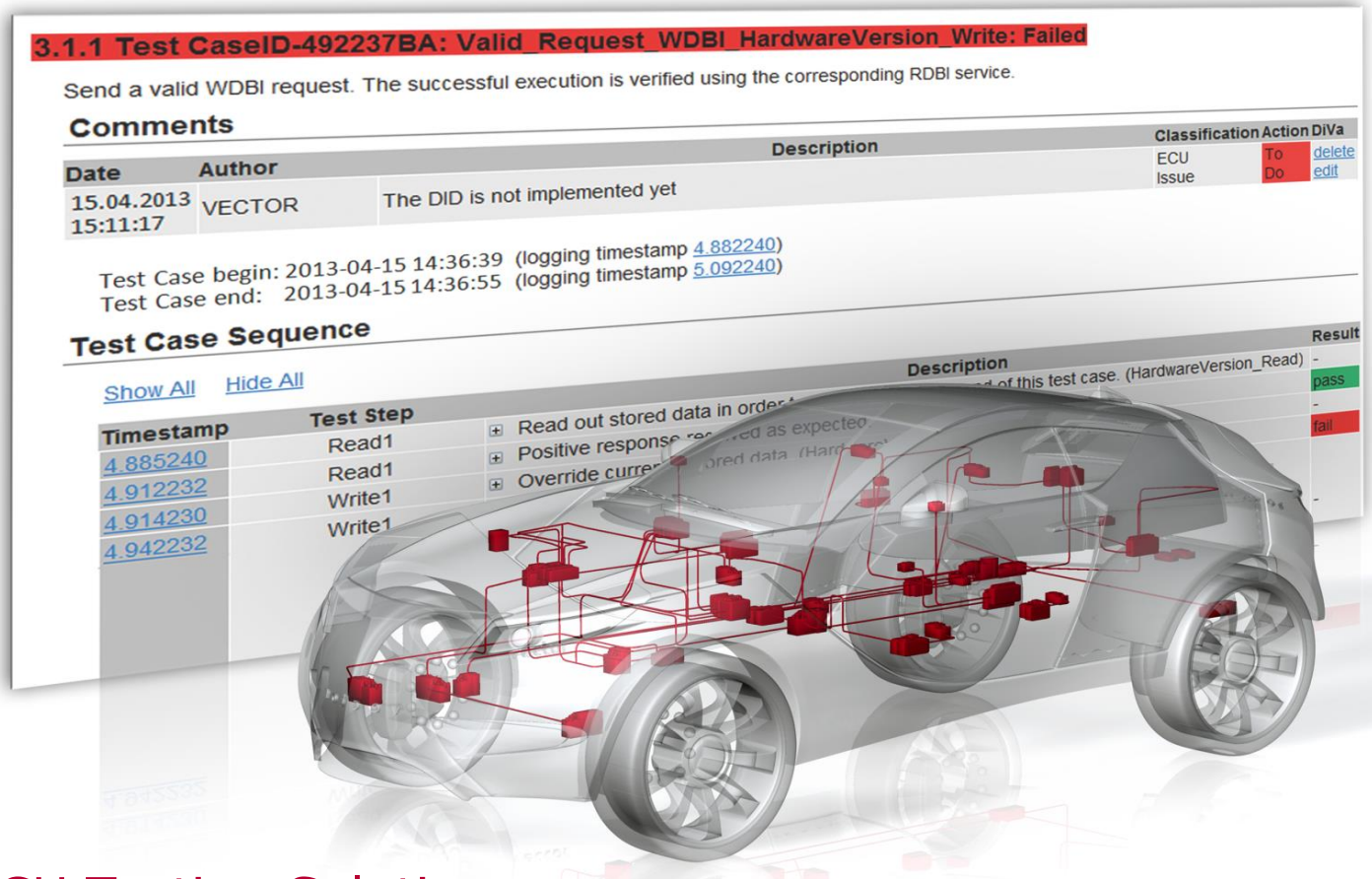
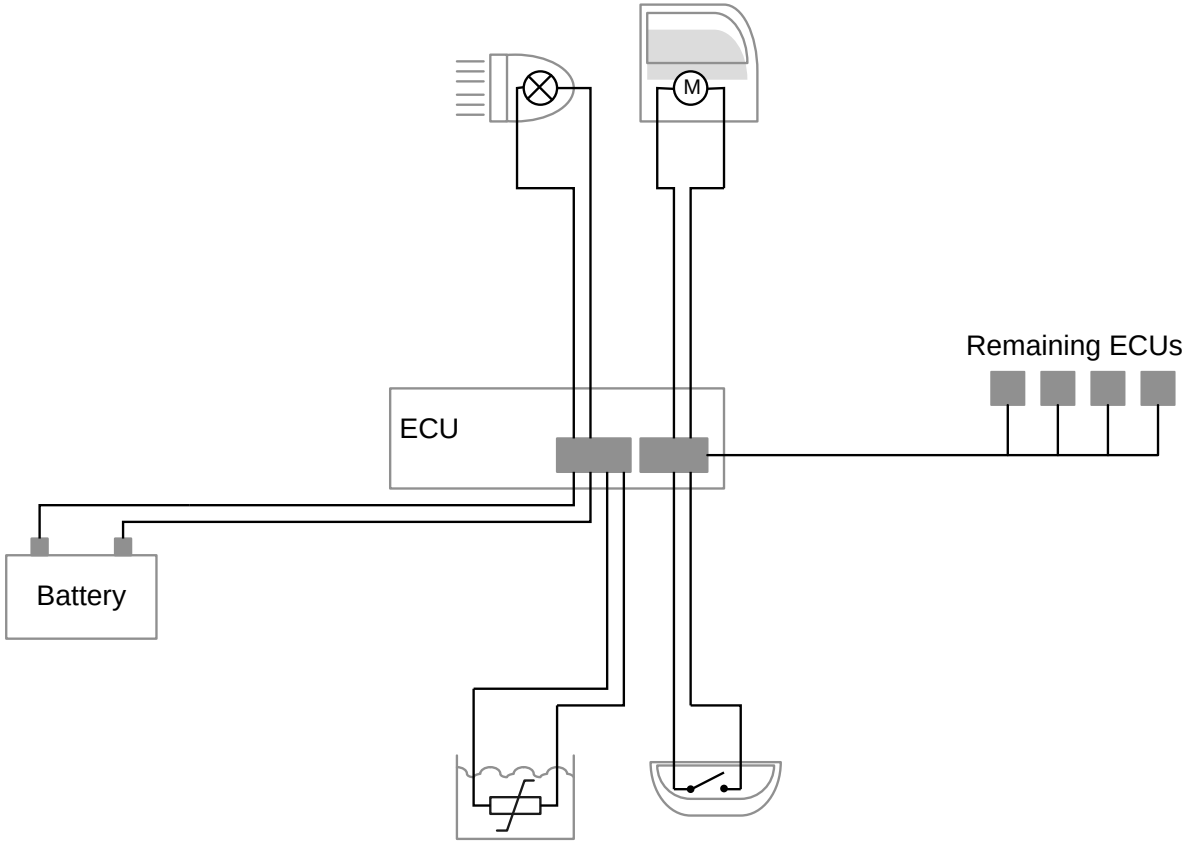



# ▶▶ ECU Testing Solution

# Agenda

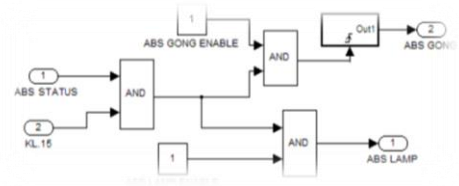
- **Testing Overview**
- HIL Test Bench: CANoe + VT System
- Testing Design: vTESTstudio
- Test Data Management: vTESTcenter
- Testing Engineering Services
- Summary

# What do I need for Testing an ECU?

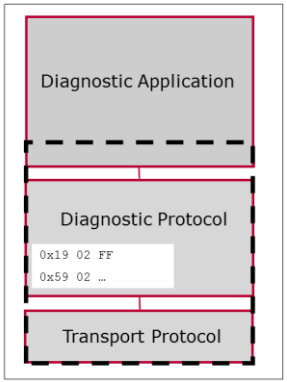


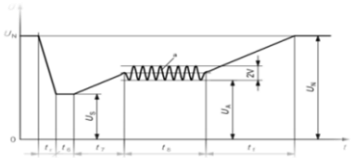
# What should be tested for ECU?

- **Application Layer Test**
  - Functionality logic test
    - Working mode
    - Control behavior
    - ……
  - Diagnostic functionality test(DTCs)




- Electrical Test
  - Over voltage or Under voltage test
  - Starting profile
  - …
- System Integration Test
  - ECUs Interaction Behaviors
  - …



- **Communication Test**
  - Physical Layer
    - CAN/LIN Bus output voltage level
    - DUT Ground shift tolerance
    - Electric capacity and resistance characteristics
    - ……
  - Data Link Layer
    - Bit timing parameters
    - DLC check
    - Cycle time check
    - ……
  - Interaction Layer
    - Message transmission(e.g. Periodic/on event/if active)
    - Default value check
  - Network Management Test
    - Establish ring
    - Bus sleep & wake up
    - Loss of node in a running network test
  - Diagnostic Protocol Test
    - P2,P2*
    - …

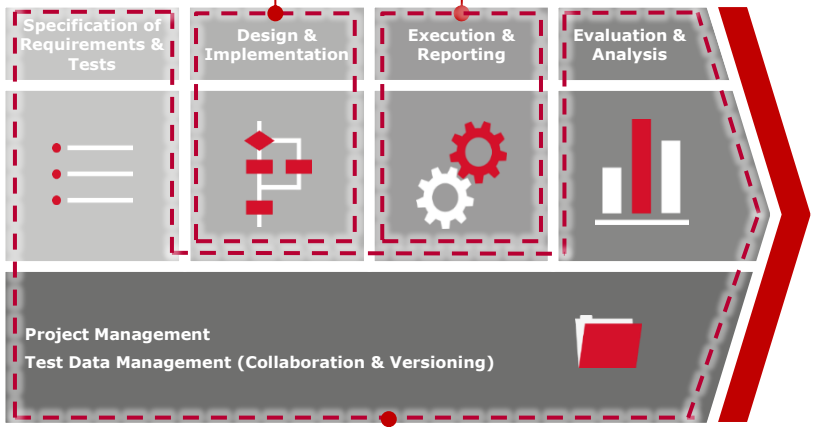
# Overview Vector Test Solution

## vTESTstudio

- Test programming (CAPL, C#)
- Table based test design
- Graphical test design (diagrams)
- Definition of parameters & curves

## CANoe + VT Modules + Bus Interfaces

- Realtime execution of tests
- Access to SUT via
  - I/Os,
  - bus systems and
  - protocols (diagnostics, XCP, …)
  - Debug Interface
- Detailed automatic test reporting




## vTESTcenter

- Management of testing projects: Planning & Tracking
- Configuration management of test data
- Team collaboration by multi-user support
- Requirements and test engineering
- Bidirectional traceability
- Review & rework
- Import of test exec. reports
- High-level analysis of test results and trends

# Agenda

- Testing Overview
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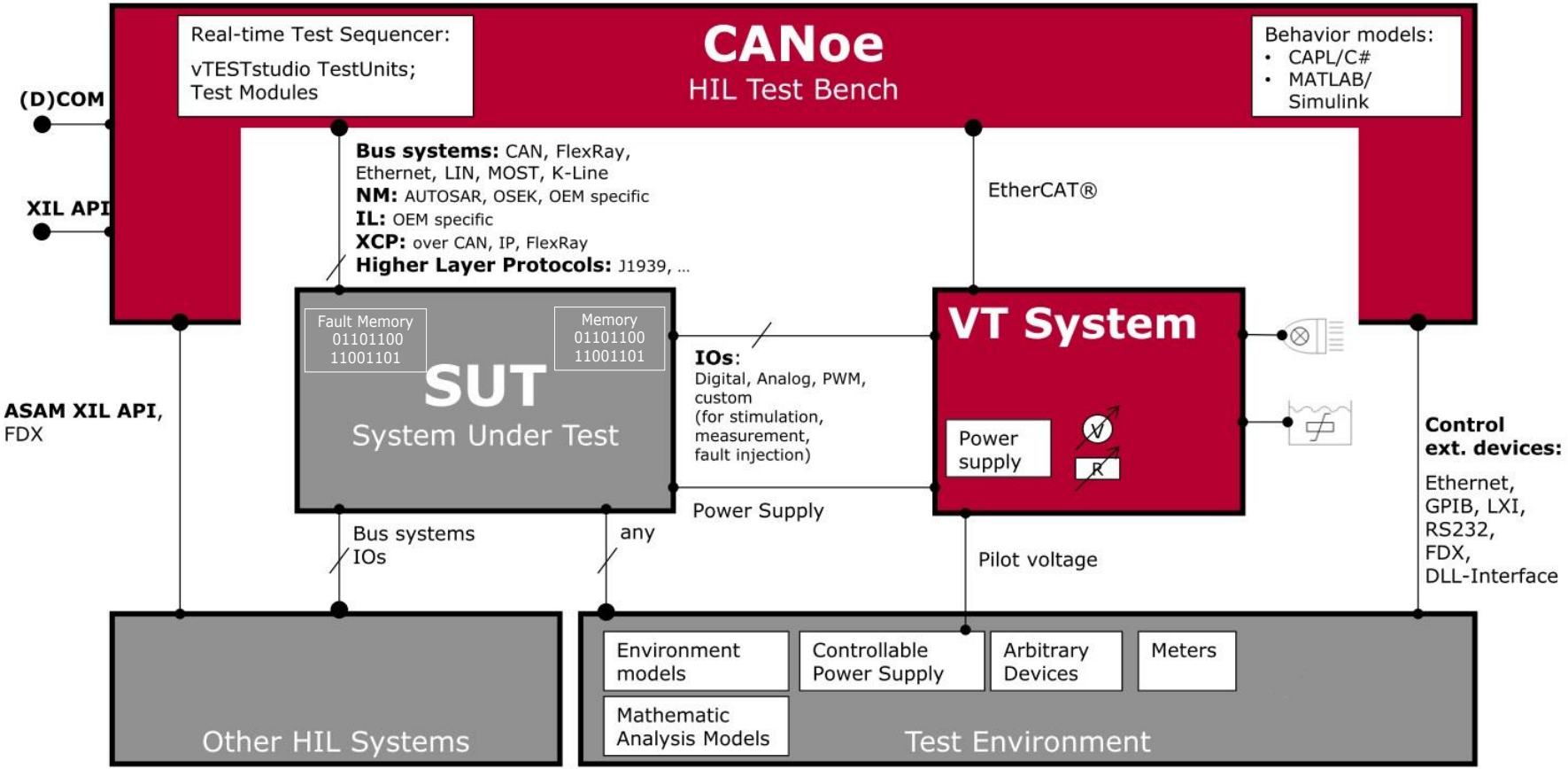
# Served SUT Interfaces, Served Interfaces of HIL test bench



