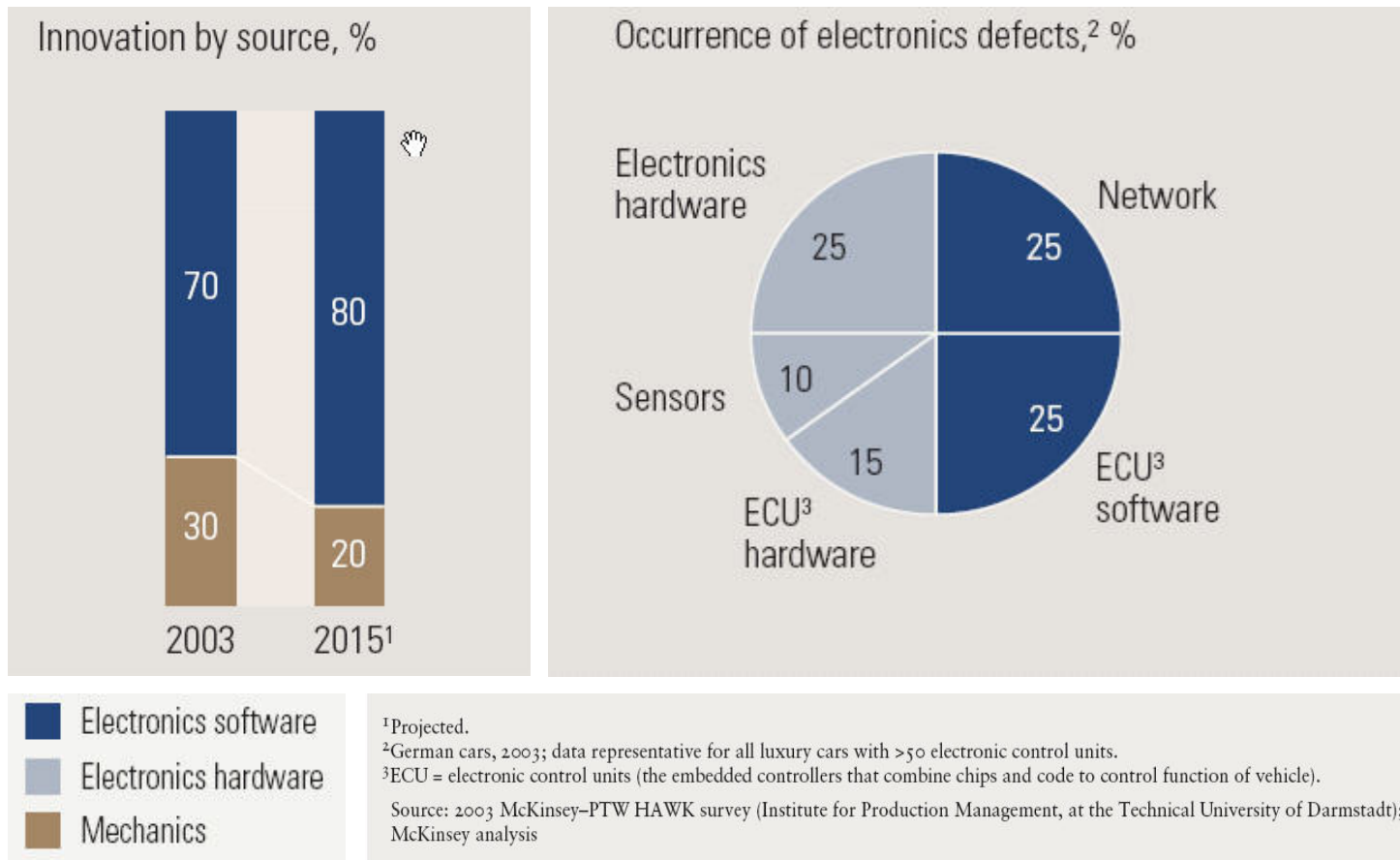
Source: NEC, 2006 (TOP57)



Source: Daimler-Chrysler 2004; Philips

Status Quo

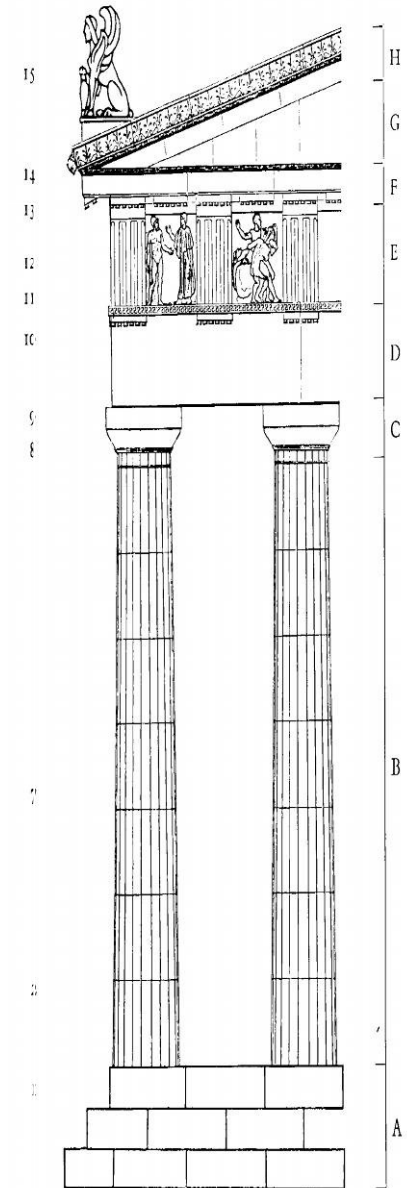
Software as major driver for Innovation and as a Quality issue



Development of AUTOSAR SW Components

AUTOSAR is coming

- AUTOSAR – software architecture
 - helps to avoid OEM/Tier1 specific SW architectures
 - makes commercial SW components and modules possible
 - makes commercial tools possible
 - reduces dependencies on dedicated suppliers
 - makes integration of „proven“ third party software possible – e.g. OEM to ECU supplier
 - helps to concentrate on new/innovative functions – instead of interface/integration problems
 - helps to gain development efficiency
 - helps to increase SW quality
 - helps to cope with complexity



