AUTOSAR Overview

AUTomotive Open System ARchitecture

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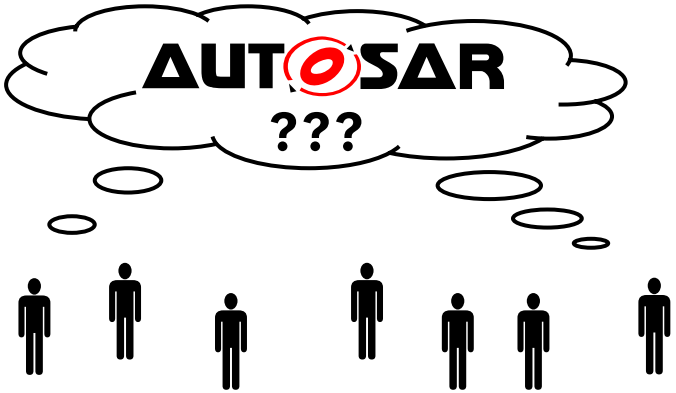
Presentation Goal

Provide some Top Level information to support the audience in answering the question:

What is AUTOSAR and in which areas could it influence my work?

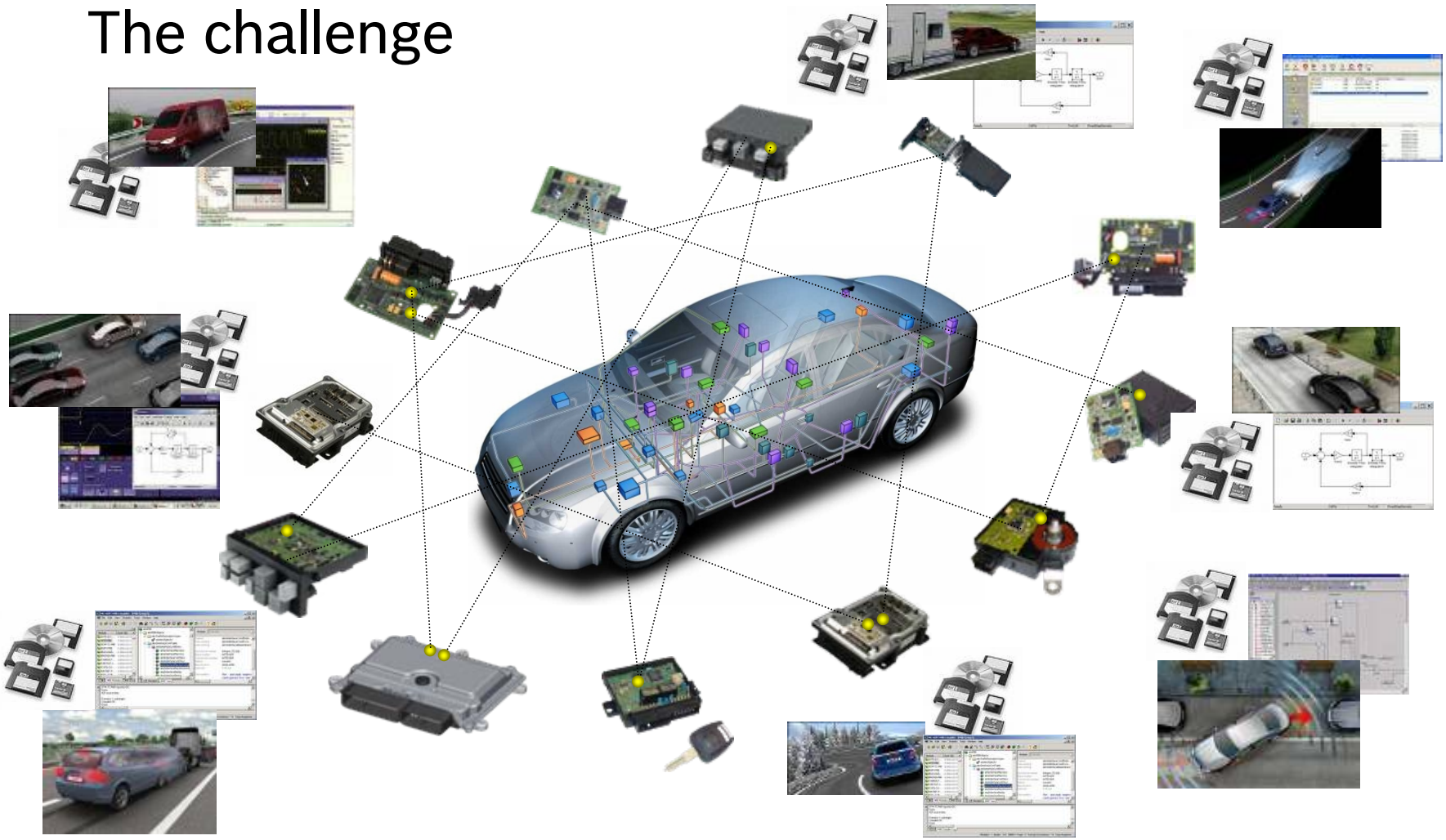


Sales .. Project handling .. Function development .. SW development .. SW integration .. Application .. HW development .. Processes ..

Content

- Objectives, partners, organization
- Technical approach
  - Methodology
  - ECU SW Architecture
  - Application Interfaces
- AUTOSAR communication patterns
- Roadmap
- Business cases
- AUTOSAR at Bosch
- AUTOSAR at DGS
- Links

The challenge



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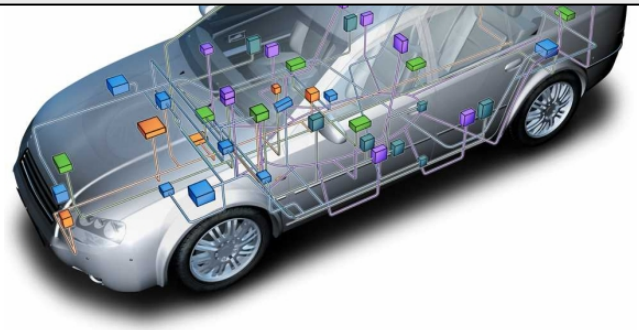
The challenge

- **Master growing complexity** by networking of functions
- **Flexible E/E architectures**
- **Flexible exchangeability** between supplier's and manufacturer's applications
- **Increase of quality inline with high reliability** of the E/E system
- **Reduce effort**
- **Enable global shared development**



- **Solution:** **Reuse and sharing of software**
- **Strategy:** **Standardization of system and software structure**

AUTOSAR

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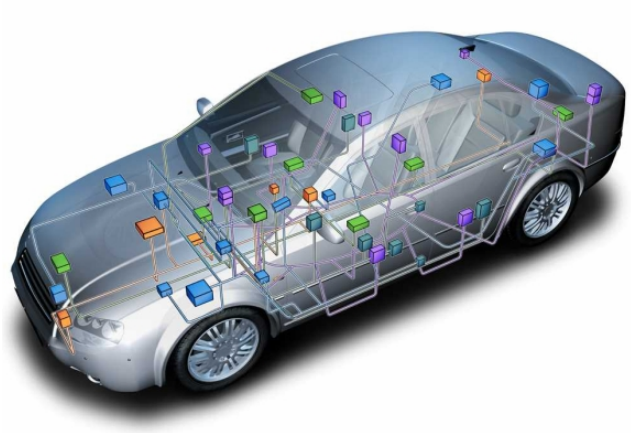
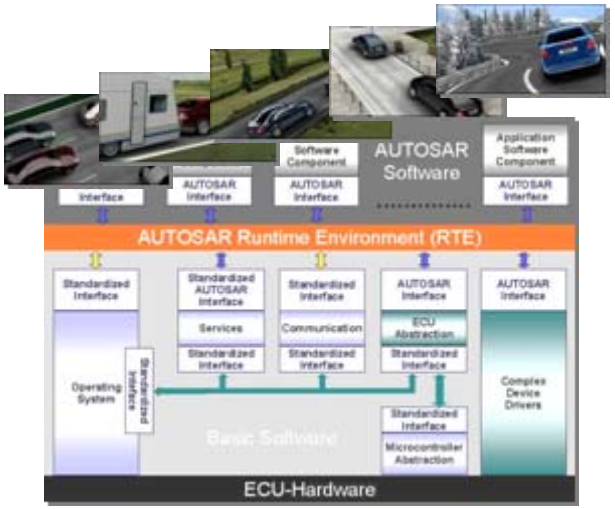
Goals of AUTOSAR

Scalability, Relocatability and Re-Use
of Basic Software & Application Software Components
across world-leading OEMs and Suppliers.

AUTomotive Open
System ARchitecture





- **Cooperate on standards**
- **Compete on innovations / implementations**

AUTOSAR is mainly a SW topic !

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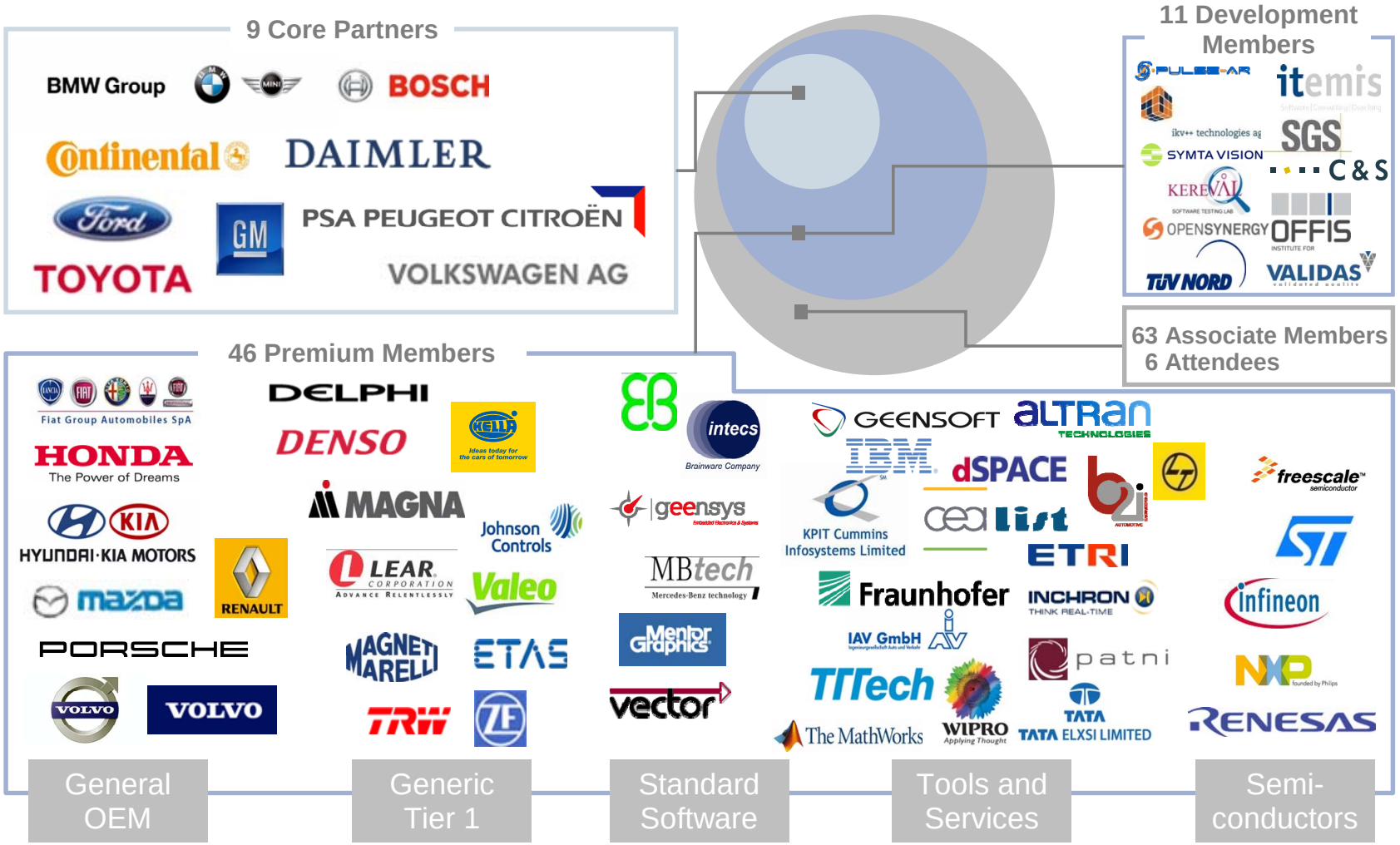
AUTOSAR partners