# VT System – A Modular System

Relays for switching and fault injection

Phoenix connectors for test harness

ECU

Plugs for manual measurement

Status LEDs for each channel

Backplane connector (control, supply power)

Signal conditioning

Modules for 19” racks

**Load Module**
VT1004A(FPGA)

**Stimulation Modules**
analog VT2004A(FPGA)
digital VT2516A(FPGA)

**General Purpose Modules**
analog VT2816(FPGA)
digital VT2848(FPGA)
Relais VT2820

**Extension Module**
VT7900

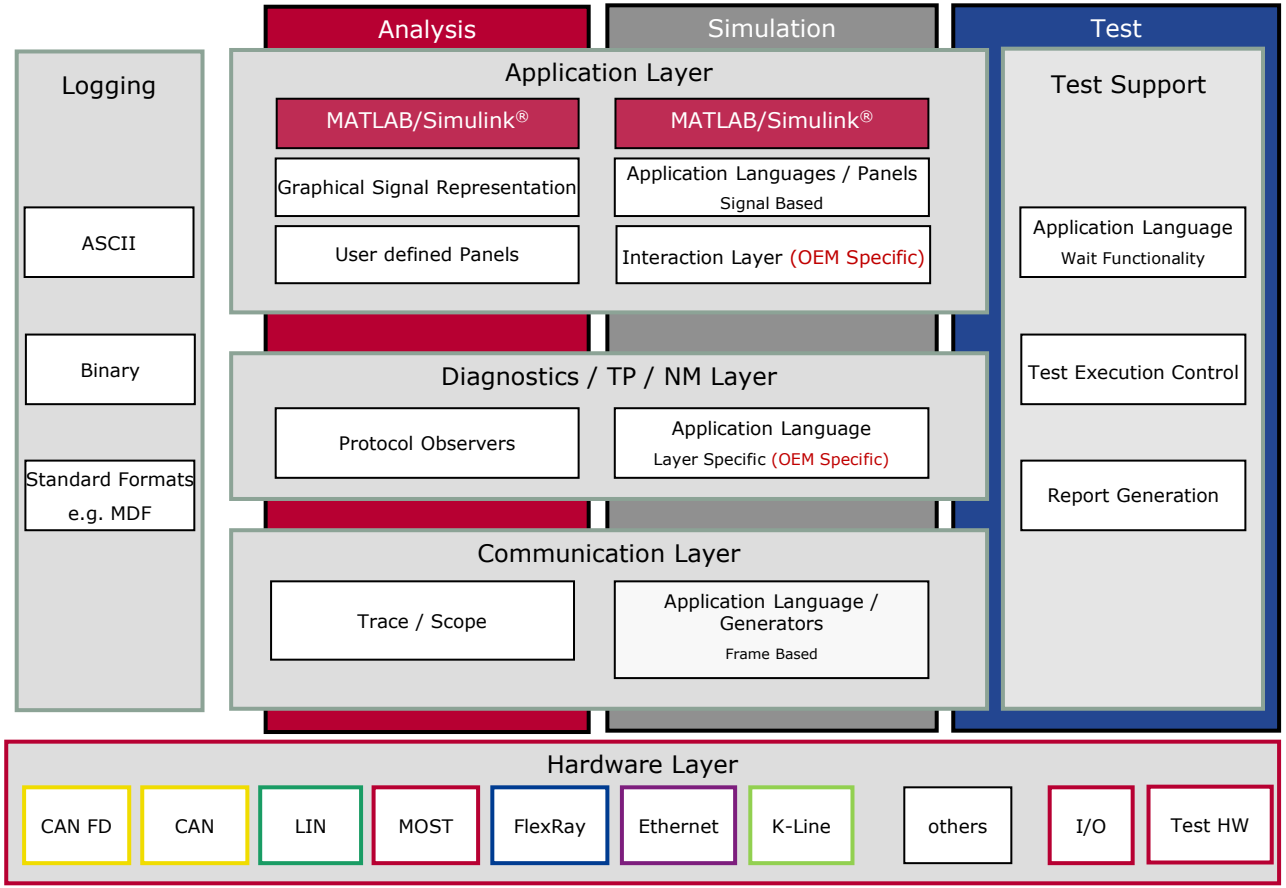
**Real-Time Modules**
ATOM VT6010
Core™ i7 VT6051A

**Network Interface Module**
VT6104
VT6204

**Power Module**
VT7001A

**Backplanes & Chassis**
VT8006
VT8012

# Open Environment CANoe



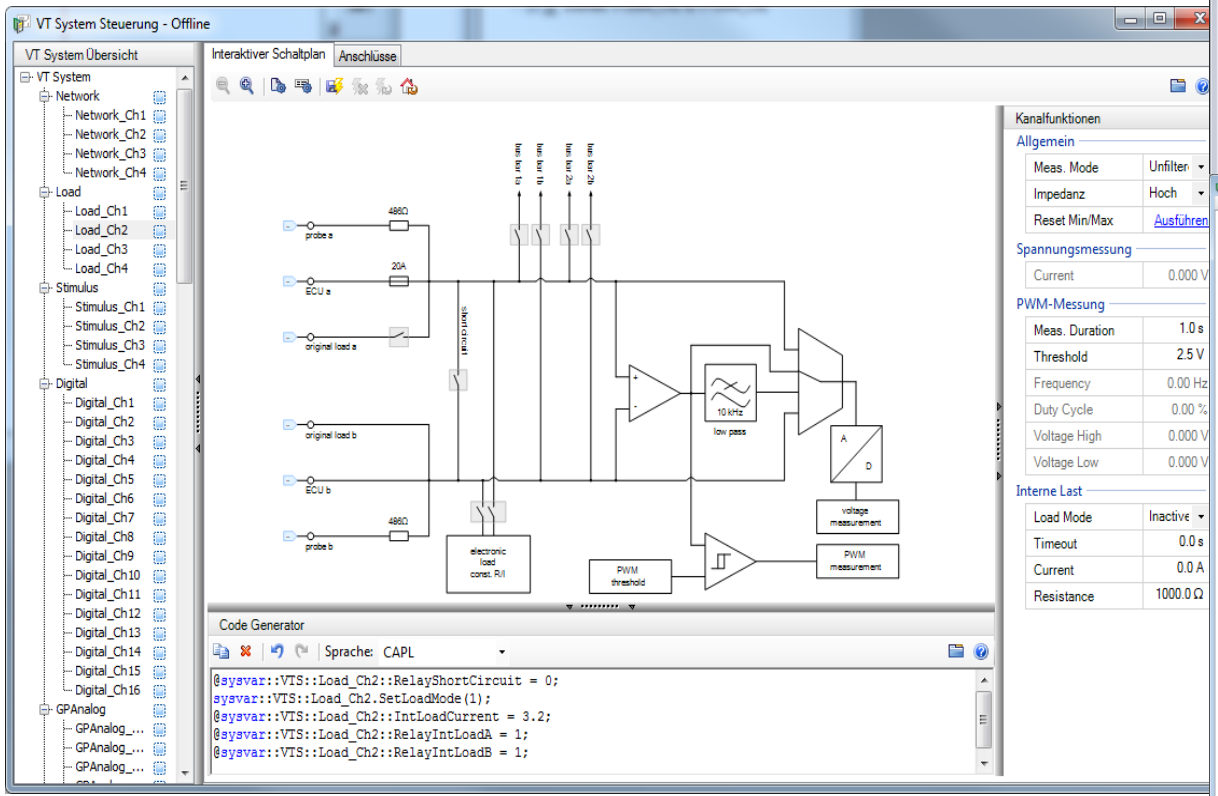


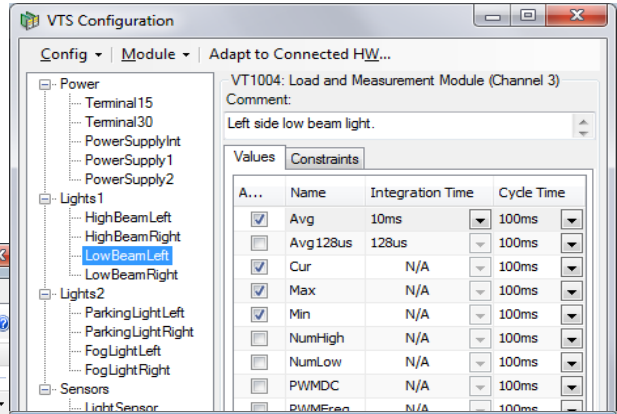


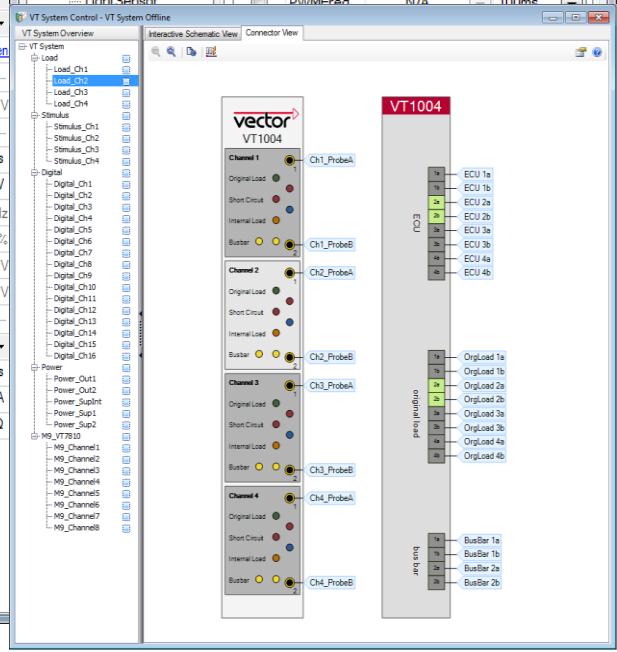
CANoe.SCOPE、CANoe.XCP、CANoe.AMD、CANoe.DiVa……

# Fully CANoe Integration

- Graphical user interface to control all VT module settings
- Relay switching apply directly on the schematic + code generation
- Display current state, settings and measurement values

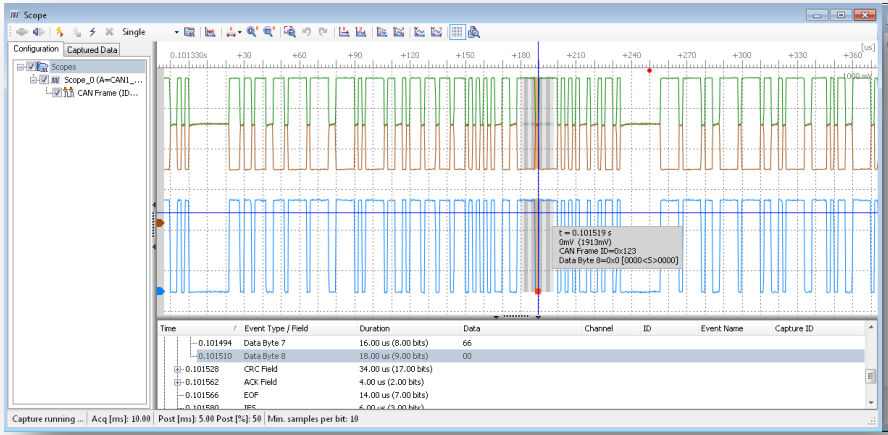


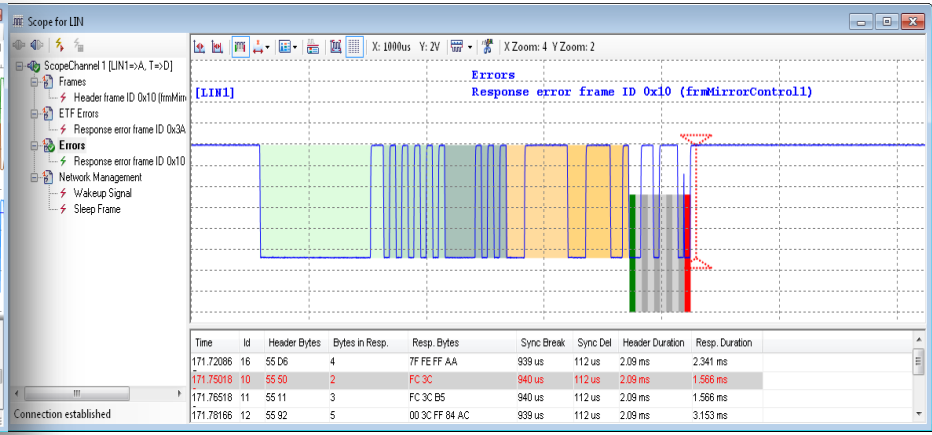



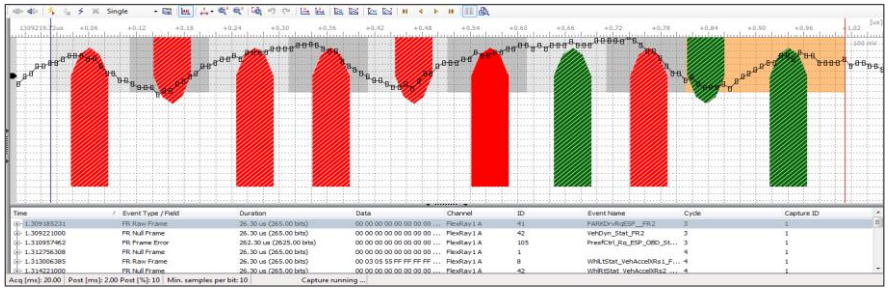
# CANoe.SCOPE

- Decode/analysis of bus voltage signals: CAN, CAN-FD, FlexRay, LIN
- External triggering via sync line of bus interface
- Typical use cases: protocol error analysis, automated physical layer tests



