Virtual Integration and Test of AUTOSAR Systems at Daimler – Body & Comfort Domain

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Overview

- Virtual Integration in the Body & Comfort Domain
- Application of vVIRTUALtarget
- Experiences and Outlook
Characteristics of Body&Comfort Domain

**Non-functional Requirements**
- High quality
- Similar functions for all model-series
- Evolutionary development
- Supplier independent
- Minimal resource consumption
- Short implementation time
- ...

**Distributed functions over several networks**

**Logical Architecture**

**Technical Architecture**
Motivation: Digital Development

Challenging E/E Development
• Addressing the growth of complexity, reduced development times, reduced prototype vehicles

Digital Approach
• Efficient development, reduced hardware-costs, maturity improvement by early validation

Model-based development
Simulation of individual functional models

Central AUTOSAR system design & model-based Dev.
Static definition of the overall vehicle communication incl. functional models, based on AR3.2.2

Virtual Integration of distributed functions based on AUTOSAR
Simulation of distributed systems (function models and bus communication)

2002 2008 2015ff
Virtual Integration: Benefits

**Model-based Development and AUTOSAR-Process**
- Various Roles

**Simulation/Validation of distributed systems on PC**
- E/E-System Speaker

**Systematic HiL-Test**
- HiL-Tester

### Benefits

**AUTOSAR-MBD-Toolchain**
- Early validation of SW-arch. and tools based on virtual ECUs
  - MBD: Model-Based Development

**Fct.-Pre-Development**
- Proof of concept of distributed functions by early simulation in pre-development-phase

**Model-bas. Developmnt.**
- Maturity improvement and validation during series modeling cycles

**HiL-Tests**
- Early HiL-test development based on virtual ECUs
- Early start of HiL operation using mixed-ECU-Mode (virtual/real)
Virtual Integration: Requirements for Tools

• Quality of Simulation Results
  – Real basic software behavior (instead of abstract BSW for simulation purposes only), especially COM-timing
  – Use of series artifacts: Series ECU-extracts and same BSW-configuration for tools
  – Support of simulated bus and real bus connection

• Effort for Configuration and Integration
  – Usability: Easy to use, without BSW-know-how
  – Usage of “spin-off” artifacts of “normal” development process
  – Support for different development phases with scalable level of abstraction, and use of default behavior
  – Use of established simulation and test tools

• Reaction time for Virtual Integration
  – Automatic, repeatable configuration
  – Nightly build

• Contrary requirements on virtual integration tools
• Challenge: finding the right level of abstraction
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Integration of vVIRTUALtarget

Model-Based AUTOSAR-Toolchain

Generation of virtual ECUs by vVIRTUALtarget

CANoe Simulation Execution

Connection of established Test-Tools

- Continuous Virtual Integration Environment (Jenkins, Ant)
- Virtual Integration and Test of AUTOSAR Systems at Daimler – Body & Comfort Domain

- Configuration
  - Version of ECU Extract
  - Modell Release Labels
  - Further configuration...

- ECU extract

- SWC code

- Command line based adaption of ARXML
  - NVRAM wrapper
  - EcuM/ComM control wrapper
  - Further complex operations...

- ARXML-Wizard

- Extended ECU extract

- SWC code
Integration of vVIRTUALtarget

Model-Based AUTOSAR-Toolchain

Generation of virtual ECU by vVIRTUALtarget

CANoe Simulation Execution

Connection of established Test-Tools

- Extended ECU extract
- SWC code
- Optional: Order of runnable and runnable task mapping definition
- Optional: Service mapping definition
- Command line based creation of vVIRTUALtarget project

Hook 1: pre code-generation

Hook 2: pre-build

Continuous Virtual Integration Environment (Jenkins, Ant)

# Automation of: InitialEcuCGen, Geny, MicrosarGen, RTEGen,...

CANoe node layer DLL
Integration of vVIRUTALtarget

Model-Based AUTOSAR-Toolchain

Generation of virtual ECUs by vVIRUTALtarget

CANoe Simulation Execution

Connection of established Test-Tools

CANoe:
- Basis: Rest bus simulation (RBS)
- Virtual ECUs replace RBS-nodes
- Integration of Simulink® plant models by CANoe Simulink blockset
- Simulated bus and real bus simulation for mixed ECU mode
- Usage of various CANoe-features (trace, CAPL-scripts, panels etc.)

Physical connection to real bus
Integration of vVIRTUALtarget

Model-Based AUTOSAR-Toolchain

Generation of virtual ECU

CANoe Simulation Execution

Connection of established Test-Tools

CANoe

Connection with MiL tests

Connection with HiL tests

Mercedes-Benz
**Example**

**Logical Architecture**
Distributed system described as AUTOSAR composition

**Technical Architecture**
ECU1
SWC
GW
I/O
Bus 1

SwC

GW

Bus 2

ECU2

Composition

Starting Point

- Virtual integration of a distributed E/E-System (e.g. exterior light)
- Basis: ECU extracts of involved ECUs

**Content of Virtual ECU**

- Virtual gateway ECUs
- ECU-Software
- Daimler function models of E/E-system
- Generated wrappers# for NVRAM and connection to ComM & EcuM

**Excluding Supplier Artefacts**

- No I/O-access: open SWC-ports
- No diagnosis: open SWC-parameter-ports

# due to limits of AUTOSAR3.2 & Simulink/TargetLink

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Example

**Logical Architecture**
Distributed system described as AUTOSAR Composition

**Technical Architecture**

**vVIRTUALtarget**
- Configuration & generation of selected BSW-modules:
  - OS, RTE, COM, EcuM, ComM, ...
  - Service mapping
  - Runnable to task mapping

- Generation of CANoe system-variables for open SWC-ports
  - Open SWC-ports
  - Open SWC-parameter-ports accessible by test tools

CANoe system-variables for open SWC ports
Runnable to task mapping

**Bus 1**
**Bus 2**
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Experiences and Outlook

Status
• Fast and successful ramp-up of vVIRTUALtarget for AUTOSAR3.2.2 in the last months
• Model-based Body&Comfort ECUs (~10 ECUs) are generated automatically

Challenges
• Getting distributed functions to run
• Defining the right user-interface for the simulation of distributed systems
• Simulation performance: Further experiences and optimization needed
• Data provision process in early stages for „virtual ECU releases“

Outlook
• Application in series projects
• Preparation for AUTOSAR4.2