Development of AUTOSAR Software

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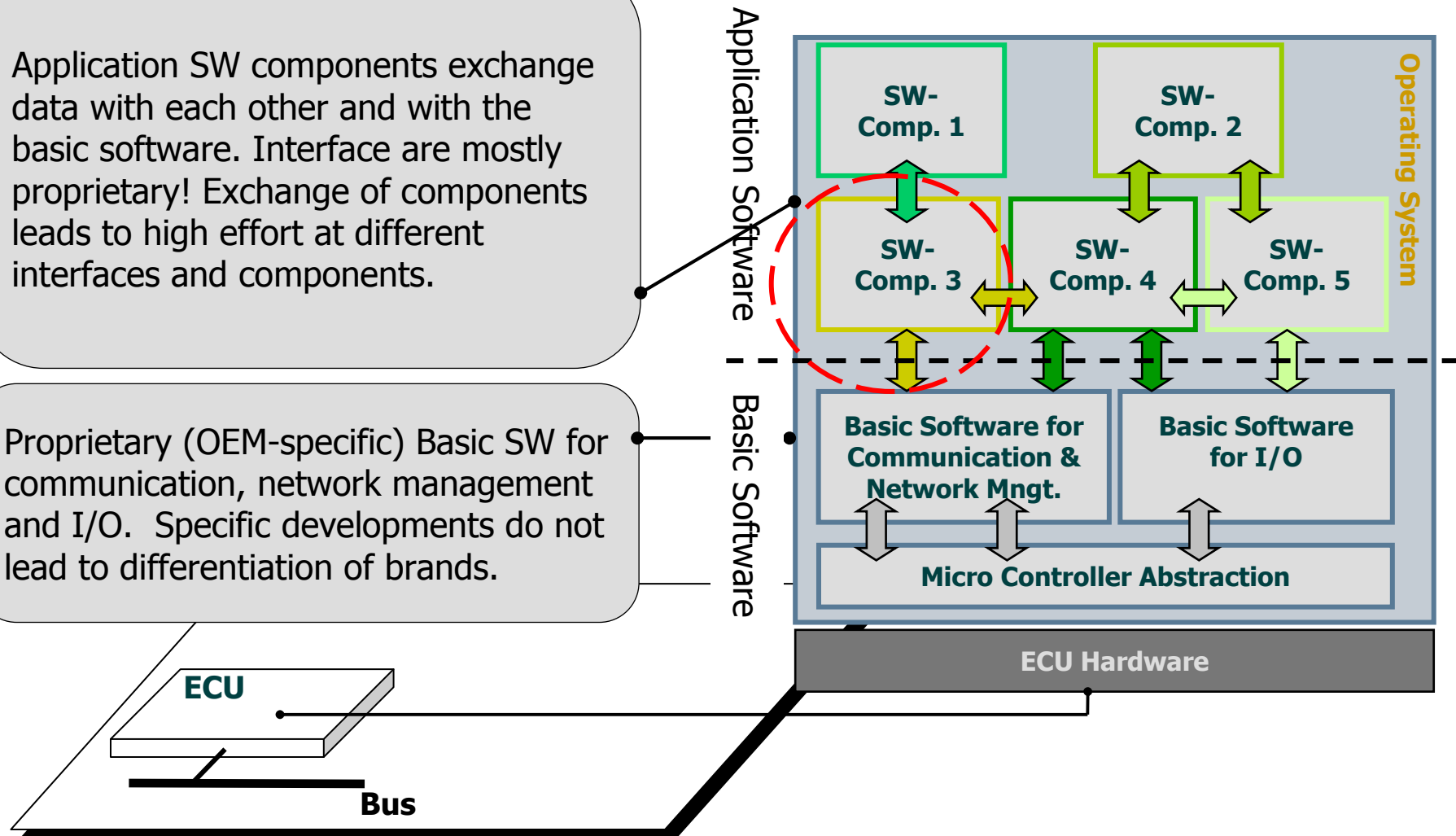


Software- and System-Architecture of ECUs

Today: Proprietary Software-Architecture

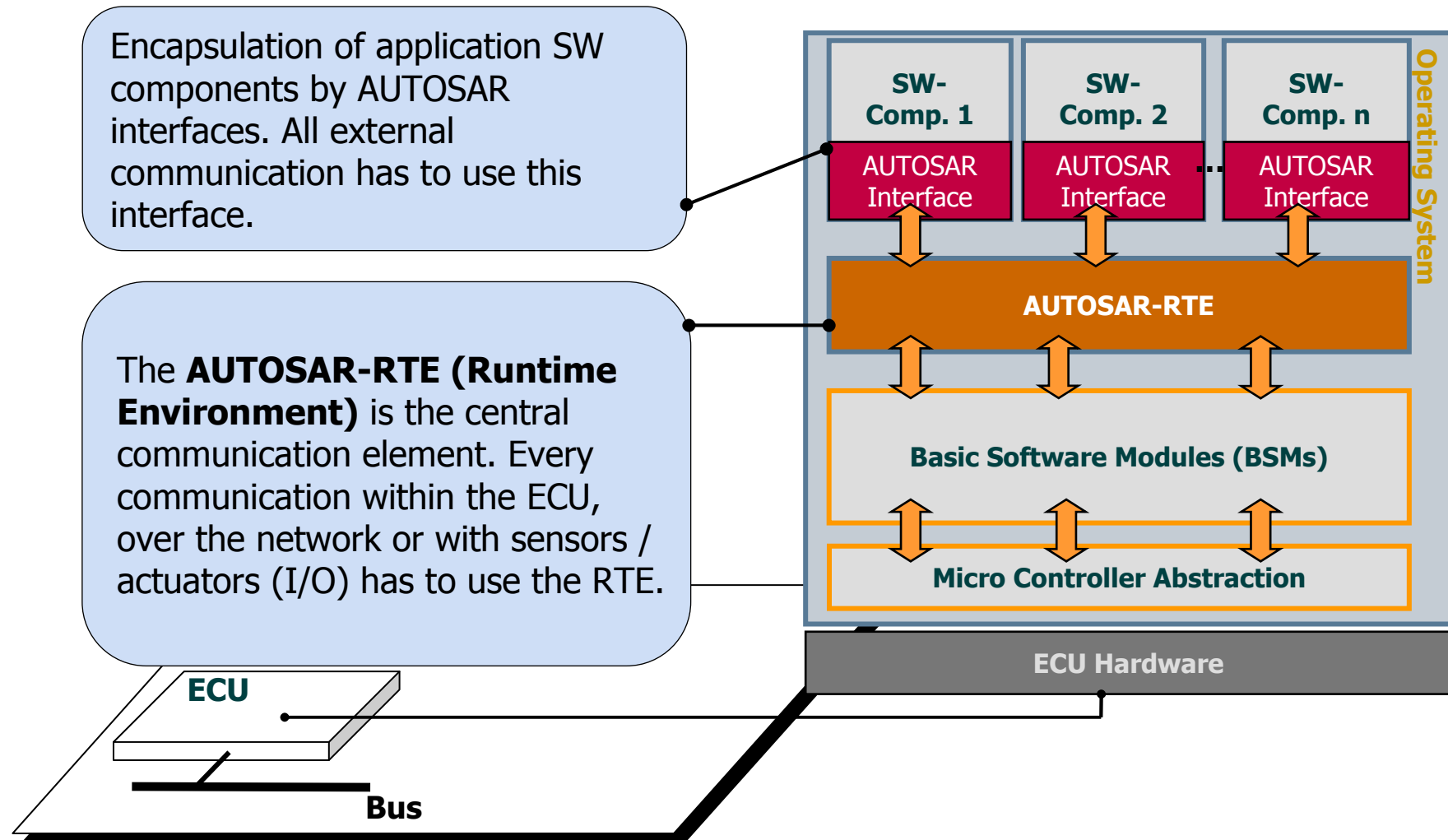
Application SW components exchange data with each other and with the basic software. Interface are mostly proprietary! Exchange of components leads to high effort at different interfaces and components.