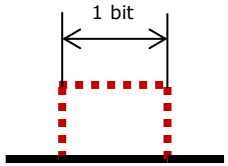





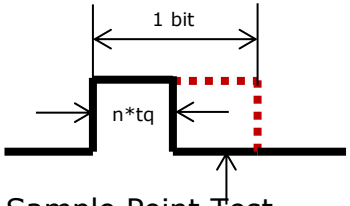


# CANstress

- Disturb on CAN protocol level(Digital) – **Bit** level & **BTL**(Bit Timing Logic=tq) cycles

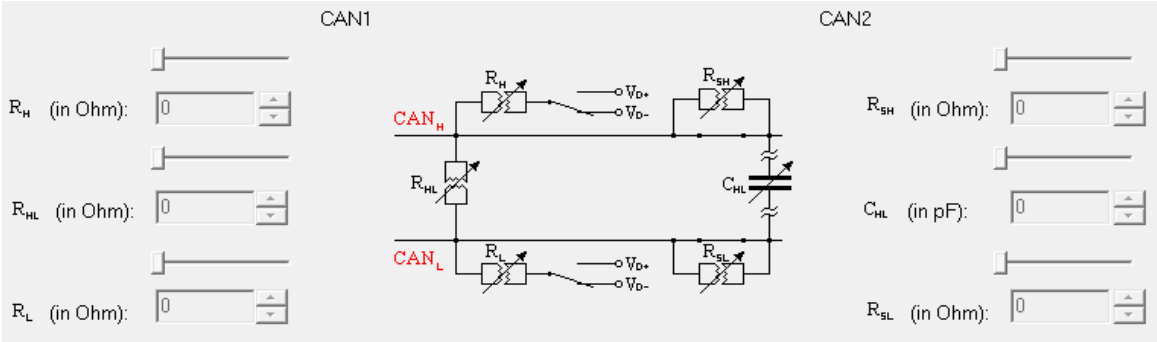



Bus-off Test



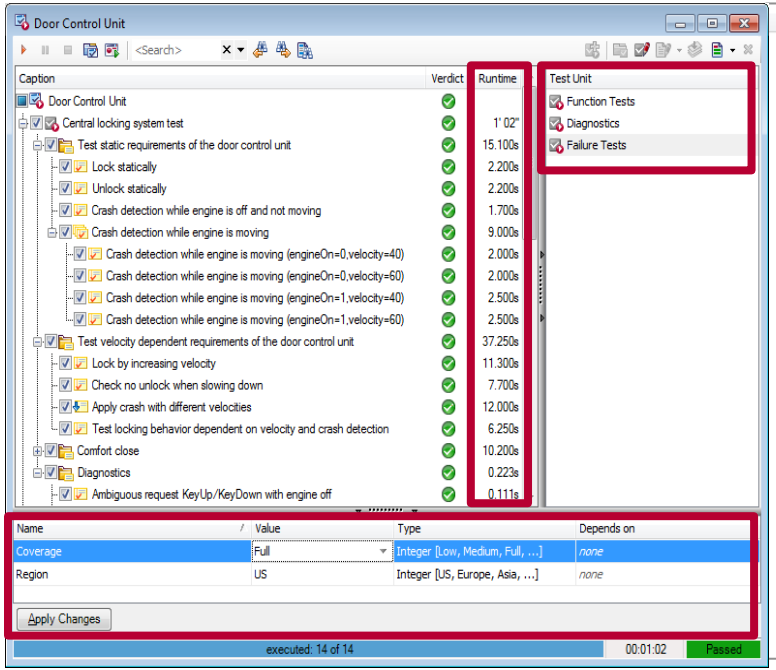

Sample Point Test

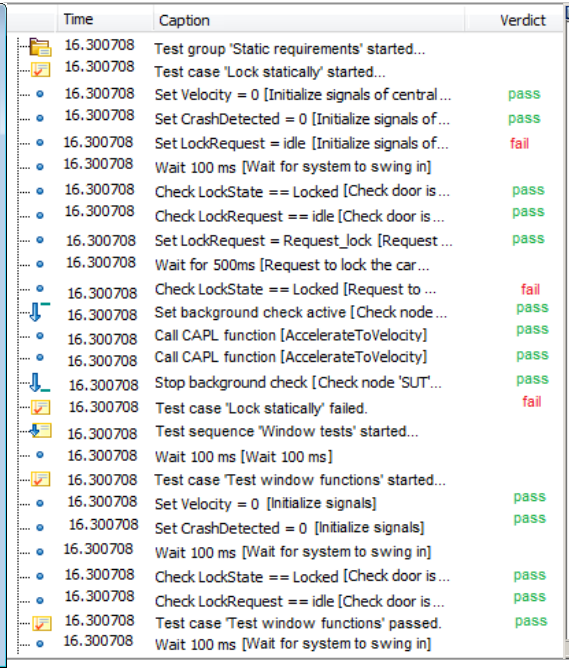

- Disturb on CAN physical level(Analog)

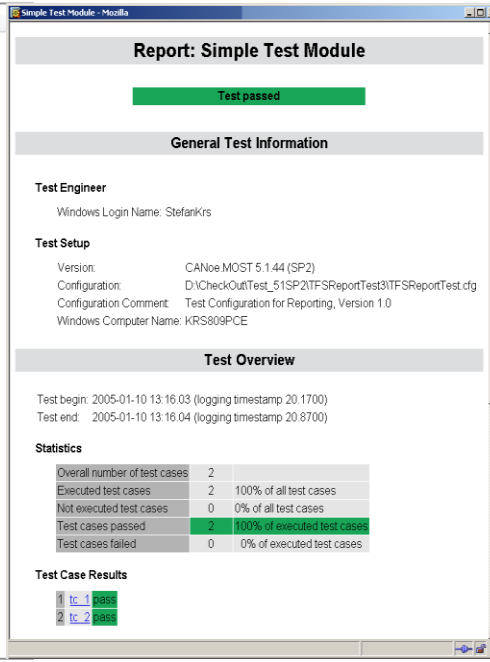


# Test Run with CANoe

- Possibility to observe and analyze a test during the test run in the Test Trace Window
- Detailed information about executed test cases and test steps
- Automatic Report Generation



## Data Logger

- **GL1000 Family**
  - Compact fleet logger for 2 CAN, 2 LIN and I/Os
  - GL1010 as waterproof IP65 variant

- **GL2000**
  - Handy fleet logger for 4 CAN, 2 LIN and I/Os
  - Fast wake-up to record the first message
  - Slim and cost-efficient GPS receiver


- **GL3000/GL4000 Family**
  - Flexibly expandable multi bus fleet logger for 9 CAN, 2 LIN, 2 FlexRay, 1 MOST150 and I/Os
  - 2 independent logging memories for separate configuration
  - High storage capacities on CF card, SSD or external USB hard disk
  - Wireless data exchange via WiFi

# Agenda

- Testing Overview
- HIL Test Bench: CANoe + VT System
- **Testing Design: vTESTstudio**
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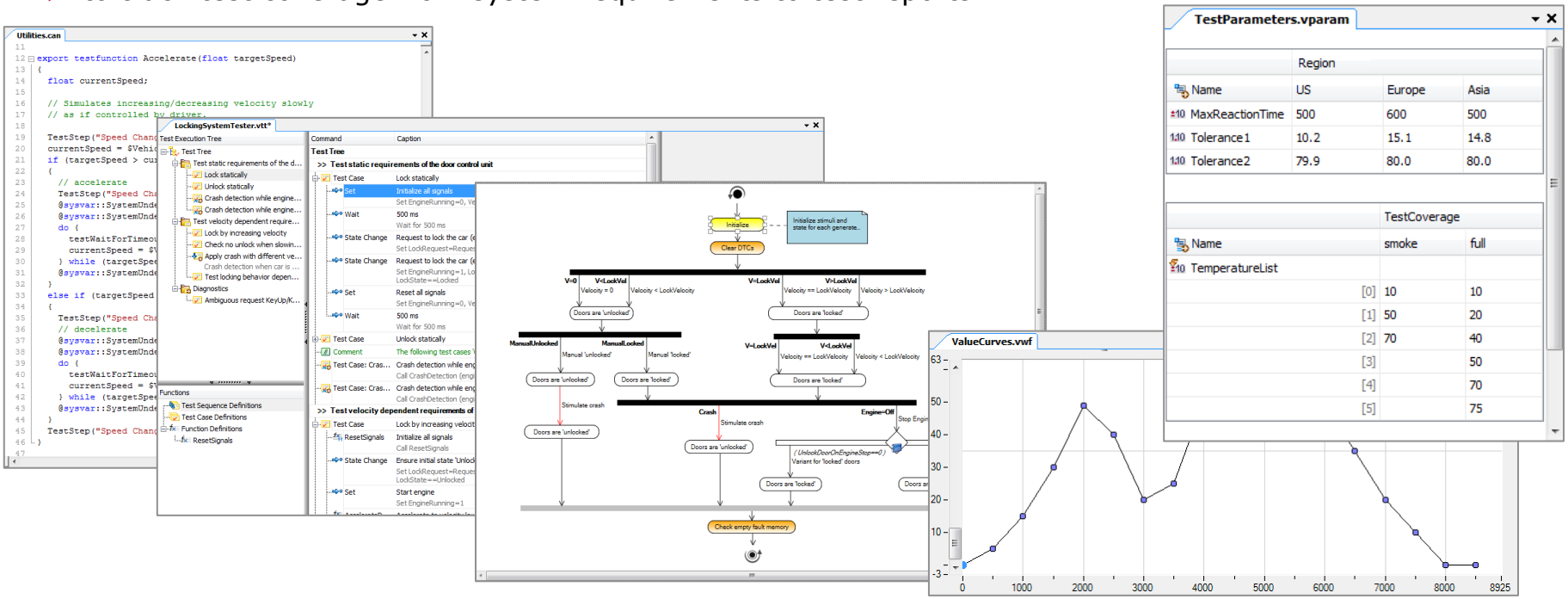
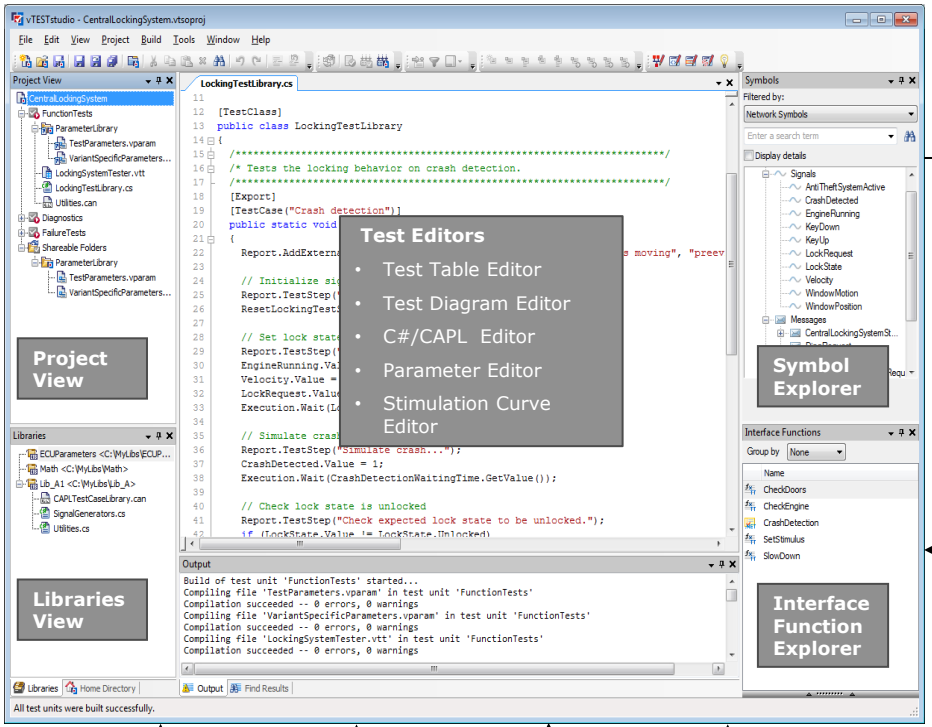
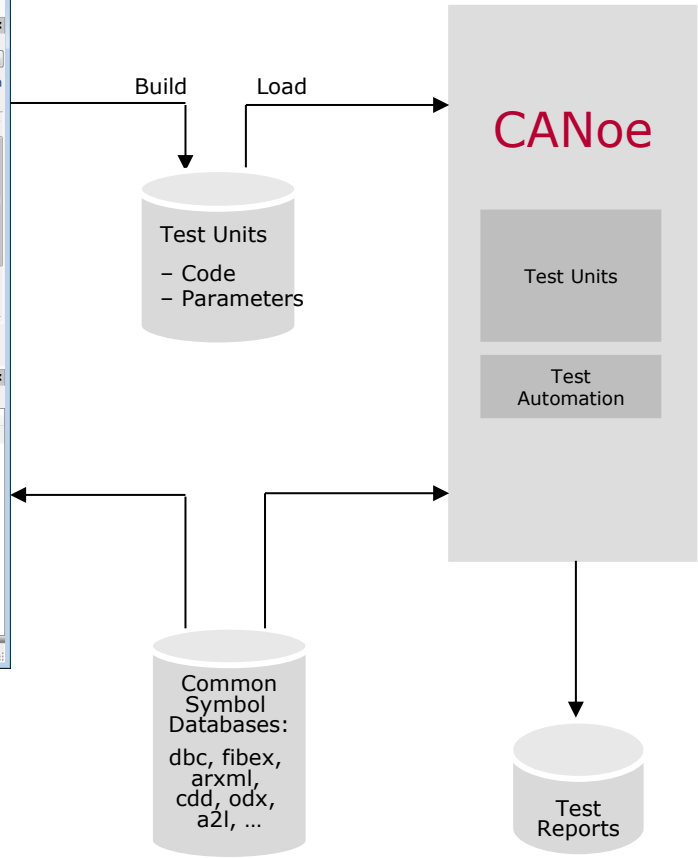
# Comfortable Design of Automated Test Sequences for Embedded Systems