Status of 05.08.2010

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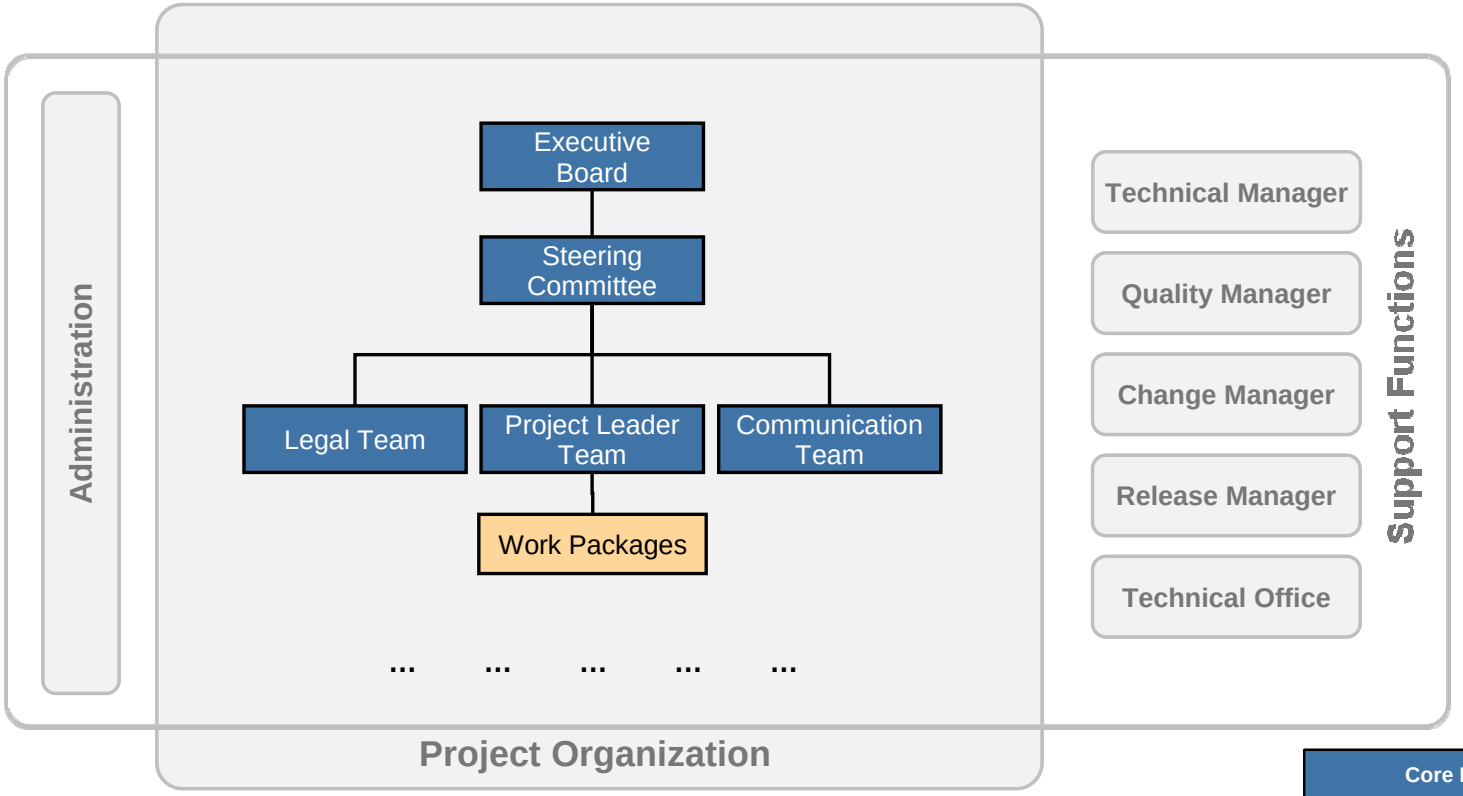
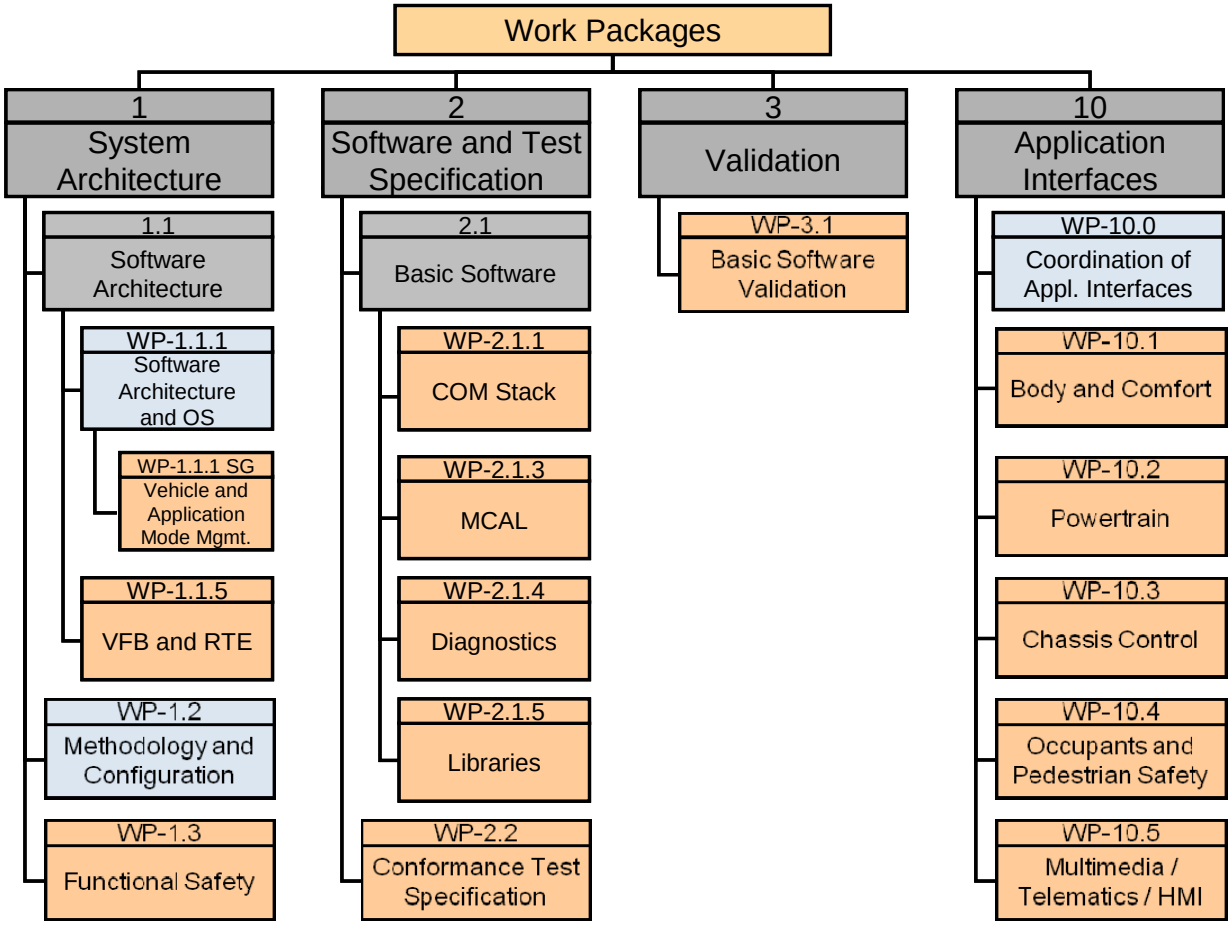
Project organization



Core Partner
Core Partner, Premium and Development Member
Subcontractor

Work package structure in Phase III



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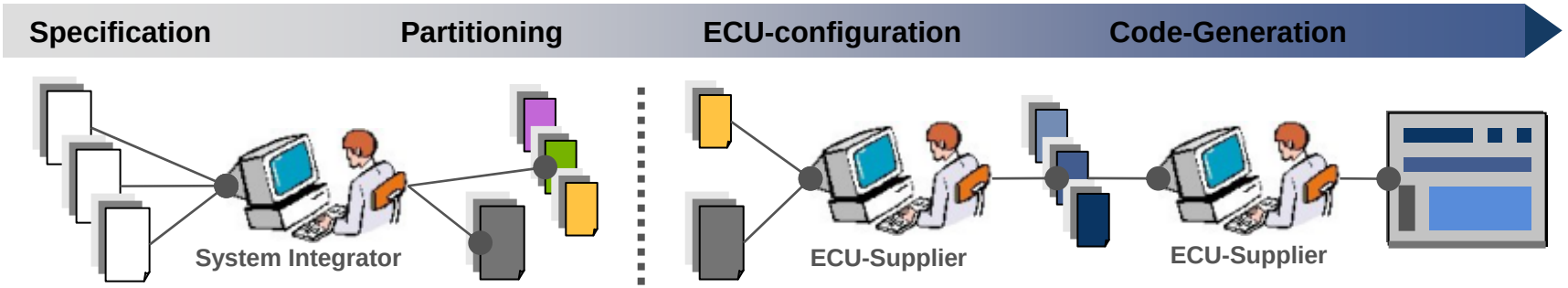
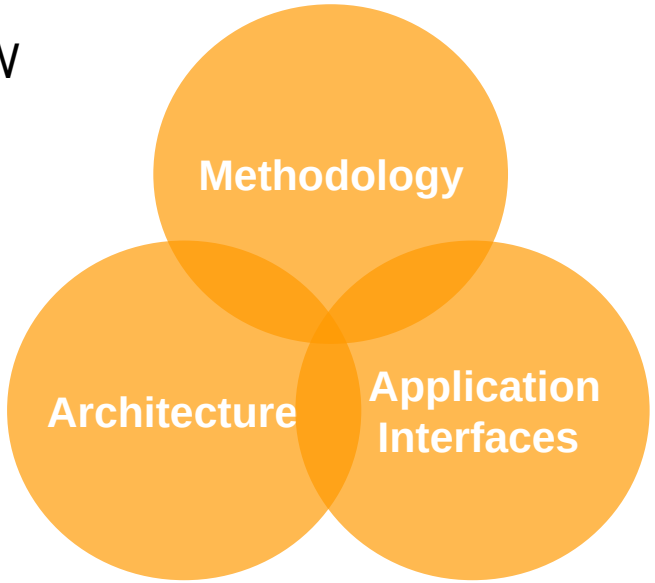
Top-down development approach !