Proprietary (OEM-specific) Basic SW for communication, network management and I/O. Specific developments do not lead to differentiation of brands.



Software- and System-Architecture of ECUs

Tomorrow: AUTOSAR – Standardized Software Architecture

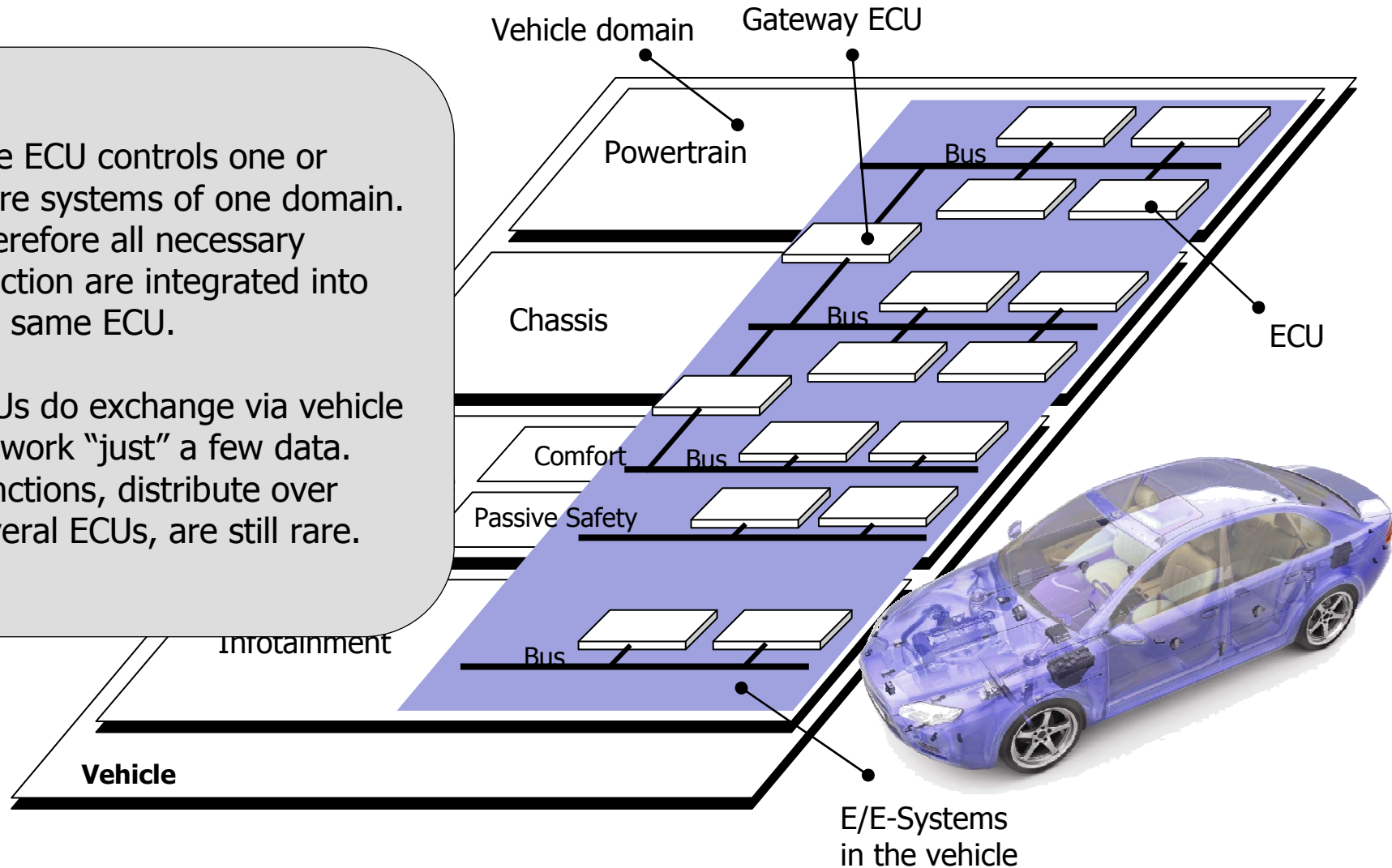


Software- and System-Architecture of ECUs

Today: ECU network