- Vector vTESTstudio is a test design environment that enables the user
  - to simplify test design by combining different programming languages and graphical notations in one integrated design environment
  - to efficiently increase test coverage by specific test design features
  - to define and reuse test cases for and across product lines by supporting parameters, ECU variants and test variants
  - to track test coverage from system requirements to test reports



# Schematic Overview: vTESTstudio and CANoe

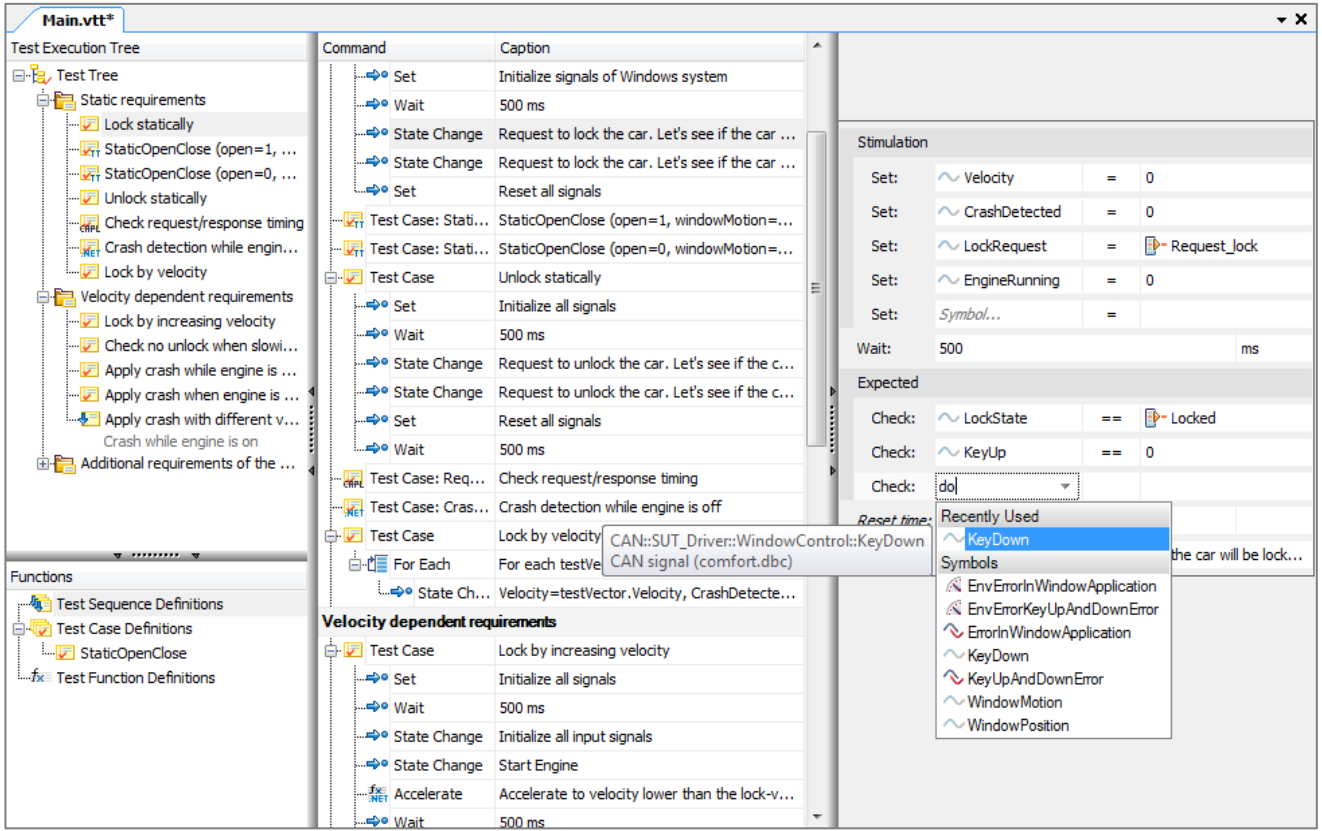


# vTESTstudio: Test Table Editor

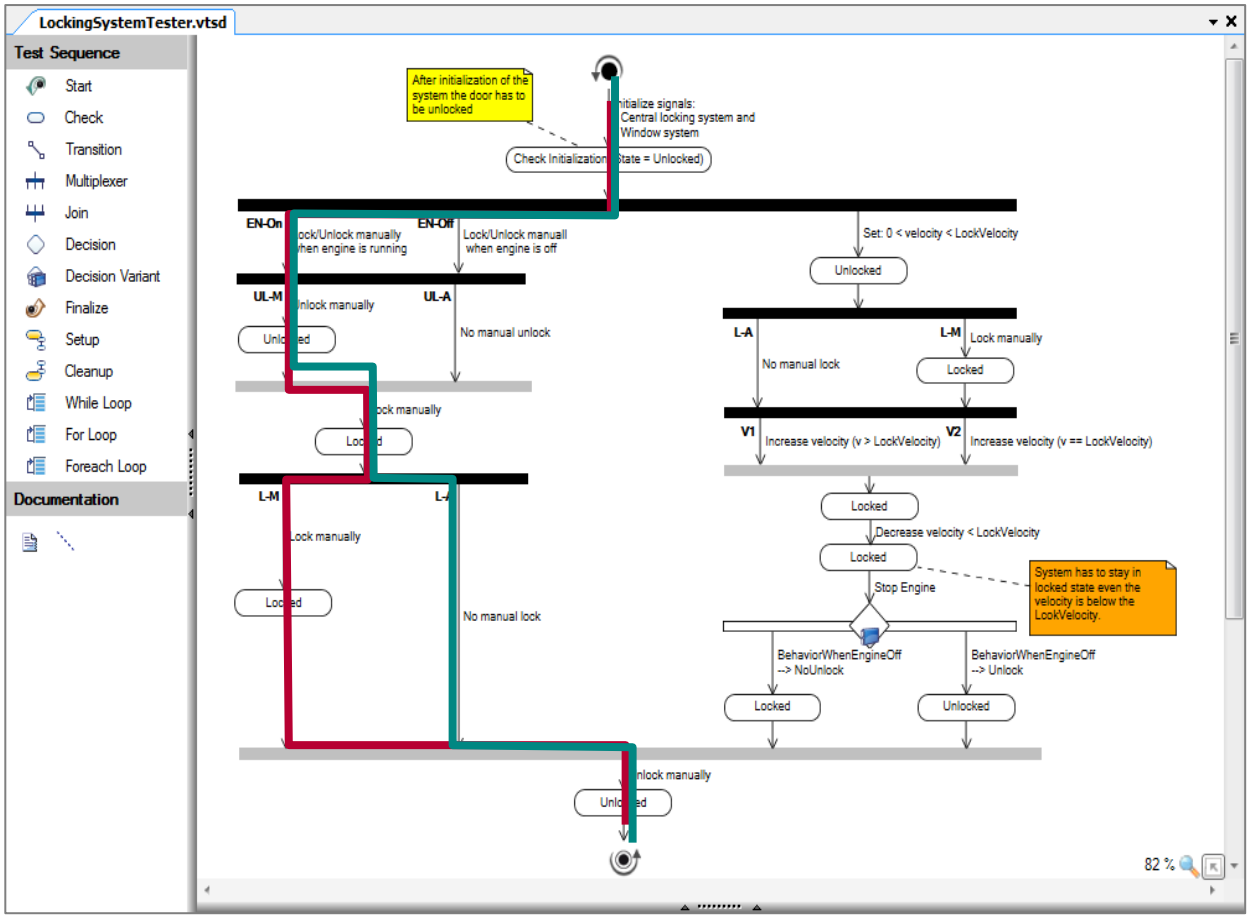
Test Table Editor:

- Easily define test sequences without programming knowledge
- Comfortable support of test step parameterization by drag & drop
- Direct calls to CAPL, and C# test cases and functions possible



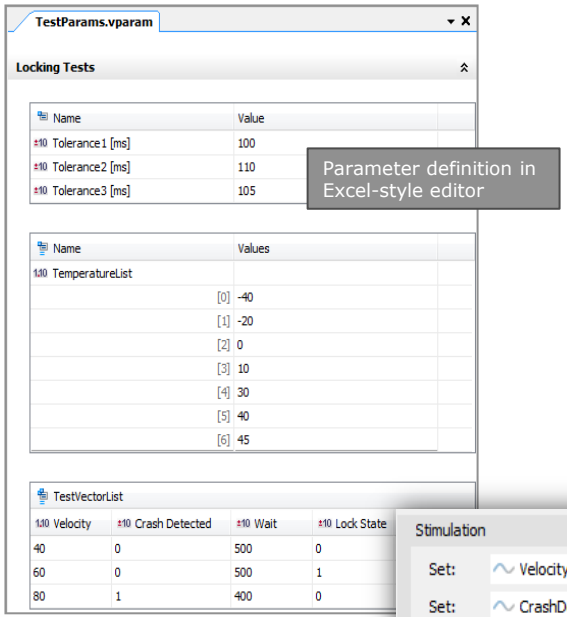
# vTESTstudio: Test Diagram Editor

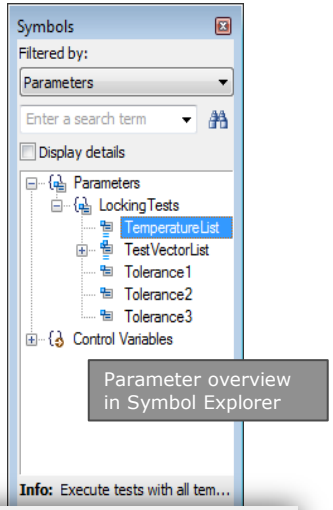
- Test sequence diagram for an clear and concise representation
- Direct calls to CAPL and C# test cases and functions possible
- Test coverage easily to be reviewed
- Easy reuse of test sequence parts



# vTESTstudio: Parameters and Test Vector Editors

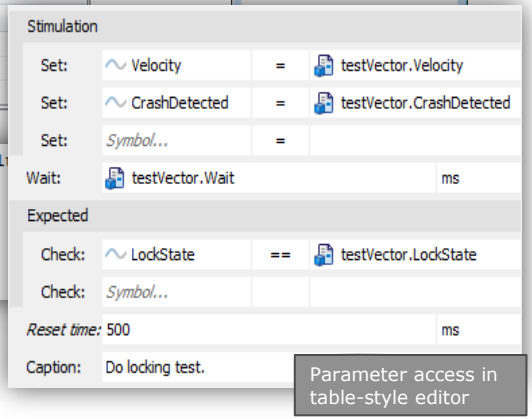
- Define parameters separated from test sequences
  - ECU parameters
  - Test vectors
- Standard file format (CSV), also directly editable in MS Excel
- Use parameters directly in code e.g. for value assignments, comparisons and variant decisions



