BMW Car IT GmbH.

AUTOSAR - First Experiences and the Migration Strategy of the BMW Group

Dr. Christian Salzmann, BMW Car IT

BMW Group
AUTOSAR - First Experiences.

Overview.

1. **Focus of this talk**: Model based development under AUTOSAR – the Virtual Function Bus (VFB) and its implementation, the Runtime Environment (RTE)

2. **History and Lessons learned**

3. **The AUTOSAR Strategy of the BMW Group**: Migration into the AUTOSAR world.

4. **Future Steps**: „Beyond AUTOSAR“
AUTOSAR – ECU Software Architecture

AUTOSAR RTE:
- by specifying interfaces and their communication mechanisms, the applications are decoupled from the underlying HW and Basic SW, enabling the realization of Standard Library Functions.

Automotive Open System Architecture (AUTOSAR):
- Standardized, openly disclosed interfaces
- HW independent SW layer
- Transferability of functions
- Redundancy activation

source: www.autosar.org
AUTOSAR - First Experiences.
Model based development under AUTOSAR.

This takes place at Application level – not the basic software.
AUTOSAR - First Experiences.
A subset of the Virtual Function Bus.
Experiences gained of three phases:

1. „Proof of Concept“: technical feasibility and feedback from the developer’s perspective.

2. „Piloting“: Confirming the applicability in the automotive domains by piloting existing functions and ECUs in the domains.

3. „Consolidation Phase“: Integration of resulting software and tools into the BMW Standard Core 6.
AUTOSAR - First Experiences.
„Proof of Concept“ (June 2004).

- Display
  - MMI: WaferBoard
  - QNX / JAVA
- Basic SW
- RTE (JAVA/QNX)
- Basic SW
- RTE (C/SC)
- EC E60

Rear mirror left
- LIN
- MPC 565 OSEK SC /C

Rear mirror right
- Mirror Control
- Mirror Park
- RTE (C/SC)

CAN
Simulation

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AUTOSAR - First Experiences.
Architecture of the BMW SC/RTE.
AUTOSAR - First Experiences.
Pilots (07/04 – 03/05).

- Body sun roof (finished)
- Body fuel gauge (finished)
- Body climate control finished)
- Chassis chassis management (finished)
- Powertrain Driver Request (finished)

Resulting steps:

1. The RTE is the appropriate interface for migration.
2. An optimized RTE Code Generator is needed.
3. Integrated tool support for modeling, configuration that fits into the BMW design process.
AUTOSAR – Migration Strategy.
A stable subset of the VFB for migration.

Communication

Paradigm

Connector

Encryption
Integration Check
Reliability

C/S

Client
Server

Mode
Sync
Async

Receive Mode
Timeout
ARE
WWP
DRA

Timeout Value

S/R

Sender

Information Type
Event
Data

Receive Mode
Filter
Init Value
Send Mode
Once
N Times
Cyclic
On Request
ARE

Filter

Receiver

Filter
Buffering

Timeout Value

Unimplemented Attributes
Implemented Attributes

(Attributed not on a mature specification level are not listed)
RTE based SW Components are migratable with an calculable amount of adaption.

An application, coded against the RTE interface, can be migrated up to the fully compliant AUTOSAR standard core.

„Stepwise Migration of Software Level"
AUTOSAR – Migration Strategy.
RTE against an existing COM Matrix.

AUTOSAR Vision:
From the partitioning to the COM matrix.

Ergo: „AUTOSAR brings up a new requirement for migration: generating an RTE against an existing COM matrix“
AUTOSAR – Migration Strategy.
Migration into an existing board network.

Bus Mapping
• Integration of an RTE based ECU into an existing system.
• No ADUs > 8 Byte
AUTOSAR – Migration Strategy.
Migration into a board net.

The RTE based ECU behaves towards the bus exactly like a “classical“ ECU.
AUTOSAR – Migration Strategy.

ORPHEUS.

ORPHEUS = modeling tools + code generator

- Enabler for migration
  Integrated in BMW SC6, Import DBC/FIBEX

- Graphical Modeling of
  - AUTOSAR Application Components
  - Mapping to CAN and Flexray Bus
  - Scheduling
  - Partitioning of Software

- Optimized Codegeneration of RTE
  (incl. autom. Unit Tests)

- Open
  (Adaption to ASCET, AUTOSAR Templates)
Voices outside AUTOSAR back in 2002:

„AUTOSAR will never work!“

„AUTOSAR is not feasible“

„The runtime environment will double the RAM/ROM allocations!“
AUTOSAR – Migration Strategy.

The Powertrain Pilot.

Cooperation between BMW AG, BMW Car IT and Siemens VDO

MSV80

PVI  Momenten- Erzeugung  Codier Daten

Siemens BSW  ipol  math

MSV80-AS

PVI  Momenten- Erzeugung  Codier Daten

ssRTE  Siemens BSW  ipol  math

MSV80-AS

Momenten- Erzeugung  Codier Daten

ssRTE  Siemens BSW  ipol  math

S12X Eval Board

PVI  Codier Daten  math

ssRTE (Orpheus)  BMW SC 6.4  ipol

ISG (Imaginary ECU)

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AUTOSAR – Migration Strategy.
The Powertrain Pilot.

The AUTOSAR Car at BMW CarIT

The Imaginary ECU (ISG)

The MSV80 on and under the hood

On the rear seat of the AUTOSAR car.
AUTOSAR – Migration Strategy.
Resource Allocation: RAM and ROM.

<table>
<thead>
<tr>
<th># of Software components</th>
<th>9</th>
<th>2 full compliant: PVI, TRCG9 capable: PVSV ... MTAC</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Interfaces</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td># of Data Elements</td>
<td>15</td>
<td>1:3, 1:2, 10:1</td>
</tr>
<tr>
<td># of Provided Ports</td>
<td>12</td>
<td>-</td>
</tr>
<tr>
<td># of Required Ports</td>
<td>22</td>
<td>-</td>
</tr>
<tr>
<td># of Connectors</td>
<td>22</td>
<td>15 RTE Write Functions 25 RTE Read Functions (26)</td>
</tr>
<tr>
<td># of Runnables</td>
<td>none</td>
<td>Scenario II: 1 – PVI on ISG</td>
</tr>
<tr>
<td>Access Types</td>
<td>R, W</td>
<td>Data read and write access</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Additional resources</th>
<th>Scenario I</th>
<th>Scenario II</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROM in bytes</td>
<td>$390^{3+?4}$</td>
<td>$428^{3+?4}$</td>
</tr>
<tr>
<td>RAM in bytes</td>
<td>$23^{1}$</td>
<td>$20^{1+9^{2}}$</td>
</tr>
</tbody>
</table>

1 – Internal RTE buffers
2 – Temporary CAN message buffers
3 – RTE Functions (RTE read/write, RTE PDU send/receive)
4 – Additional code within the aggregates to call the RTE read and write functions and dealing with different resolutions of data.
AUTOSAR – Migration Strategy.
Resource Allocation: How does it scale?

Data Elements / Operations

Orpheus 6.1.0 RAM
Orpheus 6.1.0 ROM
Future Work.

- Timing & Scheduling
- Safety aspects at model level
- Error handling at VFB level.
AUTOSAR at BMW Group.

Conclusion.

- The AUTOSAR approach is feasible
- AUTOSAR getting into series production
- Iterative prototyping is an appropriate way to boost the quality and acceptance of software innovations.
- AUTOSAR is an enabler for future innovations concerning timing, error management and safety aspects.
AUTOSAR at BMW Group.
Thank you for your attention.

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