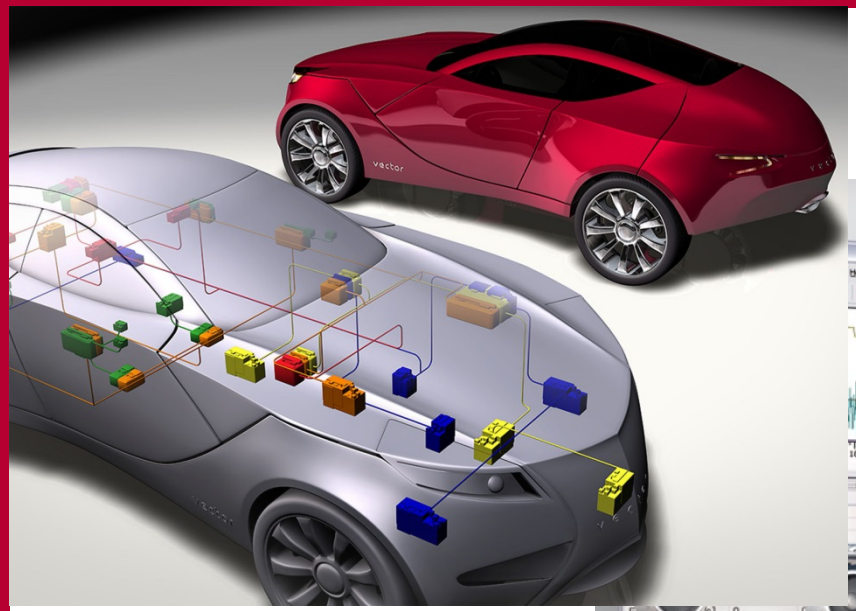


Tools for CAN based networking

On the street, in the air, in the orbit

Vector Informatik GmbH

Vector provides OEMs and suppliers

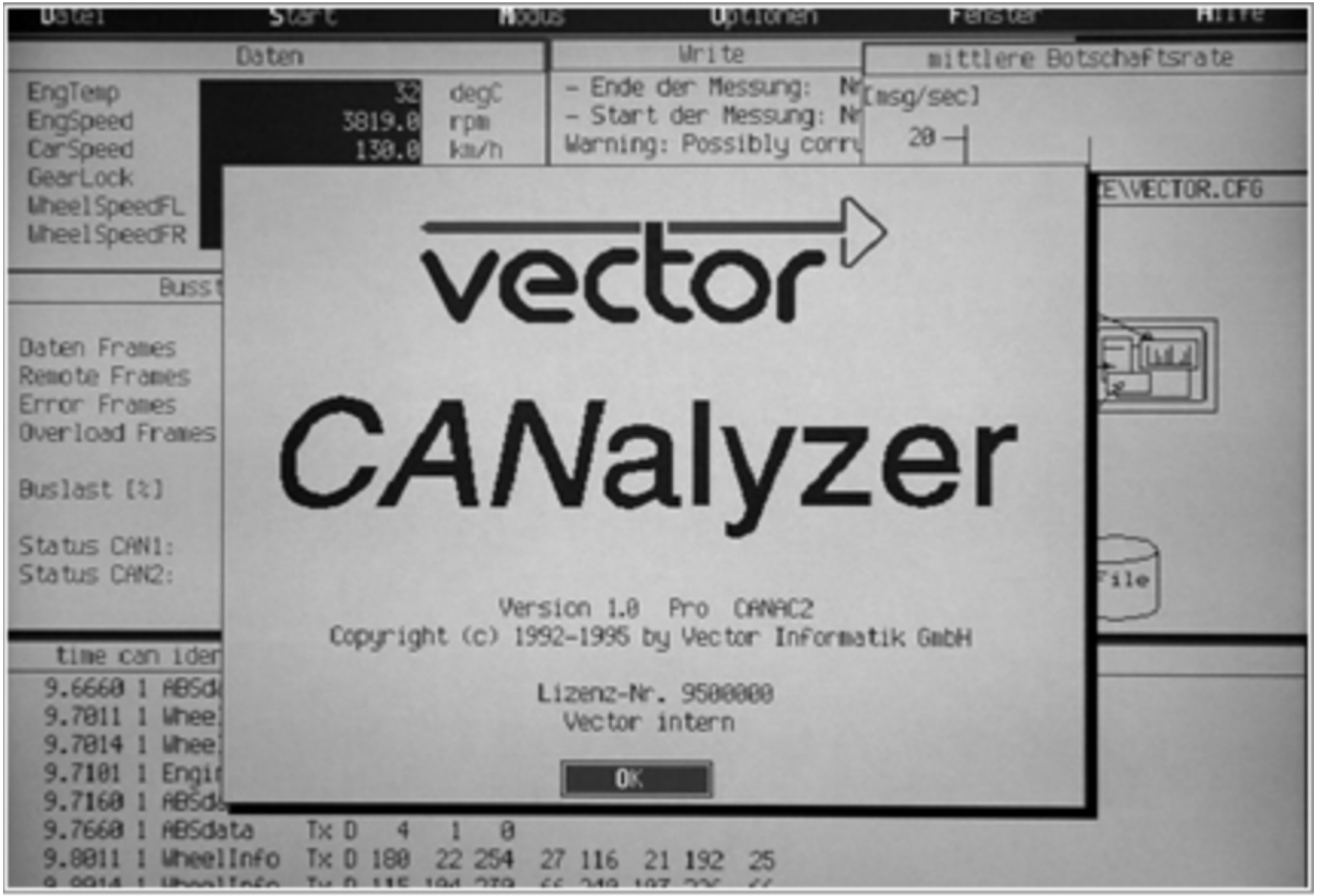
of automotive and related industries

a professional and open development platform of

tools, software components and services

for creating embedded systems.

Vector: state of the art tools for (CAN) Networking



25 Years vector

Vector's History

▶ 2013	25th company anniversary, foundation of Vector Austria
▶ 2012	Foundation of the office for Aerospace customers in Hamburg
▶ 2010	Formation of the 2 Vector foundations, more than 1,000 employees
▶ 2010	aquintos becomes part of the Vector Group
▶ 2007-09	Vector Korea, UK, India and China
▶ 2005	More than 500 employees worldwide
▶ 2001/02	Foundation of Vector Consulting, Vector France and Scandinavia
▶ 1999	More than 100 employees worldwide
▶ 1997/98	Vector USA and Japan
▶ 1996	Delivery of the first CANoe and CANape
▶ 1992	Delivery of the first CANalyzer license
▶ 1988	Foundation of Vector

CAN Milestones

CAN FD as part of ISO11898	▶ 2012
ARNIC 825 for avionics	▶ 2004
J1939 for commercial vehicles	▶ 2003
CAN used in car interior (C-class)	▶ 1997
CANopen / CAN in Automation (CiA)	▶ 1995
ISO 11898	▶ 1994
CAN ECU in series production (S-class) (ECU contained Vector embedded software)	▶ 1990
Intel 82C526 in series	▶ 1988
First silicon from Intel	▶ 1987
CAN Spec completed, cooperation with Intel	▶ 1985
Start of CAN development at Bosch	▶ 1983

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Vector Application Areas and Product Examples

Development of Distributed Systems
PREEvision, Network Designer

ECU Software
MICROSAR, Customer Services

ECU Analysis, Simulation & Testing
CANoe, vTESTcenter, vTESTstudio, VT System, Logger

Diagnostics
CANdela, Indigo, vFlash

ECU Calibration
CANape, VX1000, vCDM

Consulting
Consulting Services, Engineering Services

Vector offers solutions for ... >

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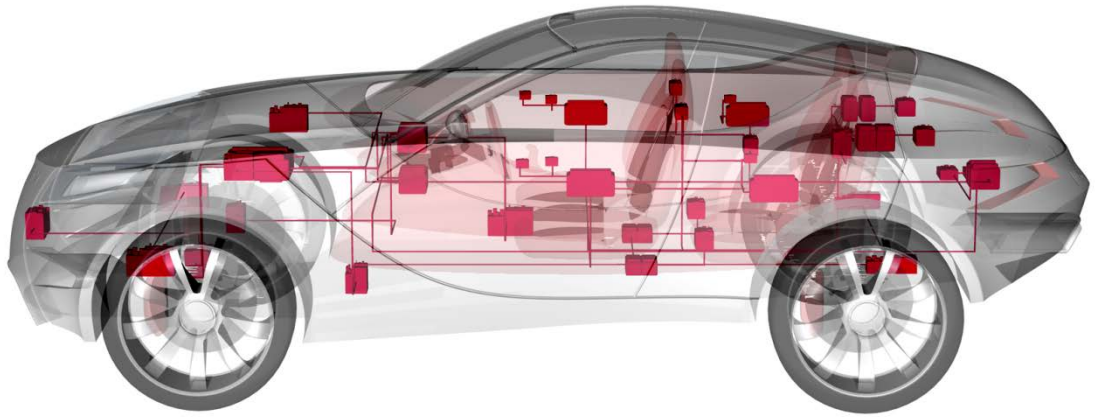
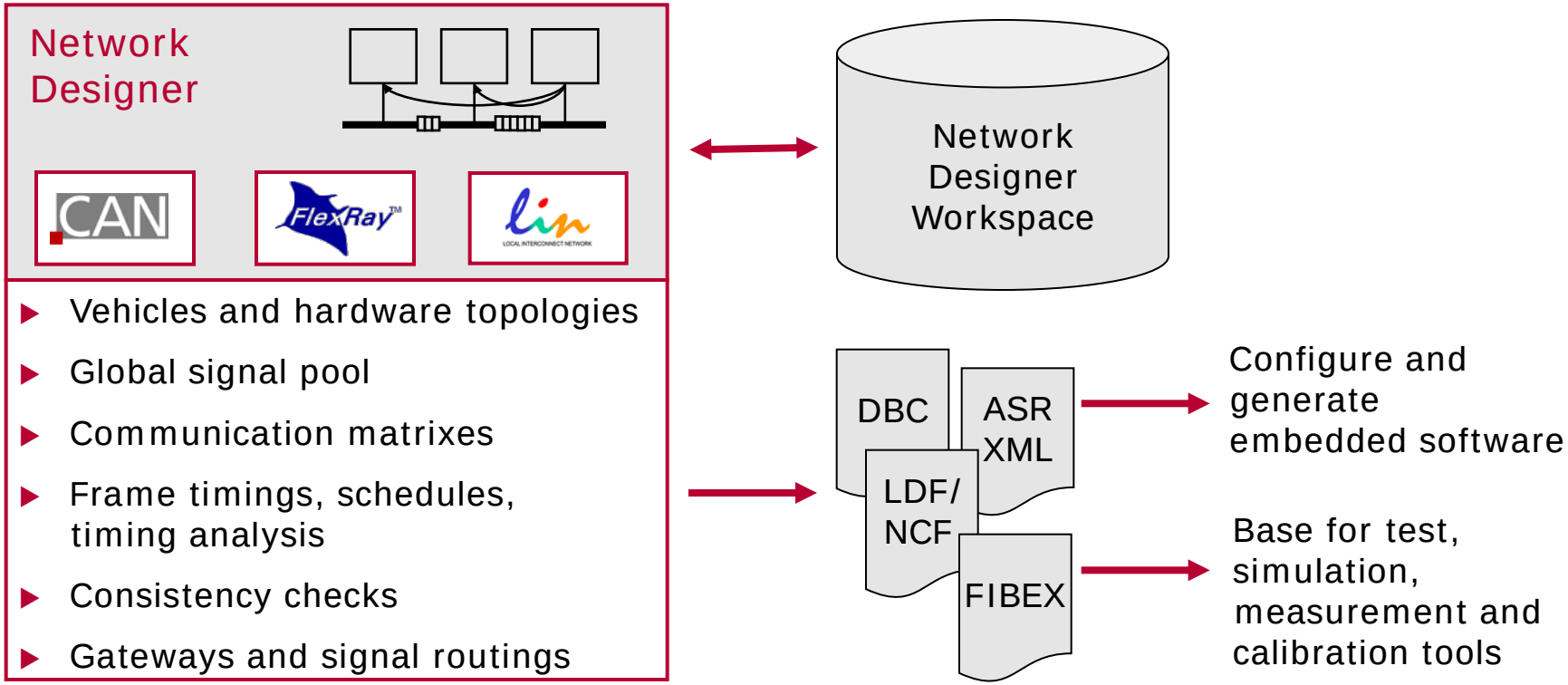
Our Portfolio

Development of Distributed Systems

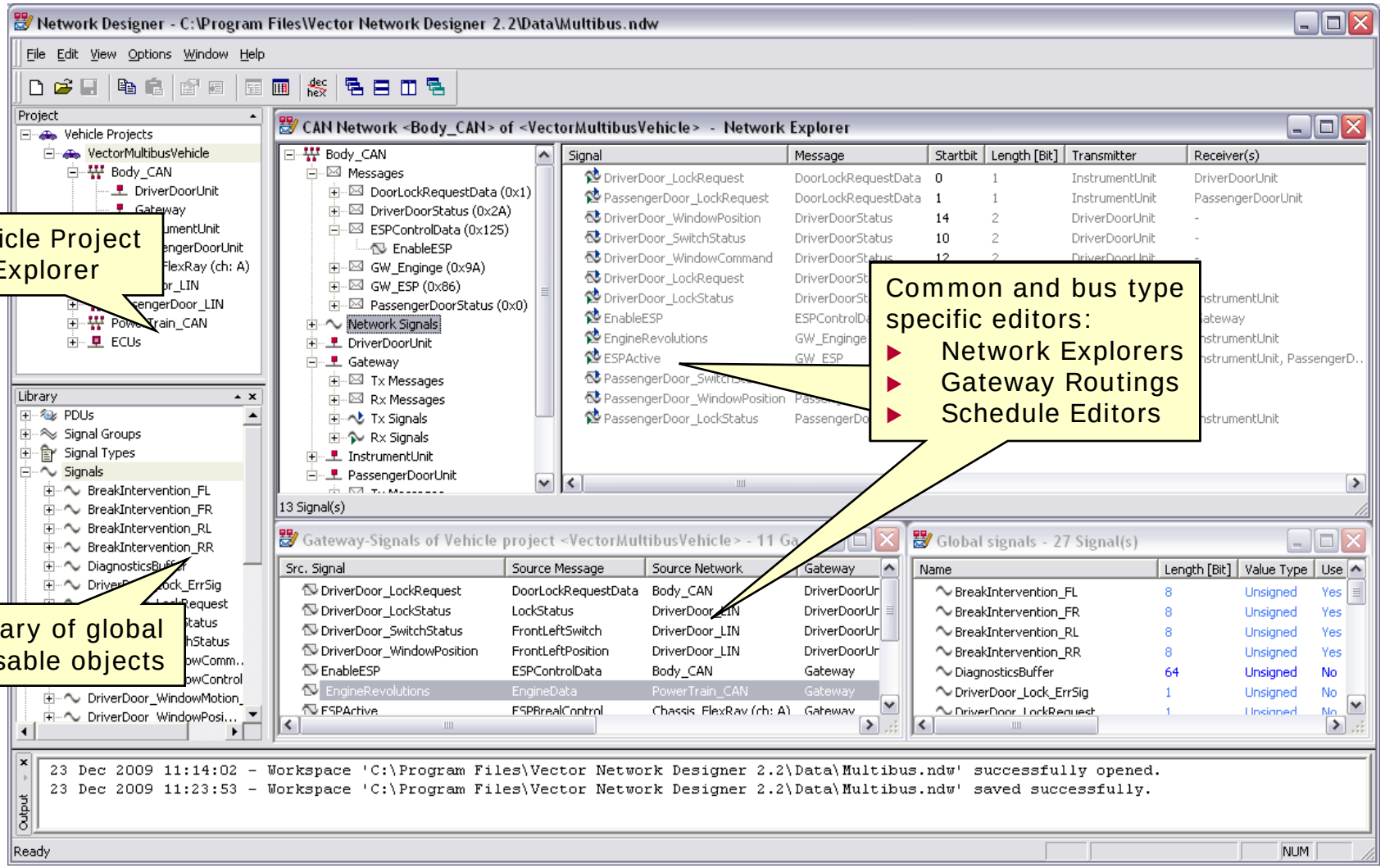
- Partitioning of the complete system
- Definition of the network communication
- Realization of the single ECU functions