The standard covers

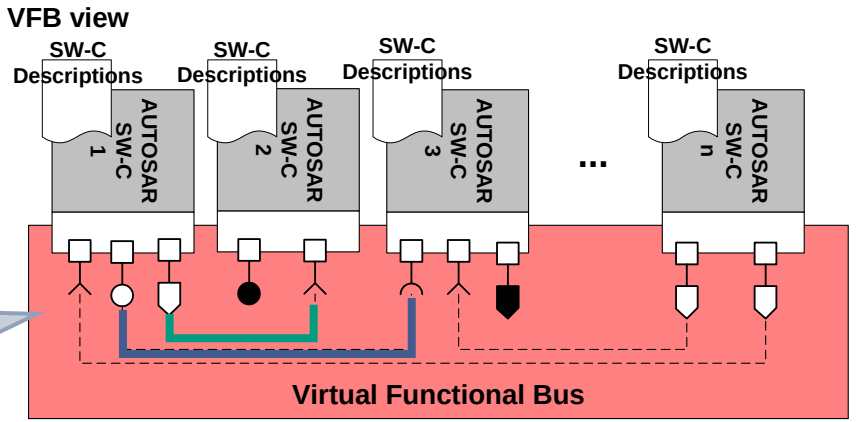
AUTOSAR output: Specifications

- Methodology
  - Vehicle SW system modelling and partitioning
  - ECU configuration, implementation and integration
- ECU SW-Architecture
  - Allowing HW independent Application SW
  - Standardized ECU Basic SW
  - Conformance tests for SW
- Application Interfaces
  - Domain specific partitioning and definition of signal



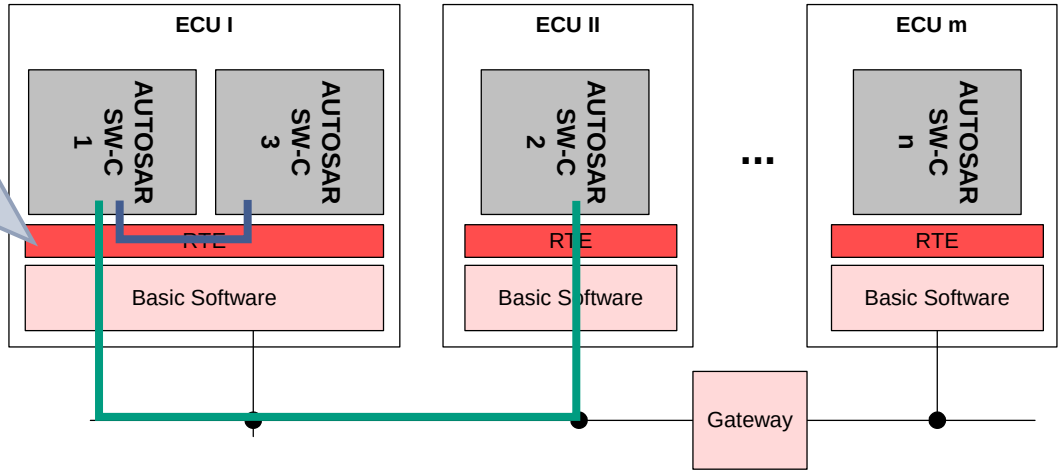
From VFB to ECU

Virtual Functional Bus (VFB)
- Independent of specific ECU, bus protocol, …
- Independent of programming language
- global system optimization possible



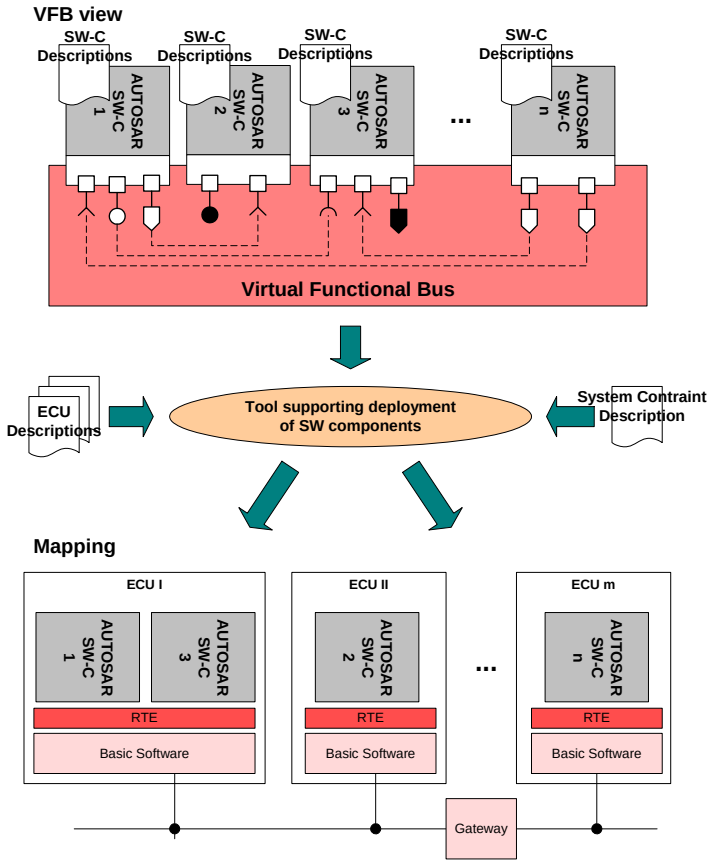
Mapping to ECU network

Runtime Environment
- ECU specific instantiation of the VFB
- Connecting application and Basic SW
- Has to ensure that SW-Cs can communicate, regardless where a SW-C is mapped



Methodology

AUTOSAR Methodology and Tooling

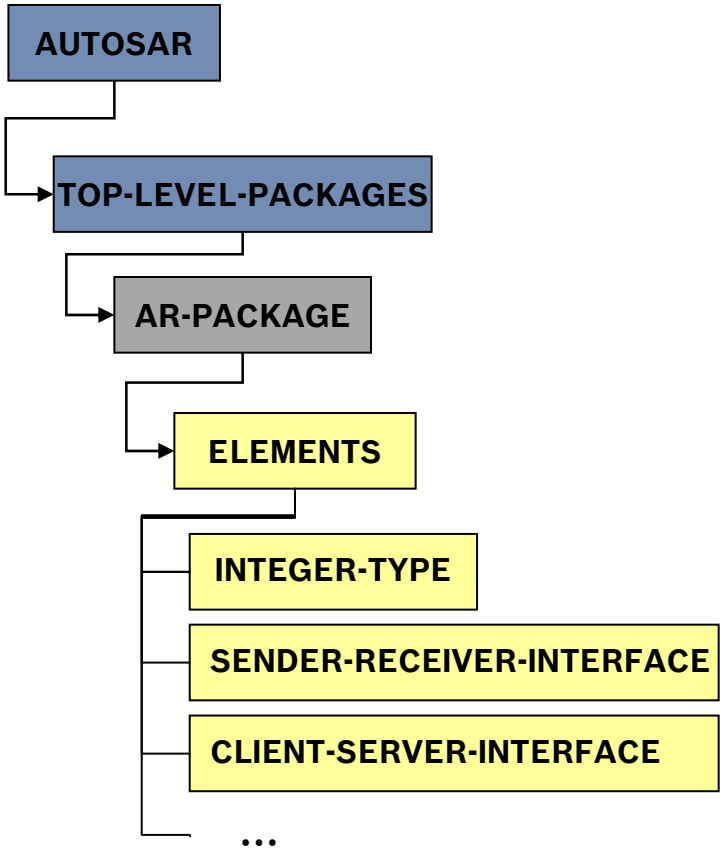


The AUTOSAR methodology

- defines activities, work products and their logical relationship
- does NOT prescribe a precise order of activities or iterations
- is NOT a complete process description
- is NOT a business model with “roles” and “responsibilities”
- defines XML as description format

Common formats (common “language”)
=> Equal interpretations

AUTOSAR XML (ARXML)




```
<?xml version="1.0" encoding="UTF-8"?>
<AUTOSAR xmlns="http://autosar.org/3.1.2">
  <TOP-LEVEL-PACKAGES>
    <AR-PACKAGE>
     <SHORT-NAME>Package_ShortName</SHORT-NAME>
      <ELEMENTS>
        <INTEGER-TYPE>
          ...
        </INTEGER-TYPE>
        <SENDER-RECEIVER-INTERFACE>
         ...
        </SENDER-RECEIVER-INTERFACE>
        <CLIENT-SERVER-INTERFACE>
         ...
        </CLIENT-SERVER-INTERFACE>
        ...
        ...
      </ELEMENTS>
    </AR-PACKAGE>
  </TOP-LEVEL-PACKAGES>
</AUTOSAR>
```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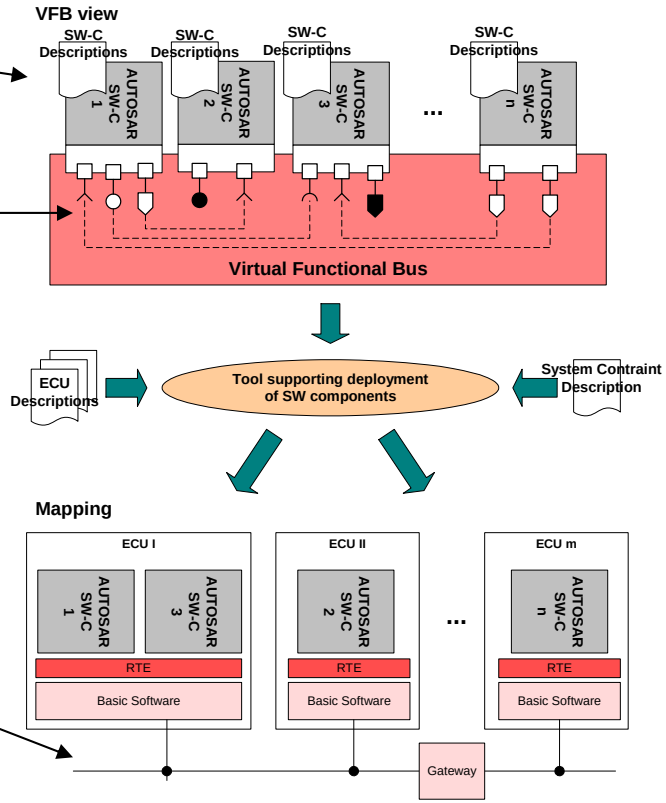
AUTOSAR XML

- AUTOSAR describes everything tool readable in XML
  - SW-Component Types
    - Ports, Interfaces, Runnables, ..
  - Compositions
    - Grouping of SW-Component Types
    - Connections between Ports
  - System constraints
  - Descriptions of ECU resources
  - ECU configuration
  - Network communication
    - System signals, ..

