Automated Protocol Conformance/Compliance Testing with CANoe

For Ethernet (TC8), J1939, LIN, Smart Charging Communications, Car2x, CANopen, and Diagnostics
Agenda

- CANoe, vTESTstudio, Network Interfaces and the VT System
  - CANoe.Ethernet (TC8)
  - CANoe.J1939 (J1939-82)
  - CANoe.LIN (LIN Slave)
  - CANoe.SCC (Smart Charging Communications)
  - CANoe.Car2x (Scenario Simulation)
  - CANoe.CANopen
  - CANoe.DiVa (Diagnostic Integration and Validation Assistant)

Application and hardware requirements
The Vector Testing Toolset

<table>
<thead>
<tr>
<th>vTESTstudio</th>
<th>CANoe + VT Modules + Bus Interfaces + External HW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Automated Test Design &amp; Implementation</td>
<td>Execution &amp; Reporting</td>
</tr>
<tr>
<td>Test programming (CAPL, C#)</td>
<td>Real-time execution of tests</td>
</tr>
<tr>
<td>Table based test design</td>
<td>Access to SUT via</td>
</tr>
<tr>
<td>Graphical test design</td>
<td>- IOs</td>
</tr>
<tr>
<td>Parameters and variants</td>
<td>- bus systems</td>
</tr>
<tr>
<td>Classification tree method</td>
<td>- protocols (diagnostics, XCP, …)</td>
</tr>
<tr>
<td>Stimulation curves</td>
<td>- debug interfaces</td>
</tr>
<tr>
<td>Traceability</td>
<td>Analysis of test run</td>
</tr>
</tbody>
</table>

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

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

**Build**

**Load**
Agenda

CANoe, vTESTstudio, Network Interfaces and the VT System

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Application and hardware requirements
Open Alliance Tech Committee 8 (TC8) Ethernet Conformance

- Test Procedure defined in vTESTstudio (required)
  - easily configurable via Test Parameters
  - easy selection of Test Cases
  - different Test Variants (must, may)
- Upper Tester Stub Functions
  - allows individual implementation
  - Autosar Testability Protocol as default implementation
  - sample of non-standard Service Primitives
- Includes a Golden Simulated Node
- Delivered as Demo with CANoe.Ethernet
  - allows continuous testing during development
**Current release of CANoe**

<table>
<thead>
<tr>
<th>Test Group</th>
<th>CANoe 12.0 SP2</th>
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<tbody>
<tr>
<td><strong>Layer 1</strong></td>
<td></td>
</tr>
<tr>
<td>Physical Layer</td>
<td>partially</td>
</tr>
<tr>
<td>TC8 Switch Tests</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Layer 2</strong></td>
<td></td>
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<tr>
<td>TC11 Switch Tests</td>
<td>✔</td>
</tr>
<tr>
<td>ARP (Address Resolution Protocol)</td>
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</tr>
<tr>
<td>ICMPv4</td>
<td>✔</td>
</tr>
<tr>
<td>IPv4</td>
<td>✔</td>
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<tr>
<td><strong>Layer 3</strong></td>
<td></td>
</tr>
<tr>
<td>Dynamic IPv4 Link Local Address</td>
<td>✔</td>
</tr>
<tr>
<td><strong>Layer 4</strong></td>
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<tr>
<td>UDP (User Datagram Protocol)</td>
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</tr>
<tr>
<td>TCP (Transmission Control Protocol)</td>
<td>✔</td>
</tr>
<tr>
<td>DHCPv4</td>
<td>✔</td>
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<tr>
<td><strong>Layer 7</strong></td>
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</tr>
<tr>
<td>SOME/IP Server</td>
<td>✔</td>
</tr>
<tr>
<td>SOME/IP ETS</td>
<td>✔</td>
</tr>
</tbody>
</table>
TC8 Example Configuration
Agenda

CANoe, vTESTstudio, Network Interfaces and the VT System
CANoe.Ethernet (TC8)

- CANoe.J1939 (J1939-82)
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  - CANoe.DiVa (Diagnostic Integration and Validation Assistant)

Application and hardware requirements
J1939-82 Compliance Test: 2008 and 2015 specification have been implemented

- Easy configuration with panel:

- Well structured report:
J1939-82 Tables A3-A8 and A10 are implemented
Test Feature Set (CANoe)

- J1939 Test Service Library
  - J1939 specific test functions and extensions
- J1939 XML Test Module Manager
  - Test Management
  - Configuration of test cases
  - Generation of compliance tests according to J1939-82
  - Step by step example how to create compliance tests
Agenda

CANoe, vTESTstudio, Network Interfaces and the VT System
CANoe.Ethernet (TC8)
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  - Application and hardware requirements
LIN Slave Conformance Tests