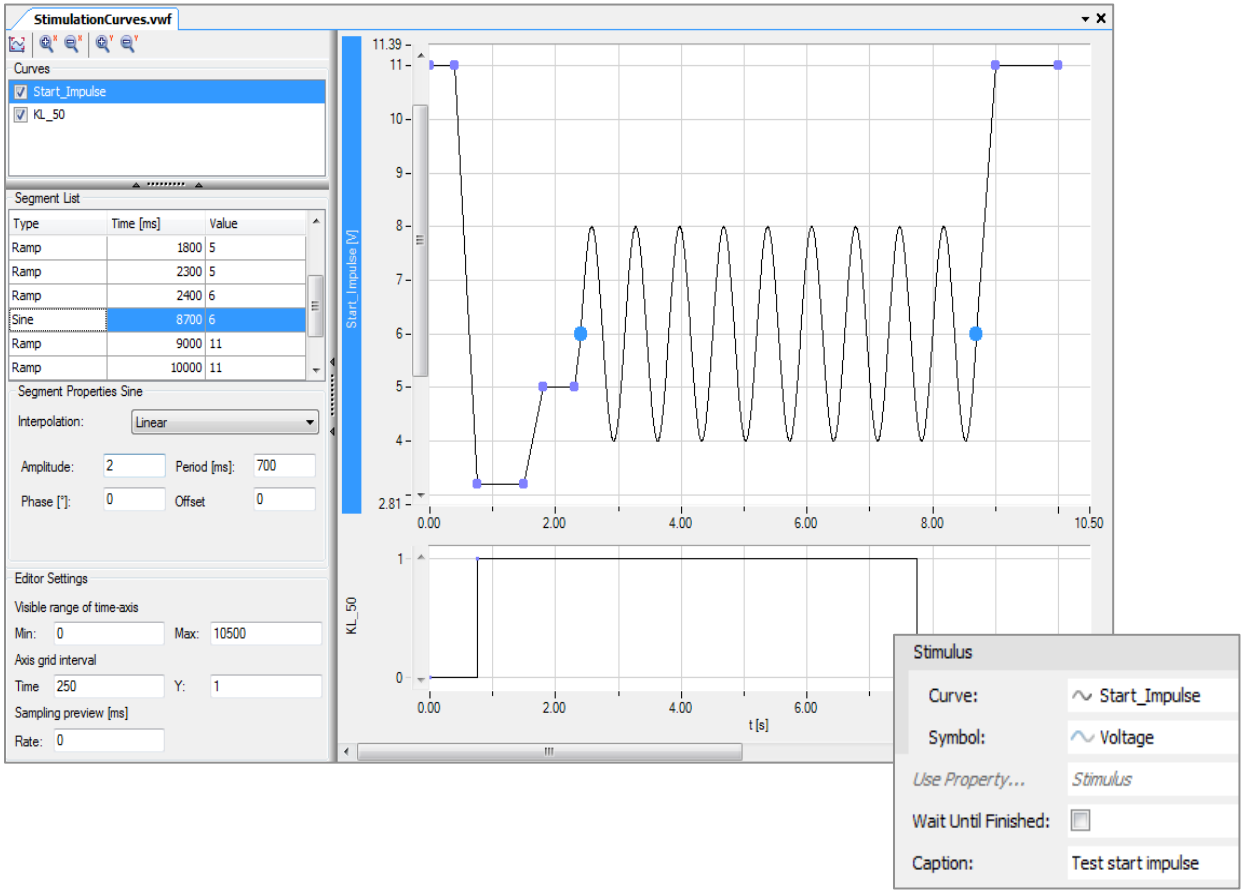

```
foreach (double temperature in SysPars.LockingTests.TemperatureList.GetVal
{
  EngTemp.Value = temperature;

  DoMotorCheck1(SysPars.LockingTests.Tolerance1.GetValue());
}
```

Parameter access in coding editors



# vTESTstudio: Stimulation Curve Editor

- Define curves graphically with the Waveform Editor
- Predefined segment types (sinus, pulse, ..) enable easy definition of e.g. voltage curves defined by test standards like LV124 norm
- Use curves for the stimulation of the system under test
- Multiple curves can easily be synchronized within the design and for test execution



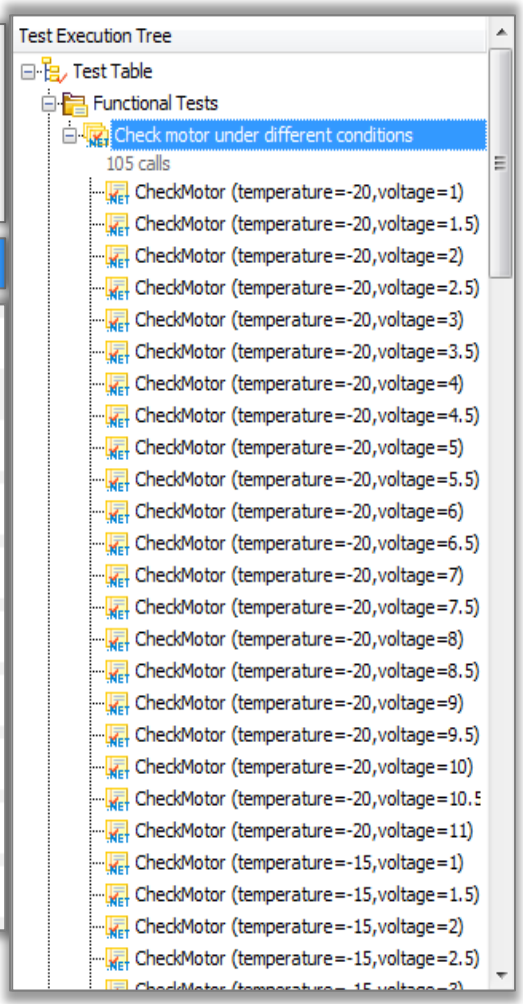
# vTESTstudio: Parameterized Test Case Lists

- Quick definition of a large number of test cases to increase test coverage
- Combinations
  - Sequential
  - All possible permutations
- Value definitions
  - Lists of values
  - Value ranges
- Direct use of parameters from parameter files as test case parameters

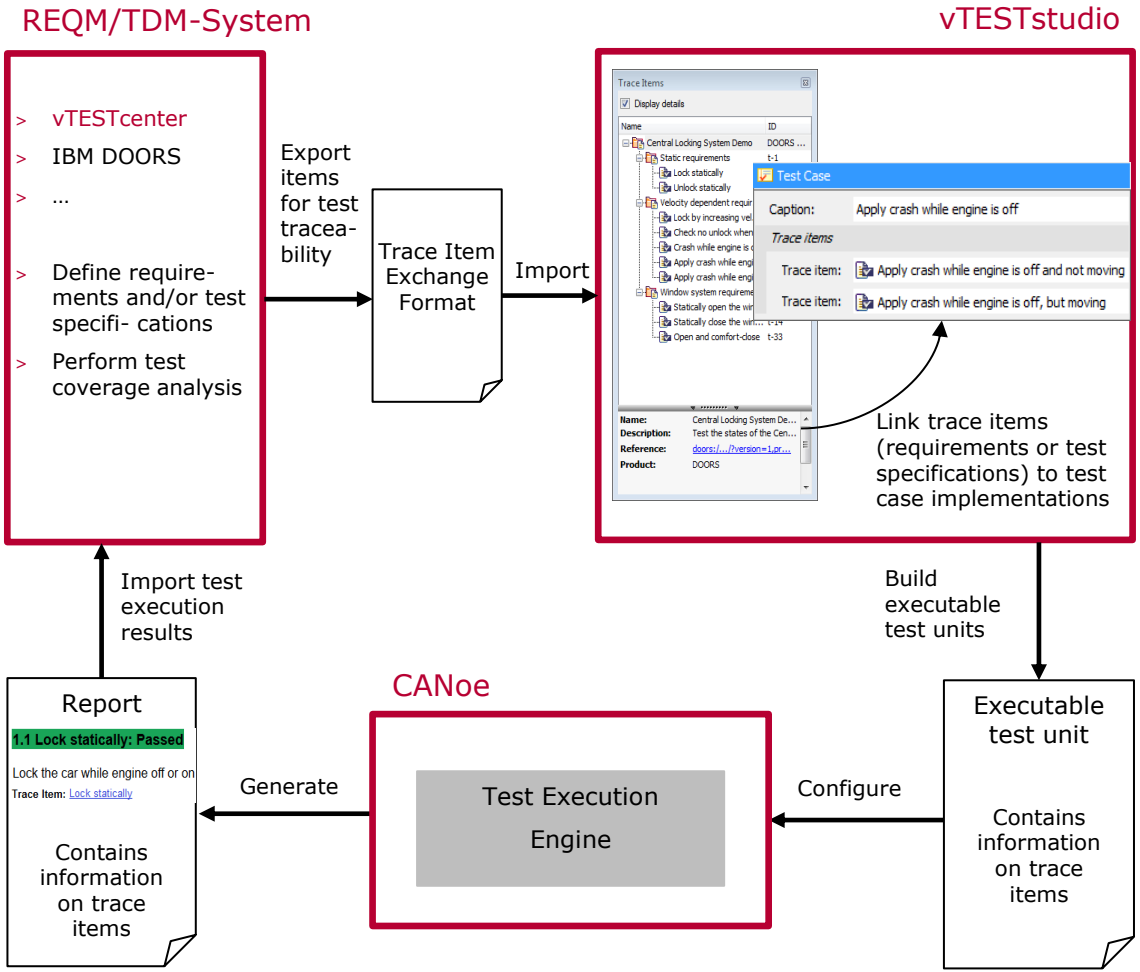
```
[TestCase]
public void CheckMotor(int temperature, double voltage)
{
  // ...
}
```

Test Case [list]: CheckMotor | Check motor under different conditions

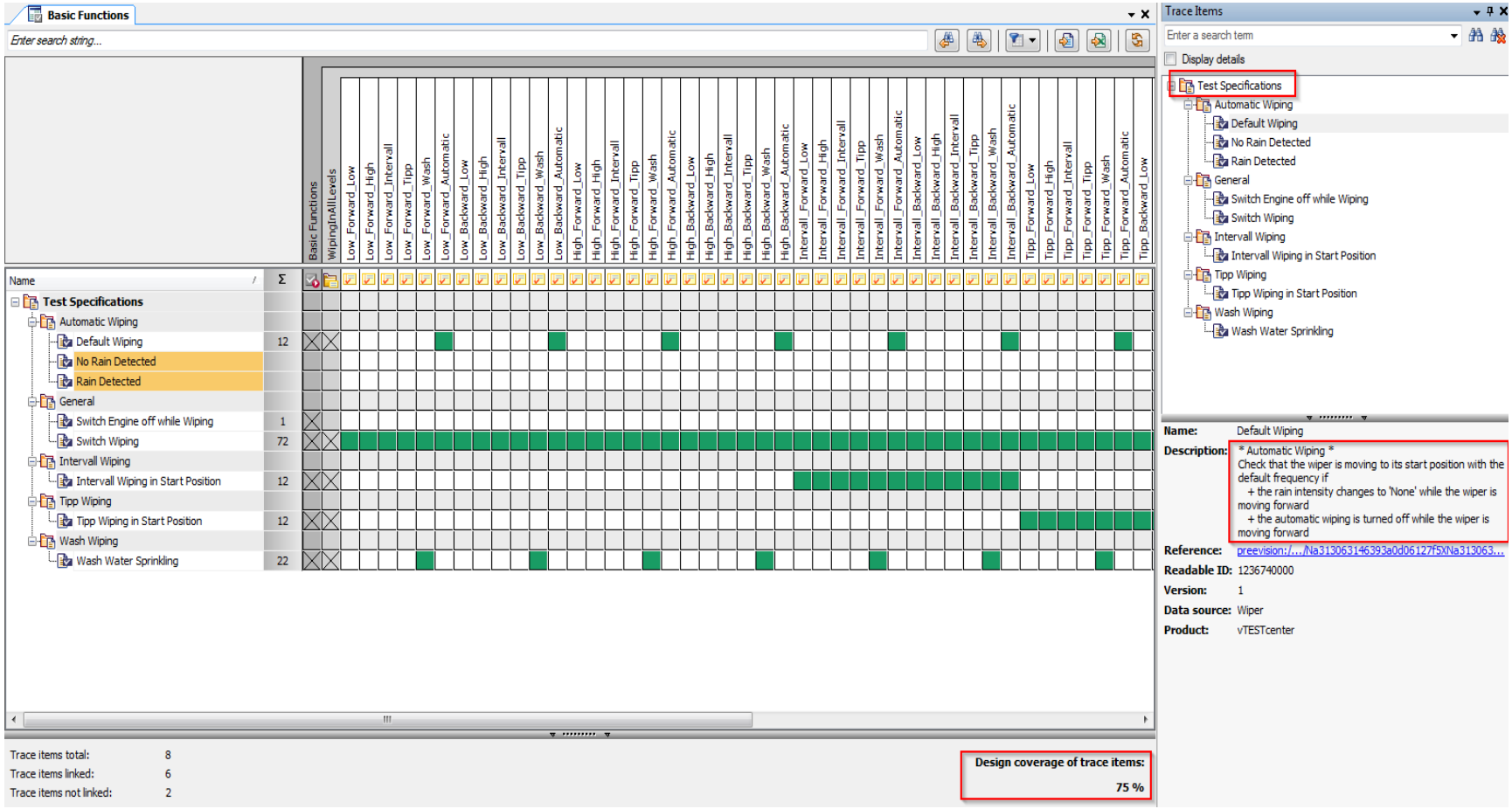
| Combinatorics: | Combinatorial | |
|---|---|---|
| Name: | **temperature** | **voltage** |
| Value Source: | From Parameter File | Value Range |
| Range/Parameter: | TemperatureList | [min=1, max=11, inc=0.5] |
| Values: | -20 | 1 |
| | -15 | 1.5 |
| | 0 | 2 |
| | 10 | 2.5 |
| | 40 | 3 |
| | | ... |