Network Designer supports the design of network architectures for distributed automotive systems



Network Designer



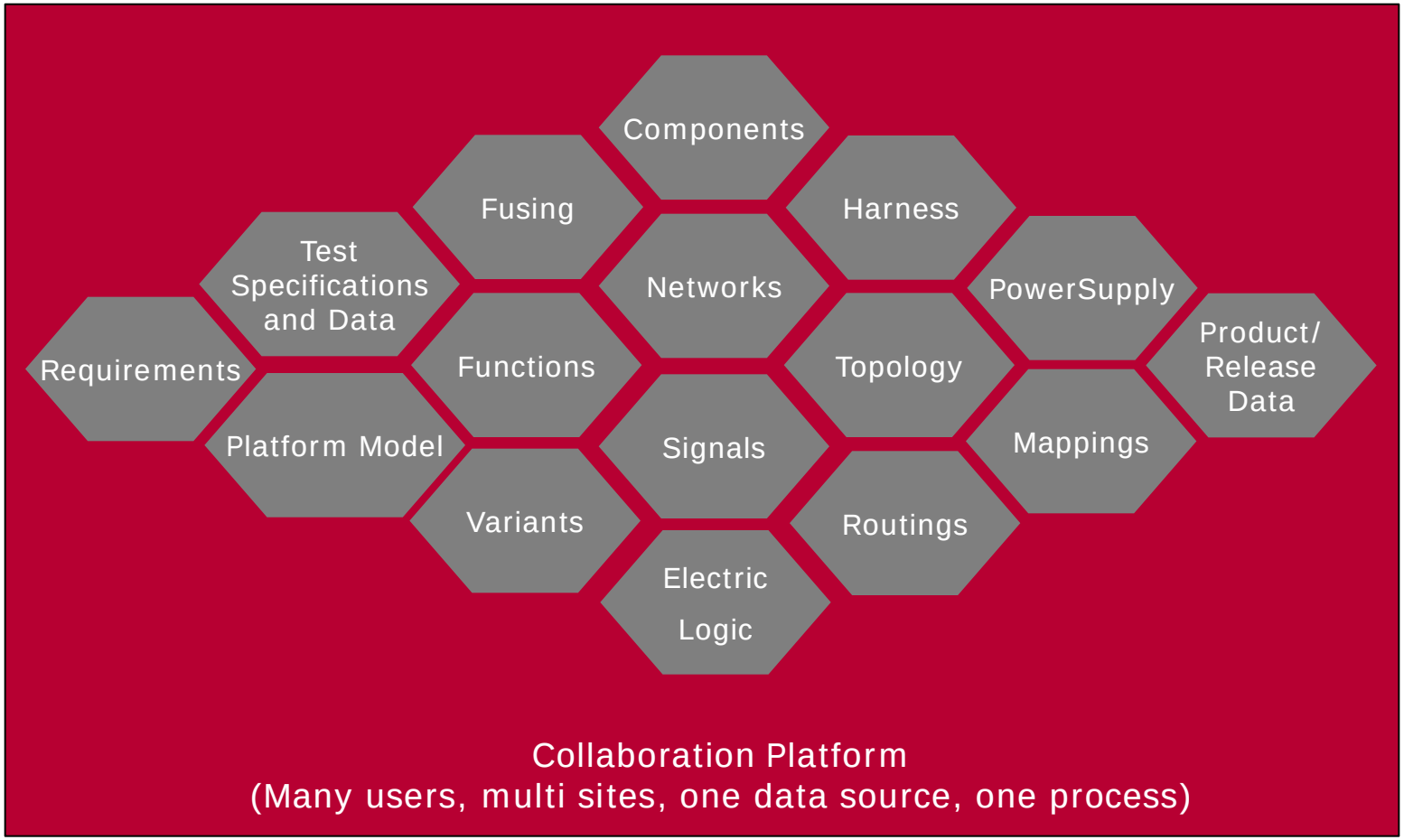
Vehicle Project Explorer

Library of global reusable objects

Common and bus type specific editors:

- Network Explorers
- Gateway Routings
- Schedule Editors

PREEVISION® One data model, one GUI, full traceability



Development of Distributed Systems

PREEvision Data Model

Requirements
(Links, Attributes)

Logical Architecture
(Domains, log. Functions, Activity Chains)

SW Architecture
(AUTOSAR, SW Components and Compositions)

SW Implementation
(Simulink „Gray Box“, Parameter Values, Basis SWCs)

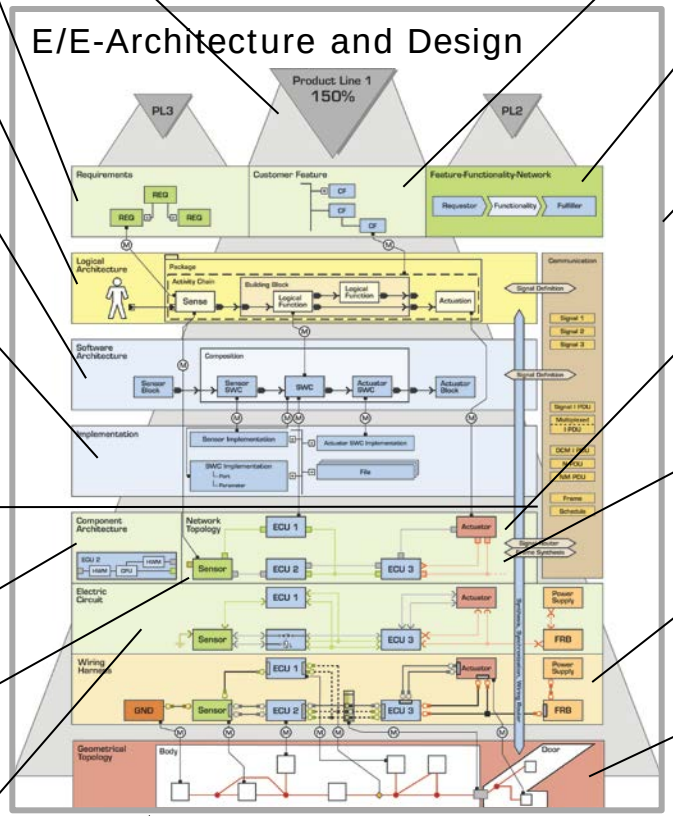
Communication
(Data Element, Signal, PDU, Frame, Bus Schedule, ...)

HW Components
(Internal Structure of ECUs, Sensors, Actuators, ...)

HW Network
(Bus Topologies & Conventional Communication Connections)

HW Schematics
(Electric Functions, Components, ...)

Product Lines
(Reuse, 150% Model, Variant Management)



Customer Features

Feature Function Network
(Use Cases)

Mapping
(Decoupling of Layers, Variant Management)

HW Power Concepts
(incl. Fusing Concepts, ...)

HW Grounding Concepts

HW Wiring Harness
(Cables, Connectors, Pins, ...)

HW Geometry
(Packaging, Environmental Requirements, ...)

Consistency Checks

Reporting
(Document and HTML Generation)

Metrics
(Calculation of Quality Characteristics)

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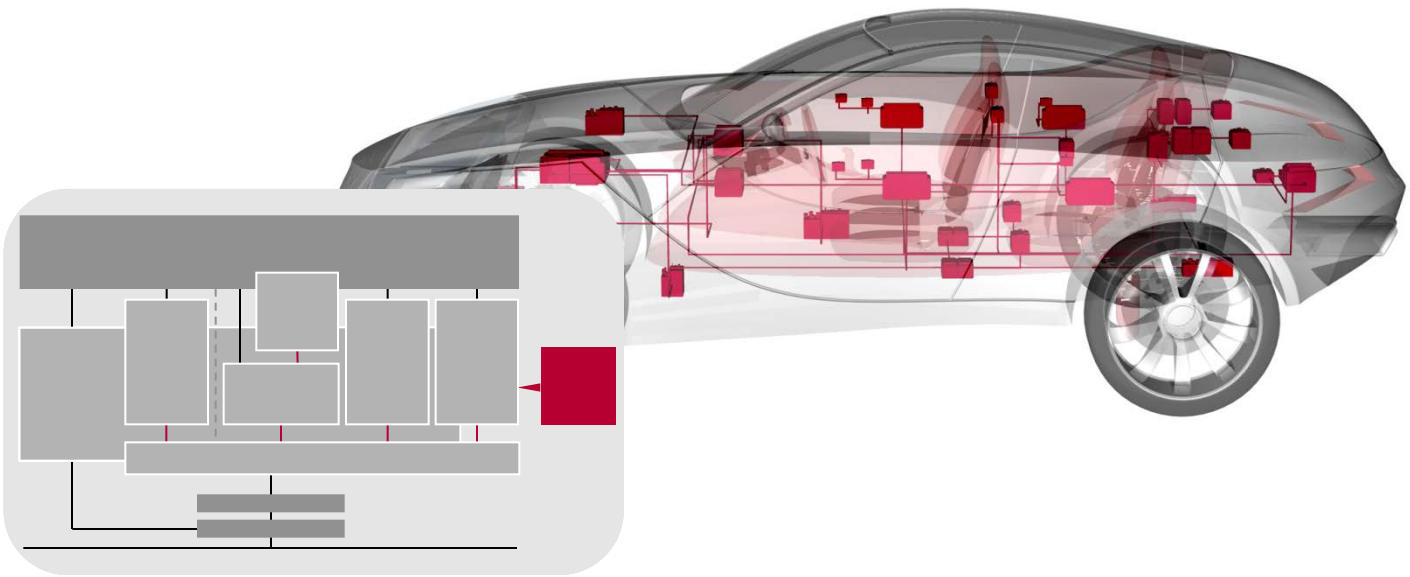
Our Portfolio

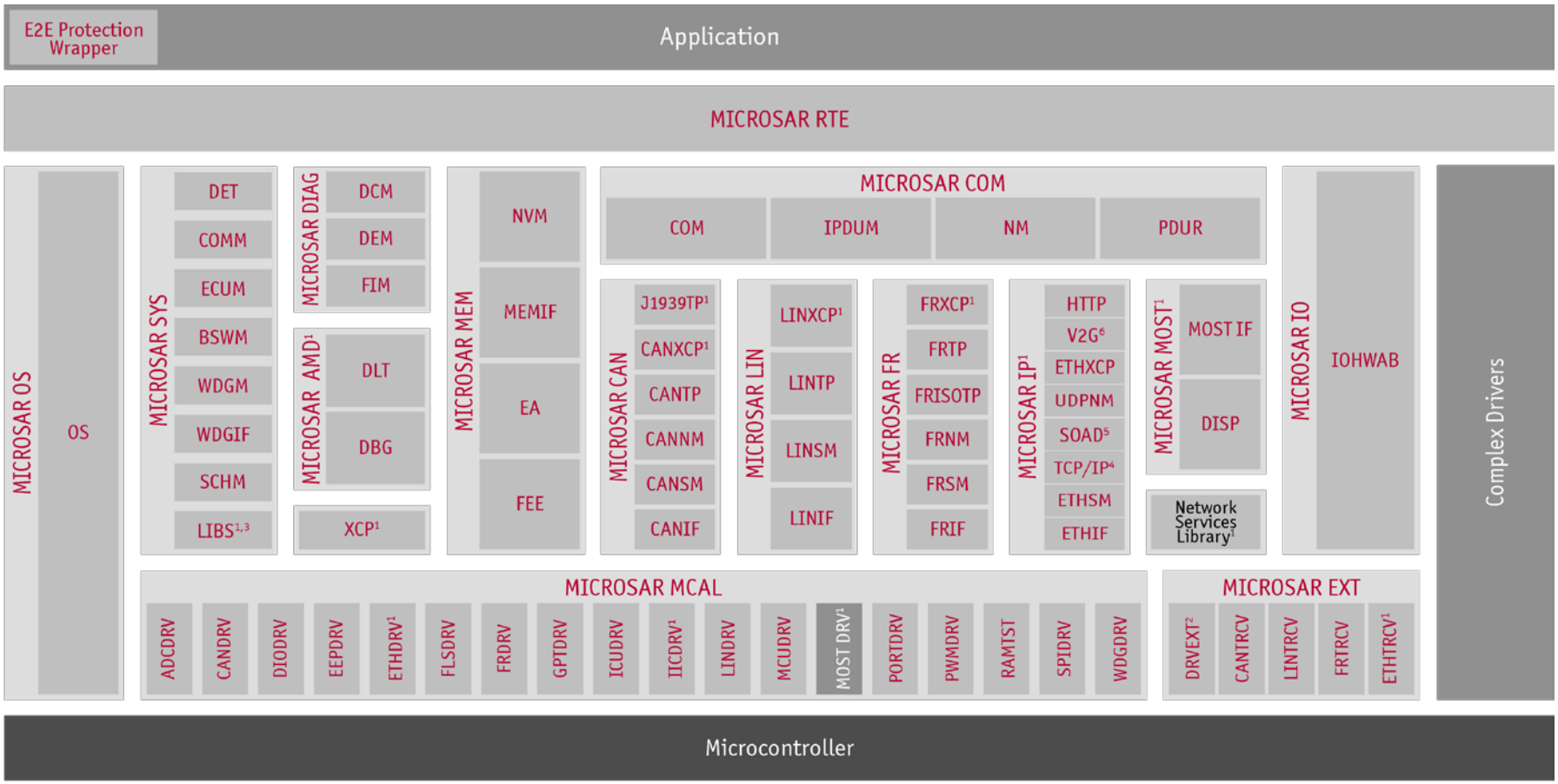
ECU Software

- Software components for the ECU communication
- Flash tools for CAN, LIN and FlexRay
- Real-time operating systems, hardware drivers for ECUs
- Engineering services, project specific developments for customers



ECU Software

Example Autosar Stack



Standard Software | Projects and Services | 3rd Party Software

[1] Available extensions for AUTOSAR
[2] Includes EEPEXT, FLSEXT, and WDGEXT
[3] Includes E2E, CPL and CRC
[4] Includes IPv4/v6, ARP/NDP, ICMP, UDP, TCP, DNS, DHCP and TLS
[5] Includes Diagnostics over IP (DoIP)
[6] Includes SCC according to ISO 15118 and