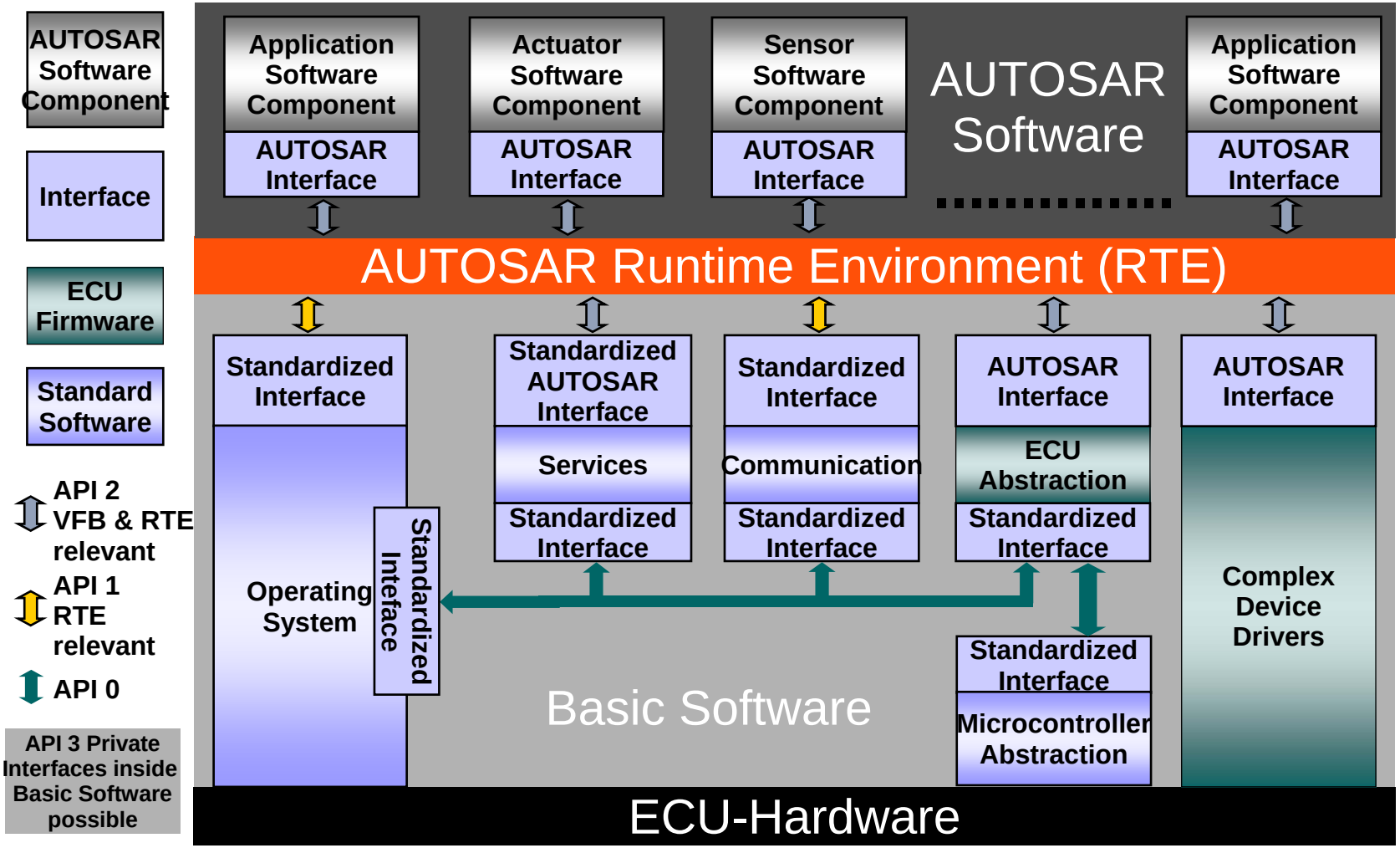


- File extension **.arxml*

Some major Methodology differences to MSR

MSR / MDX (MEDC17)	AUTOSAR
ECU centric approch	Vehicle wide approach
Single instantiation	Multiple instatiation of SWCs
Implicit Binding via names	Explicit Binding via connectors
SW-VARIABLE	Port prototype + Port-Interface + DataElement / Operation Prototypes
1:1:1-relationship MSR model - SW-Variable – A2L Display name	No 1:1:1-relationship between model (=.arxml), code and display names.
1 global name space per element type (e.g. variable und parameter are allowed to have same name)	Individual name spaces via AUTOSAR packages (AR-PACKAGE)

AUTOSAR technical approach - SW-Architecture



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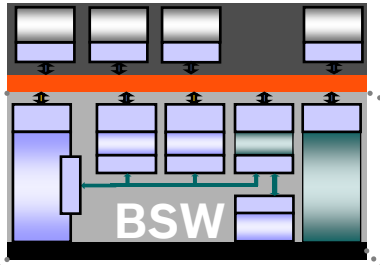
AUTOSAR technical approach - SW Architecture



Services Layer
OS, Libs, ECU states, Wdog, COM, NVRAM, Diagnostic, ..

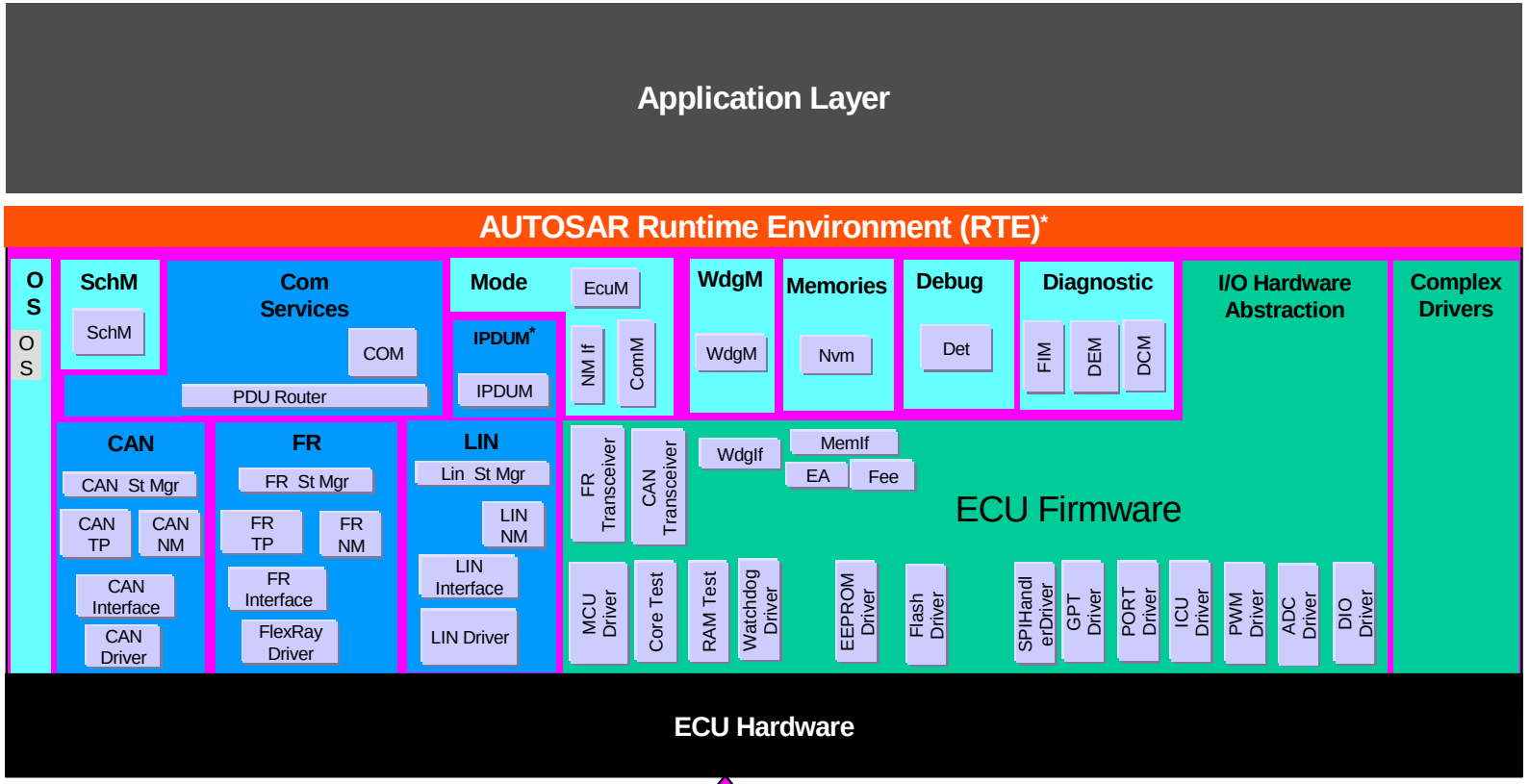
ECU Abstraction Layer
µC onboard, memory-, COM- and IO-abstraction

Microcontroller Abstraction Layer
µC driver, memory driver, COM driver, I/O driver

Complex Drivers

Microcontroller

Release 3.1 Basic-SW Modules

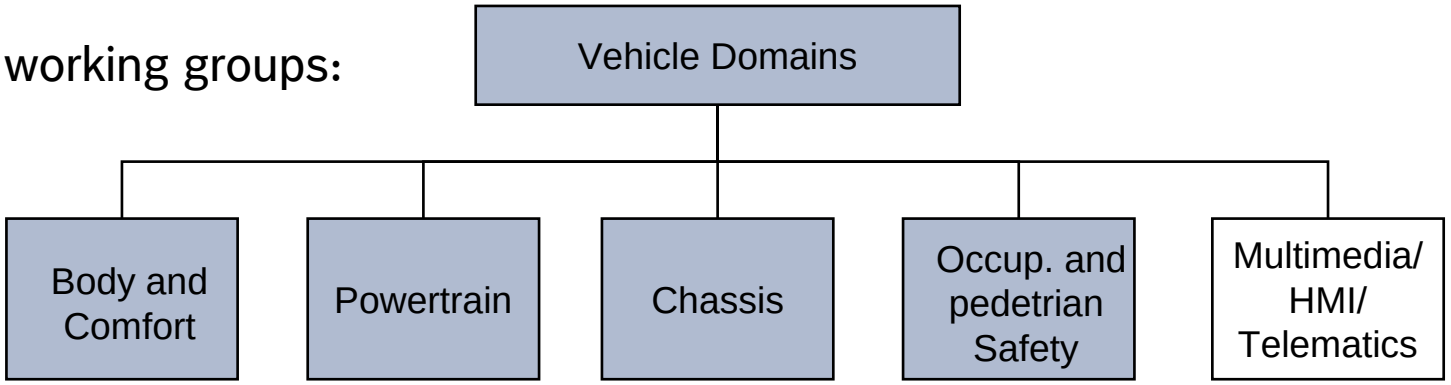


MOST and XCP are not included presently

xxx = BSW Module fully specified

Functional interfaces (e.g. BatteryVoltage or EngineSpeed)

4 active working groups:



Goals

- Standardization of (often used) „signals“ with all required details (type, range, unit, default display name, ...) for all vehicle domains

Not addressed

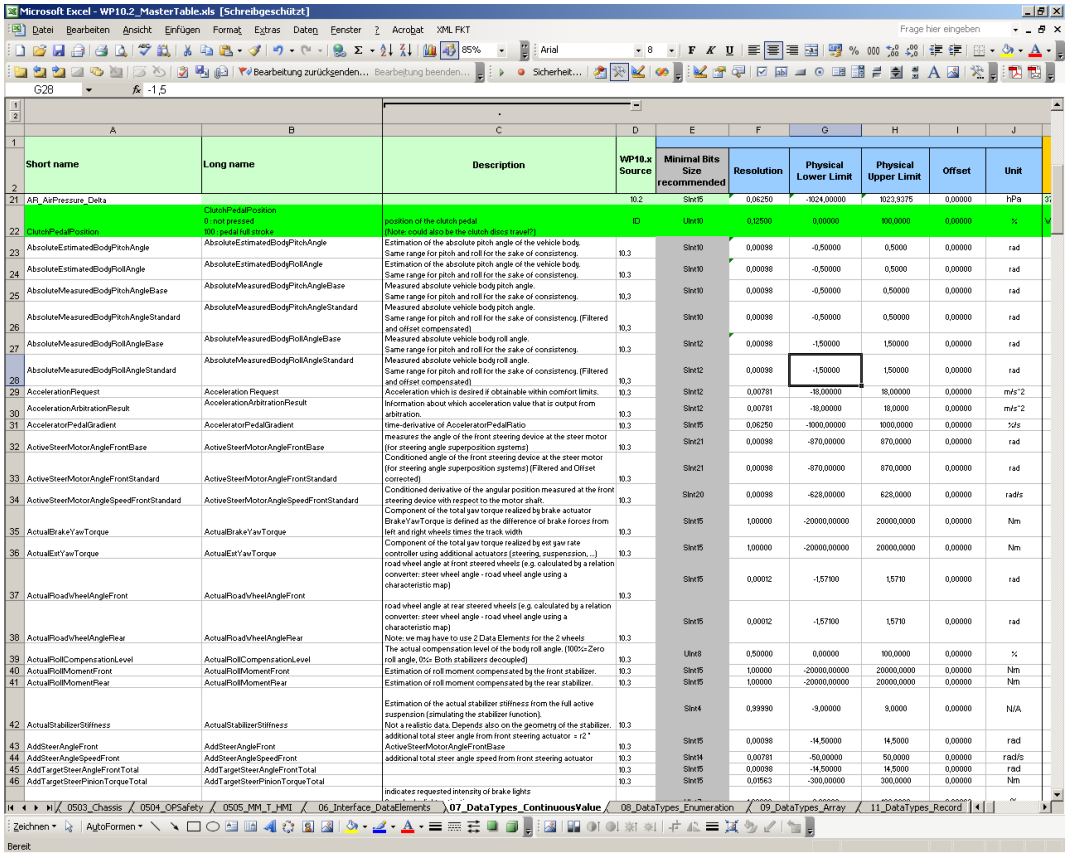
- Application SW functionality and architecture

Standardization of functional interfaces

- Physical/logical interfaces of sensors and actuators
- Mechanism: Port-BluePrints