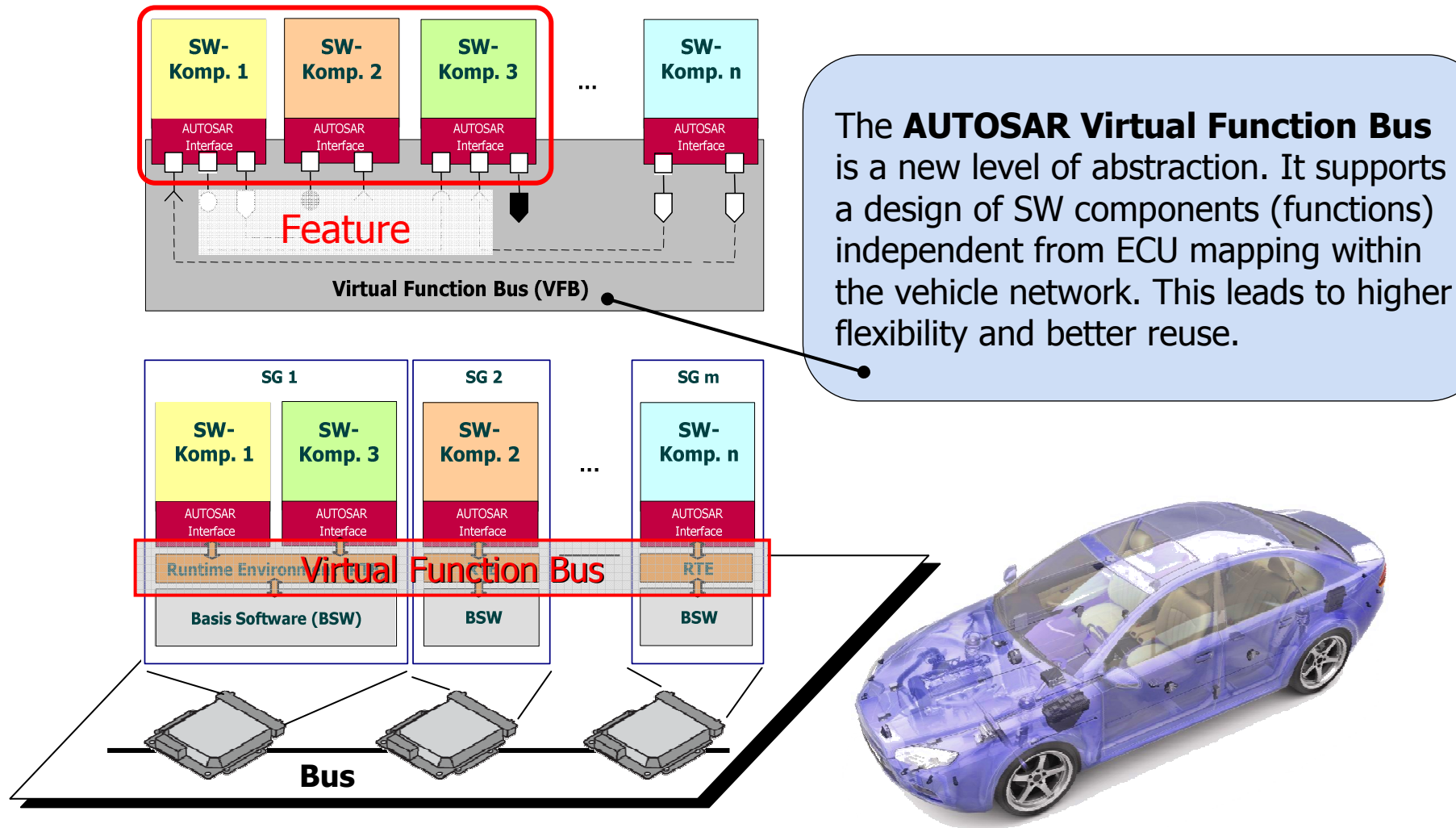
One ECU controls one or more systems of one domain. Therefore all necessary functions are integrated into the same ECU.

ECUs do exchange via vehicle network "just" a few data. Functions, distribute over several ECUs, are still rare.



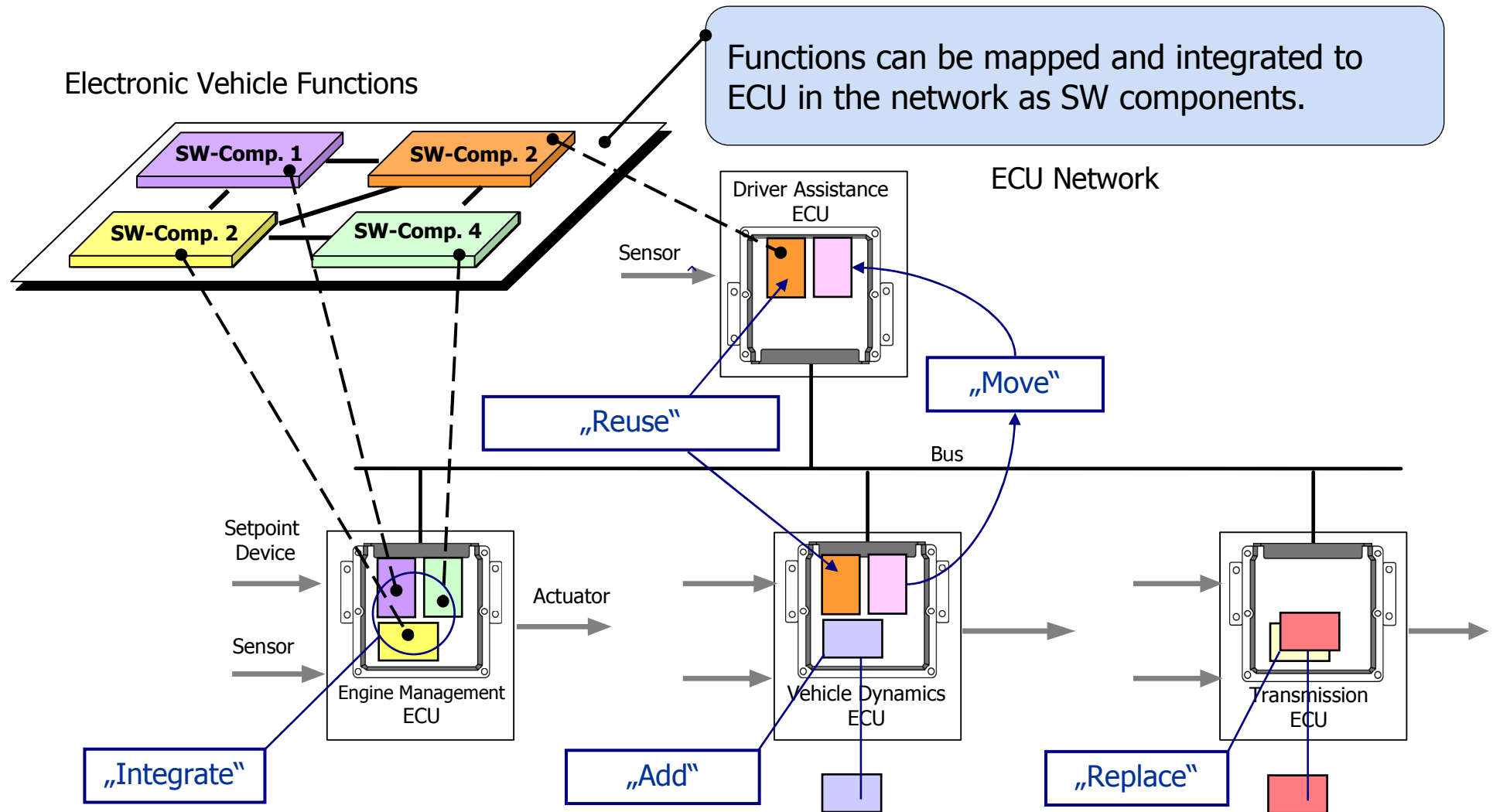
Software- and System-Architecture of ECUs