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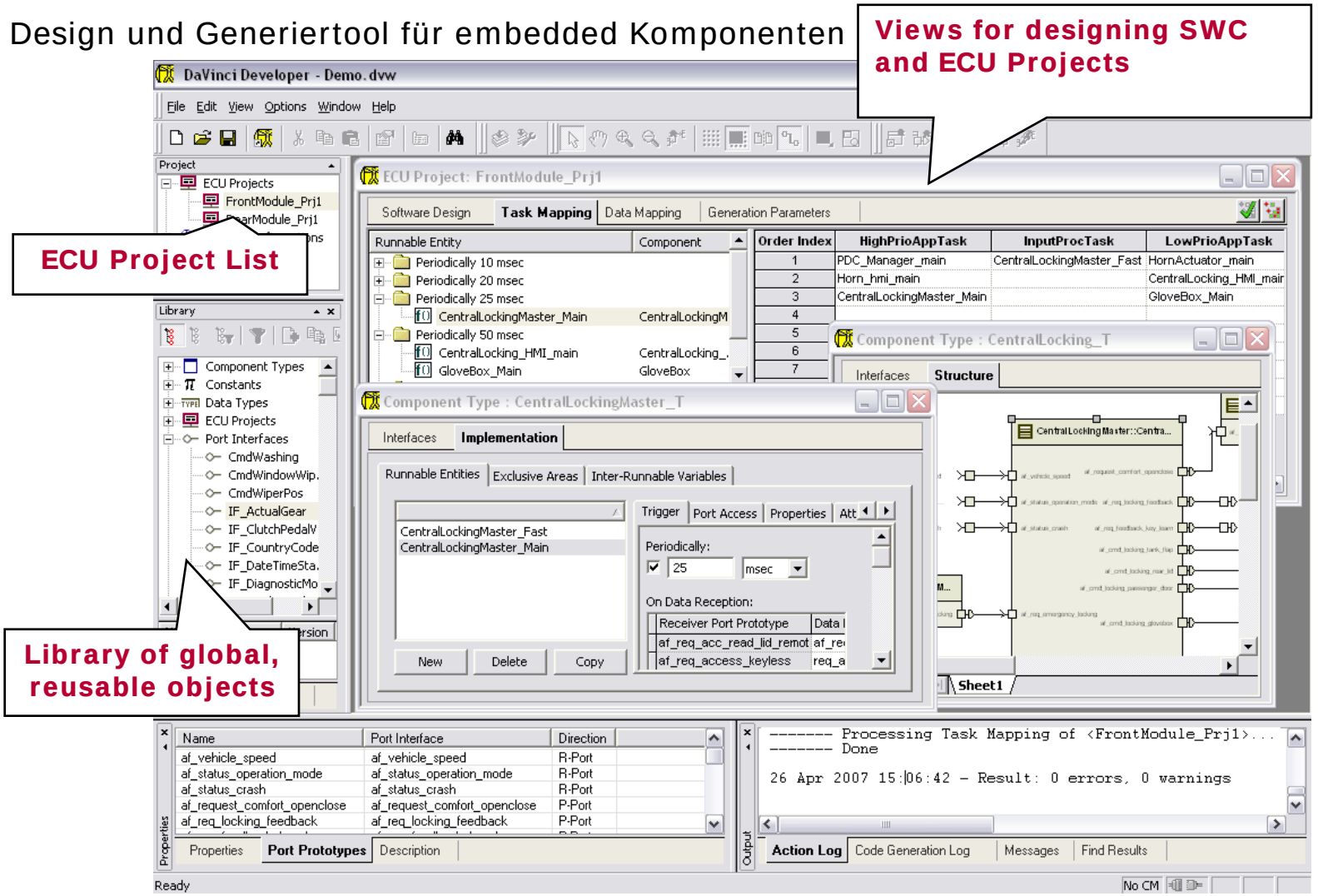
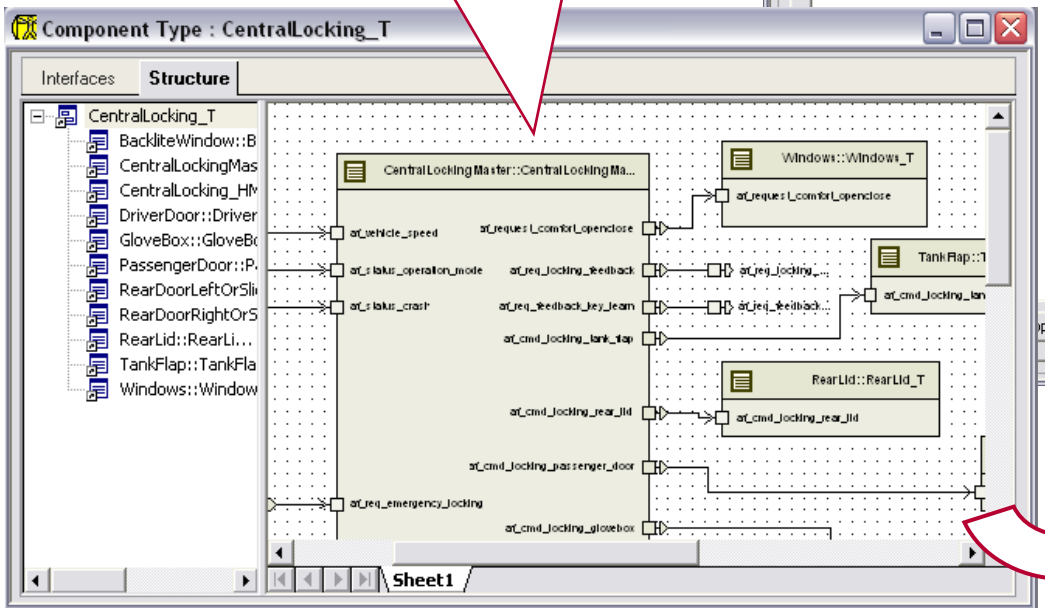
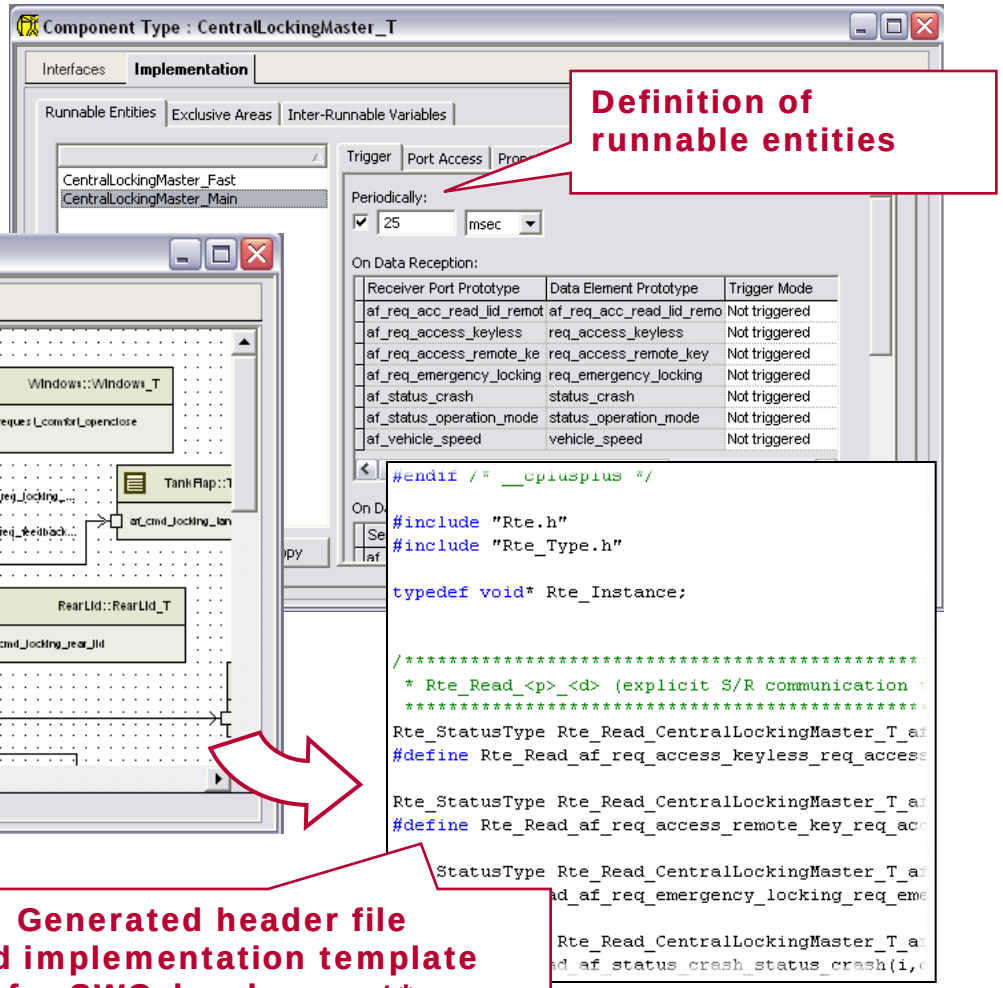
Design und Generiertool für embedded Komponenten



Graphical editor for interfaces and structure of SWC



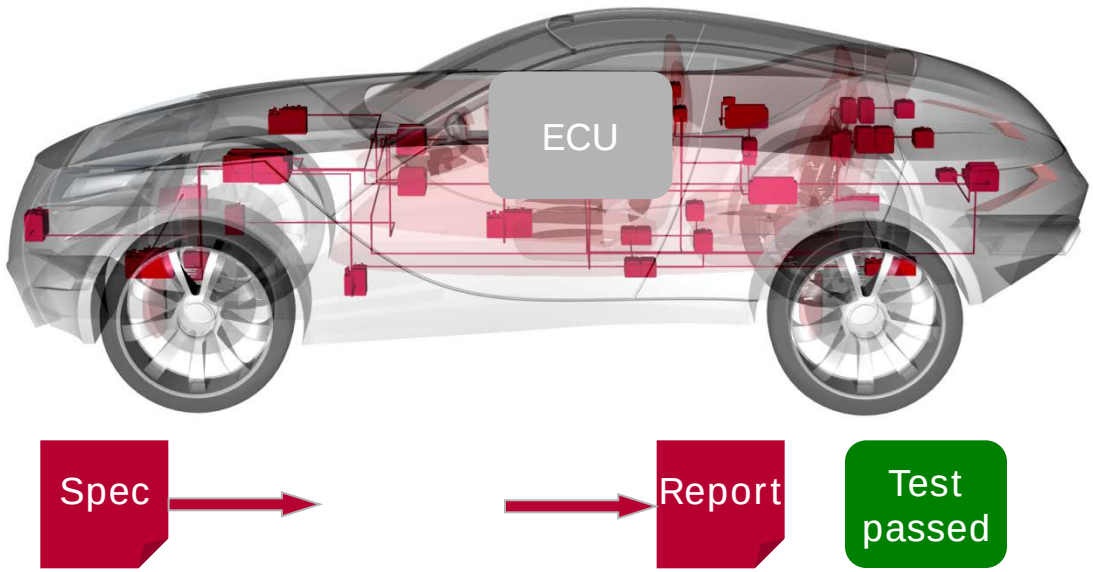


Definition of runnable entities

Generated header file and implementation template for SWC development*

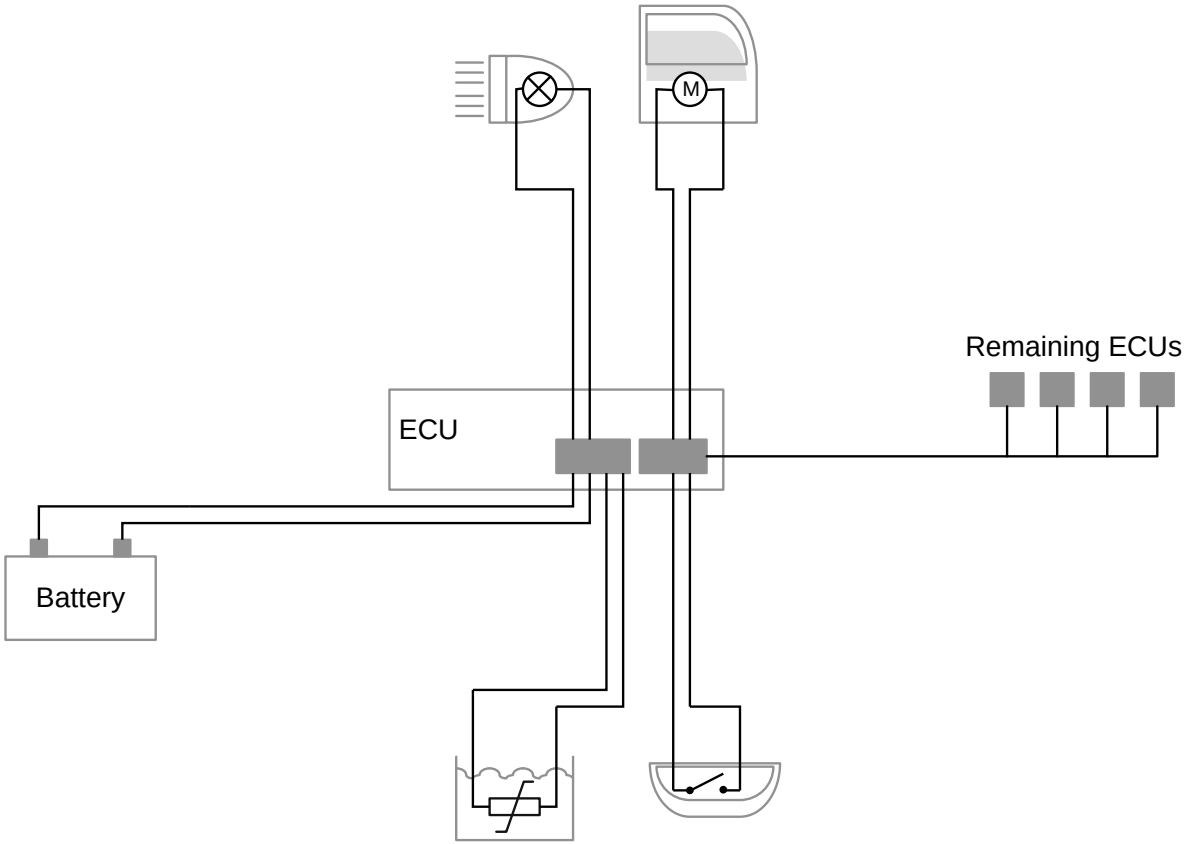
* Requires license of MICROSAR RTE

- Implementation of environments and scenarios for the test of ECUs and the bus communication during all development phases



What do I need for Testing an ECU?

ECU in its natural environment



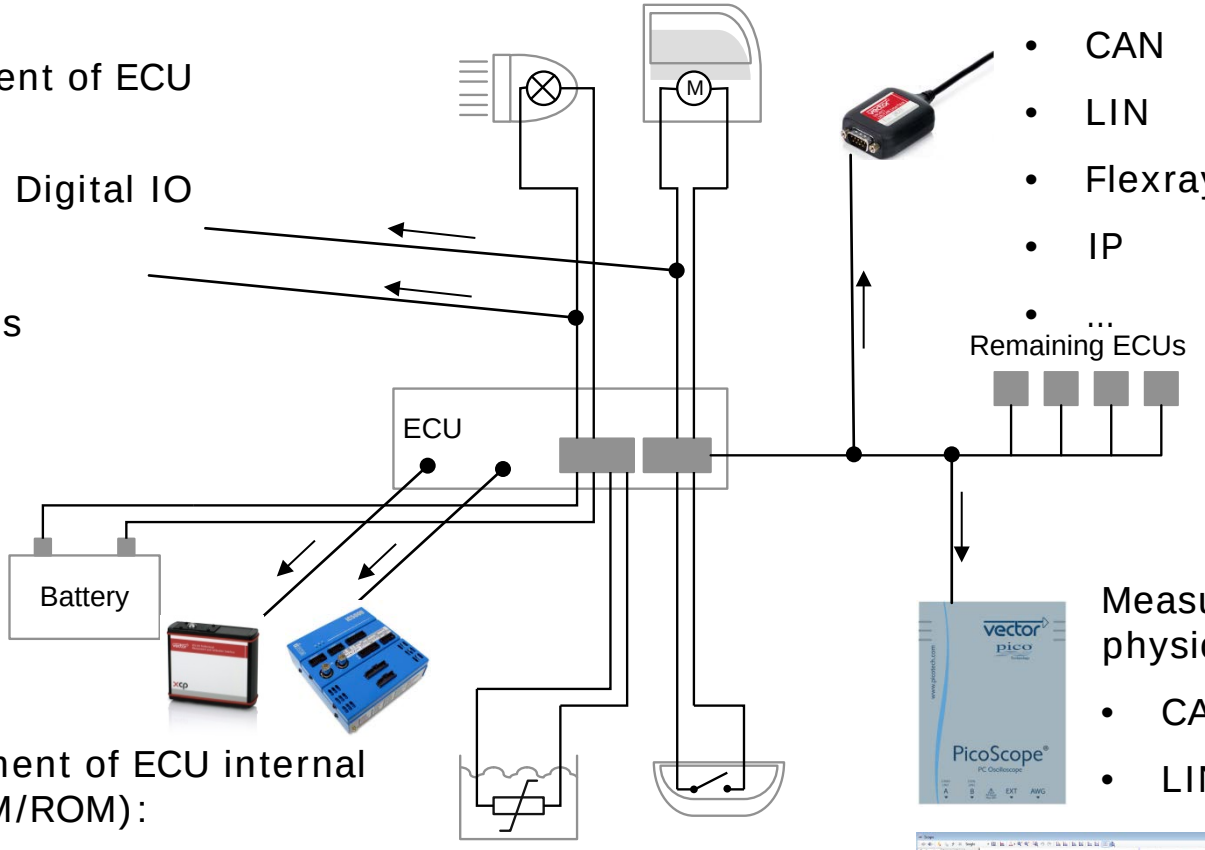
ECU: Electronic Control Unit

ECU test, simulation and analysis

Analysis / Data aquisition

Measurement of ECU outputs:

- Analog, Digital IO
- PWM
- Currents
- ...