# vTESTstudio: Traceability



# vTESTstudio: Traceability Matrix



# Agenda

- Testing Overview
- HIL Test Bench: CANoe + VT System
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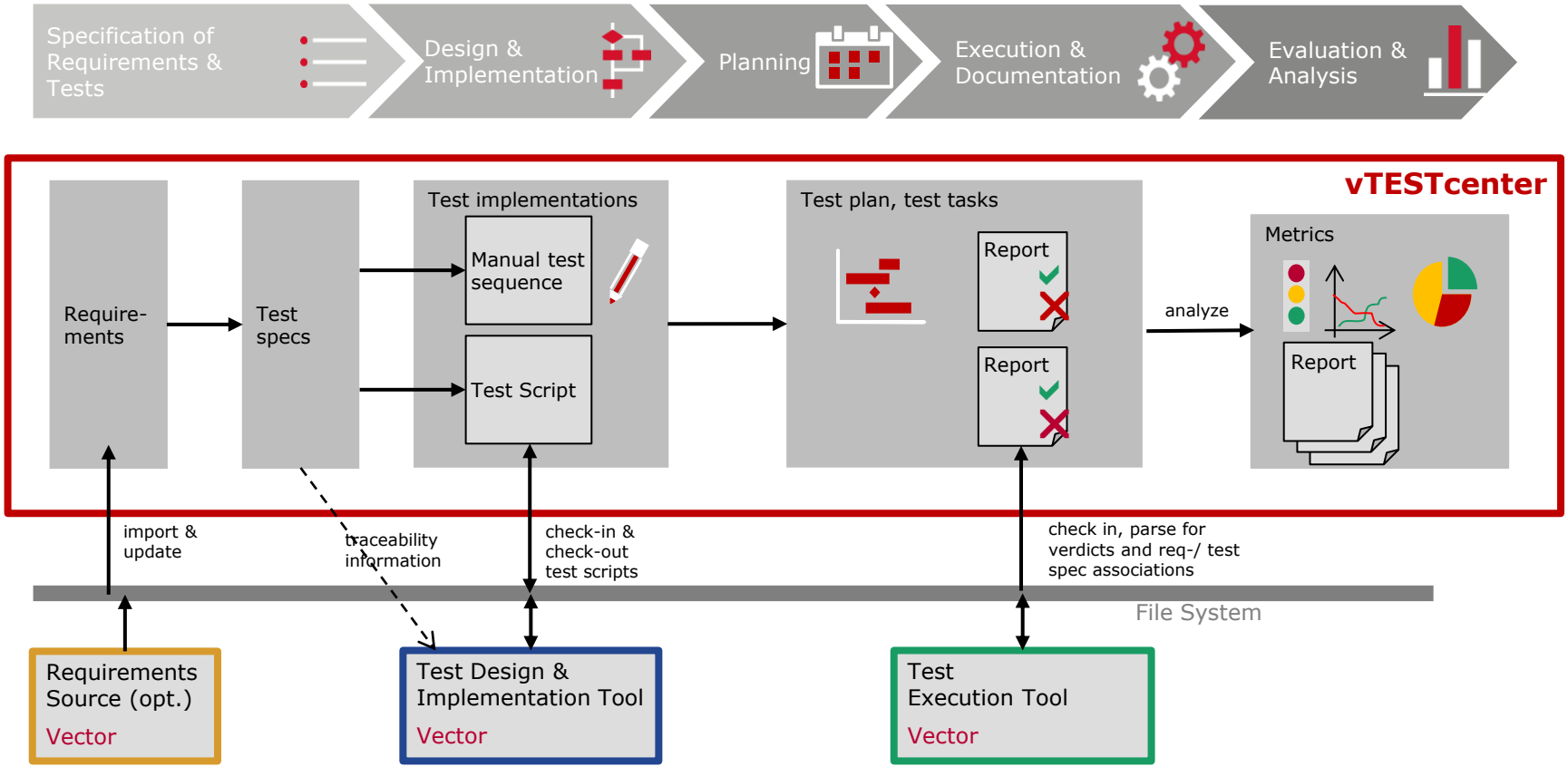
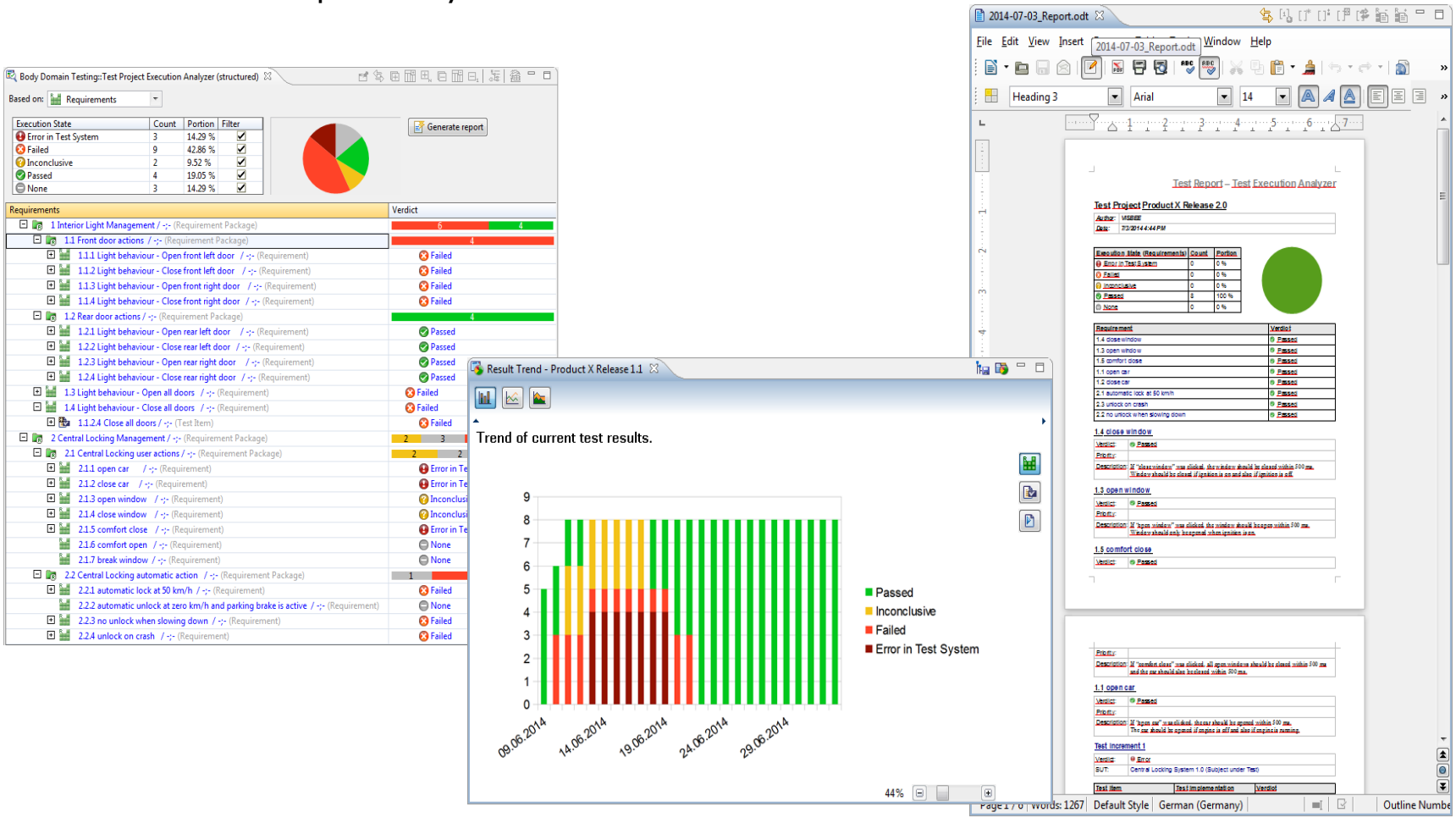
# Major Market Challenges

- Tons of data:
  - 1000‘s of requirements,
  - 100‘s of test scripts,
  - many SUT versions, many test executions
  - Allow / detect changes
- Address relevant roles
  - Stakeholders external & internal: Customers, Requirements Engineers, Management
  - Project members: Project leaders, Test Designers, Testers, Quality Engineers, …
  - External contributors: Suppliers, service providers, …
- Collaboration – all users access the same data
  - Consider roles & rights to derive permissions for viewing / editing
  - Different locations
  - Configuration management with versioning
- Tracking of progress & quality
  - Review & release of each data element (→ ‘artifact’)
  - Informative reports with flexible level of details, graphical representations

# vTESTcenter: Information Flow



# vTESTcenter: Example Analysis of Test Results



# Agenda

- Testing Overview
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# Range of Engineering Services

**Customer specific:**
**Test Design & Reporting**

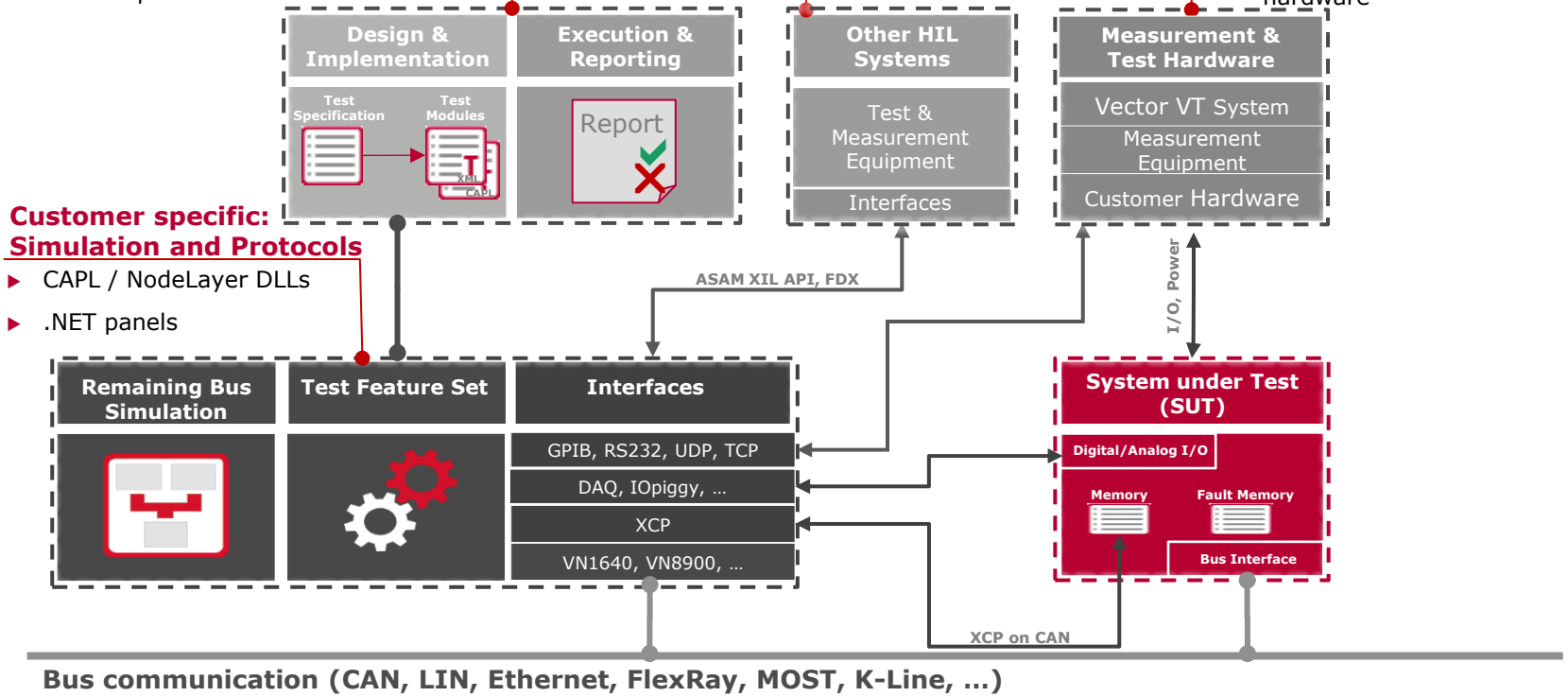
- Test programming / test patterns (CAPL, XML,.NET,C#)
- Test reports

**Customer specific:**
**Hardware Connection**

- Access to customer Hardware & Interfaces

**Customer specific:**
**Housing & Wiring**

- Individual wiring, connectors, front panels
- Integration of 3rd party hardware




**Customer specific:**
**Simulation and Protocols**

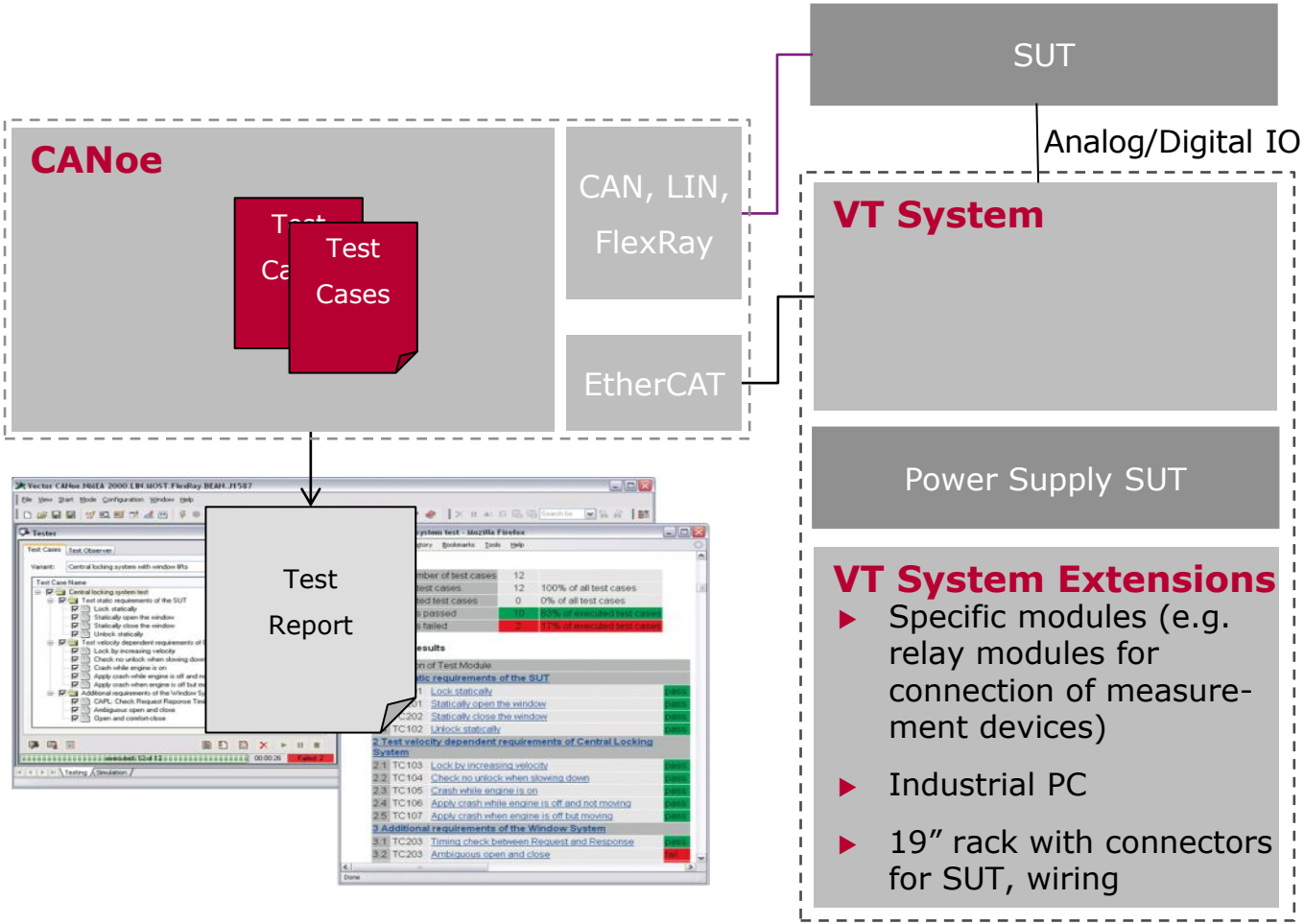
- CAPL / NodeLayer DLLs
- .NET panels

# Types of Tests

- **We support you with various kinds of tests**
  - Functional Tests of ECUs with stimulation / measurement of IOs
    - Integration of network communication and electronic signals
  - Gateway Tests
    - Routing of messages and signals
  - Diagnostic Tests (ECU functional behavior)
    - E.g. check of fault memory entries
  - Conformance Tests
    - For standard protocols, based on OEM specific specifications


