

### **Networked Embedded Systems**

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## Overview

- Introduction
- Middleware: Run-Time Environment
- HW-Abstraction: Basic Software
- Scheduling
- Multicore extentions
- Conclusion



Introduction

RTE

BSW

Scheduling

Multicore

### Introduction

- AUTomotive Open System Architecture
- Initial Release: 2005
- Backward compatible to OSEK (Time)

"Cooperate on standards, compete on implementation."





Introduction

RTE

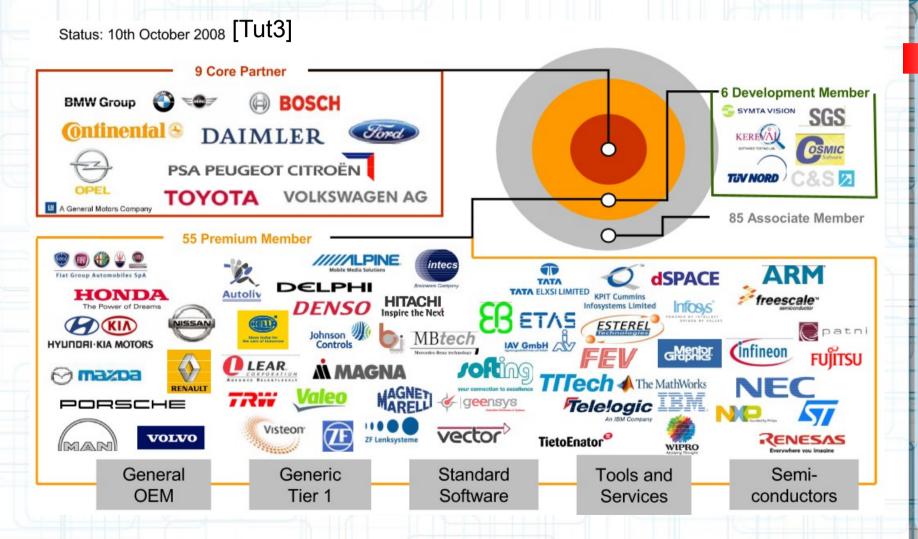
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## Partner & Member





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**AUTOSAR** 

## Goals

- Efficiency
- Quality
- Scalability
- Managing Complexity
- Maintainability
- Transferability
- Standardization



### **Architecture**



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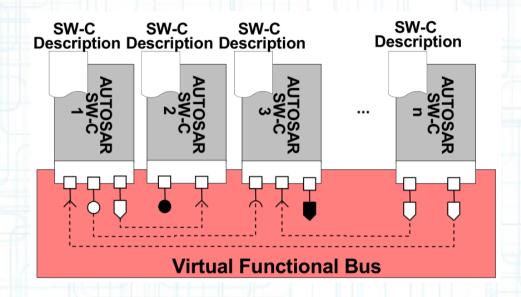
### **Application Layer**

**Run-Time Environment (RTE)** 

**Basic Software (BSW)** 

Microcontroller

### **VFB**



- Decoupling of software and infrastructure
- Application = interconnected SW-Cs

SoftWare Component

**AUTOSAR** 





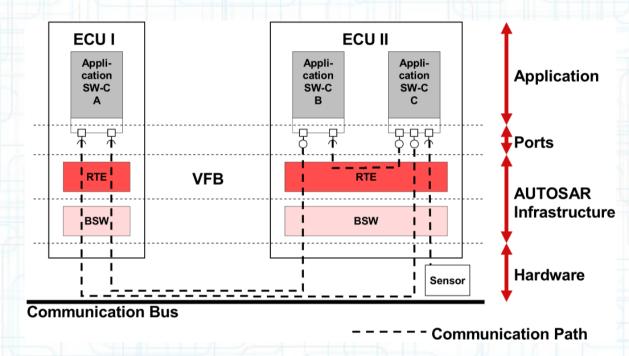
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# Communication



- Channeling communication via RTE
- Hiding communication in BSW



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**AUTOSAR** 

## Communication

- Patterns:
  - Sender-receiver
    - Mode: explicit/ implicit
  - Client-server
- Signal
  - triggered/ pending
  - data (queued) or event (unqueued)



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## **Basic Software**



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**Application Layer** 

**AUTOSAR Runtime Environment (RTE)** 

Services Layer

**ECU Abstraction Layer** 

**Microcontroller Abstraction Layer** 

Microcontroller



Complex

**Drivers** 

# **Basic Software**



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#### **Application Layer**

#### **AUTOSAR Runtime Environment (RTE)**

System Services Memory Services

**Onboard Device** 

Abstraction

**Microcontroller Drivers** 

Communication

Services

Communication
Hardware Abstraction

Communication Drivers

I/O Drivers

I/O Hardware

Abstraction

**Memory Hardware** 

Abstraction

**Memory Drivers** 

#### Microcontroller

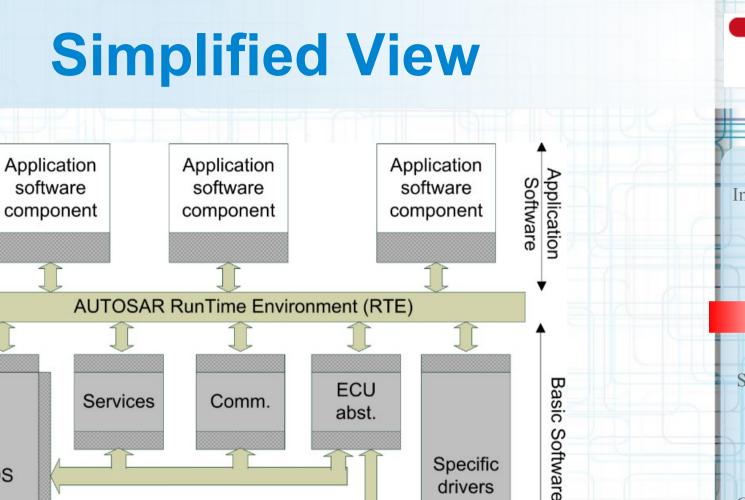
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**AUTOSAR** 