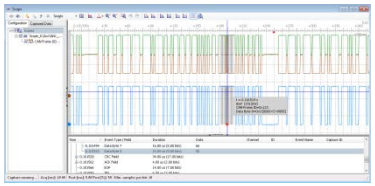


Analysis of bus data:

- CAN
- LIN
- Flexray
- IP
- ...

Measurement of bus physics:

- CAN
- LIN



Measurement of ECU internal data (RAM/ROM):

- XCP via CAN, FR
- XCP via Vx Hardware
- XCP via iSystem Debugger

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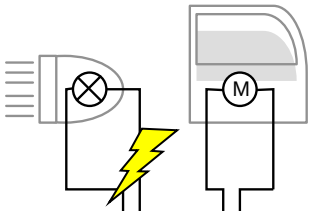
ECU test, simulation and analysis

Simulation of the ECU Environment

Stimulation of ECU inputs:

- Sensor simulation
- PWM
- Resistor
- ...



„Cut ECU free“

ECU

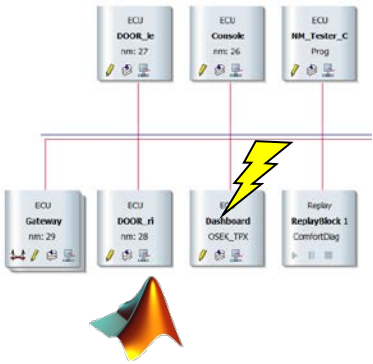
Battery

Access and control all ECU IOs

Remaining bus simulation:

- CAN
- LIN
- Flexray
- IP
- ...

Remaining ECUs



Diagnostics:

- Fault memory
- Coding
- Read/write ECU data
- ...

Fault injection:

- Broken wires,
- Short to Vbat, Gnd,
- communication errors (IL)
- Bus errors
- ...

Conclusion:

A powerful environment simulation which:

- provides access to all inputs and outputs of the SUT,
- is easy and flexible to setup and
- also provides interfaces to other systems

is the basis for a performant test setup.

ECU test, simulation and analysis

CANoe

GUI | Panels | COM | HIL-API/ FDX

Analysis	Simulation	Diagnostic	Test
Online	Matlab/Simulink ®	DiVa	XCP/CCP
Offline	OSEK/ Autosar Emulation		
Logging			

Extensions (OEM specific, J1939, BAP, CANopen, AUTOSAR, ..)

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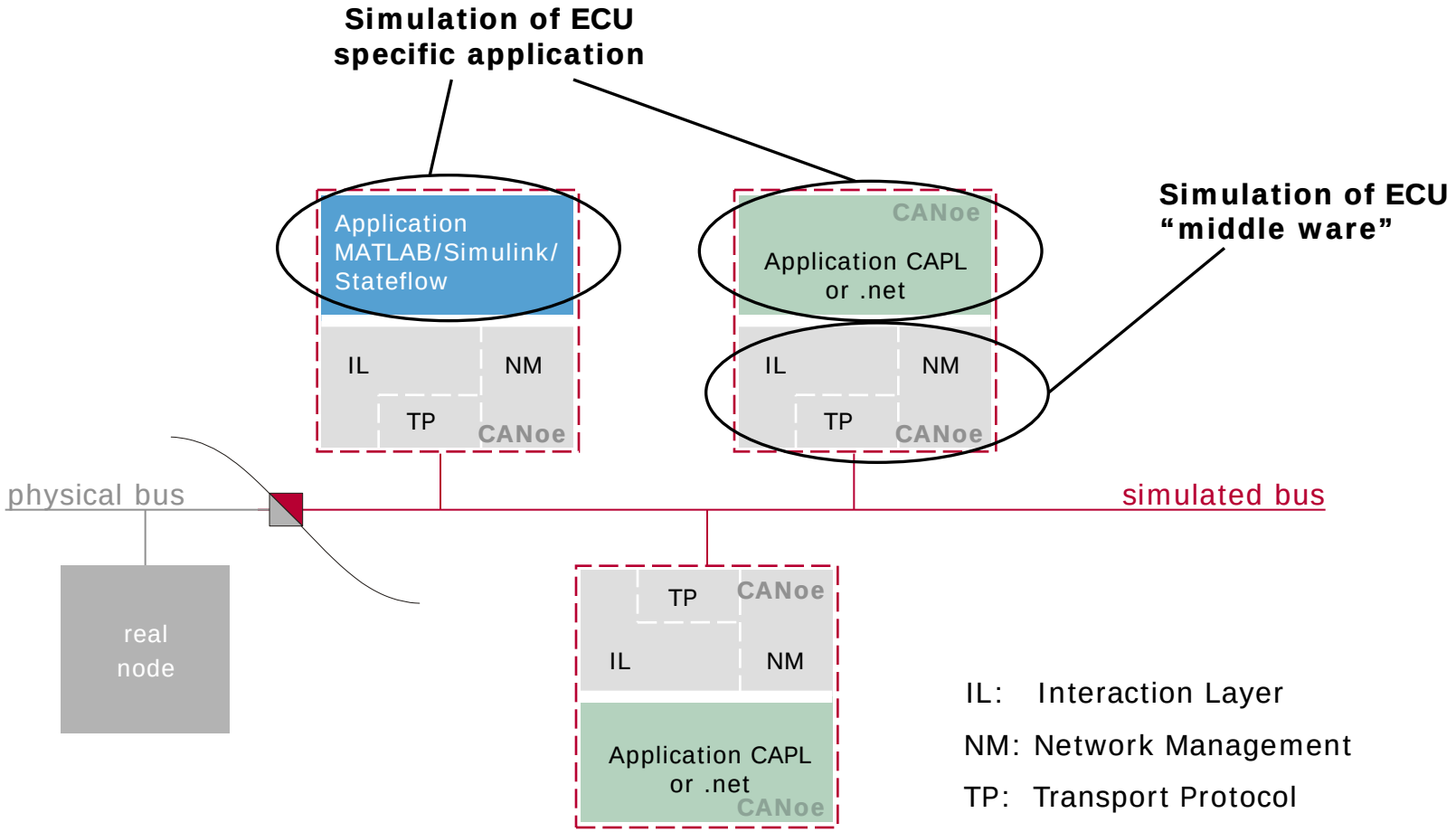
Creating a Remaining Bus Simulation with CANoe

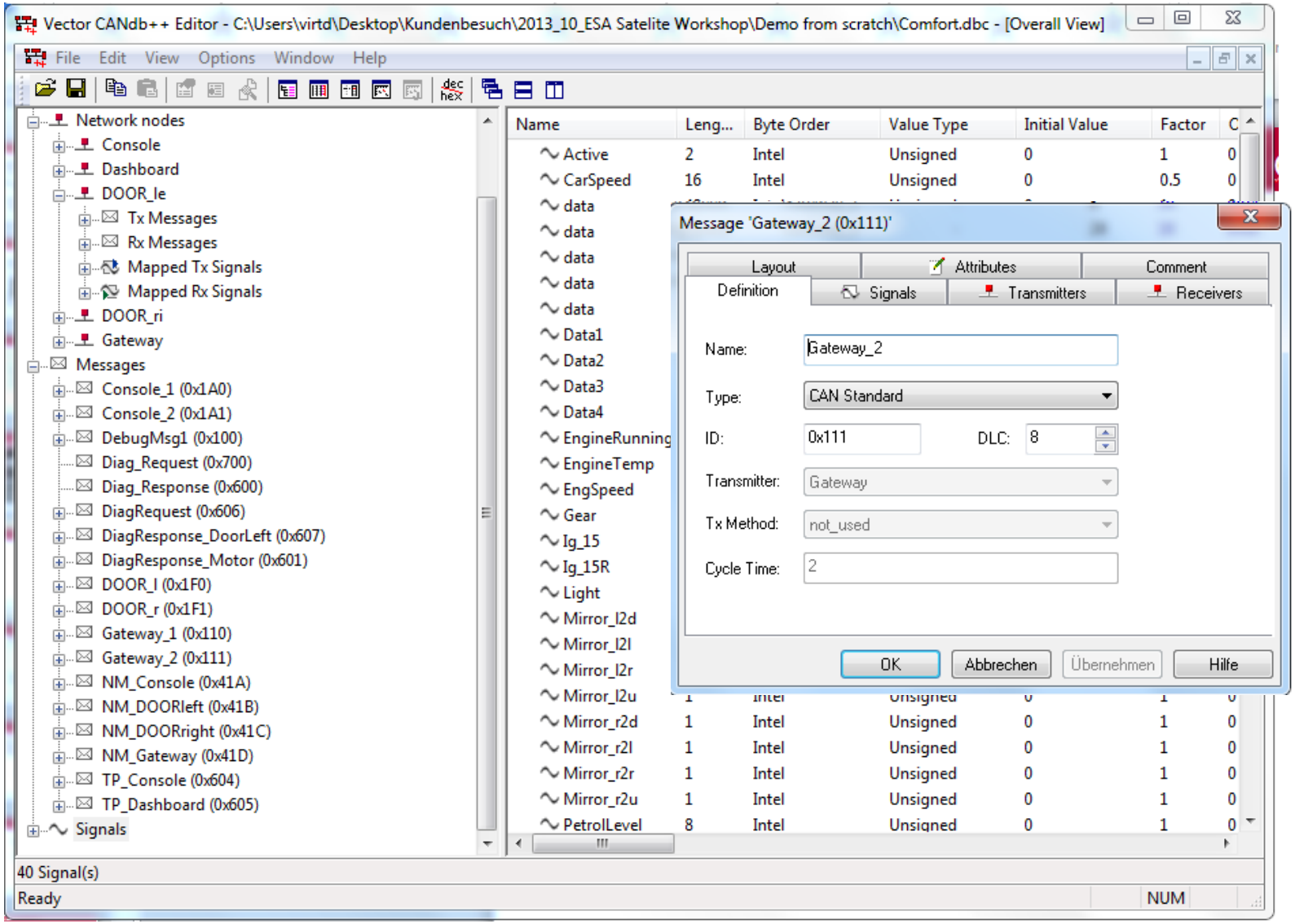
What do I need for a bus simulation?



Details

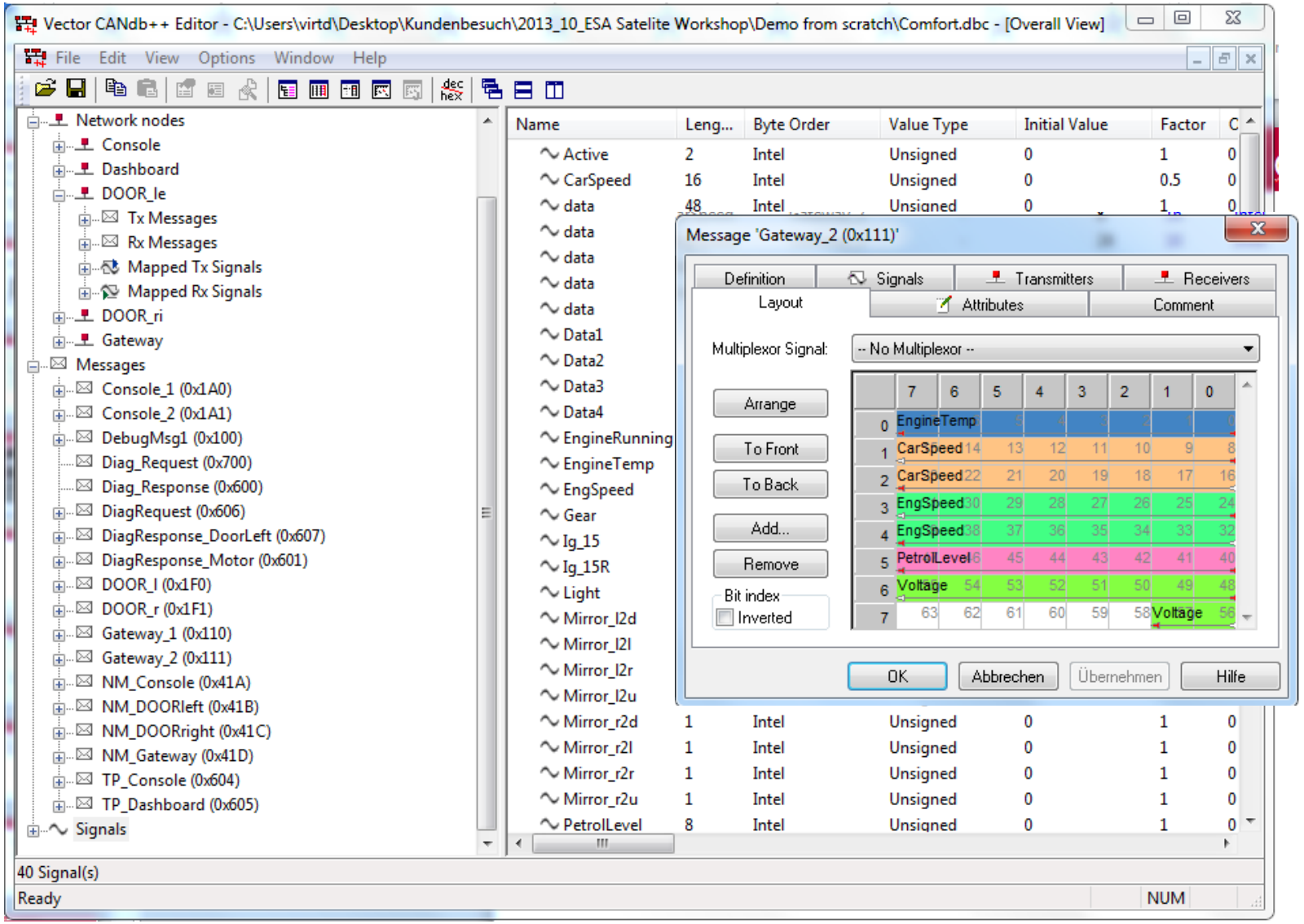
Creating a Remaining Bus Simulation with CANoe