- **For various application areas**
  - Interactive Tests
    - With graphical user interface
  - Automated Tests
    - With monitoring of test progress
  - Endurance Tests
    - E.g. with different environmental conditions (control of climate chamber)

# Functional ECU Tests with VT System




# VT System Based Test Solutions For…

Energy / Battery Management Module

Headlights Control Unit

ABS Control Unit

Tire Pressure Control Unit

Power Steering Module

Braking System

Wiper Module

Electric Sunroof Control Unit

Passive Safety Module

Central Body Component

Cockpit Module

Exhaust Door

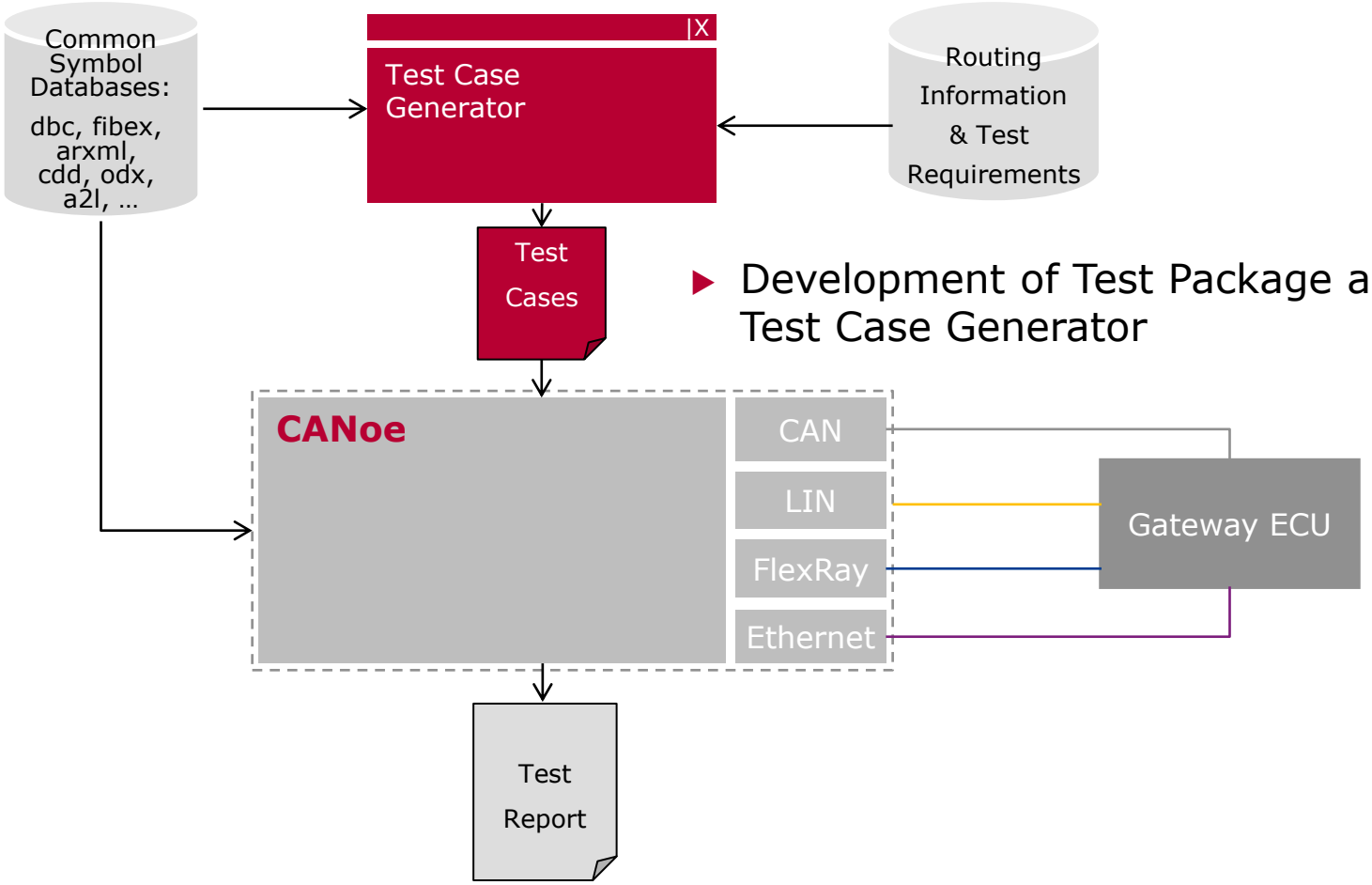
Multiplex System

Rain Sensor Module

Park Distance Control Unit

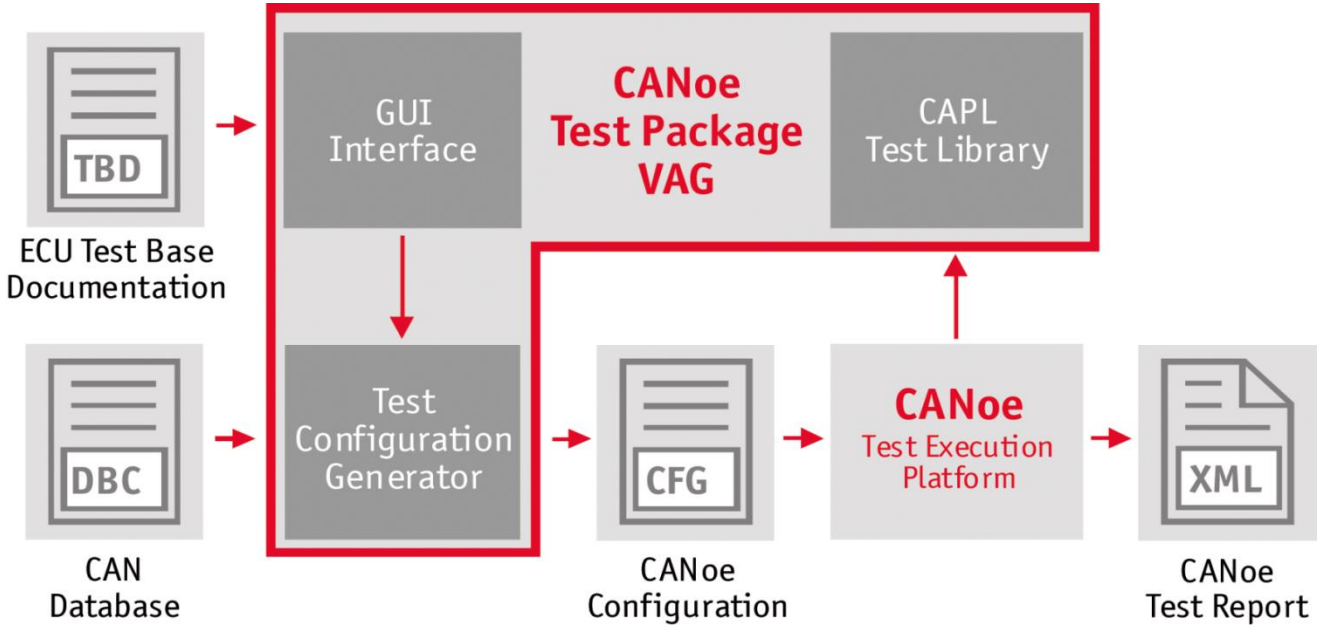
Valve Control Unit

# Gateway Tests / Conformance Tests




- Development of Test Package and Test Case Generator

# Example VAG Test Package Cover VW80118 & VW80119




# Automated Test Process With CANoe.DiVa

**CANdelaStudio**
Diagnostic Authoring Tool

**CDD**

**ODX**

ECU Specification