Complex

**Drivers** 

# **Simplified View**



mctlr abst. drivers

Standardized interfaces

**ECU** hardware

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OS





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## Communication

 Behavoural and timing properties

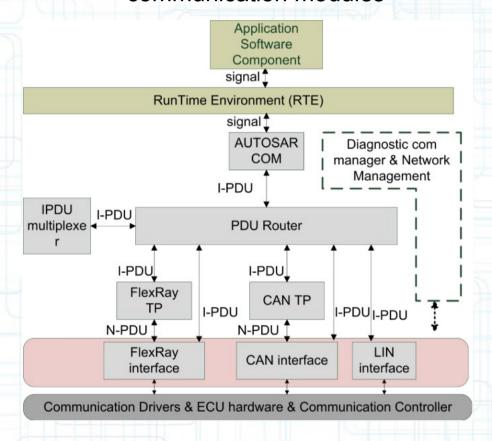
Signal

I-PDU: Interactional

N-PDU: Network

L-PDU: Data Link

 Local Transmission on same ECU Overview on some communication modules







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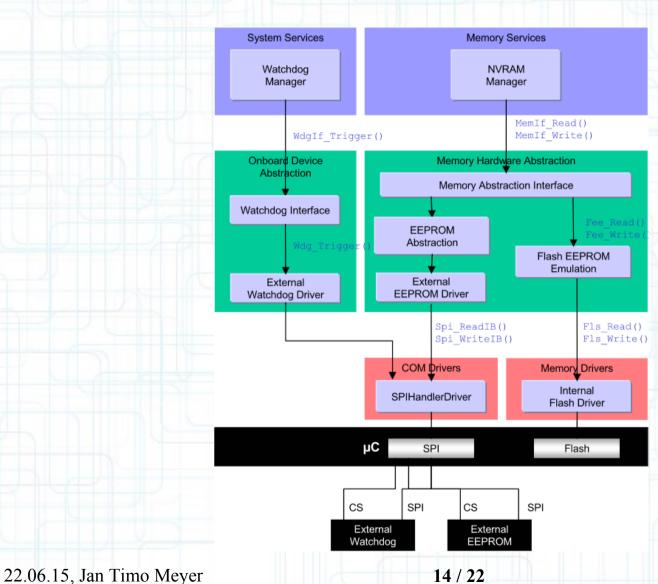
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# Interaction of Layers



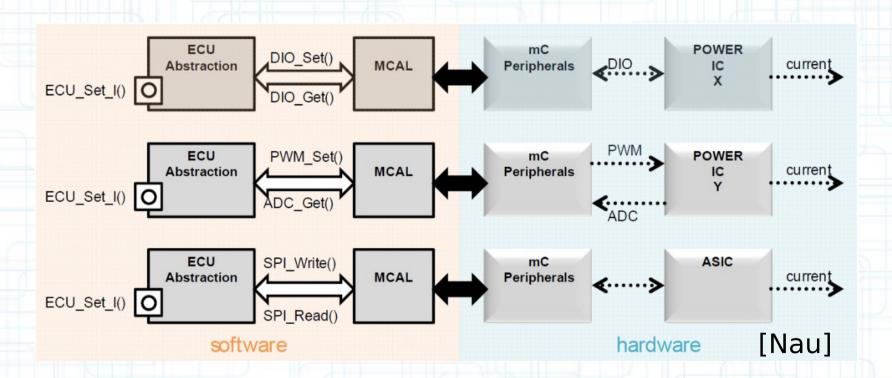




### **ECU Abstraction**

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1 command 3 different implementations



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# Scheduling

- Timing Protection Service
- Priority Ceiling Protocol
- Schedule table



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# Scheduling: Policy

- OSEK concepts:
  - Highest Priority, FIFO
  - Recource groupes
- Timing Protection Service
  - Excution time > WCET (predefined)
  - Holding shared resource too long
  - Violate arrival rate (time spent in time frame)
    - Periodic server concept



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**Scheduling** 

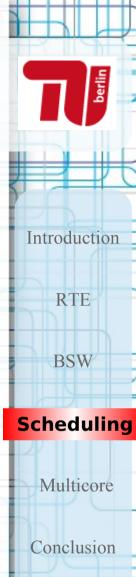
Multicore

Conclusion

**AUT** SAR

# Scheduling: Schedule table

- Like alarms linked to a counter
- Single-shot or cyclic
- Offline scheduling techniques
- Activation points of all tasks
- No preemption



# **V4.0 Multicore Architecture**

- LE: Locatable Entities
- Multi-core startup/ shutdown
- IOC: Inter-OS-Appclication Communicator
- SpinlockTypes



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# **V4.0 Multicore Architecture**

- LE: Locatable Entities
- Multi-core startup/ shutdown
- IOC: Inter-OS-Appclication Communicator
- SpinlockTypes



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# Questions



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