1. Database – define communication



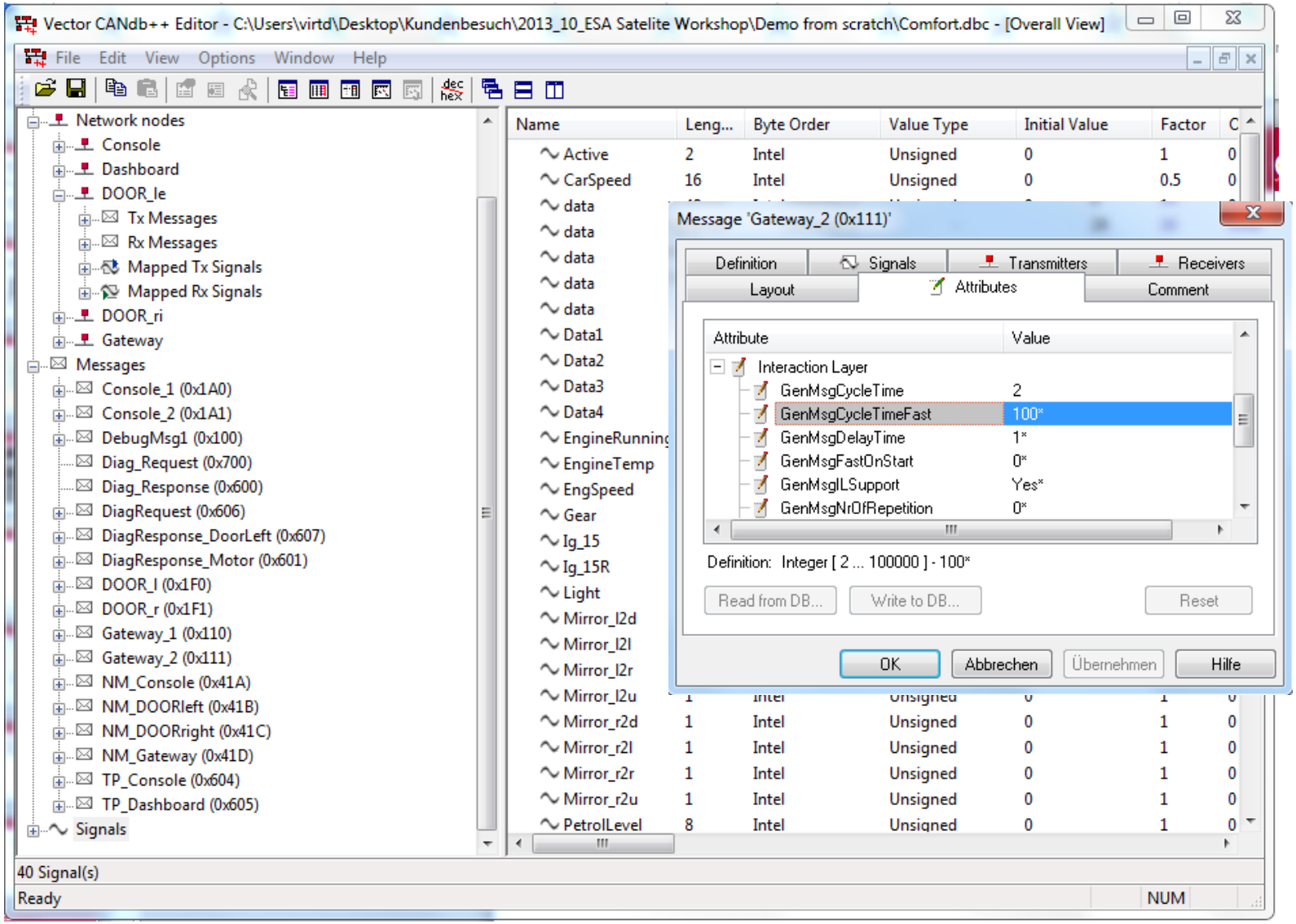
Creating a Remaining Bus Simulation with CANoe

1. Database – define communication



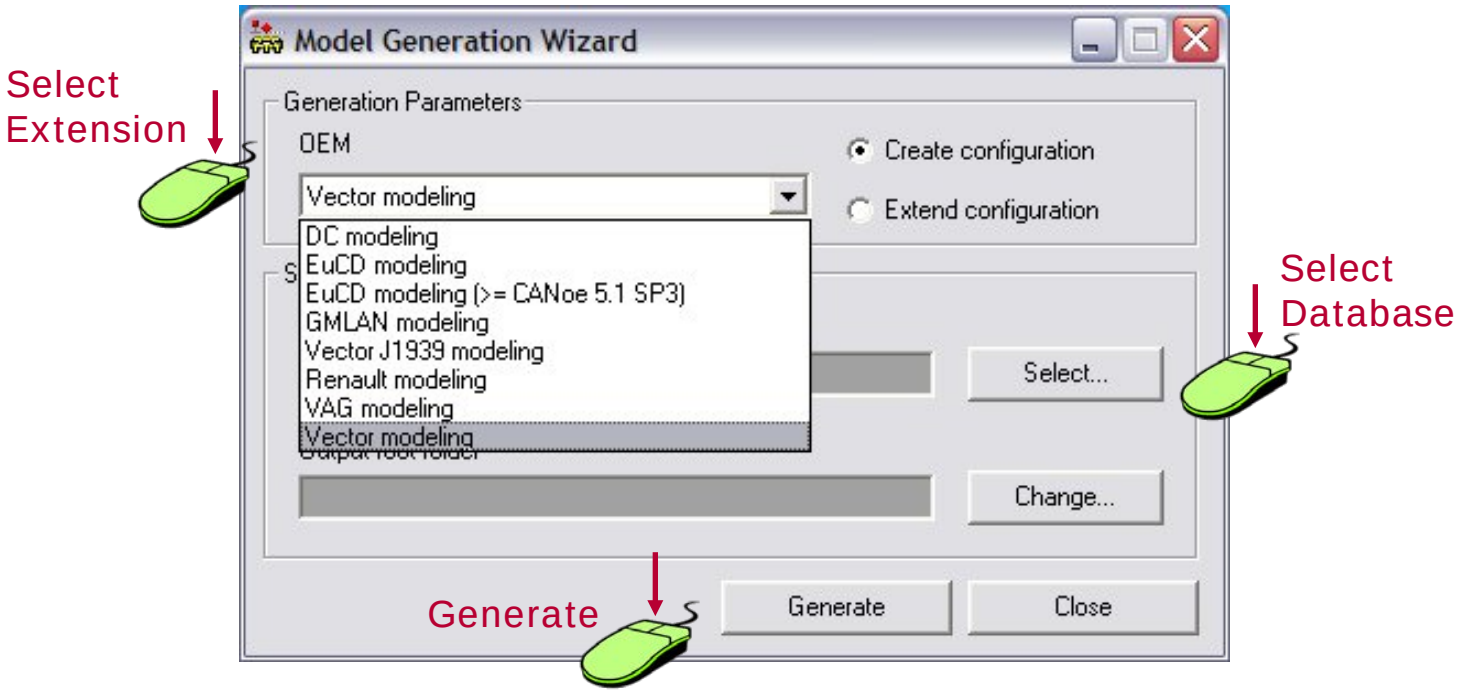
Creating a Remaining Bus Simulation with CANoe

1. Database – define communication



Creating a Remaining Bus Simulation with CANoe

2. Generate a basic bus simulation



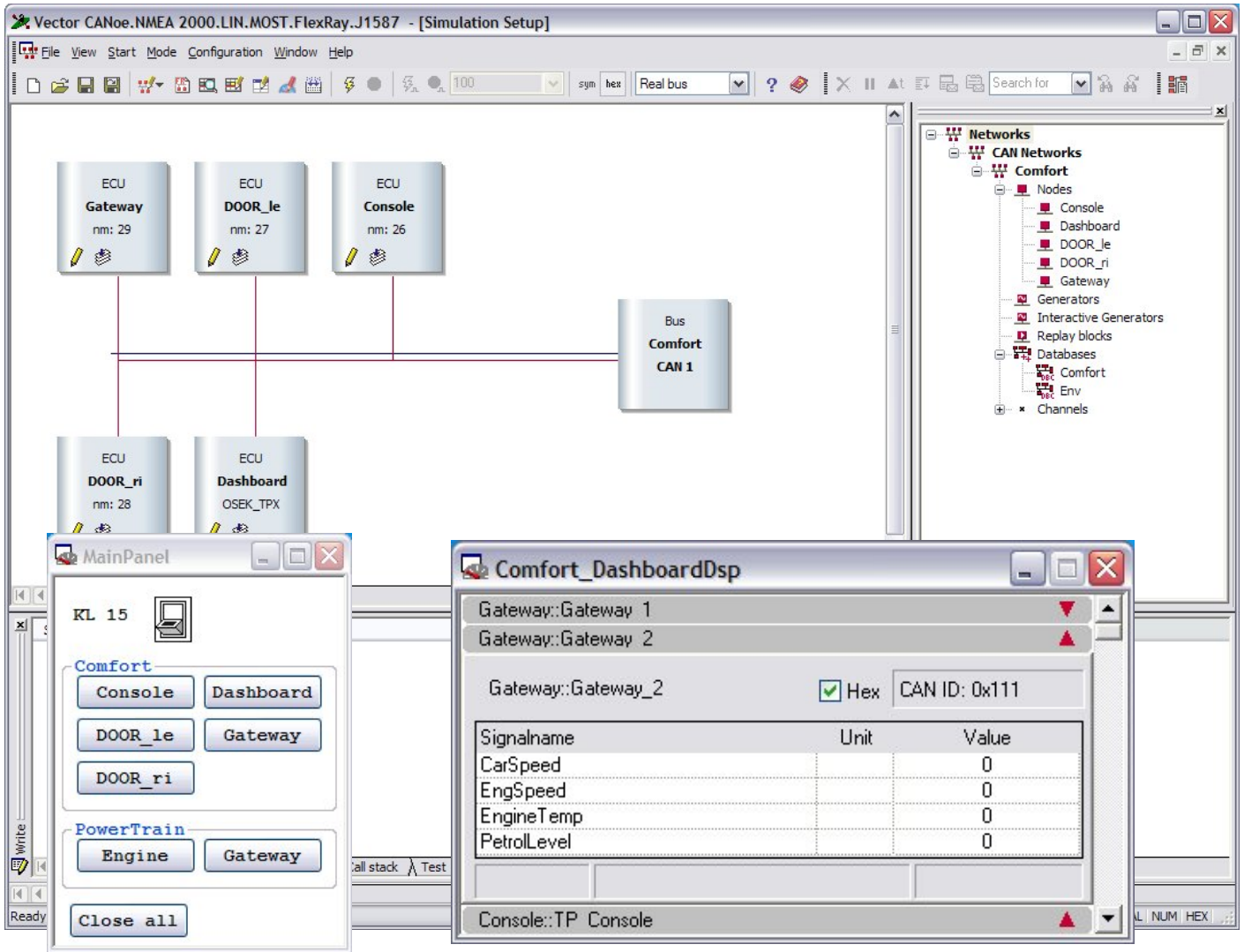
For various OEMs there exist oem extension packages that implement the OEM specific basic software behavior.

With „OEM“ Vector nearly everything can be realized if no package is available.

New OEM Packages can be implemented.

Creating a Remaining Bus Simulation with CANoe

3. Result: complete basic simulation

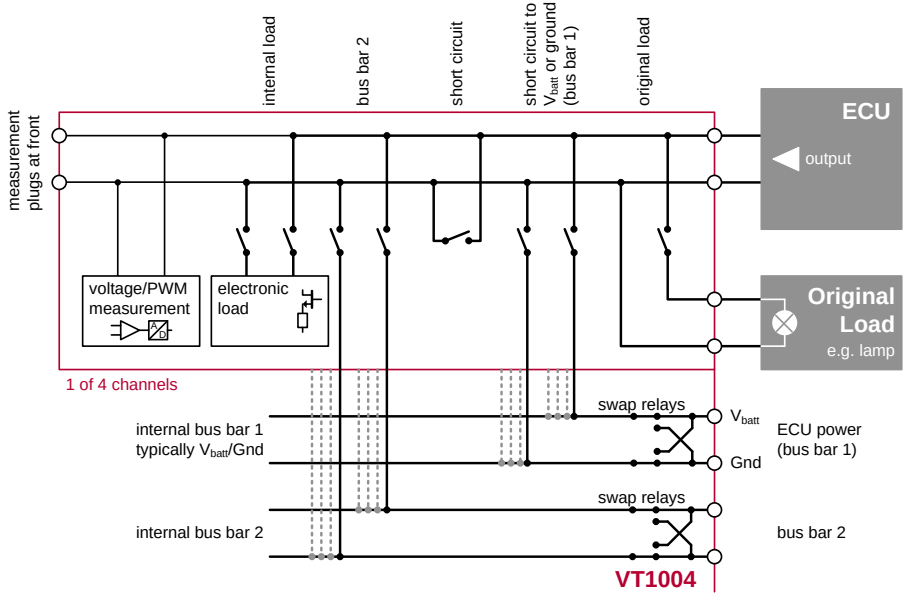


4. Contact to further interfaces of the ECU

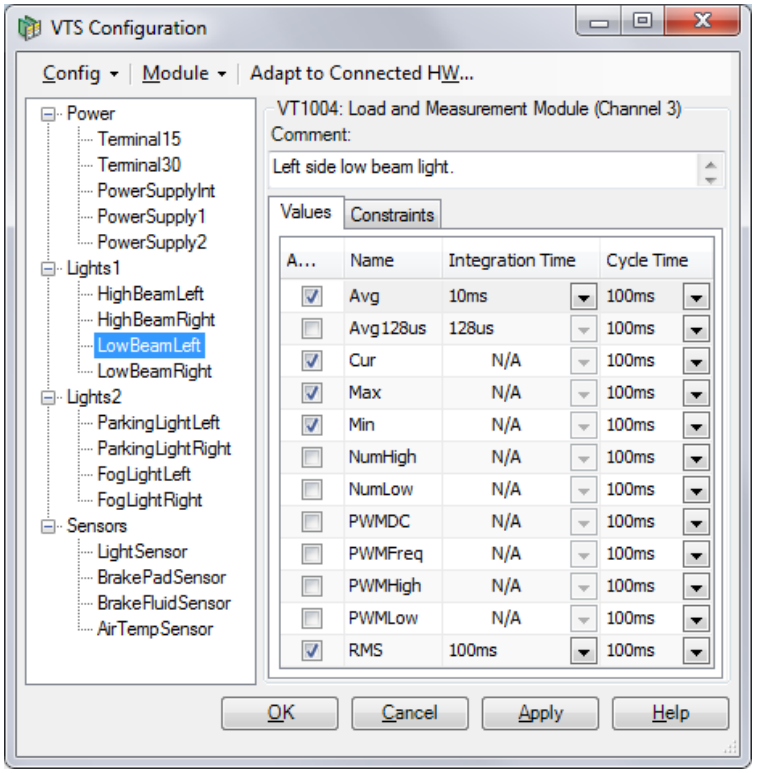
- Digital/analog IOs of the ECU
- Equipment for fault injection
- ECU internal data (XCP)
- Scopes (triggered out of CANoe)
- Controllable Power supply
- External measurement devices (e.g. via GPIB)
- ...