AR4.0 example: EngineSpeed

PortBluePrint: EngSpd
PortInterface: EngN1
DataPrototype: EngN
ApplDataType: N1
DataConstraint: 0..16383.5
Unit: Rpm
IntendedResolution: 0.5
(No CompuMethod)



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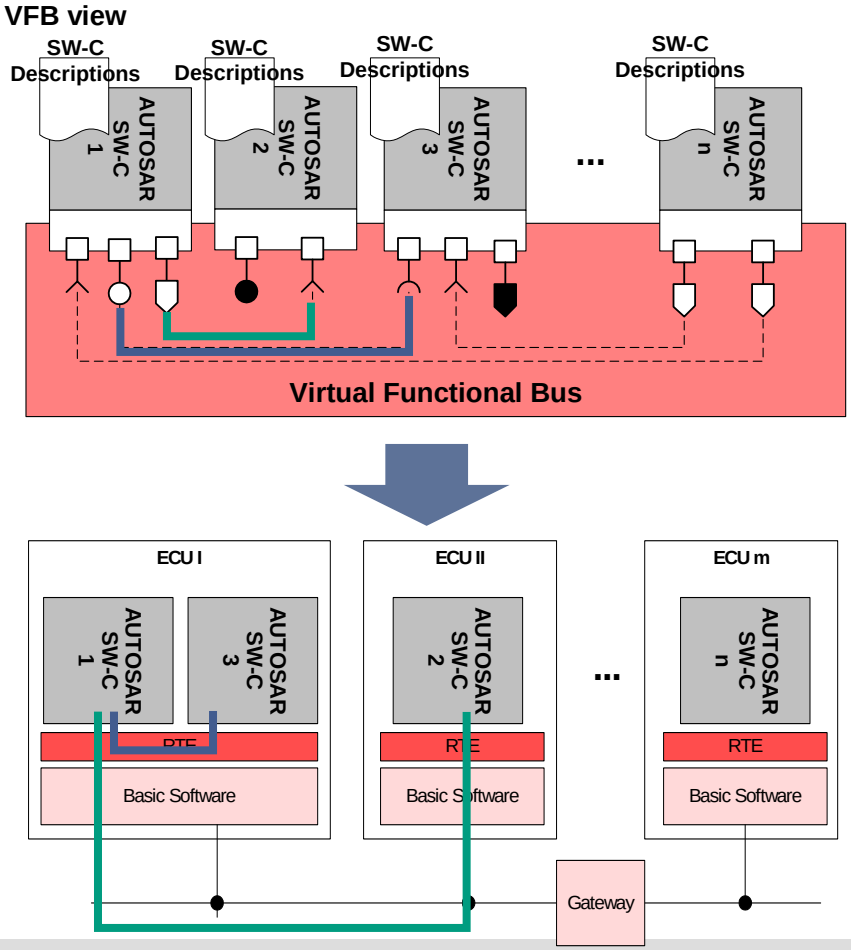
SW-Components communicate via „Ports“

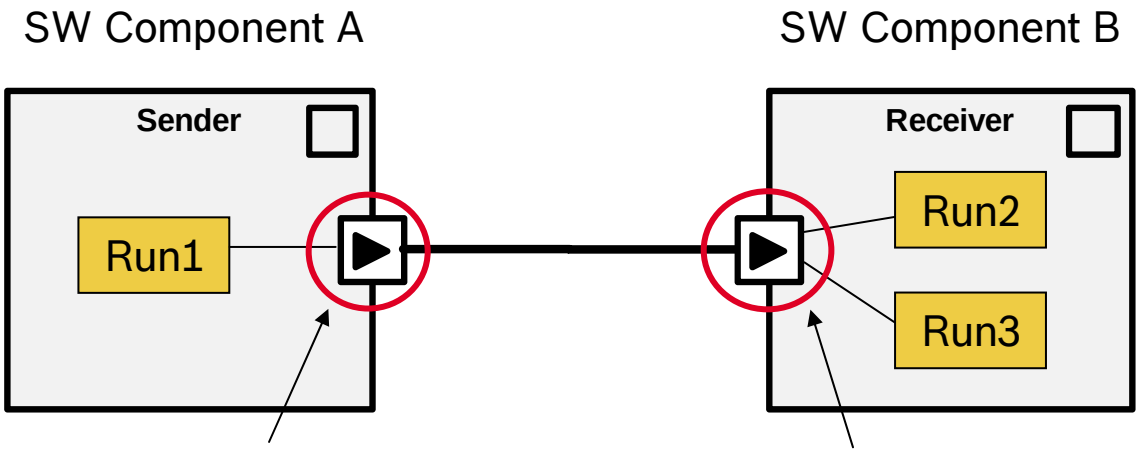


Virtual on the VFB

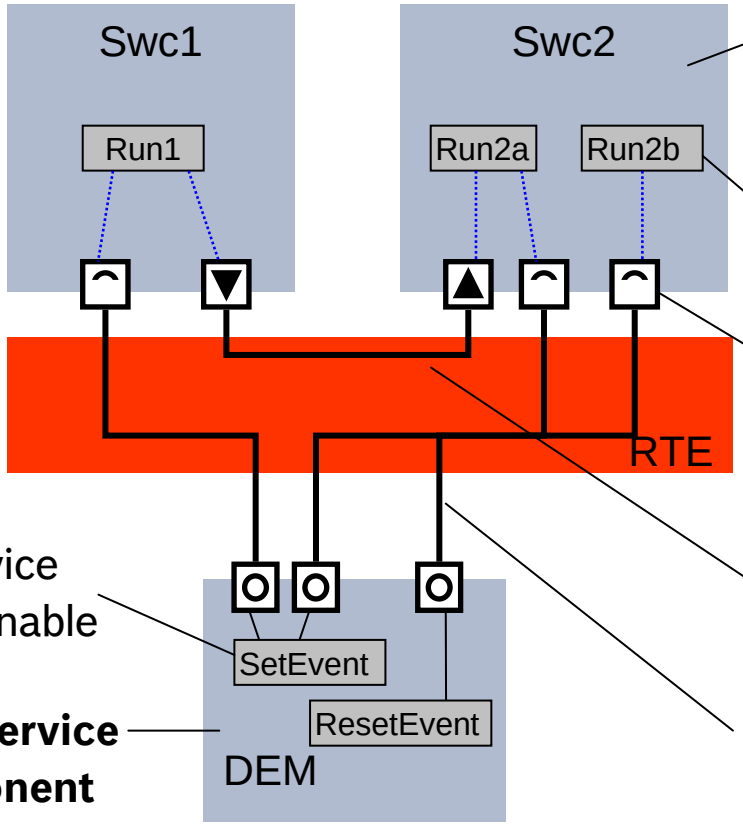
as well as

via RTE in the ECU

Communication via Ports



SWC communication – only via RTE !



Application SW-Component (SWC)
= consisting of Code (*.c/*.o) and SWC Description in AUTOSAR XML (*.arxml)

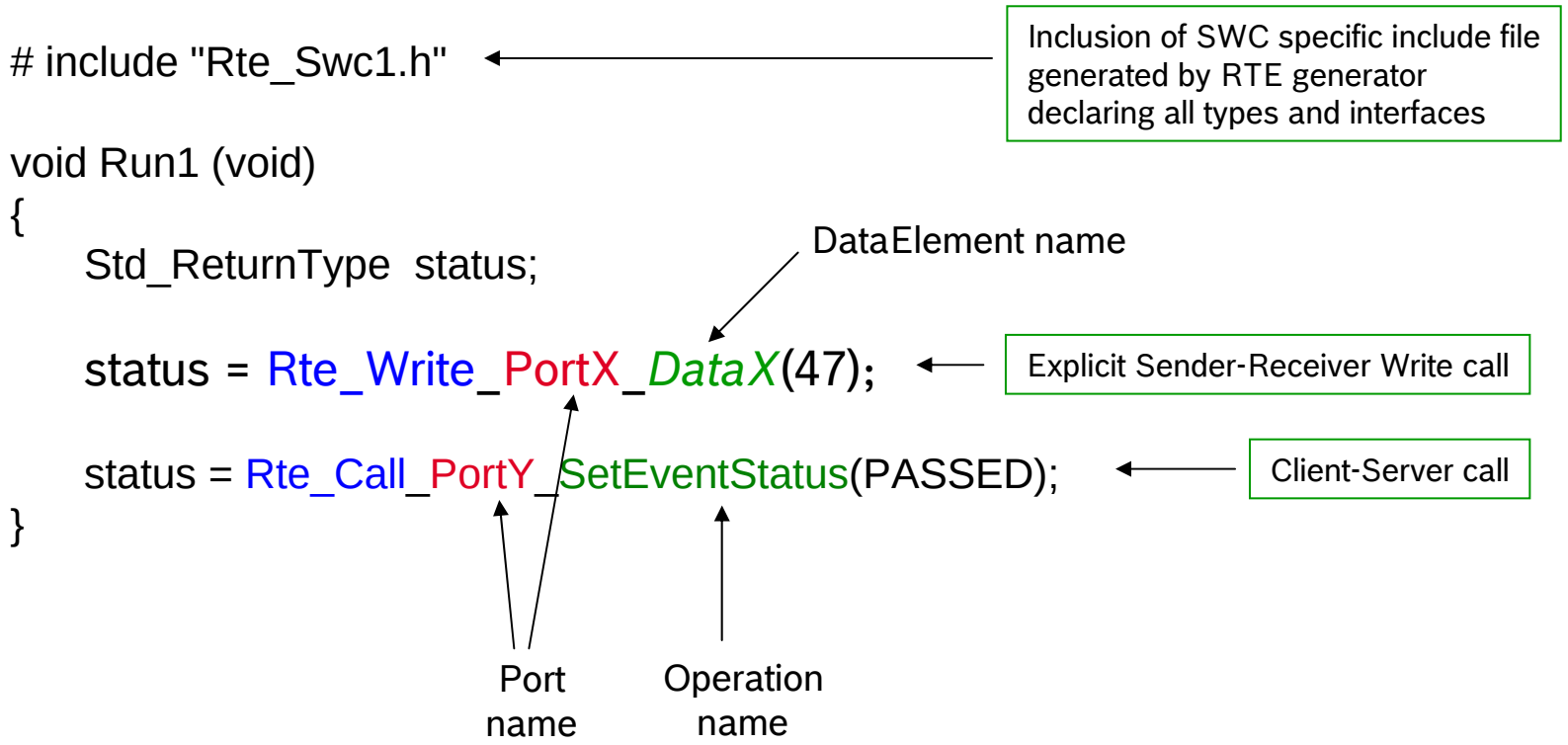
Runnable
= executable code

Port
= the only way a SWC can communicate with outer world

Sender-Receiver communication
= like message communication

Client-Server communication
= like function calls

Example: SWC with 1 Runnable



AUTOSAR communication

Swc1.arxml

```
<APPLICATION-SOFTWARE-COMPONENT-TYPE>
  <SHORT-NAME>Swc1</SHORT-NAME>
  <PORTS>
    <P-PORT-PROTOTYPE>
      <SHORT-NAME>PortX</SHORT-NAME>
      <PROVIDED-INTERFACE-TREF DEST="SENDER-
        RECEIVER-INTERFACE">/Interfaces/IfaceX
        </PROVIDED-INTERFACE-TREF>
    </P-PORT-PROTOTYPE>
```

Interfaces.arxml

```
<AR-PACKAGE>
  <SHORT-NAME>Interfaces</SHORT-NAME>
  <ELEMENTS>
    <SENDER-RECEIVER-INTERFACE>
      <SHORT-NAME>IFaceX</SHORT-NAME>
      <IS-SERVICE>false</IS-SERVICE>
      <DATA-ELEMENTS>
        <DATA-ELEMENT-PROTOTYPE>
          <SHORT-NAME>DataX</SHORT-NAME>
          <TYPE-TREF DEST="INTEGER-
            TYPE">/DataTypes/TypeX</TYPE-TREF>
          <IS-QUEUED>false</IS-QUEUED>
        </DATA-ELEMENT-PROTOTYPE>
      </DATA-ELEMENTS>
    </SENDER-RECEIVER-INTERFACE>
```