- Slave Conformance Test Module
  - Preconfigured XML test module can be added to the Test Setup
  - Automated conformance testing of any Slave in your Simulation Setup
  - Automatic configuration of conformance tests according to LDF (or optionally NCF)
  - Create a reference trace or logging by testing the simulated version of your Slave
  - Full support of the LIN1.3, LIN2.x and J2602 Slave conformance tests (Data Link Layer)
  - Optional hardware reset prior to each test case using VH1150 or VT System with a VT7001 (no extra configuration required)
  - All settings automatically saved with the configuration
  - Test cases can be repeated at any number of times
  - Detailed XML-report automatically translated to HTML
5 Steps to Insert a LIN Slave Conformance Tester

1. Insert LIN Slave Conformance Tester
2. Configure the LIN Slave CT Configuration
3. Assign the LIN network
4. Start the test
5. View the test report
CANoe.LIN (LIN Slave)

LIN Slave Conformance Test Module (Number 4 in previous slide)

Selection of test cases
Test specification
Test report
Start / Pause / Stopp
Feedback during test sequence
Agenda

CANoe, vTESTstudio, Network Interfaces and the VT System
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**CANoe.SCC (Smart Charging Communications)**
CANoe.Car2x (Scenario Simulation)
CANoe.CANopen
CANoe.DiVa (Diagnostic Integration and Validation Assistant)
Application and hardware requirements
Features

- ISO15118 & DIN70121 (requires Option Ethernet)
  - Vehicle and charge point simulation
  - Analysis and monitoring
    - Man-in-the-middle and Offline analysis of the smart charging communication
    - Interpretation of the messages in the trace window
- Support for SLAC and Vehicle2Grid protocols
- Transport Layer Security (TLS) via Security Manager (only ISO 15118)
  - TLS communication with automatic encryption and decryption
  - Public Key Infrastructure (PKI) support and management of certificates

- GB/T 27930 (requires Option J1939)
  - Trace window analysis
    - Clear and compact presentation of the message flow
    - Interpretation of each individual GB/T 27930 message

- CHAdemo (requires Option CAN)
  - Currently no special support
SCC Testing configurations

**SCC over Ethernet**

**VT System incl. Develo dLAN® GreenPHY module on V17870**

**CANoe.Eth.SCC**

**Optional: providing real power**

**Optional: sinking real power**

**VT System incl. Develo dLAN® GreenPHY module on V17870**

**SUT on-board charger**

**SUT charge station**

**Control**

**Pilot**

**Powerline Communication**

**VT Test Configuration**

**EVSE Test Configuration**
## Smart Charging Communication Standards and Test Packages

<table>
<thead>
<tr>
<th>Standard</th>
<th>Region</th>
<th>Connector</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS (AC/DC)</td>
<td>US + EU</td>
<td>IEC 62196-2</td>
<td>IEC 61851 (PWM) ISO15118, DIN70121, SAE J2847 (Ethernet)</td>
</tr>
<tr>
<td>GB/T (DC)</td>
<td>China</td>
<td>GB/T 20234.3</td>
<td>GB/T 27930 (J1939)</td>
</tr>
<tr>
<td>CHAdeMO (DC)</td>
<td>Japan</td>
<td>CHAdeMO</td>
<td>CHAdeMo (CAN)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standard</th>
<th>VT-Modules</th>
<th>Required CANoe Options</th>
<th>CANoe Test Packages*</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCS (AC/DC)</td>
<td>7900A</td>
<td>Smart Charging</td>
<td>CCS EV</td>
</tr>
<tr>
<td></td>
<td>7870</td>
<td>Ethernet</td>
<td>CCS EVSE (Next year)</td>
</tr>
<tr>
<td>GB/T (DC)</td>
<td>6104A/6204</td>
<td>Smart Charging</td>
<td>GB/T EV (Next year)</td>
</tr>
<tr>
<td></td>
<td>2004A</td>
<td>J1939</td>
<td>GB/T EVSE (Next year)</td>
</tr>
<tr>
<td>CHAdeMO (DC)</td>
<td>6104A/6204</td>
<td>Smart Charging (planned)</td>
<td>CHAdeMO 2.0 EV (planned)</td>
</tr>
<tr>
<td></td>
<td>2004A</td>
<td>CAN</td>
<td>CHAdeMO 2.0 EVSE (planned)</td>
</tr>
</tbody>
</table>

* vTESTstudio required
Agenda

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- **CANoe.Car2x (Scenario Simulation)**
  CANoe.CANopen
  CANoe.DiVa (Diagnostic Integration and Validation Assistant)
  Application and hardware requirements
Analysis, Simulation and Test of V2X Communications
Simulation, analysis and test of C-V2X applications

- Quick and easy test case development with CANoe.Car2x scenario editor
  - Simulation of multiple vehicles and infrastructure elements (e.g. traffic light)
  - Generation of ITS frames following European or US standards (ETSI, WAVE/SAE)

- With Rohde & Schwarz Hardware
  
  ROHDE & SCHWARZ
  
  - CMW500 for LTE-PC5 communication
  - SMBV100A for GNSS simulation

- Testing of DUT applications
  - CAN, Automotive Ethernet traffic
Multi-technology (LTE, WCDMA, GSM and CDMA2000®) protocol tester with a layer 1 to layer 3 stack implementation