4. Vector Test System (VTS)

- All channels work parallel
- Designed for automotive ECUs
  - Automotive loads and sensors
  - Voltage range ±32 … ±40 V
  - Currents up to 16 A
- Fully integrated in CANoe



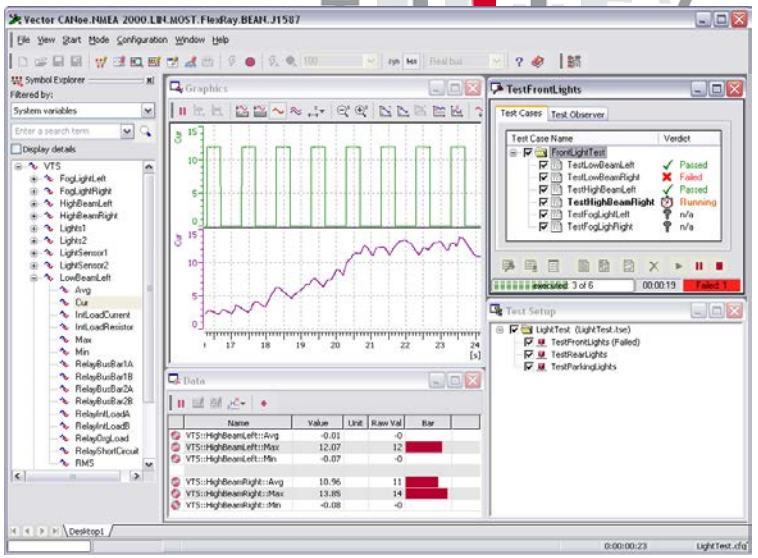
- VT System is easily configured via CANoe
  - Individual name can be assigned to each VT System channel
  - Used measurement signals are selected
  - Parameters like integration time (e.g. for average value calculation at the module) are configured
    - > Manually using the GUI
    - > Programmatically via CAPL and XML test modules
  - Constraints can be defined to protect the hardware (e.g. definition of the maximum output voltage)

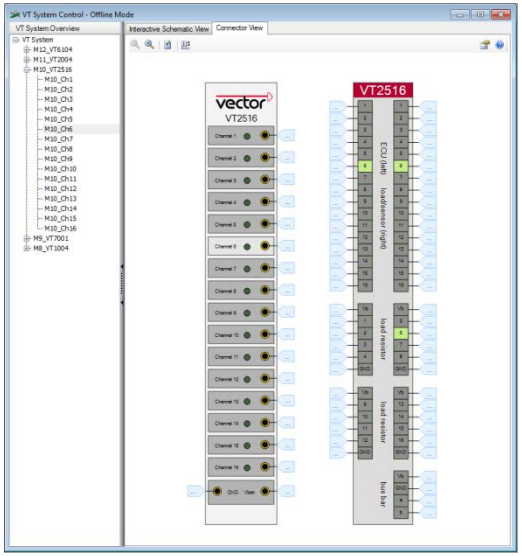


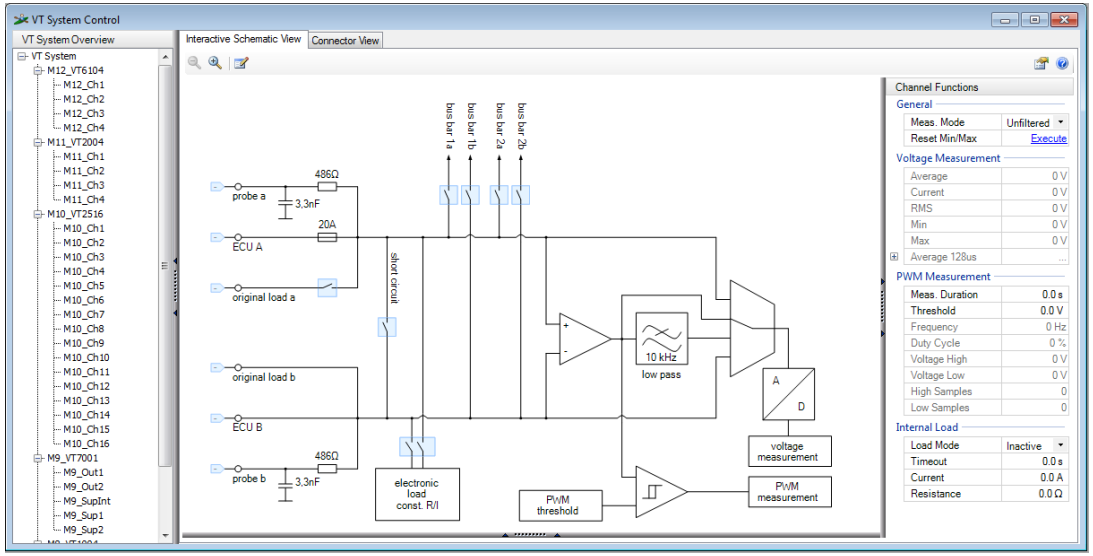
Creating a Remaining Bus Simulation with CANoe

4. Vector Test System (VTS)

- Fully integrated into CANoe
- Direct access to all I/O signals in XML, CAPL, .NET and data visualization
- Interface to control all settings (CANoe 8.0)
- Automatic Documentation as GUI and PDF (CANoe 8.0)







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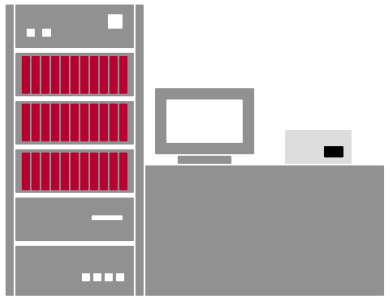
4. Vector Test System (VTS)

- Modular and scaleable system

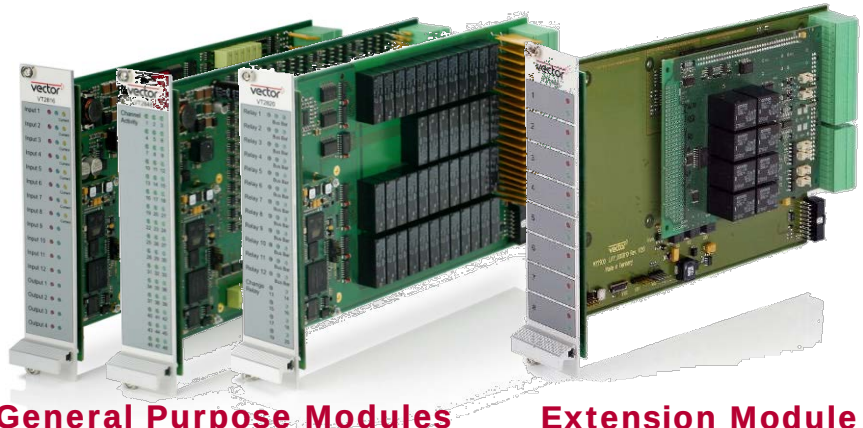


Creating a Remaining Bus Simulation with CANoe

4. Vector Test System (VTS)

Load Module
VT1004

Stimulation Modules
analog VT2004
digital VT2516



General Purpose Modules
analog VT2816
digital VT2848
Relais VT2820

Extension Module
VT7900

Real-Time Modules
ATOM VT6010
Core2Duo VT6050

Network Interface Module
VT6104

Power Module
VT7001

Creating a Remaining Bus Simulation with CANoe

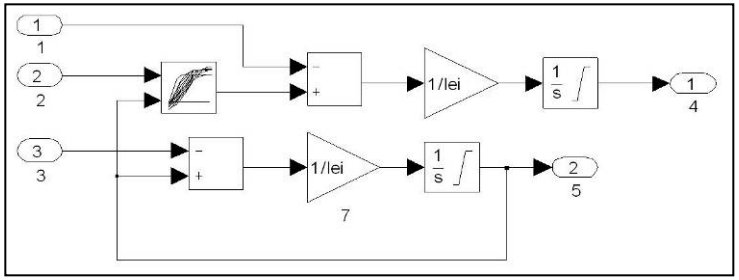
4. Vector Test System (VTS)

Module	Purpose	Fault Inject.	Channels
Load and Measurement Module VT1004	ECU actuator outputs	Yes	4
Stimulation Module VT2004	ECU sensor inputs	Yes	4
Digital Module VT2516	Digital ECU inputs and outputs	Yes	16
Power Supply Module VT7001	ECU power inputs (term. 15, 30)	Yes	2
Network Module VT6104	ECU networks (CAN/LIN)	Yes	4
Real-time Module VT6010	RT part execution (atom)	-	-
Real-time Module VT6050	RT part execution (core 2 duo)	-	-
General-Purpose Analog I/O Module VT2816 (FPGA)	Analog I/O for arbitrary use (user defined FPGA optionally)	No	in: 12 out: 4
General-Purpose Relay Module VT2820	Relays for arbitrary use	No	20
General-Purpose Digital I/O Module VT2848 (FPGA)	Digital I/O for arbitrary use (user defined FPGA optionally)	No	48
Extension Module VT7900	Base board for appl.-specific electronics	No	-

Creating a Remaining Bus Simulation with CANoe

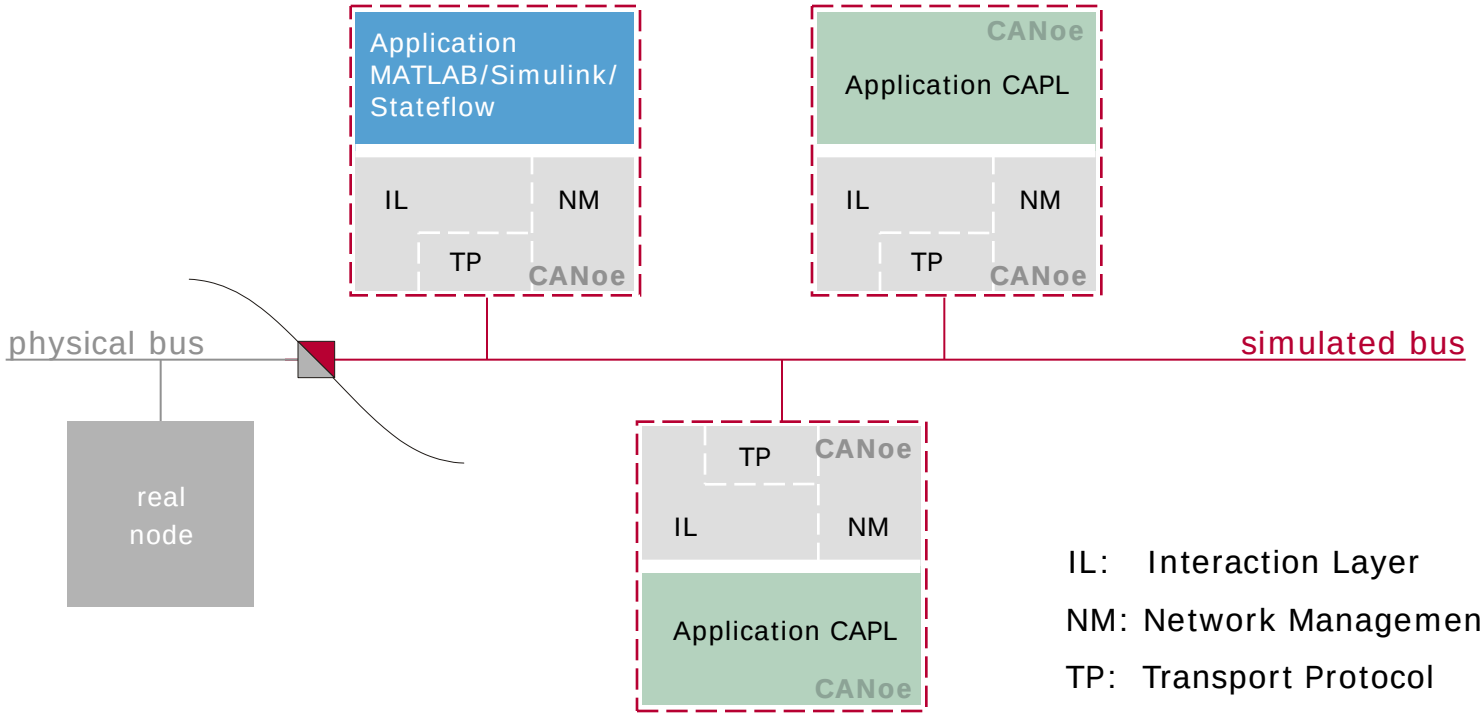
5. Implement the application behavior

Application Model in MATLAB



Application Model in CAPL or .net

```
on timer tConsoleElementsDsp2
{
  // Shows the elements "Oil", "Water" & "Battery" in the Dashboard.
  // When the devices are ok the lights will disappear.
  if(gIg_15R)
  {
    @Env%NODE_NAME%EngOilDsp_ = 0;
    @Env%NODE_NAME%EngWaterDsp_ = 0;
    @Env%NODE_NAME%EngBaterryDsp_ = 0;
  }
}
```



