AUTOSAR – Automotive Open System Architecture

“Cooperate on standards, compete on implementation.”

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Agenda

- AUTOSAR History
- Partnership Structure and Members
- AUTOSAR Main Topics and Benefits
- AUTOSAR Architecture
- Present status
- Future plans and developments
- AUTOSAR in FGA
About AUTOSAR

**AUTOSAR** (AUTomotive Open System ARchitecture) is an open and standardized automotive software architecture, jointly developed by automobile manufacturers, suppliers and tool developers.

<table>
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<th>Project Objectives</th>
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<td>- Consideration of availability and safety requirements</td>
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<td>- Redundancy activation</td>
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<td>- Scalability of different vehicle and platform variants</td>
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<td>- Implementation and standardization of basic functions as an OEM wide „Standard Core“ solution</td>
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<td>- Transferability of functions throughout the network</td>
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<td>- Integration of functional modules from multiple suppliers</td>
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<td>- Maintainability throughout the whole „Product Life Cycle“</td>
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<td>- Increased use of „Commercial off the shelf hardware“</td>
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<td>- Software updates and upgrades over vehicle lifetime</td>
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**Functional Domains**

<table>
<thead>
<tr>
<th>Vehicle centric</th>
<th>Powertrain</th>
<th>Safety (active/passive)</th>
<th>Clasrical</th>
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<td></td>
<td>AUTOSAR</td>
<td>Main Machine Interface</td>
<td>Safety</td>
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<td></td>
<td>Multi-media</td>
<td>Telematics</td>
<td>Body/Comfort</td>
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<td></td>
<td>Passenger</td>
<td>comfort</td>
<td>Body</td>
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Exchangeability and Reuse of Software Components

[Diagram showing exchangeability and reuse of software components between manufacturers, suppliers, and vehicle platforms]
**AUTOSAR History**

**July, 2003** - After an initial discussion on the common challenge and objectives (Aug. 2002) the partnership between the Core Partners was formally signed off. The Core partners were initially BMW, Bosch, Continental, DaimlerChrysler, Volkswagen and Siemens VDO than joined by Ford Motor Company (Nov. 2003), P.S.A. and Toyota (Dec. 2003) and General Motors (Nov. 2004).

**December, 2004** – FGA became AUTOSAR Premium Member

**AUTOSAR website**

[Website URL]

[Request Email]
Partnership Structure

Core Partners
(OEM & Tier 1 Supplier)
- Organizational control
- Technical contributions
- Administrative control
- Definition of external information (web-release, clearance, etc.)
- Leadership of Working Groups
- Involvement in Working Groups

Premium Members
- Leadership of Working Groups
- Involvement in Working Groups
- Technical contributions
- Access to current information

Associate Members
- Access to finalized documents
- Utilization of AUTOSAR standard

Support Roles
- Development Members
- Attendees

Core Partners and Members

Status: 10th October 2008

9 Core Partners
- BMW Group
- BOSCH
- DAIMLER
- Continental
- PSA PEUGEOT CITROEN
- TOYOTA
- VOLKSWAGEN AG

5 Development Member
- SGS
- TUV
- C&S

10 Associate Member

General
OEM

Generic
Tier 1

Standard
Software

Tools and
Services

Semiconductors
AUTOSAR Benefits

- OEM overlapping reuse of software modules
- Maintaining ability to compete on innovative functions
- Simplification of the integration task
- Reduction of total SW development costs

- Reduction of version proliferation
- Development partitioning among suppliers
- Increase of efficiency in functional development
- New business models possible

- Common interfaces with development processes
- Seamless, manageable, task optimized (time dependent) tool landscape

Basic AUTOSAR Approach

Following the AUTOSAR Methodology, the E/E architecture is derived from the formal description of software and hardware components.

Functional software is described formally in terms of “Software Components” (SW-Cs).

Using „Software Component Descriptions“ as input, the „Virtual Functional Bus“ validates the interaction of all components and interfaces before software implementation.

Mapping of “Software Components“ to ECUs.

The AUTOSAR Methodology supports the generation of an E/E architecture.
Intra- and Inter-ECU Communication

AUTOSAR Architecture

Application Layer

AUTOSAR Runtime Environment (RTE)

Basic Software Layer

Microcontroller
Microcontroller Abstraction Layer

The Microcontroller Abstraction Layer is the lowest software layer of the Basic Software. It contains internal drivers, which are software modules with direct access to the µC internal peripherals and memory mapped µC external devices.

**Task:**
Make higher software layers independent of µC

**Properties:**
- Implementation: µC dependent
- Upper Interface: standardizable and µC independent

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ECU Abstraction Layer

The ECU Abstraction Layer interfaces the drivers of the Microcontroller Abstraction Layer. It also contains drivers for external devices. It offers an API for access to peripherals and devices regardless of their location (µC internal/external) and their connection to the µC (port pins, type of interface).

