AUTOSAR Virtual Testing
with vVIRTUALtarget, vTESTstudio & CANoe

Software Testing TechDay – November 19, 2019
Agenda

1. Introduction
2. Virtualization
3. Use Cases of Virtualization
4. Testing
5. Demo
vVIRTUALtarget Pro generates the RTE and BSW Emulation for your AUTOSAR project enabling early design phase testing with CANoe's simulation power and vTESTstudio's test design environment.
The AUTOSAR Idea

- AUTOSAR (Automotive Open System Architecture) is a standardization initiative of leading automotive manufacturers and suppliers that was founded in 2003.

- AUTOSAR aims to standardize the software architecture of Electronic Control Units (ECUs). AUTOSAR paves the way for innovative electronic systems that further improve performance, safety and environmental friendliness.
## The AUTOSAR Idea

**Introduction**

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<th>9 Core Partners</th>
<th>53 Premium Partners</th>
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127 Associate Partners
21 Attendees
The AUTOSAR Advantage

- Hardware and software – widely independent of each other.
- Development can be decoupled by horizontal layers, reducing development time and costs.
- Reuse of software enhances quality and efficiency.
CANoe is a comprehensive software tool for development, test and analysis of entire ECU networks and individual ECUs.

- One tool for all development and testing tasks
- Easy automated testing
- Simulate and test ECU diagnostics
- Open environment: various APIs allow tool coupling
Using CANoe, you can create simulations of entire networks or the remaining bus:

- Usage of a single CANoe model in all phases of development
- CANoe models can be distributed by the OEM or created on the supplier side
- Function development and regression testing is supported
- Gateway simulation for different bus systems is possible
vTESTstudio provides various editors for specifying test automation for CANoe.

- These editors address specific use-cases, skills and preferences of the test designer.
- Different test notations can be combined easily - even within the same test case.

**Test Table Editor**
for tabular editing of test sequences

**Test Sequence Diagram Editor**
for graphical design of test cases in diagrams

**State Diagram Editor**
for automatic generation of test cases out of state transition diagrams

**Programming Editors**
for CAPL and C#
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Virtualization

AUTOSAR Approach

Virtual Integration

Introduction of HW Attributes

ECU Configuration
Virtualization

vVIRTUALtarget

vVIRTUALtarget (VTT) in a nutshell

- Virtual integration of ECUs on the PC
- No instrumentation necessary
- “Virtual” MCAL and OS
- Easy debugging of the virtual ECU
- Dual-Target approach
  - “One Source” development for both virtual and hardware target
- System under Test
  - Single ECU
  - ECU Network
- Test Environment
  - Test interface for 3rd party test tools
  - Integration into CANoe available

Use Cases

- Evaluation of the AUTOSAR stack
- Prototyping and serial production projects
  - Switch between virtual and hardware target (Dual-Target approach)

Virtual ECU Integration

ECU Integration

Generate Code

MICROSAR SIP
+ SIP Add-On VTT

DaVinci Configurator Pro

Dual-Target Configuration

Application source code

Executable code (.HEX)

Source code (.c/.h)
PC environment has advantages compared to a real HW

- Early test and integration results since the PC is always available – no need to wait for the HW
- Easy replication of test and integration environments on several work places
- Test scenarios can be easily applied e.g. to provoke “race conditions” and to achieve good code coverage
- Faster execution of tests possible
- Access to internal variables and observed execution is possible (debugging)
Virtualization in the Development Process

**AUTOSAR Classic**

- **Design/Development**
  - SWC Integration
    - SWC A
    - SWC B
    - SWC C
    - RTE
    - Service Emulation

- **ECU Integration**
  - SWC A
  - RTE
  - OS
  - BSW
  - MCAL

- **System Integration**
  - Virtual

**AUTOSAR Adaptive**

- **Design/Development**
  - SWC Integration
    - SWC A
    - SWC B
    - SWC C
    - RTE
  - Service Emulation

- **ECU Integration**
  - SWC A
  - RTE
  - OS
  - BSW
  - MCAL

- **Application Integration**
  - Service A
  - Service B
  - ARA:COM
  - ARA

- **System Integration**
  - Virtual
  - Virtual
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Use Cases of Virtualization