IL: Interaction Layer

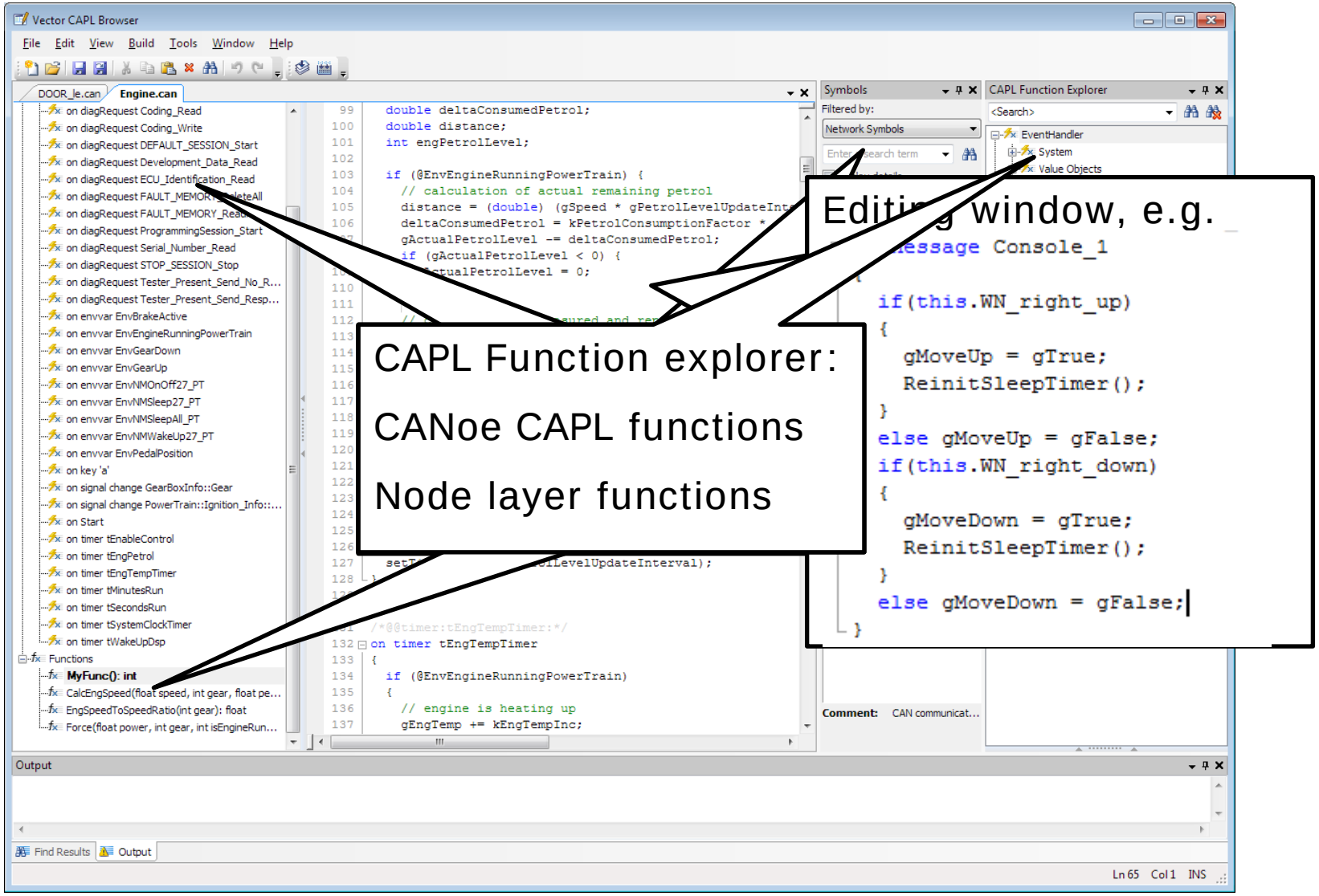
NM: Network Management

TP: Transport Protocol

Details

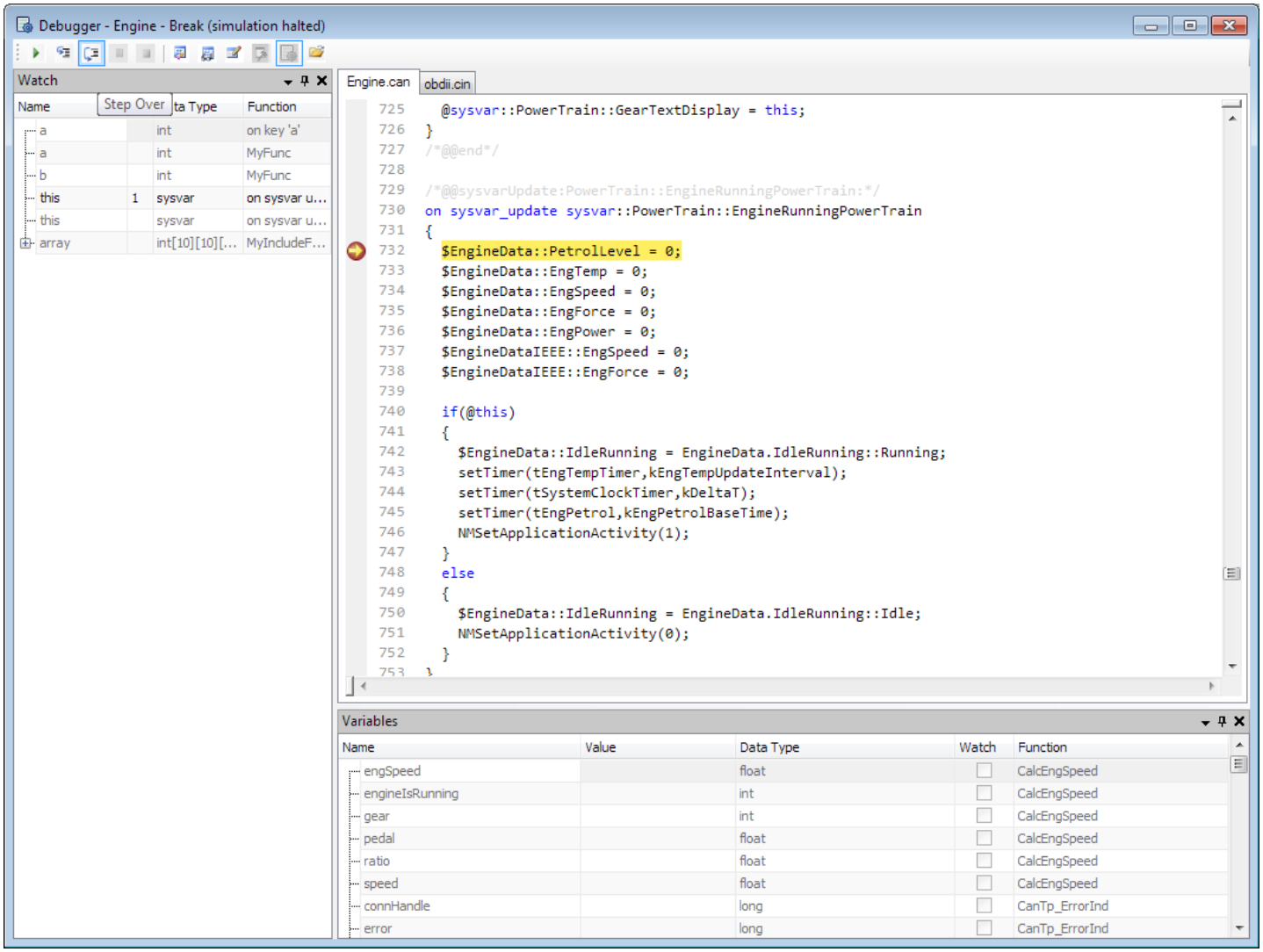
Creating a Remaining Bus Simulation with CANoe

5. CAPL Editor



Creating a Remaining Bus Simulation with CANoe

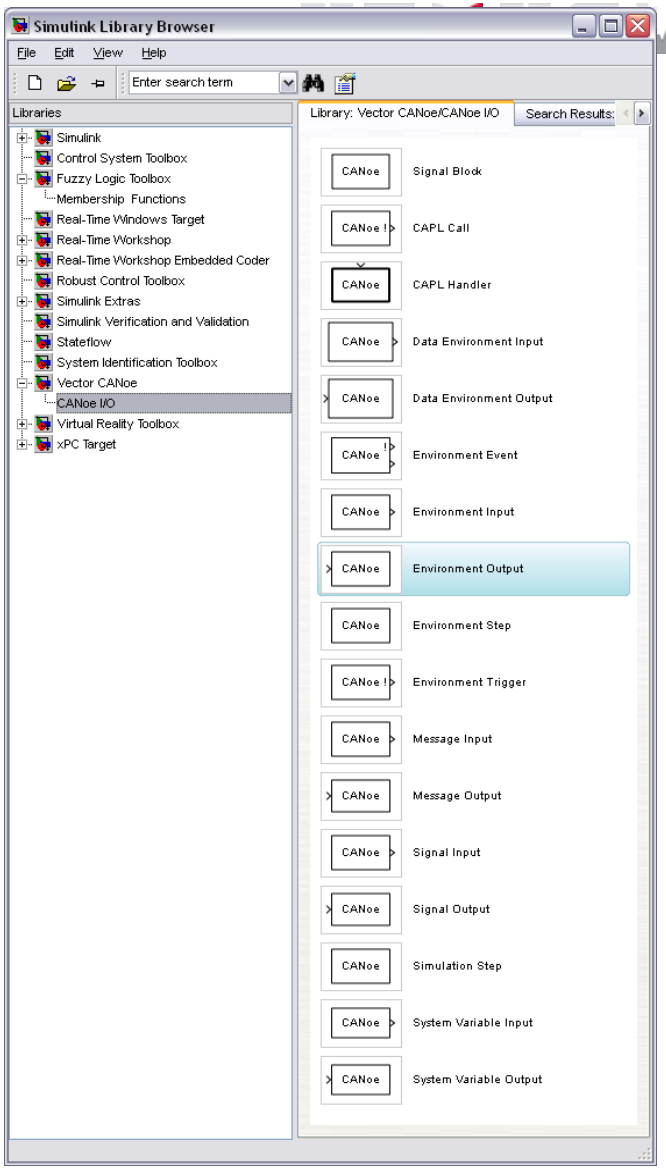
5. CAPL/.net debugger



Creating a Remaining Bus Simulation with CANoe

5. I/O Blockset in Matlab/Simulink

- I/O blocks to interface Simulink with…
  - Bus signals of any type (CAN, LIN, FlexRay) for reading and writing*
  - Environment and system variable inputs and outputs
  - CAPL functions (called from Simulink)
  - Inputs for subsystems triggered by CAPL functions
- CANoe slave mode driver (simulation step)
- Connect the Simulink model to “the real world”



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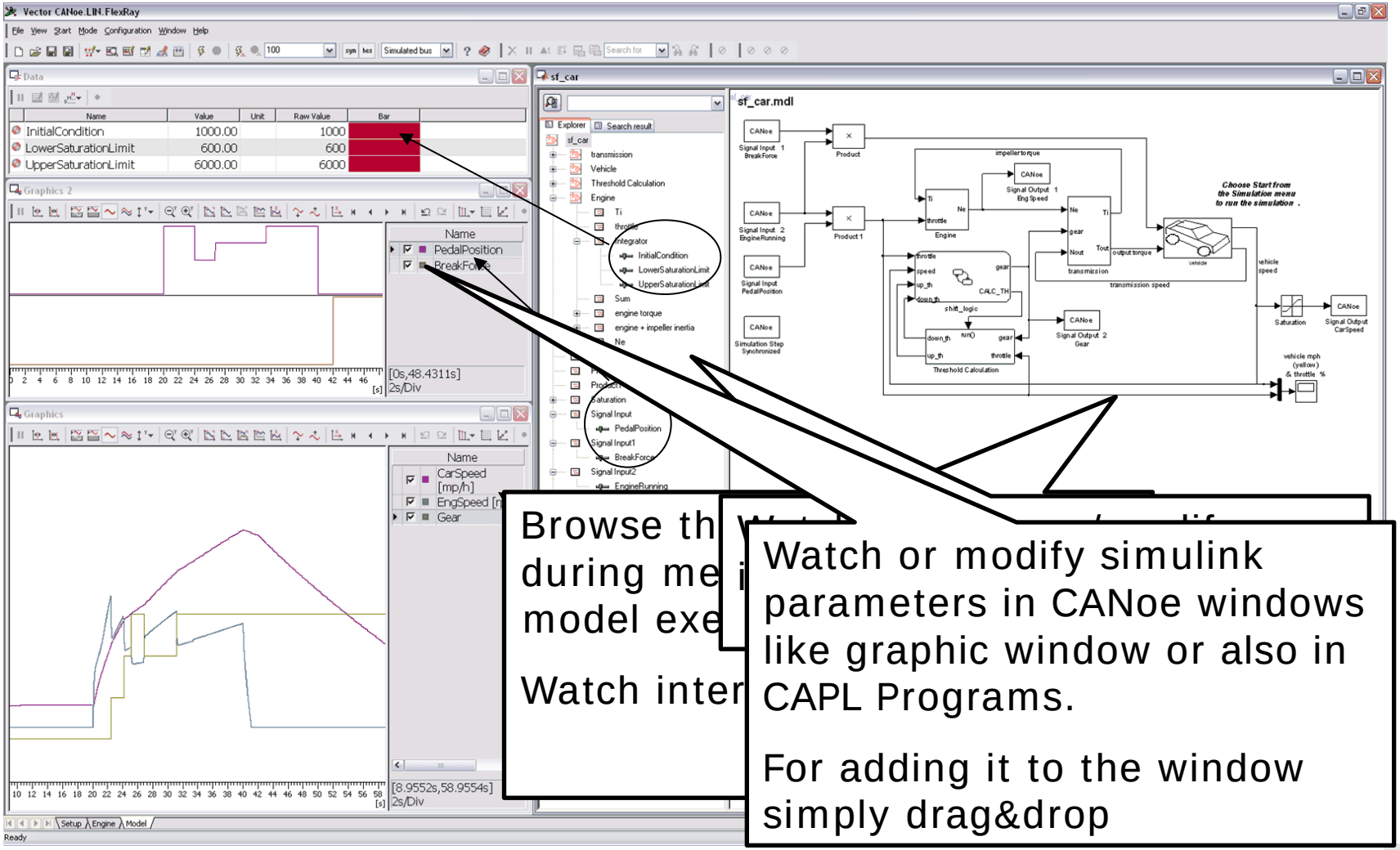
Creating a Remaining Bus Simulation with CANoe

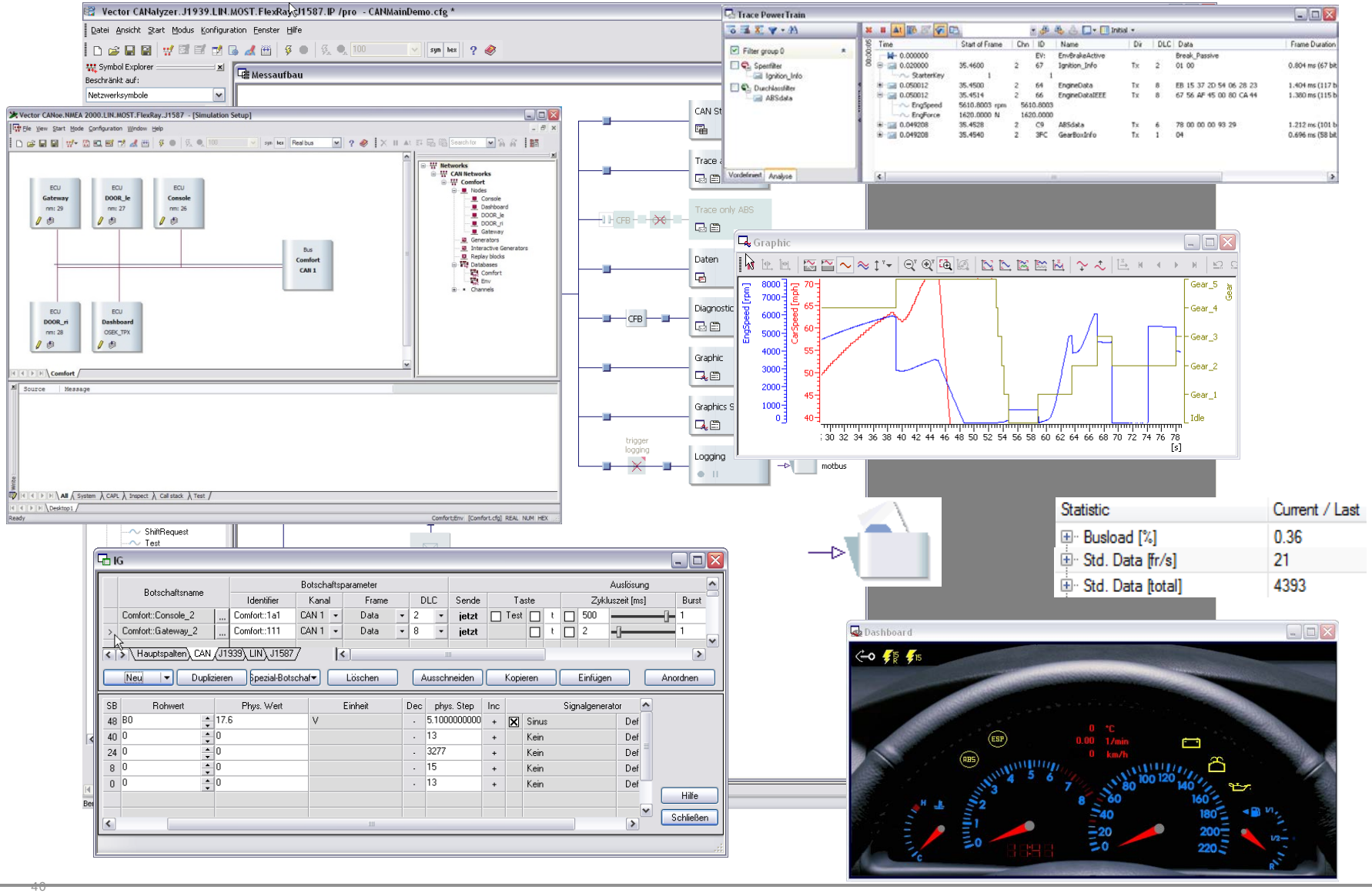
5. Example: Model browser



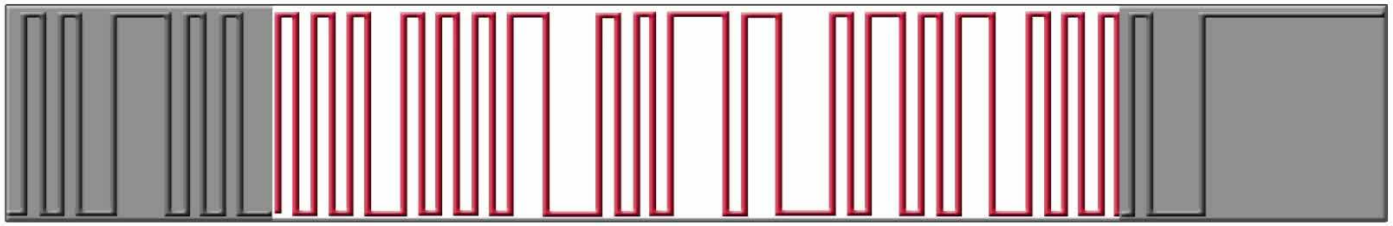
Details

ECU test, simulation and analysis

Overview: CANalyzer/CANoe

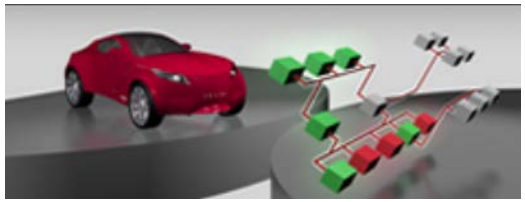


CAN FD (Flexible Data Rate)

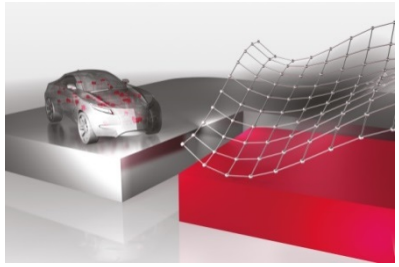


Classic CAN...