Rte_Swc1.h

```
#define Rte_Write_PortX_DataX( data )
        ( (Rte_Rx_000378_DataX = data), RTE_E_OK )
```

Swc1.c (User code)

```
void  Run1 (void)  {
      Std_ReturnType  status;
      status = Rte_Write_PortX_DataX ( 47 );
      if (status == RTE_E_OK)
        { ... }
}
```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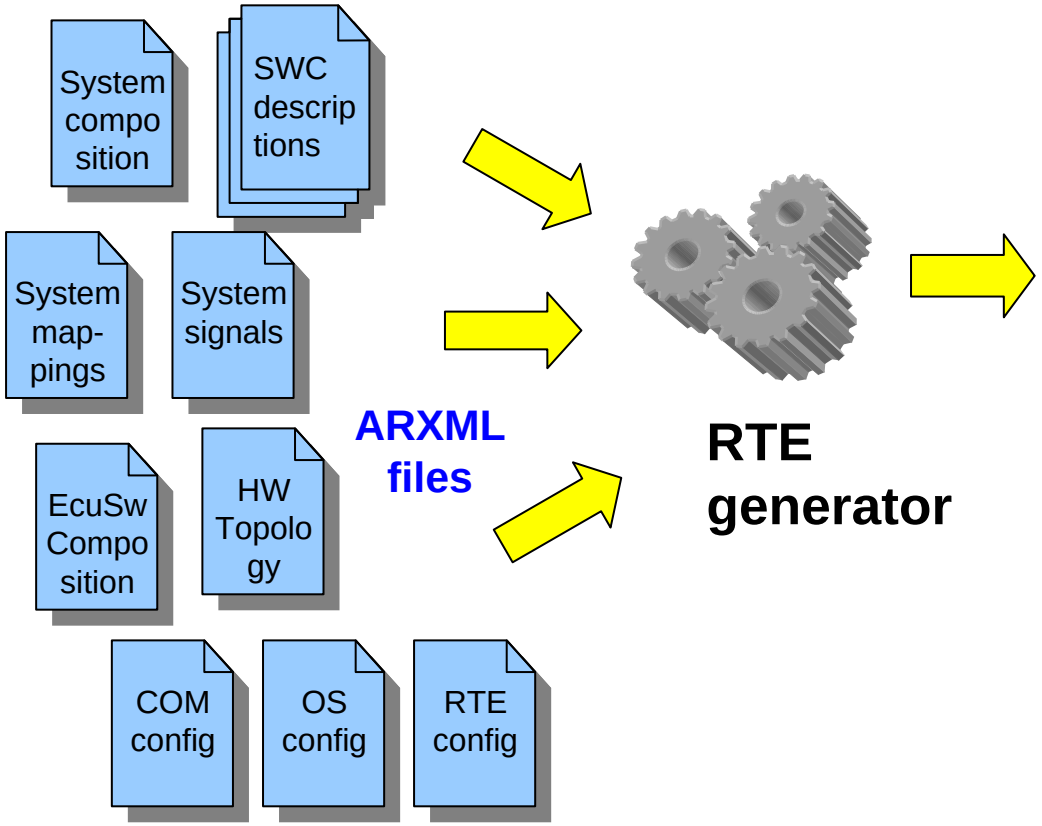
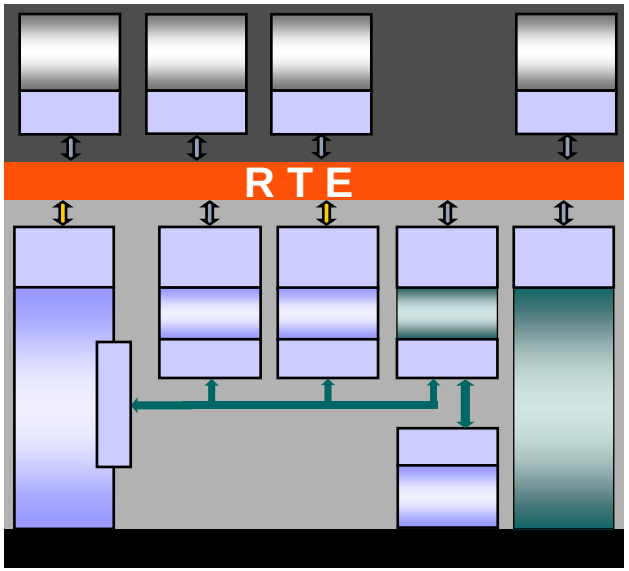
RTE generator creates the RTE SW layer

and the Header files for all SW-Components !





RTE = RunTime Environment
ARXML = AUTOSAR XML

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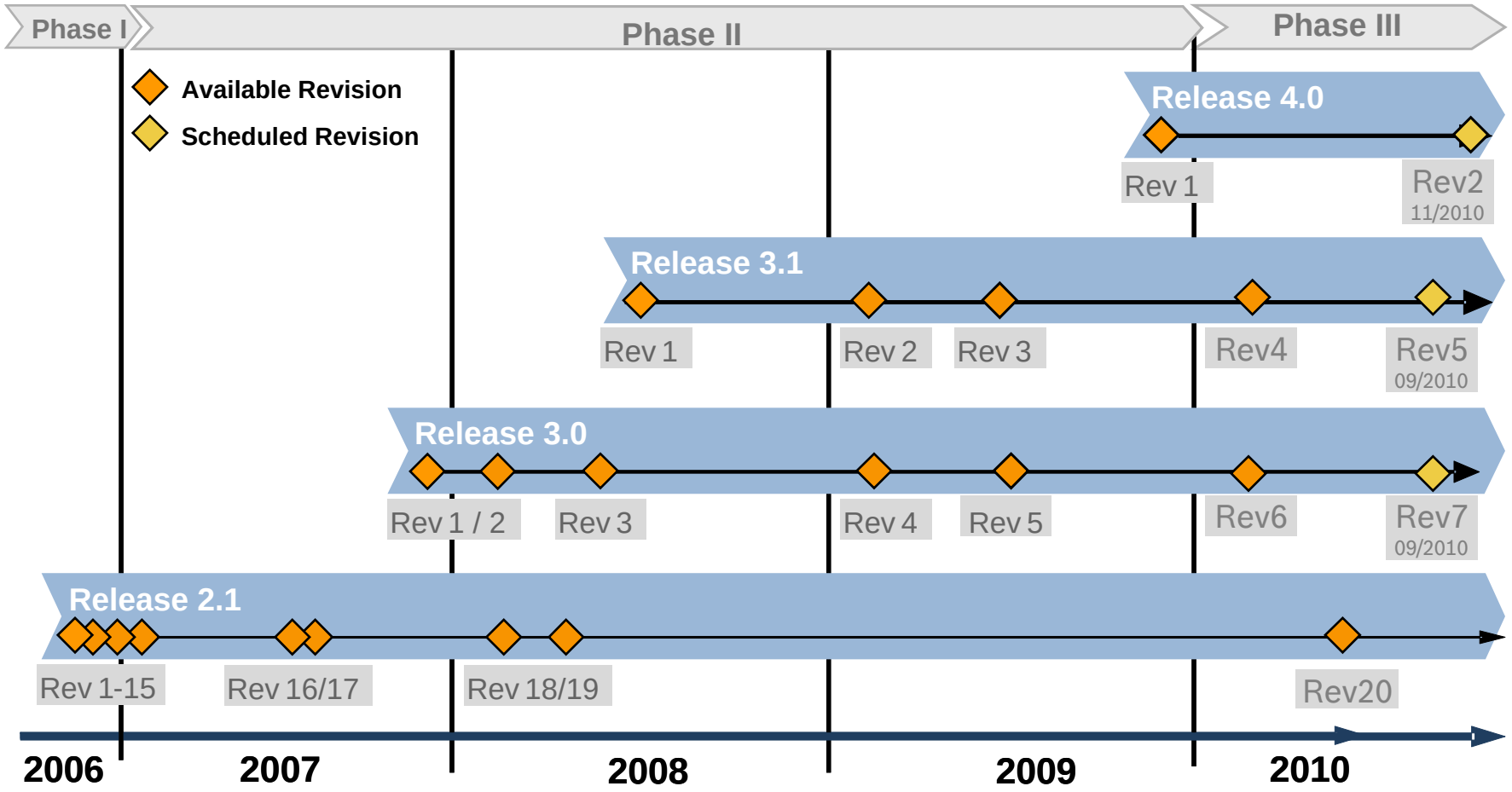
AUTOSAR releases / roadmap



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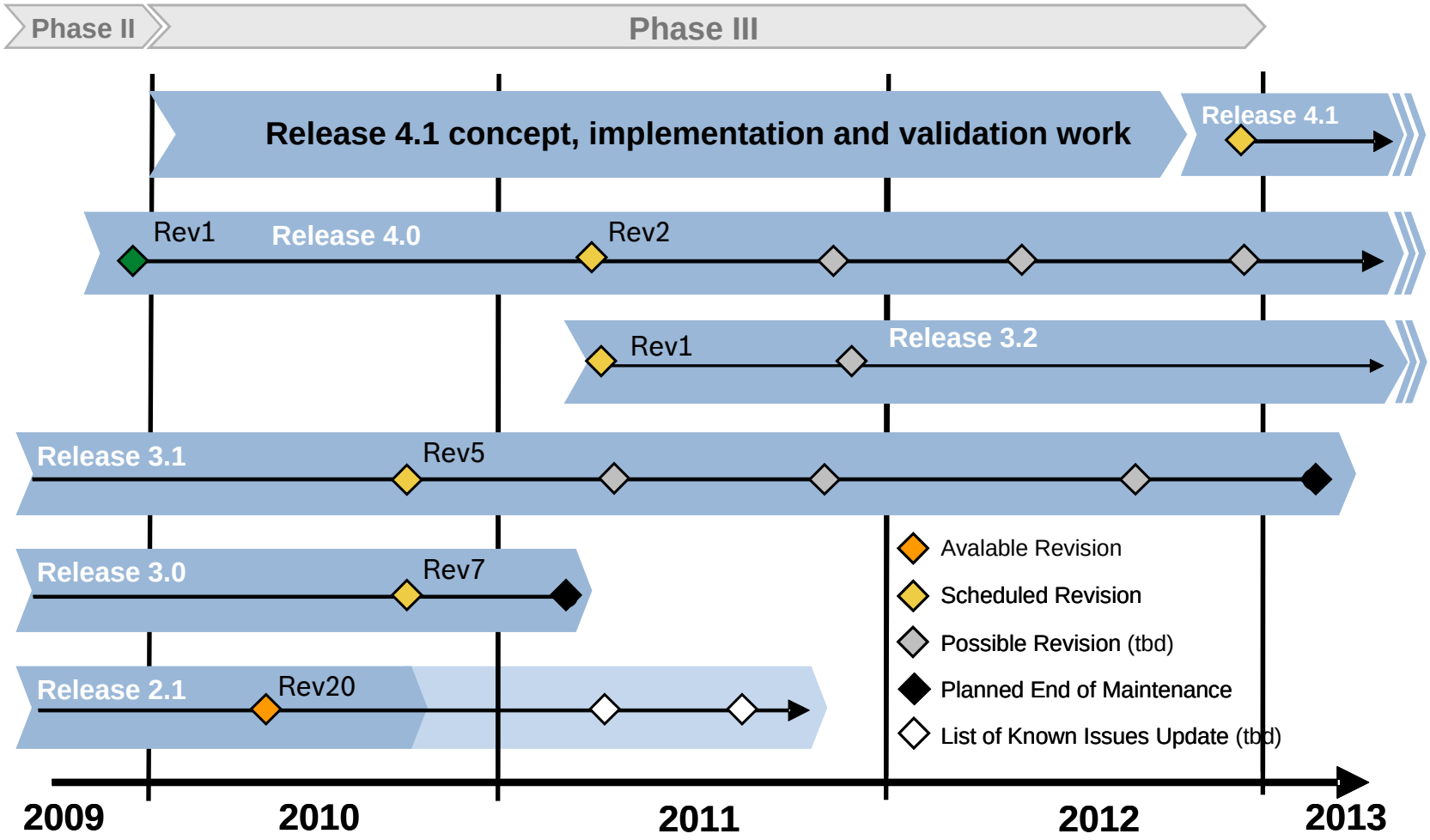
AUTOSAR releases / roadmap



New in AUTOSAR rel. 4.0 (compared to 3.1)

- Math-, bit-, ipol-, phys.-, crypto- libraries
- A2L file generation methodology => calibration approach usable
- Variant handling
- More standardized application interfaces
- Safety (Memory/Timing protection, end-to-end protection)
- Dual-Core support
- Timing Model
- Conformance tests for Base SW
- COM stack improvements including new protocols (XCP, TCP/IP, ..)
- ..