Tomorrow: AUTOSAR separates function from ECU



Software- and System-Architecture of ECUs

Future: Function oriented Architecture for higher Flexibility



Software- and System-Architecture of ECUs

What disappears? What comes up? What stays?

- **What disappears?**

- Proprietary Basic Software with proprietary interface towards the application software

- **What comes up?**

- Standardized Basic Software Modules
- RTE (Runtime Environment) make application software independent from Basic SW and specialities of ECU hardware
- Application SW Components with standardized interface description (syntax and specific signals)

- **What stays?**

- Application Software as a brand differentiating key element for the development of new vehicle functions

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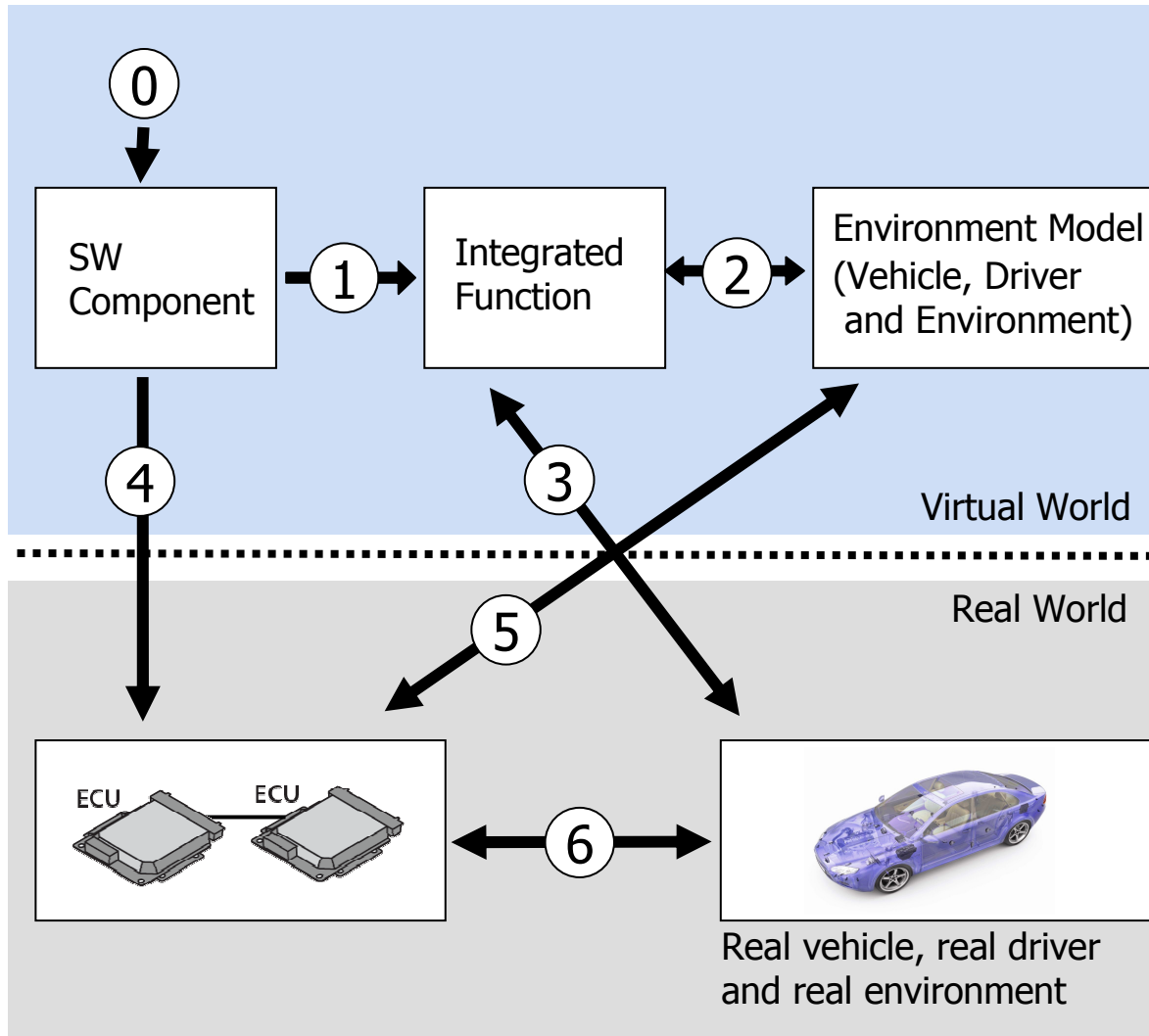
Development of AUTOSAR SW Components

Model based versus manual Software Development

	Model based Development	Manuel Development
Specification of Functions	• as executable Model	• as text
Implementation	• Modelling Guideline	• Coding Guidelines (e.g. MISRA)
Optimization	• tool based	• manually
Coding	• Automatically (inherent MISRA compliance)	• manually
Reuse and Integration	• Validated Models and/or SW Components	• Source code or SW Components
Quality Insurance	• Efficient Validation and Verification of functions on Model Level • Autom. Code Generation	• Verification of implemented functions

Development of AUTOSAR SW Components

Model based Methods and Tools - Overview



What comes up? AUTOSAR-Compliance!