Fully fledged GNSS simulator with GPS, Glonass, Galileo, BeiDou and QZSS/SBAS
Up to 24 satellites
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- **CANoe.CANopen**
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  Application and hardware requirements
CiA CANopen Conformance Test Tool
**CANoe during Conformance Test**

The image shows a screenshot of CANoe, a software tool for CAN (Controller Area Network) bus simulations and tests. The screenshot includes various tabs and windows, indicating a detailed view of the CANopen communication protocol, which is a subset of CAN. The interface is segmented into different sections, likely used for monitoring and configuring CANopen devices during conformance testing. The specific features and functionalities shown in the screenshot are indicative of the detailed setup and monitoring capabilities available in CANoe for such tests.
CiA Test Report

11.07.19 : 09:42:30.888 : Test Info : ### Prepare DUT for test

11.07.19 : 09:42:30.888 : Test Notice : Reset node (wait for 500[ms])

11.07.19 : 09:42:30.888 : Test CAN : CAN1 00 Tx SD 2 01 01

11.07.19 : 09:42:30.891 : Test CAN : CAN1 701 Rx SD 1 00

11.07.19 : 09:42:30.891 : Test Notice : Bootup message received

11.07.19 : 09:42:30.891 : Test Notice : Restored default parameters via T011h (wait for 500[ms])

11.07.19 : 09:42:30.891 : Test CAN : CAN1 601 Tx SD 8 23 11 10 01 6C 6F 61 64

11.07.19 : 09:42:30.894 : Test CAN : CAN1 501 Rx SD 8 60 10 10 01 00 00 00 00

11.07.19 : 09:42:30.894 : Test Notice : Reset node (wait for 5000[ms])

11.07.19 : 09:42:30.894 : Test CAN : CAN1 000 Tx SD 2 01 01

11.07.19 : 09:42:30.898 : Test CAN : CAN1 701 Rx SD 1 00

11.07.19 : 09:42:30.898 : Test Notice : Bootup message received

11.07.19 : 09:42:30.902 : Test Info : ### Test case : 1.0 - Test name : EDS checker

11.07.19 : 09:42:30.902 : Test Info : Check EDS file

11.07.19 : 09:42:30.908 : Test CAN : CAN1 7FF Tx SD 6 01 01 00 00 00 00

11.07.19 : 09:42:31.030 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:31.230 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:31.430 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:32.030 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:32.320 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:32.430 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:32.630 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:32.830 : Test CAN : CAN1 000 Rx SD 0

11.07.19 : 09:42:33.005 : Test Notice : CANchkEDS 2.4.15.0

11.07.19 : 09:42:33.005 : Test Notice : (c)2000-2008 Vector Informatik GmbH

11.07.19 : 09:42:33.005 : Test Notice : open file C:\Users\Public\Documents\Vector\Canoe\Sample Configurations 12.0.77\Canopen\CanopenSystem\eds\Master.eds ...

11.07.19 : 09:42:33.005 : Test Notice : Checking ...

11.07.19 : 09:42:33.005 : Test Notice : check is finished

11.07.19 : 09:42:33.005 : Test Notice : No errors or warnings detected

11.07.19 : 09:42:33.005 : Test Notice : CANchkEDS 2.4.15.0

11.07.19 : 09:42:33.005 : Test CAN : CAN1 7FF Tx SD 6 02 01 00 00 01 00


11.07.19 : 09:42:33.007 : Test Info : ### Test case : 2.1 - Test name : SDO 01

11.07.19 : 09:42:33.007 : Test Info : Read 1600h:000h with expedited transfer.

11.07.19 : 09:42:33.009 : Test CAN : CAN1 7FF Tx SD 6 01 02 01 00 00 00

11.07.19 : 09:42:33.009 : Test Notice : SDO 01: Read object 1000h:000h

11.07.19 : 09:42:33.009 : Test CAN : CAN1 601 Tx SD 8 40 00 10 00 00 00 00 00

11.07.19 : 09:42:33.012 : Test CAN : CAN1 561 Rx SD 8 43 00 10 00 05 01 00 00

...
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CANoe.CANopen

- **CANoe.DiVa (Diagnostic Integration and Validation Assistant)**
  
  Application and hardware requirements
The Diagnostics Tool chain

Much more information at 2:15 this afternoon with PDG BDM, Vivek Jolly
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- **Application and hardware requirements**
## Application and hardware requirements

<table>
<thead>
<tr>
<th></th>
<th>Ethernet (TC8)</th>
<th>J1939</th>
<th>LIN</th>
<th>SCC</th>
<th>Car2x</th>
<th>CANopen</th>
<th>DiVa (Diagnostics)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CANoe</strong></td>
<td>✓</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td><strong>.LIN</strong></td>
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<td><strong>.SCC</strong></td>
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<td><strong>.CANopen</strong></td>
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</tr>
</tbody>
</table>

✓ = required  
✓ = recommended for additional test development
For more information about Vector and our products please visit

www.vector.com

Author:
Koncsol, Jeff
Vector North America