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OEM interests: Save overall costs

- **Application SW**
  - Reuse in ECUs of different suppliers
  - Reuse over ECU generations
- **Basic SW**
  - Reduced BSW maintenance effort
    - AUTOSAR maintains the standard, no need for own standard core
    - Common behavior of ECUs (special focus on network communication)
    - „cherry picking“ of BSW modules
- **Process, Tools and Quality**
  - Common „language“ eases SW exchange and interface discussions
  - Commonly used tools
  - Promote development at small ECU suppliers
  - ..

Some DGS customers interests /approaches

Autosar rel. R3.1

PSA PEUGEOT CITROËN

- Establish an own AUTOSAR based ASW platform
  - Integrate AUTOSAR ASW unmodified in ECUs from different suppliers
    - AUTOSAR ASW created by PSA and several ECU suppliers
    - Less test and calibration effort
    - Source code sharing
- ECU supplier is responsible for BSW which must only provide AUTOSAR interfaces to ASW (ICC1 model)
- Bosch has to guarantee coexistence of legacy MEDC17 SW and AUTOSAR SW

ICC1..3 = AUTOSAR BSW Implementation Conformance Classes

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Some DGS customers interests

Autosar rel. R3.2

DAIMLER

- Establish an own AUTOSAR based ASW platform
  - Integrate Daimler AUTOSAR ASW unmodified in ECUs from different suppliers
    - Object code sharing
- ECU supplier shall provide AUTOSAR compliant BSW
  - COM stack (ICC3)
  - other BSW services (currently ICC1, later ICC3)
- Bosch has to guarantee coexistence of legacy MEDC17 SW and AUTOSAR SW

ICC1..3 = AUTOSAR BSW Implementation Conformance Classes

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AUTOSAR business cases

Source: AUTOSAR

OEM

- Establish development distribution among suppliers
- Compete on innovative functions with increased design flexibility
- Simplify software and system integration
- Reduce overall software development costs

Supplier

- Reduce version proliferation
- Reuse software modules across OEMs
- Increase efficiency of application development
- Invent new business models

Tool provider

- Interface with development processes
- Embed tools into an overall tool environment

An industry standard is established.

New market entrant

- Enable new business models by means of standardized interfaces

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AUTOSAR core partner exploitation plan

Core Partner	2008	2009	2010	2011	2012
BMW Group	■ ≈10 AUTOSAR BSW modules as part of Std Core in vehicles, tool / serial support in place			■ Powertrain-, Chassis-, Safety-, Body- ECUs use AUTOSAR architecture	
BOSCH	■ Body Computer with subset of AUTOSAR specs incorporated ■ Instrument Cluster with subset of AUTOSAR specs incorporated	■ ACC ECU using AUTOSAR architecture. ■ Powertrain EDC/ME(D)17 ECUs using AUTOSAR architecture ■ Domain Control Unit using AUTOSAR BSW	■ Chassis ECU using AUTOSAR architecture ■ Body Computer using AUTOSAR architecture		
Continental	■ Complete BSW Stack as Product ■ AUTOSAR Configuration Tool	■ Body ECUs using AUTOSAR architecture ■ Powertrain ECUs using AUTOSAR architecture	■ Chassis ECUs using AUTOSAR architecture		■ Engine Systems Platform based on AUTOSAR architecture
DAIMLER			■ First usage of AUTOSAR modules in vehicles	■ First AUTOSAR compa-tible ECUs in vehicles	■ Introduction of AUTOSAR architecture and methodology in vehicles
Ford		■ 1-2 AUTOSAR conformant ECUs; first use of conformant tools/methodology	■ Continuous roll-out of ECUs into vehicle architecture increased use of conformant tools / methodology		
OPEL			■ First usage of AUTOSAR modules	■ First use of AUTOSAR architecture ECU	
PSA PEUGEOT CITROËN		■ Powertrain ECU using AUTOSAR architecture	■ Body ECU using AUTOSAR architecture		
TOYOTA			■ First usage of AUTOSAR modules		■ AUTOSAR Architecture ECU
VOLKSWAGEN AG		■ First AUTOSAR modules in series production		■ First complete ECUs in series production	

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- AUTOSAR at Bosch
- AUTOSAR at DGS
- Links

AUTOSAR – BOSCH Application Plan**

Instrument Cluster
subset of AUTOSAR specs incorporated
SOP 2008

Instrument Cluster using AUTOSAR BSW*
SOP 2012

All BOSCH divisions are committed to

AUTOSAR

EDC/ME(D)17 ECU using AUTOSAR architecture
SOP 2009

FAS
subset of AUTOSAR specs incorporated
SOP 2011

ACC
subset of AUTOSAR specs incorporated
SOP 2009

Body ECU
subset of AUTOSAR specs incorporated
SOP 2011

Glow Control Unit
subset of AUTOSAR specs incorporated
SOP 2009

Chassis DCU
using AUTOSAR architecture
SOP 2009

ESP
Using AUTOSAR BSW* & Application Interfaces
SOP 2010

Transmission Control Unit using AUTOSAR BSW*
SOP 2010

Airbag ECU
Using AUTOSAR BSW* & Application Interfaces
SOP 2010

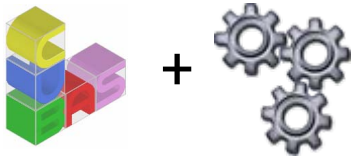
* CUBAS: Bosch AUTOSAR Base-SW ** selected products

BOSCH

AUTOSAR players at BOSCH

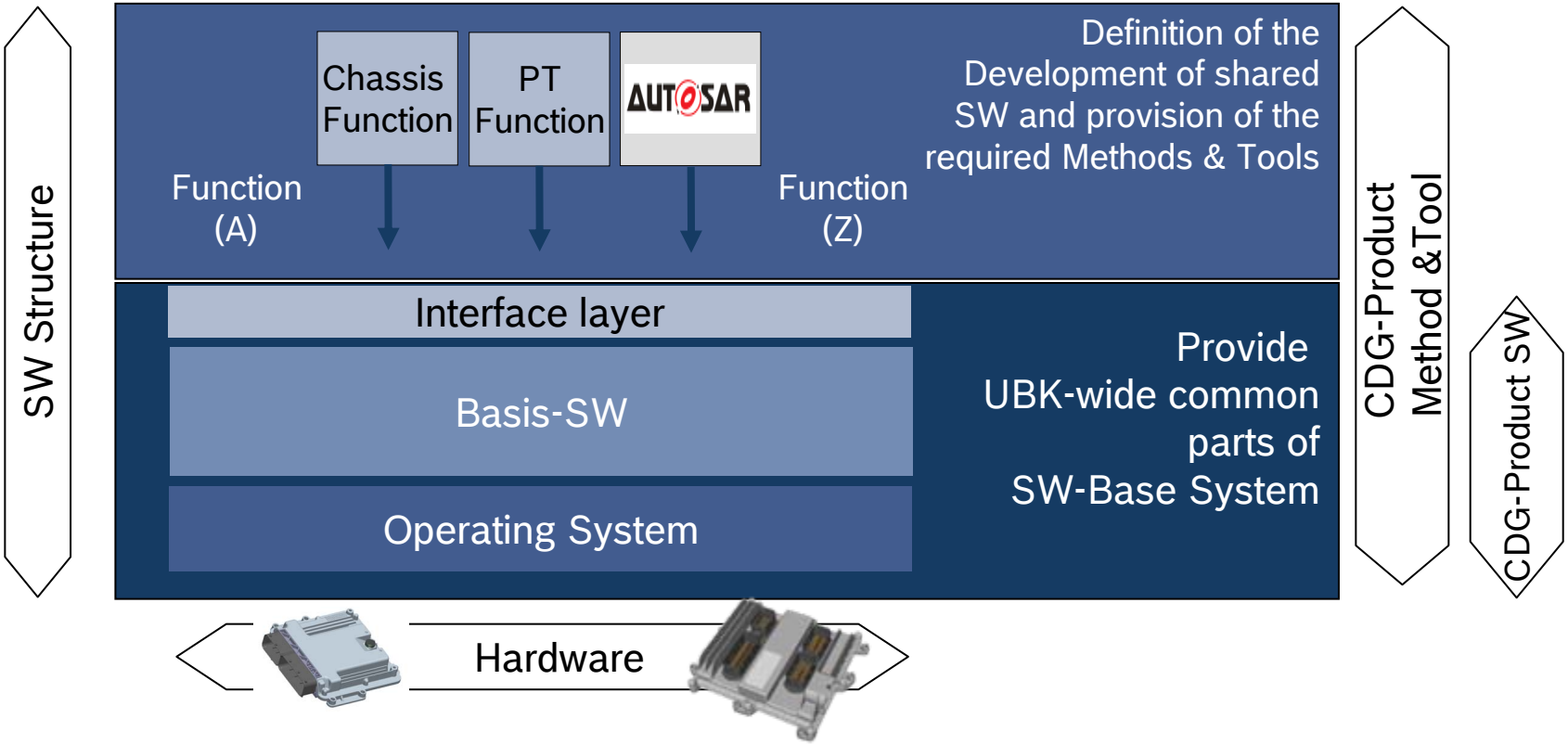
- C/AI (Corporate / Automotive Integration)
  - Central AUTOSAR coordination at Bosch
  - Bosch Project leader in AUTOSAR gremium

- CDG-SMT (Cross Divisional Group - Software Methods Tools)
  - Bosch internal joint venture between CC and DGS-EC
  - Provides
    - AUTOSAR Base Software for Bosch ECUs
    - AUTOSAR Tools and Methods



- Bosch Divisions and Product Units

Cross Divisional Group - Software Methods Tools



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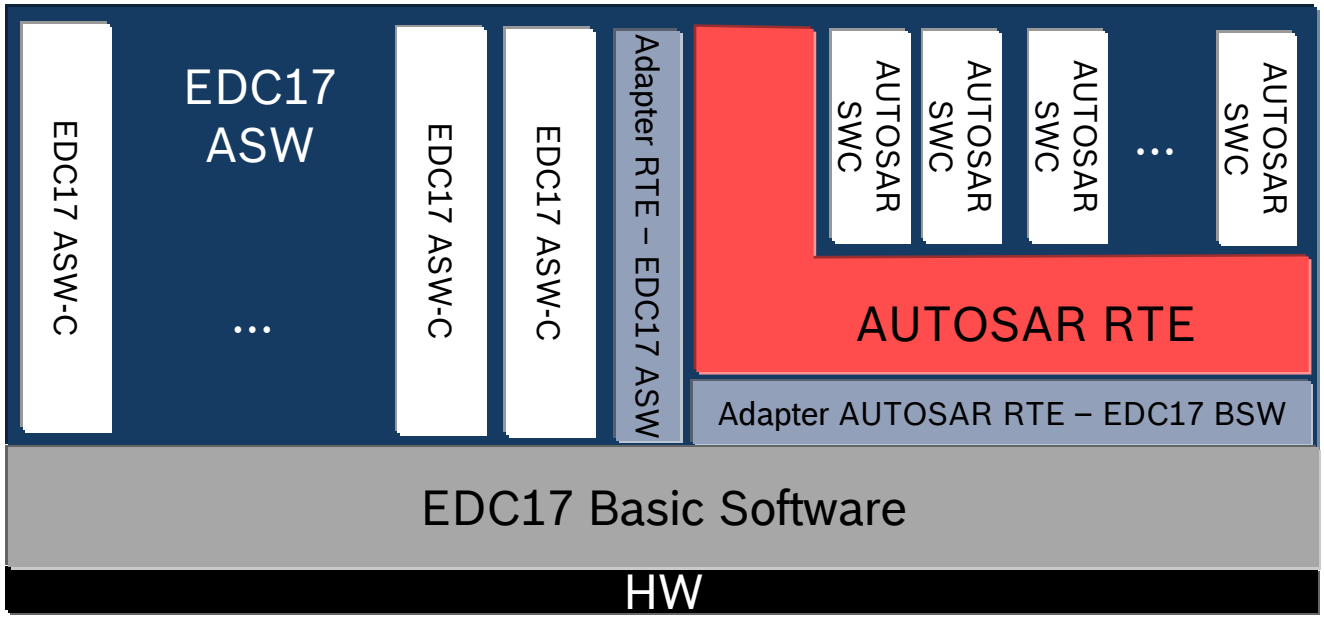
DGS series projects with AUTOSAR