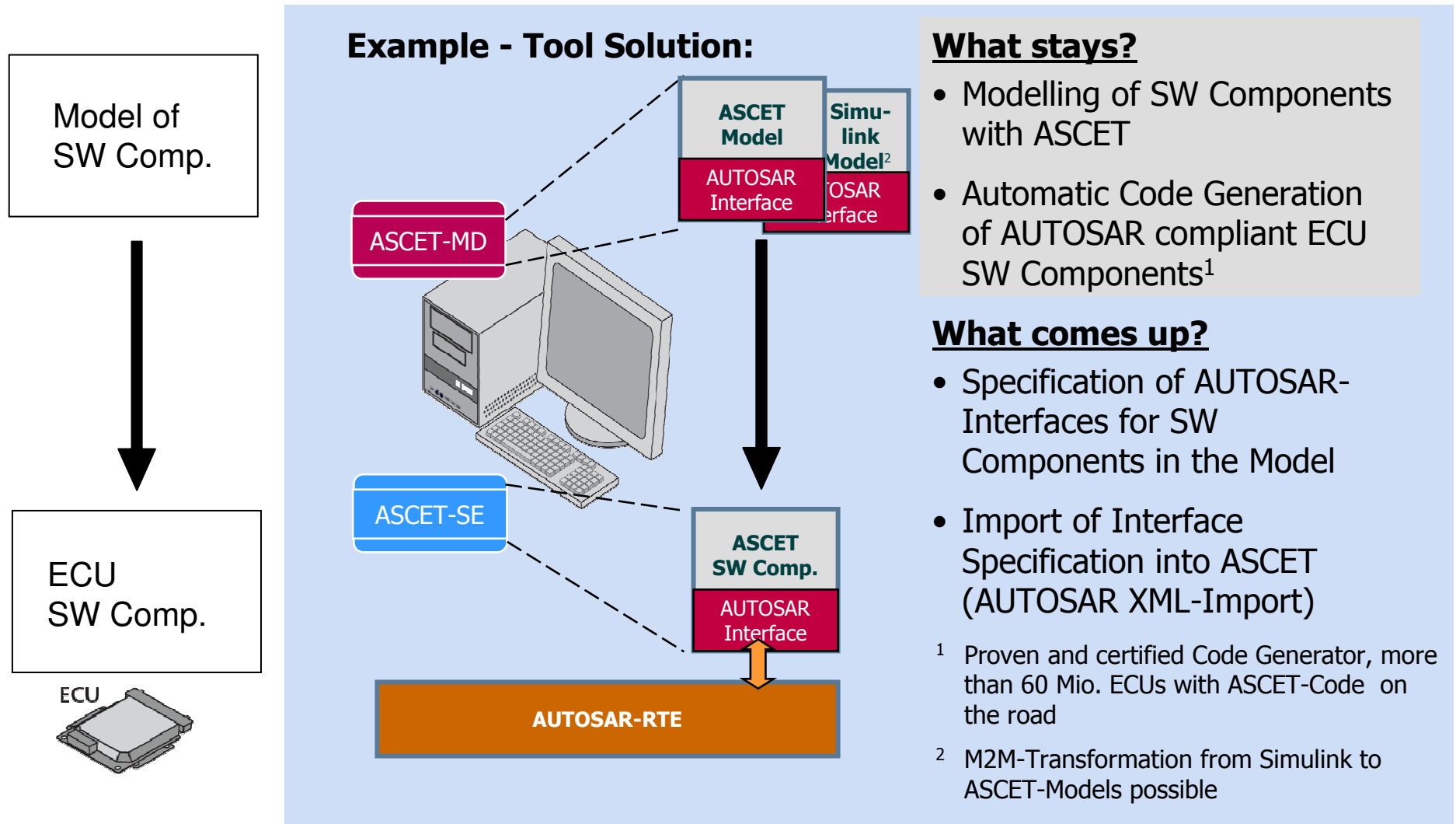
- 0** Modelling and simulation of SW components on PC
- 1** Integration of SW components on PC
- 2** Virtual Prototyping integrated functions on PC
- 3** Rapid Prototyping in real vehicles
- 4** Implementation and autom. code gen. of ECU SW Comp.

What stays?

- 5** ECU function tests with HiL systems
- 6** Function validation and parameter calibration in real vehicle