**CANoe.DiVa**

**Configurator**

**Generator**

**Runtime Library**

**Report Analyzer**

**CANoe**
**XML/ CAPL**

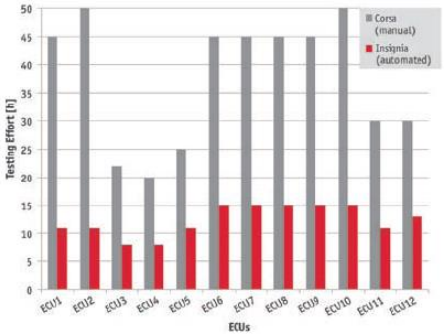
Test Module

**CANoe**
Test Feature Set

**CANoe**
**HTML/ XML**

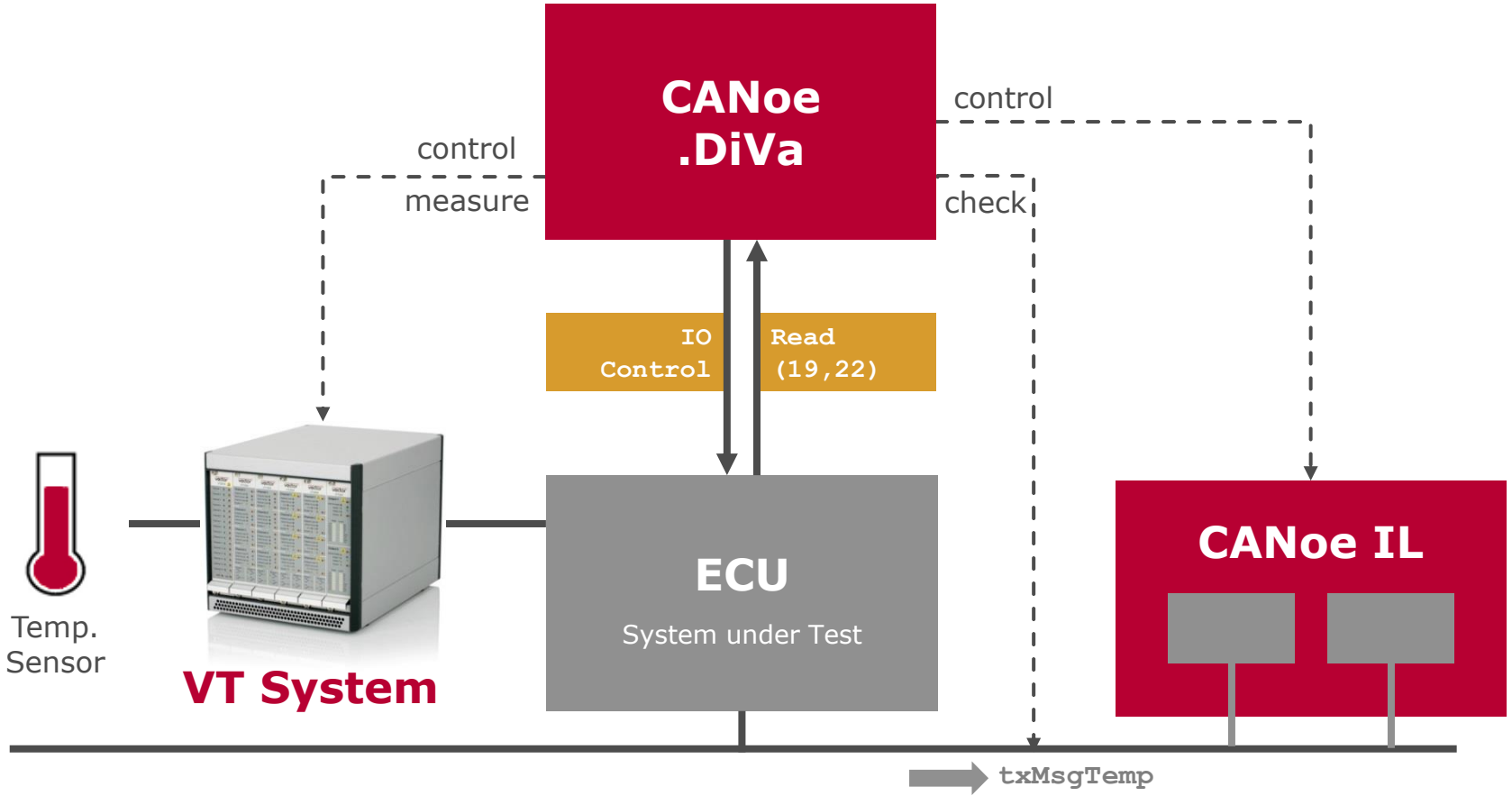
Test Report

**ECU**
System under Test

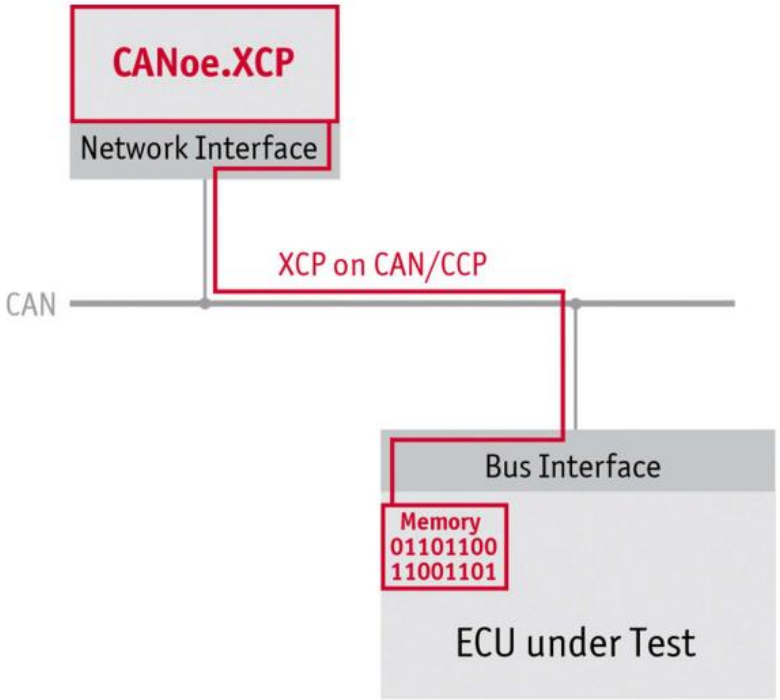



Enhance quality, reduce cost!

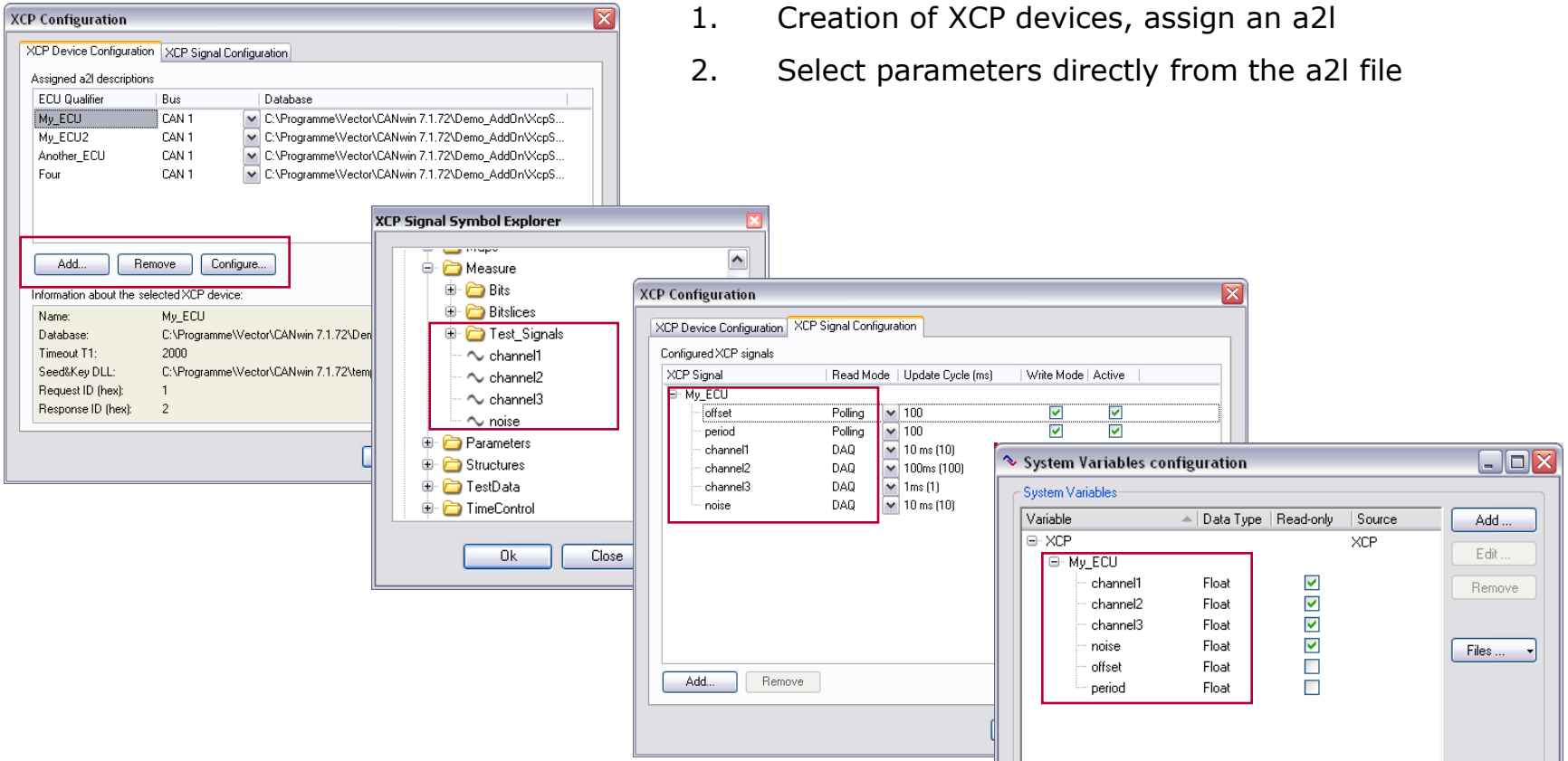
# Automated Test Process With CANoe.DiVa



# CANoe.XCP - Comprehensive ECU Access for Testing and Analysis



# CANoe.XCP - Comprehensive ECU Access for Testing and Analysis



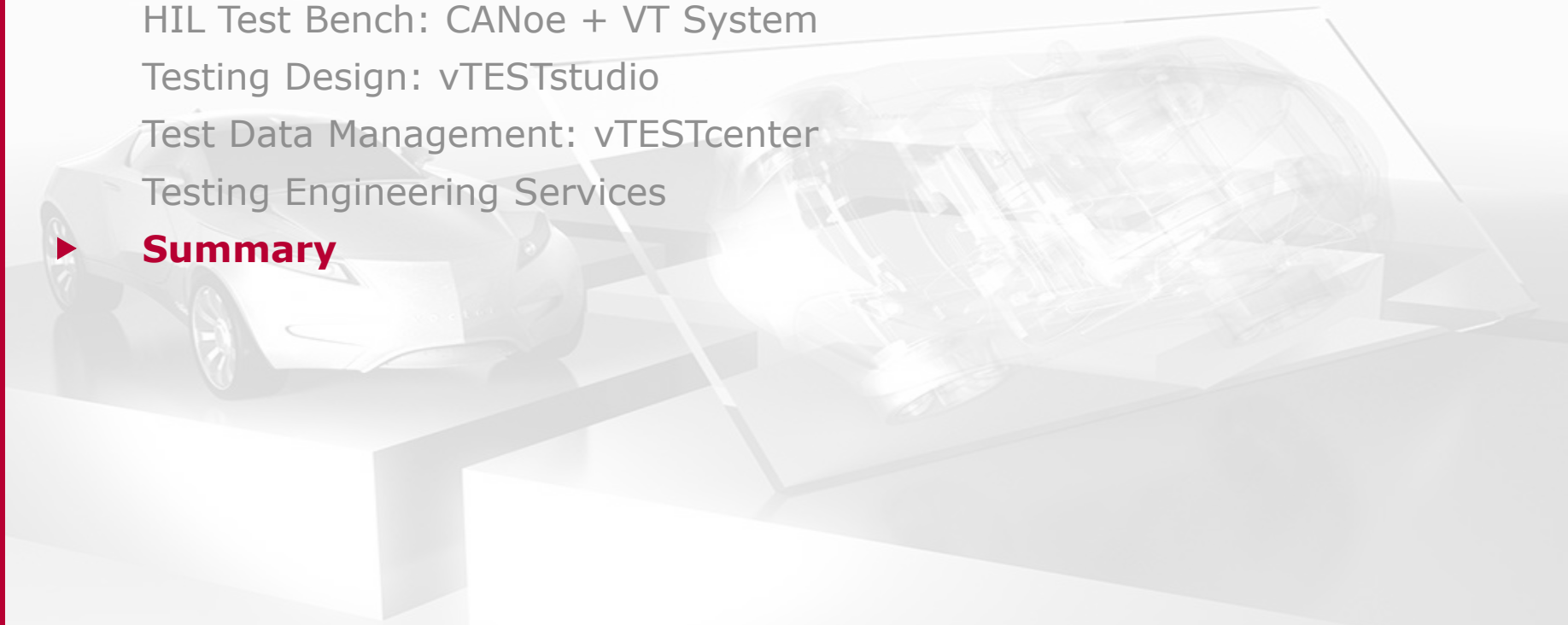

1. Creation of XCP devices, assign an a2l
2. Select parameters directly from the a2l file

3. Configure selected parameters with DAQ, OnConnect or polling mode
4. CANoe system variables are created implicitly

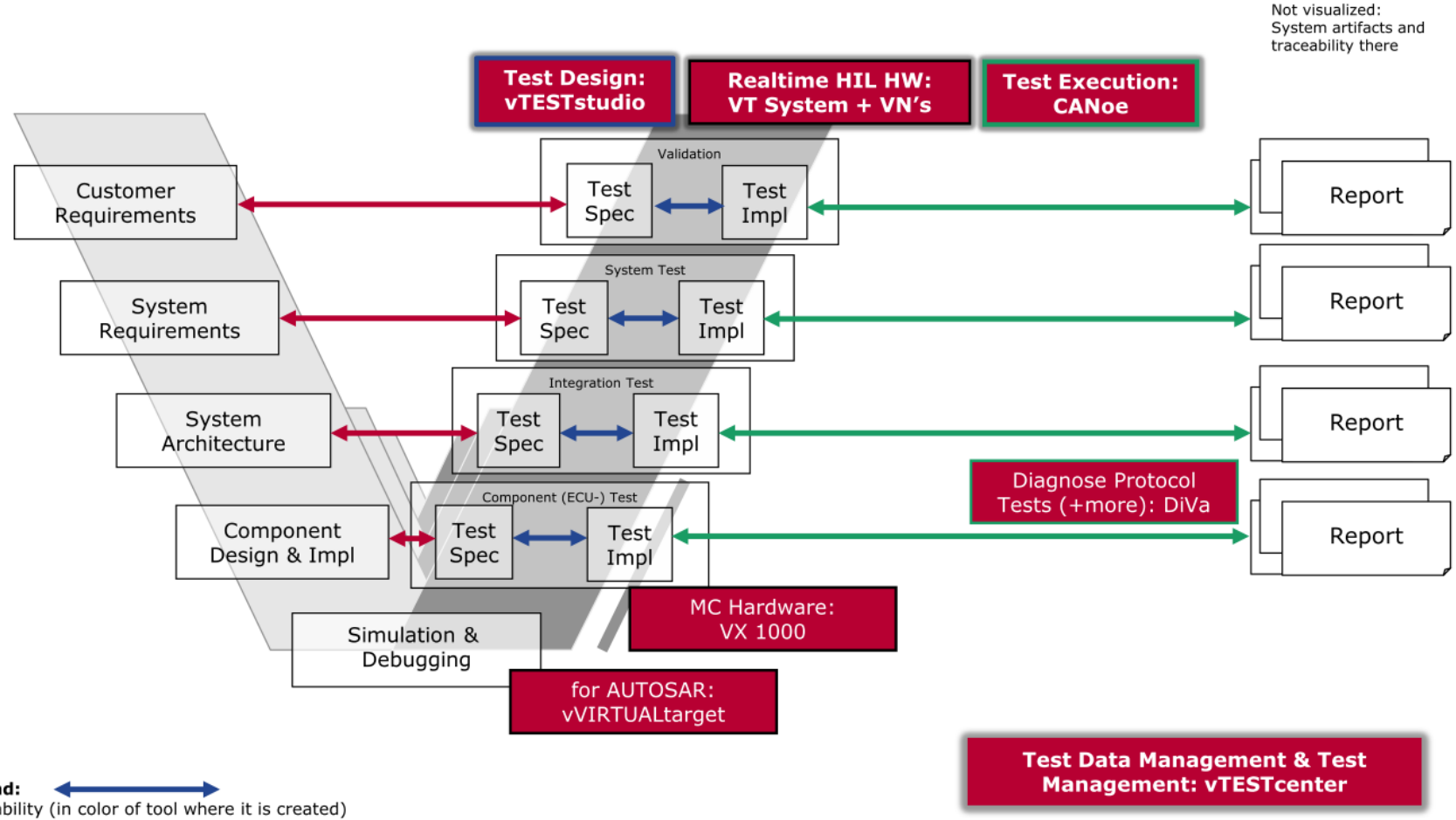
# Test bench with VT System example

# Agenda

- Testing Overview
- HIL Test Bench: CANoe + VT System
- Testing Design: vTESTstudio
- Test Data Management: vTESTcenter
- Testing Engineering Services
- **Summary**



# Vector Test Solution in the V-Model



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