Domain	Power Train, Electronic Diesel Control	SOP 2009
Features	Relocatability, reuse and sharing of ASW components	
AUTOSAR enabling technology	Implementing an RTE into exiting EDC17 Usage of standardized Application SW Interfaces Usage of standardized memory- and compiler settings	

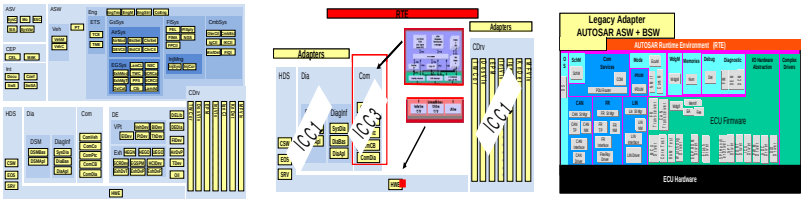


Stepwise Migration to AUTOSAR

MEDC17:

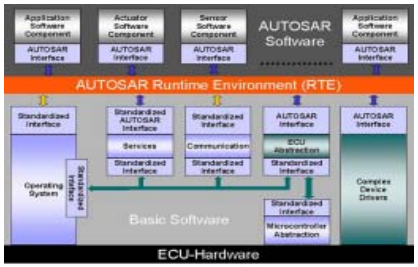
- ***Stepwise*** Migration to AUTOSAR
- Integration of ***AUTOSAR and legacy SW from RB and OEM***
  → ***"Mixed mode approach"***

Close collaboration between OEM and supplier required!



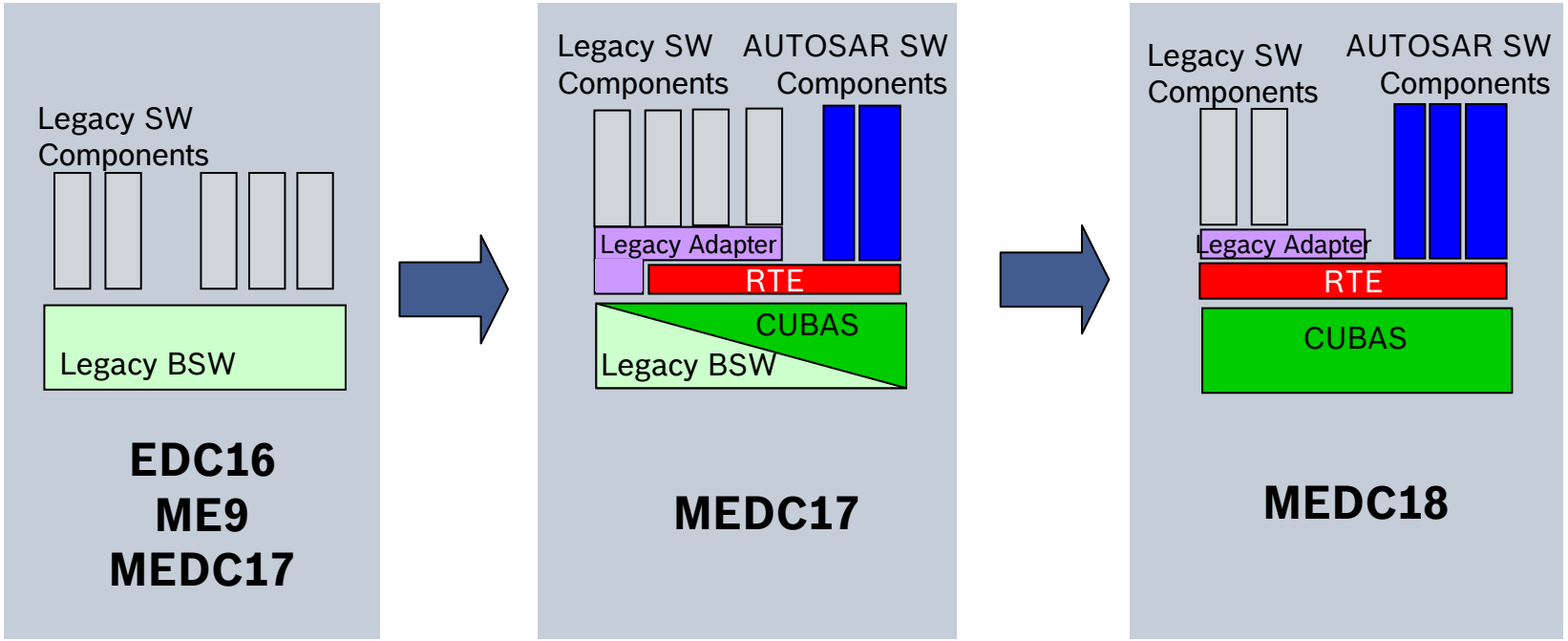
MEDC18:

- Development of an ***AUTOSAR compliant ECU***
- ***AUTOSAR Basic SW***
- ***Mixed mode approach*** in Application SW



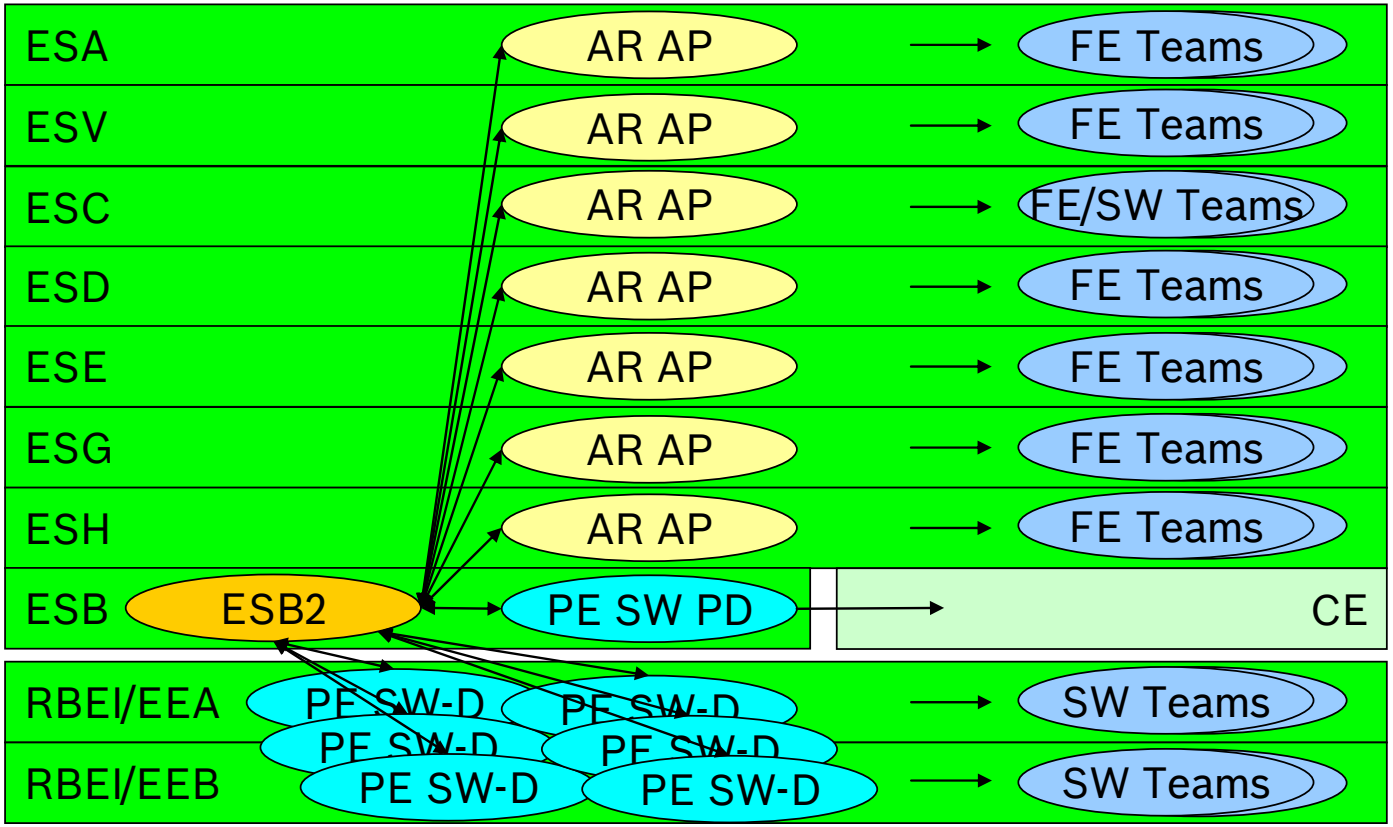
Step1 **Step2** **AUTOSAR**

DGS-EC AUTOSAR Migrationpath (platform)



CUBAS = Common UBK Basic SW

Buildup AUTOSAR competence at DGS-EC/**NE2**



ESB2 = AUTOSAR competence centure at DGS

AR AP = **A**UTOSA**R** **A**nsprech**P**artner

PE SW PD = Pilot Experte SW Product Designer

PE SW-D = Pilot Experte SW Developer

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Links

- Official AUTOSAR webside
  http://www.autosar.org/
- C/AI
  http://www.intranet.bosch.de/c/ai/documents/projects/autosar.html
- Bosch copy of AUTOSAR specifications
  \\SI8256\AUTOSAR$\SVN3-COPY\22_Releases
- CDG-SMT (In organization below CC/EE)
  https://inside-ws.bosch.com/FIRSTspiritWeb/permlink/wcms_cc_cb_-cdg_smt_pg_about_1-EN
- CUBAS
  \\bosch.com\dfsrb\DfsDE\DIV\CDG\Prj\CUBAS\01_CUBAS_ProjectMgmt\CUBAS-Intranet\index.htm

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Questions ?

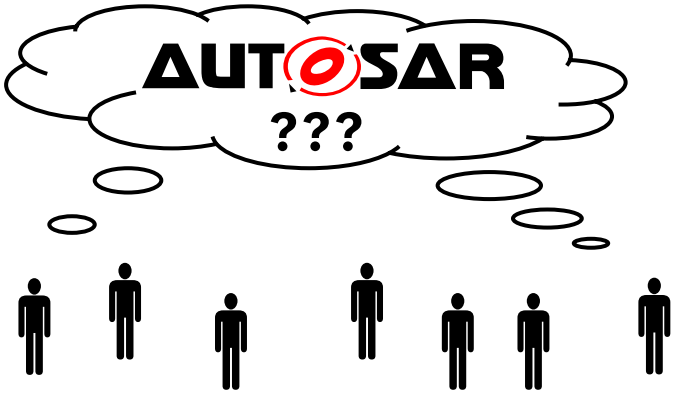
BOSCH

Presentation Goal

Has it been reached ?

Provide some top level information to support the audience in answering the question:

What is AUTOSAR and in which areas could it influence my work?



Sales .. Project handling .. Function development .. SW development .. SW integration .. Application .. HW development .. Processes ..