Development of AUTOSAR SW Software

Modelling and Automatic Code Generation of Software Components

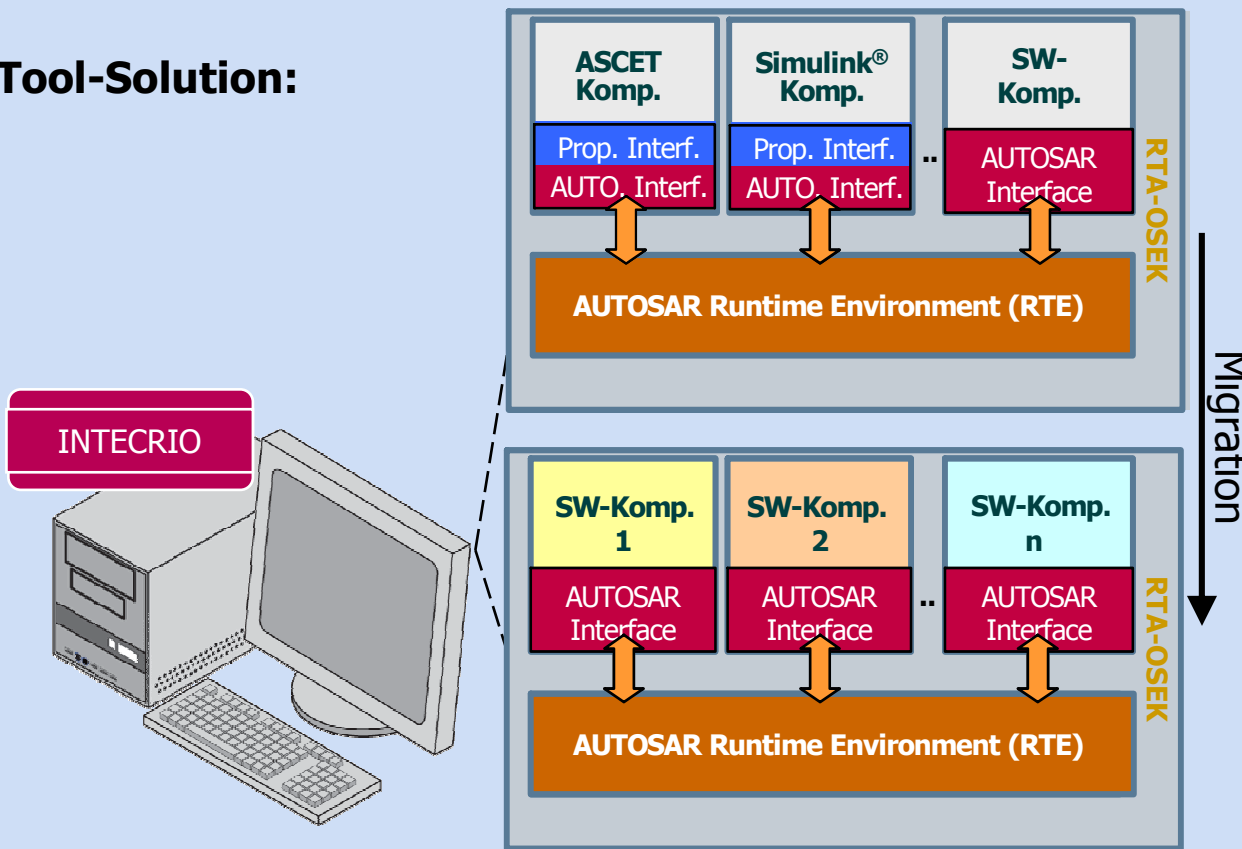


Development of AUTOSAR SW Software

Integration of Software Components on PC



Tool-Solution:



What stays?

- Integration of ASCET-, Simulink®, and C-Code-Components

What comes up?

- Integration of AUTOSAR SW Components using a RTE on PC
- AUTOSAR compliant operating system RTA-OSEK on PC
- Integration of prop. and AUTOSAR SW Components
- Export of RTE configuration for tool chain

Development of AUTOSAR SW Software

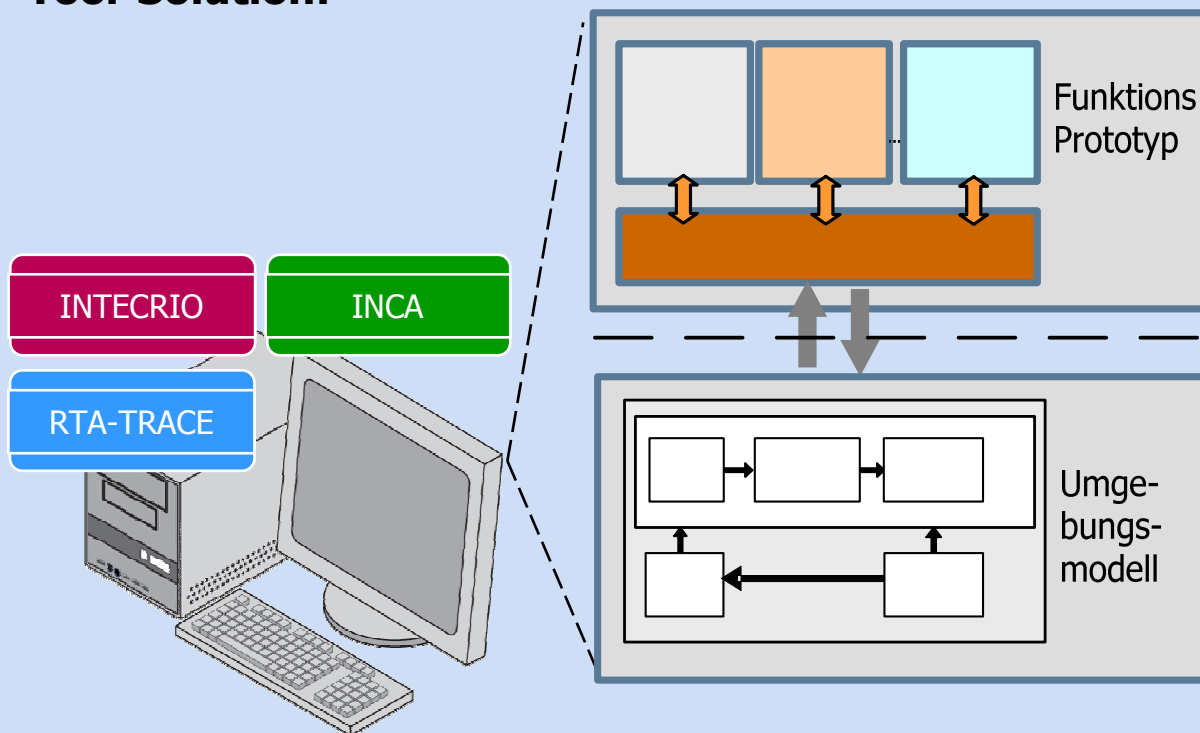
Virtual Prototyping on PC

Integrated Function



Environment Model

Tool-Solution:



What stays?

- Test of integrated functions already on the PC:
 - Simulation of Environment
 - Verification of Scheduling and communication
- Precalibration of functions on PC with INCA (automatically)

What comes up?

- Method provides valuable test results due to HW abstraction by RTE
- Test of integrated functions **prior** to the mapping on ECUs