**Task:**
Make higher software layers independent of ECU hardware layout

**Properties:**
- Implementation: µC independent, ECU hardware dependent
- Upper Interface: µC and ECU hardware independent, dependent on signal type
Services Layer

The Services Layer is the highest layer of the Basic Software which also applies for its relevance for the application software: while access to I/O signals is covered by the ECU Abstraction Layer, the Services Layer offers:
- Operating system functionality
- Vehicle network communication and management services
- Memory services (NVRAM management)
- Diagnostic Services (including UDS communication, error memory and fault treatment)
- ECU state management

Task:
Provide basic services for application and basic software modules.

Properties:
- Implementation: partly µC, ECU hardware and application specific
- Upper Interface: µC and ECU hardware independent

RTE

The RTE is a layer providing communication services to the application software (AUTOSAR Software Components and/or AUTOSAR Sensor/Actuator components).

The RTE is the implementation of the Virtual Functional Bus (VFB) concepts. It realizes the communication between software-components (SWCs) and between SWC and basic software (BSW) modules.

Above the RTE the software architecture style changes from “layered” to “component style”. The AUTOSAR Software Components communicate with other components (inter and intra ECU) and/or services via the RTE.

Task:
Make AUTOSAR Software Components independent from the mapping to a specific ECU

Properties:
- Implementation: ECU and application specific (generated individually for each ECU)
- Upper Interface: completely ECU independent
AUTOSAR Architecture: Standard Interfaces

AUTOSAR – Validation

- **Release 1.0 and 2.0** have been validated developing two validators, mainly focused on BSW.
- The approach for BSW validation was focusing on:
  - Exchangeability of implementations from different implementers
  - Check of interoperability of the modules in the stack (does the APIs fit together?)
  - Check whether the specifications are unambiguous

- **Releases 2.1, 3.0 and 3.1** have been validated by each implementer.

- **Release 4.0**: the results of the validation are expected to be incorporated into the Release 4.0
AUTOSAR – Validation Results

- AUTOSAR harmonizes already existing basic software solutions and closes gaps for a seamless basic software architecture.
- AUTOSAR aims at finding the best solution for each requirement and not finding the highest common multiple.
- The decomposition of the AUTOSAR layered architecture into some 50 modules has proven to be functional and complete.
- The AUTOSAR 2.0 specifications for the modules of the layered architecture have been successfully implemented and integrated.

Next Steps: AUTOSAR release 4.0 (Nov. 2009)

**Architecture**
- Architectural improvement in terms of error handling and multicore support
- Communication stack evolution related to FlexRay and diagnostic over Ethernet.
- Support for functional safety.
- Functional enhancement of BSW mode managers.
- Quality improvement developing conformance tests specifications and applying validation.

**Application level**: Continuous development in the 5 different domains
- Body and comfort
- Powertrain
- Chassis control
- Occupants and pedestrian safety
- MM / T / HMI

**Methodology and templates enhancement**
- Timing specification
- Variant handling
FGA in AUTOSAR Consortium

FGA starts working in AUTOSAR consortium as Premium Member at the end of 2004 with 10 active and passive members in some Work Packages.

Next Steps: Time plan of AUTOSAR phase III

AUTOSAR Phase II
AUTOSAR Phase III

AUTOSAR Phase III contract preparation including specification of Exhibit I
Early signature phase for current AUTOSAR members for AUTOSAR Phase III
Regular signature phase for AUTOSAR Phase III contract

2008
2009
2010

Mid 2009

Active Members
Passive Members
FGA AUTOSAR Strategy

**Application Software**
- 30%
- SWC's "in-house" development in Body Electronics, Infotainment, Climate Control and Chassy environment.
- SWC's reuse and standardization in many car projects

**Basic Software**
- 70%
- Management of some BSW stacks:
  - Communication
  - Diagnosis
- Centralized development of cited SWC's stacks
- Centralized distribution of cited SWC's stacks
- Optimization of validation phases
- 100% AUTOSAR compatibility for some ECU Suppliers

AUTOSAR: Application SW development

**“AUTOSAR Body Computer” Project**
- 6 SW modules nowadays in production, including "Alfa D.N.A." e "Stop&Start"
- 11 SW modules in production "fully operational" (2010)
- 14 SW modules involved on 3 architectures
- 81% of application software developed by FGA "fully operational"
- 100% reuse of software deliberato
- 80% minimum reuse in different cars

**Body Computer - FGA Software Modules**

**Future developments on different systems/environments**
- 3 modules in Chassis Control Systems environment
- Instrument Panel Cluster: an enquiry is going on with Suppliers
- Climate Control System: possible synergy with already developed SW modules by Interiors
Thank you!

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