Software Test

Regression Test

System Test
Software Test

- Integration of Software Components in a realistic AUTOSAR environment
- Testing during development of functional code
- Using the same code and interfaces as in the embedded ECU project
- Test with the application layer interface (RTE)
- Parallel Development of test libraries for later reuse
- Easier and faster configuration compared to simulation with complete BSW
Use Cases of Virtualization

ECU Test

- Use of the complete AUTOSAR basic software (BSW)
- Verification of the ECU configuration (ECUC) in the virtual environment without the need of target hardware
- Stimulation via μC abstraction layer (MCAL i.e. buses and IO) and internal ports
- Debugging of internal behavior is possible for the complete ECU software
System Test

- Test of distributed functions in virtual or partially virtual environment
- Reuse of already configured virtual SUTs also in combination with real ECUs
- Usage of test libraries developed in earlier phases
- Stimulation via μC abstraction layer (MCAL i.e. buses and IO) and internal ports
Use Cases of Virtualization

Regression Test

- Reproduce functional behavior or misbehavior with measurements of field test in the virtual world
- Difficultly achievable situations can be generated virtually
- Simulation time is not linked to real time, so pausing and resuming when debugging and execution faster than real-time is possible
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One of the primary use cases of CANoe is to test ECUs and networks. These tests are used to verify individual development steps, test prototypes or to perform regression and conformance tests. CANoe services the **System Under Test** at all interfaces. This assures the fullest possible test coverage.

The Test Feature Set in CANoe consists of the following components:

- Test Modules/Test Units
- Constraints and Conditions
- Collection of test functions
  (Test Service Library)
- Automatic report generation
- Direct control of I/O hardware
Accessing the System Under Test

**CANoe**

- **Interaction Layers**
  - OEM specific

- **Higher Layer Protocols**

- **Network Management**
  - AUTOSAR, OSEK NM, OEM specific

- **XCP**

- **Diagnostics**

- **Ethernet, GPIB, RS232 etc.**

**System Under Test**

- **Network Interface**

- **Digital/Analog I/O**

- **SENT/PSI5/...**

- **Memory**
  - 01001011
  - 11010010

- **Fault Memory**
  - 01100110
  - 10011010

**Measurement & Test Hardware**

- VT System
- IOpiggy
- DAQ, etc.

**Test Execution**

**VN Interfaces**

**Test**

**Execution**

**Sensor Protocols**
vTESTstudio and CANoe

### vTESTstudio

**Design & Implementation**
- Test programming (CAPL, C#)
- Table based test design
- Graphical test design
- Parameters and variants
- Classification tree method
- Stimulation curves
- Traceability

### CANoe + Bus Interfaces

**Execution & Reporting**
- Real-time execution of tests
- Access to SUT via
  - IOs
  - bus systems
  - protocols (diagnostics, XCP, ...)
  - debug interfaces
- Analysis of test run
- Automatic detailed reporting

Test Units:
- Code
- Parameter
- Traceability Information
- ...

Symbol databases:
- DBC
- ARXML
- CDD
- ...

Build Load
A test report is generated automatically during the execution of a Test Module/ Test Unit. It can be analyzed using the CANoe Test Report Viewer:
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SWC Integration with vVIRTUALtarget pro – Testing the Source Code

vVIRTUALtarget pro

Service Configuration

SWC A   SWC B   SWC C
RTE

Service Emulation

Generate Code

SWC Implementation

.c/.h

Application source code

.vVIRTUALtarget pro

.c/.h

.vVIRTUALtarget pro

.c/.h

.c/.h

Virtual target

ECU integration for virtual hardware

Application source code

Virtual target

.vVIRTUALtarget pro
Software Layers in simulated network nodes

A simulation includes all software components that can occur in the real control unit, as well as the basic transmission behavior of the control unit:

IL: Interaction Layer
NM: Network Management
TP: Transport Protocol
Virtual Testing of AUTOSAR w/vVIRTUALtarget, vTESTstudio & CANoe
For more information about Vector and our products please visit

www.vector.com