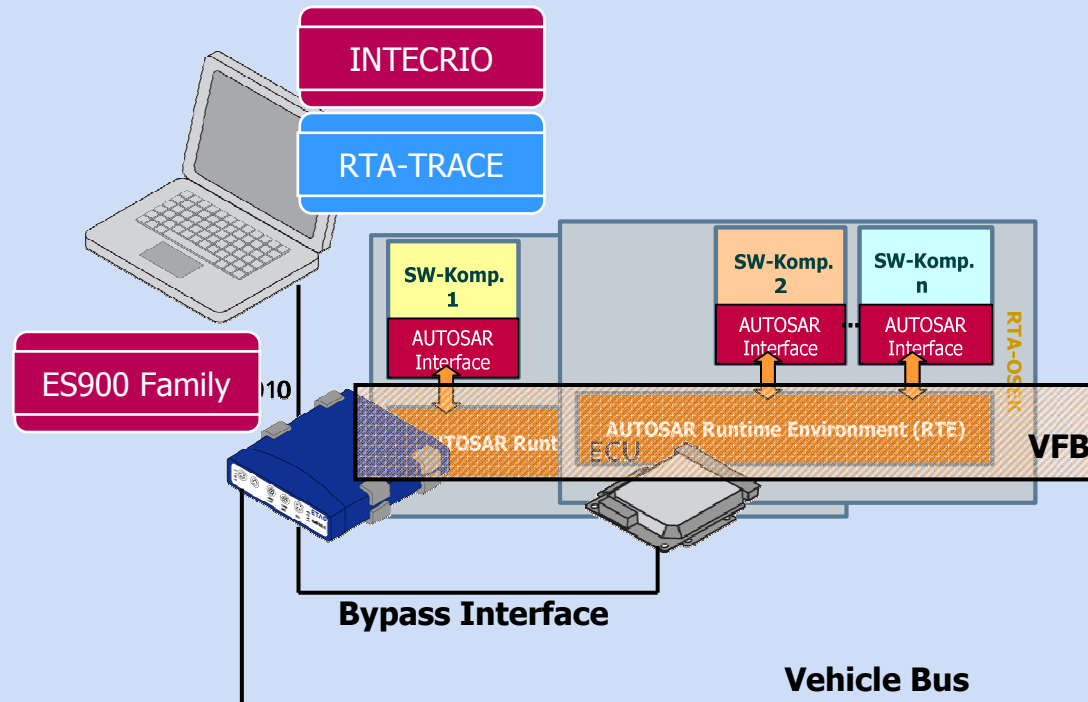
Development of AUTOSAR SW Software

Rapid Prototyping in the Vehicle

Integrated Function



Tool-Solution:



What stays?

- Early Validation of Function Prototypes in the vehicle
- Integration of Prototypes via Bypass and Vehicle Bus Interfaces (ETK, CAN, LIN, FlexRay) into exiting ECU Networks
- Verification of timing behaviour and communication

What comes up?

- Rapid Prototyping Hardware with AUTOSAR-RTE and -OS
- Standardized Method with Virtual Function Bus (VFB) as „Bypass Interface“

Development of AUTOSAR SW Software

What disappears? What comes up? What stays?

- **What disappears?**

- Proprietary Methods and Tools for the Development of ECU Functions

- **What comes up?**

- AUTOSAR provides the framework (AUTOSAR Interfaces) for SW Components, which are used to create higher level System Functions
- Tools for Integration and Validation for SW Components from different suppliers

- **What stays?**

- Functional Algorithms will not be defined by AUTOSAR and can be developed with established tools
- RTE enables – together with appropriate tools – an easy migration from existing proprietary SW components to AUTOSAR SW components /ECUs

Development of AUTOSAR SW Software

Reengineering of an Engine Management System towards AUTOSAR

Goal:

AUTOSAR migration of existing engine management functions

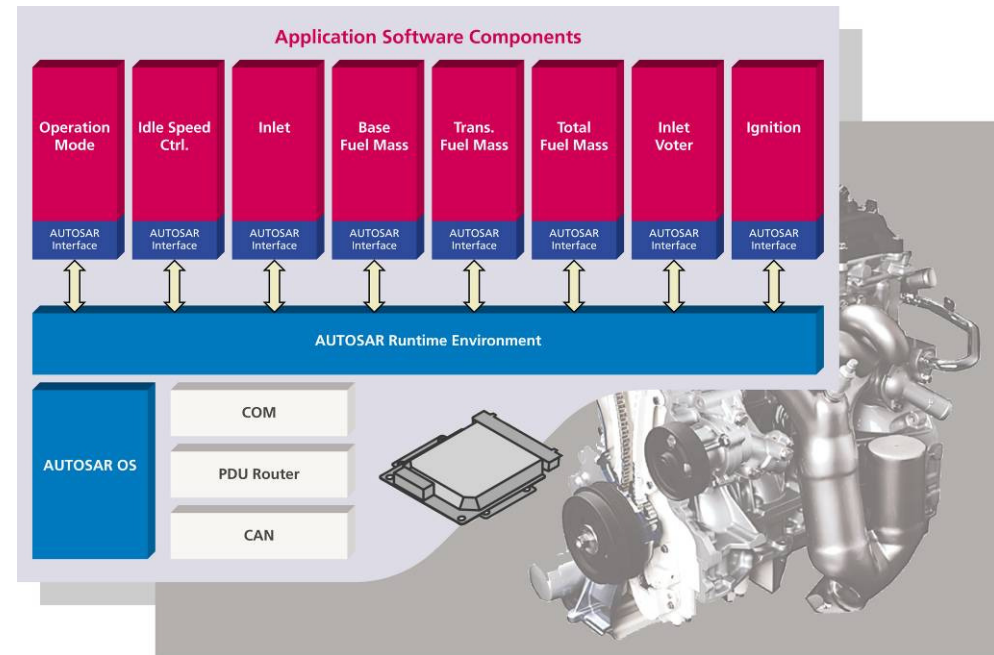
Development Process:

Modelling tool (here: ASCET) :

- Partitioning of existing functions into AUTOSAR Software Comp.
- Creation of AUTOSAR Interface Wrapper
- Automatic Generation of AUTOSAR compliant ECU code

Integration tool (here: INTECRIO) :

- Integration of AUTOSAR SW Comp. into Engine Management Function
- Validation of function with Virtual and Rapid Prototyping



Reference: ATZ Elektronik, Volume 4, 2007

Result:

- AUTOSAR can be implemented with existing tools
- Depending on requirements (e.g. IP protection or modularisation) it is easily possible to reparation application SW into differently designed AUTOSAR SW Components

Development of AUTOSAR Software

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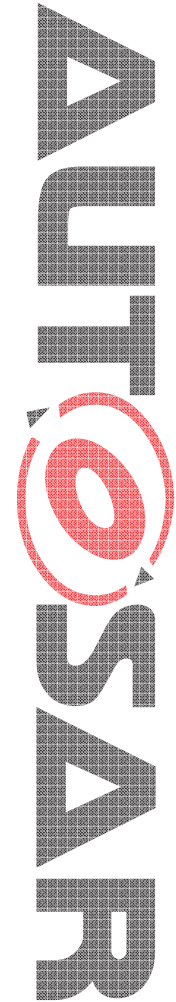
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Development of AUTOSAR Application Software

Conclusion

- AUTOSAR standardizes the software architecture of electronic systems for vehicles
 - to cope with complexity, to increase software quality and to gain more freedom for innovations
- AUTOSAR RTE (Runtime Environment) is the central element to separate application and basic software
 - to enable the development of well encapsulated and reusable software components
- AUTOSAR compliant software components / models can be specified in standardized manner by the OEM and can be integrated into the ECUs by the suppliers
- ETAS provides already today model based tools and methods to develop AUTOSAR series software at outstanding quality



Thank you for your attention!

Your questions are welcome