- CANoe/CANalyzer
  - Full support since version 8.1 (Aug. 2013)



- CANape
  - Full support since version 12.0 (Aug. 2013)



VN1611

1 LIN/K-Line

+ 1 CAN/CAN FD

VN1610

2 CAN/CAN FD

VN1630

2 CAN/CAN FD or LIN/K-Line (as piggy)

+ 2 CAN/CAN FD

VN1640

4 CAN/CAN FD or LIN/K-Line (as piggy)

- Other „VN“ Interfaces will follow in 2014

ECU test, simulation and analysis

Vector Testing Solution

Test Data Management

Vector vTESTcenter / PREEvision. vTESTcenter

- Configuration Management for test implementations and test parameters
- Scalable Team Collaboration Platform
- Traceability from test reports to requirements and vice versa
- Analysis of test results
- Management of testing projects

Test Design and Authoring Tool

vTESTstudio – Vector Test Studio (formerly ITE)

- Test programming (CAPL, C/C++, C#)
- Interactive test design: Test Table Editor "style of Test Automation Editor"
- Test Diagram Editor
- Definition of parameters and curves

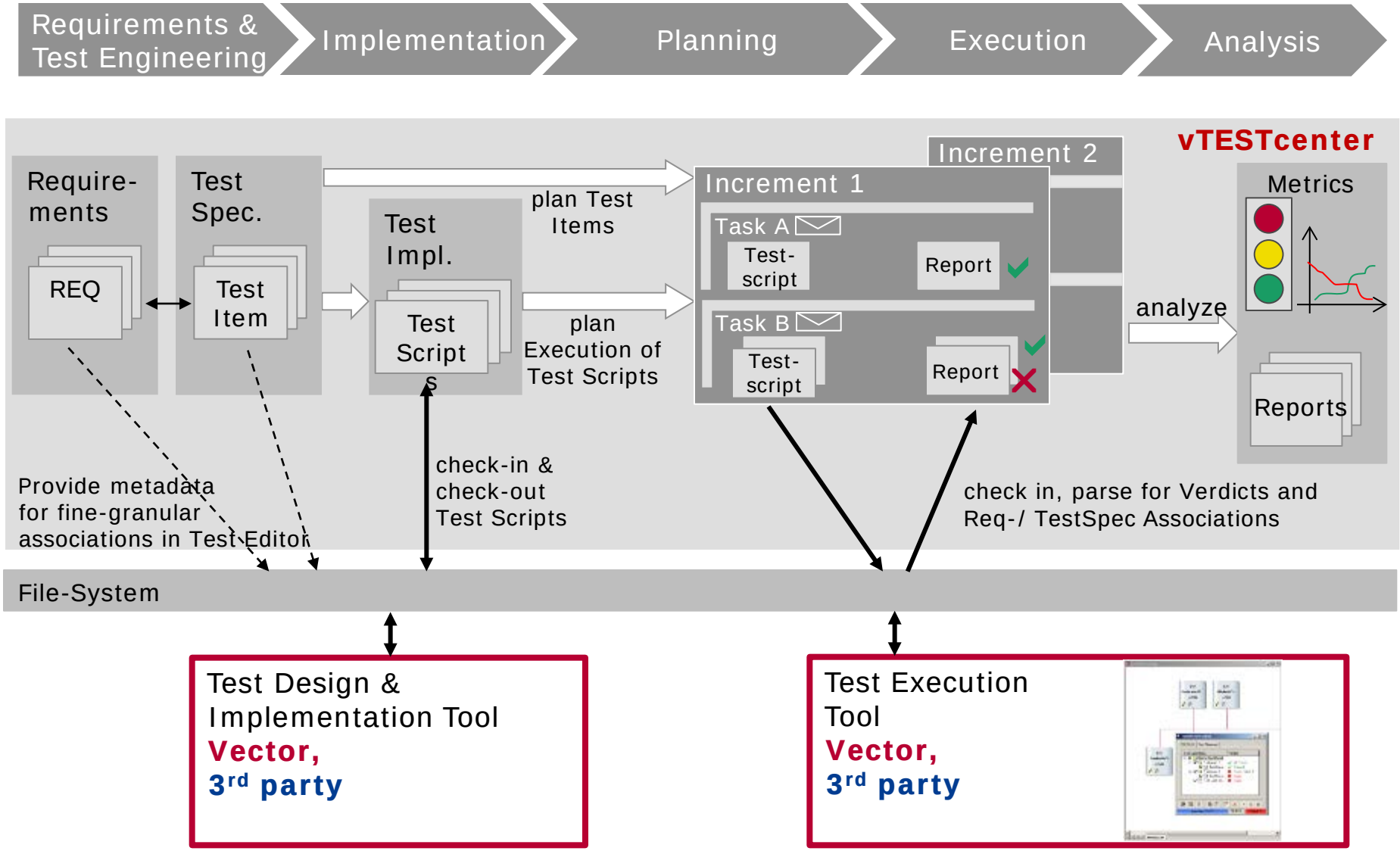
HIL Test Bench (applicable for SIL, MIL, … as well)

CANoe + VT Modules + Bus Interfaces

- Real-time execution engine for tests and experiments
- Access to System under Test via bus systems and protocols (I/Os, diagnostics, XCP, DebugInterface, …)
- Huge set of specific test functions
- Test reporting

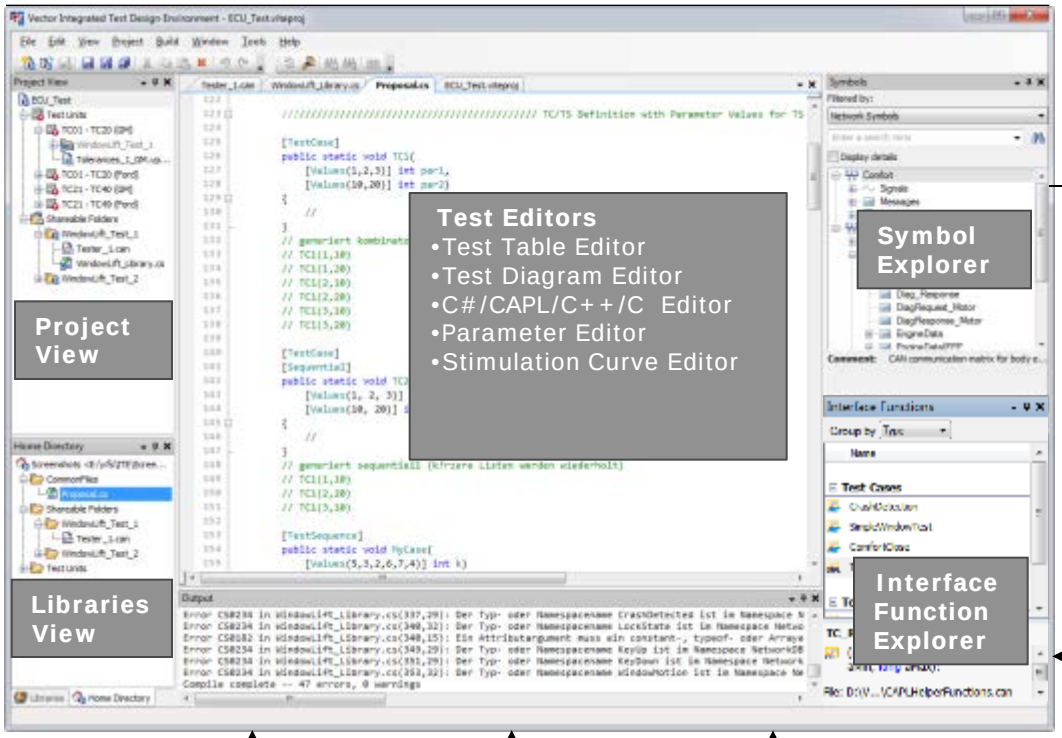
ECU test, simulation and analysis

Vector Testing Solution: vTESTcenter



ECU test, simulation and analysis

Vector Testing Solution: vTESTstudio



Build

Load

CANoe

Test Units
– Code
– Parameters

Test Units & Experiments

Test Automation

r/w

r/w

r/w

Stimulation Curves

C#, TTE, CAPL, ...

Parameter Files

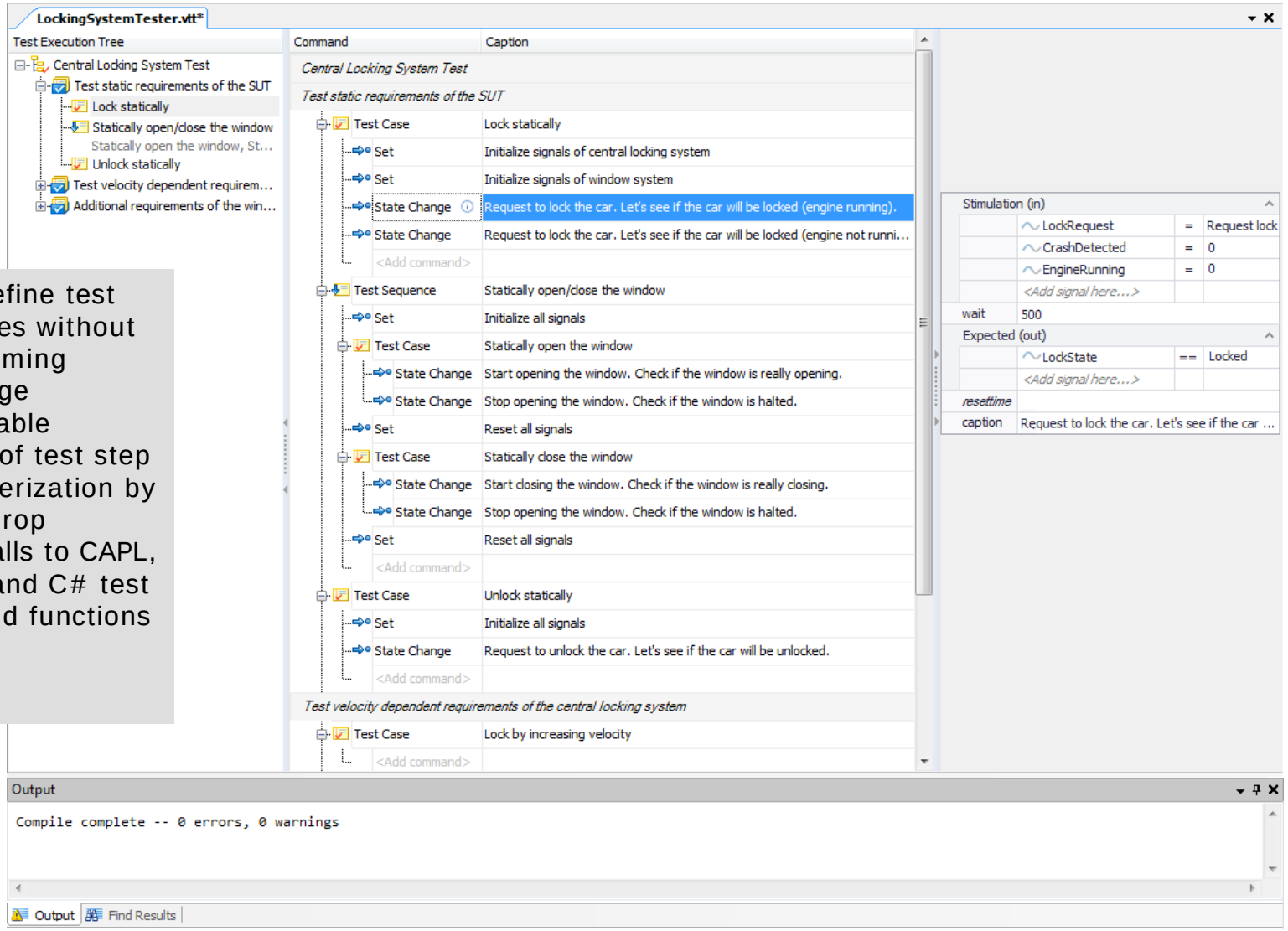
Common Symbol Databases: dbc, fibex, asrxml, cdd, odx, a2l, ...

Test Reports

ECU test, simulation and analysis

Vector Testing Solution: vTESTstudio

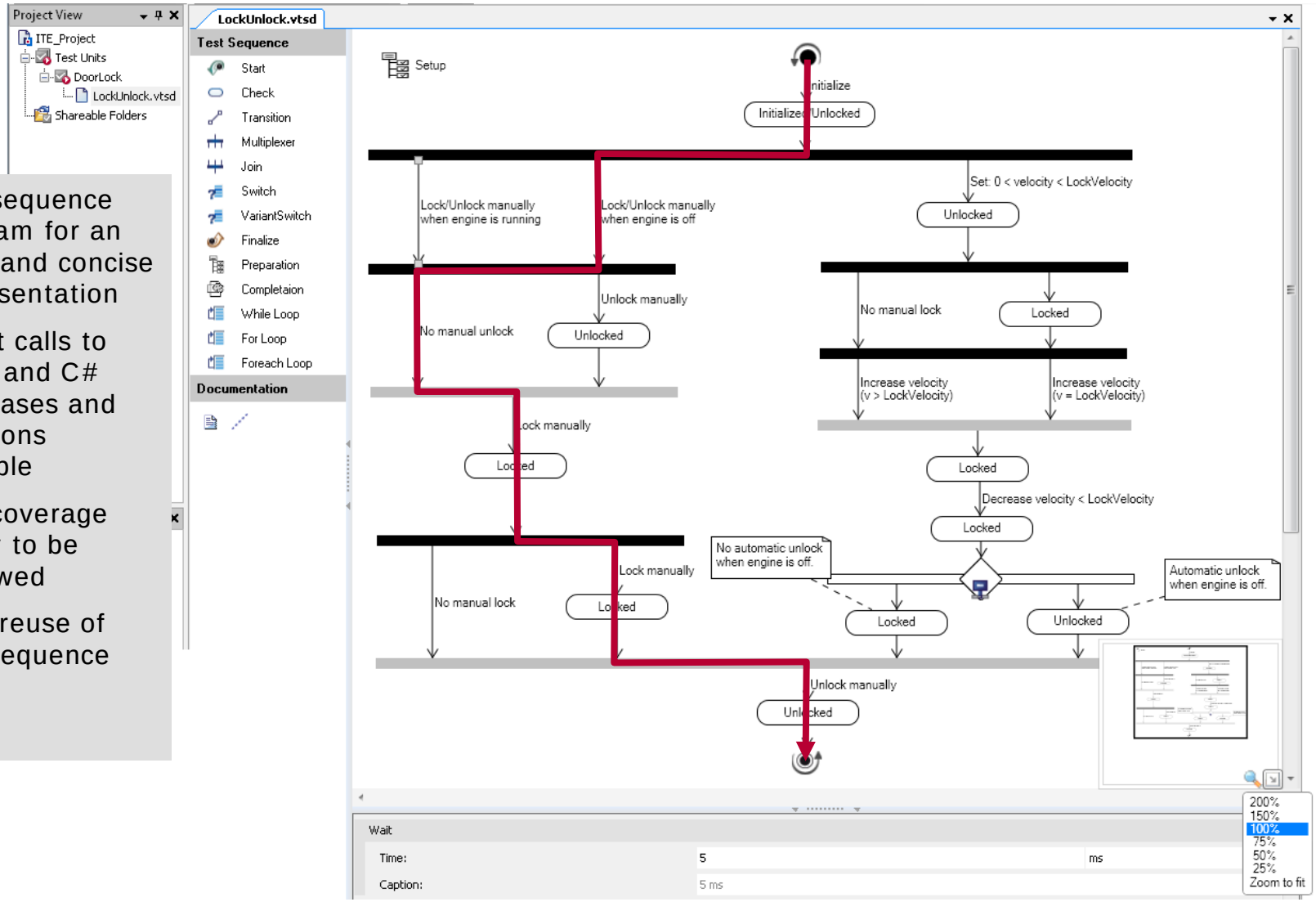
- Easily define test sequences without programming knowledge
- Comfortable support of test step parameterization by drag & drop
- Direct calls to CAPL, C/C++ and C# test cases and functions possible



ECU test, simulation and analysis

Vector Testing Solution: vTESTstudio

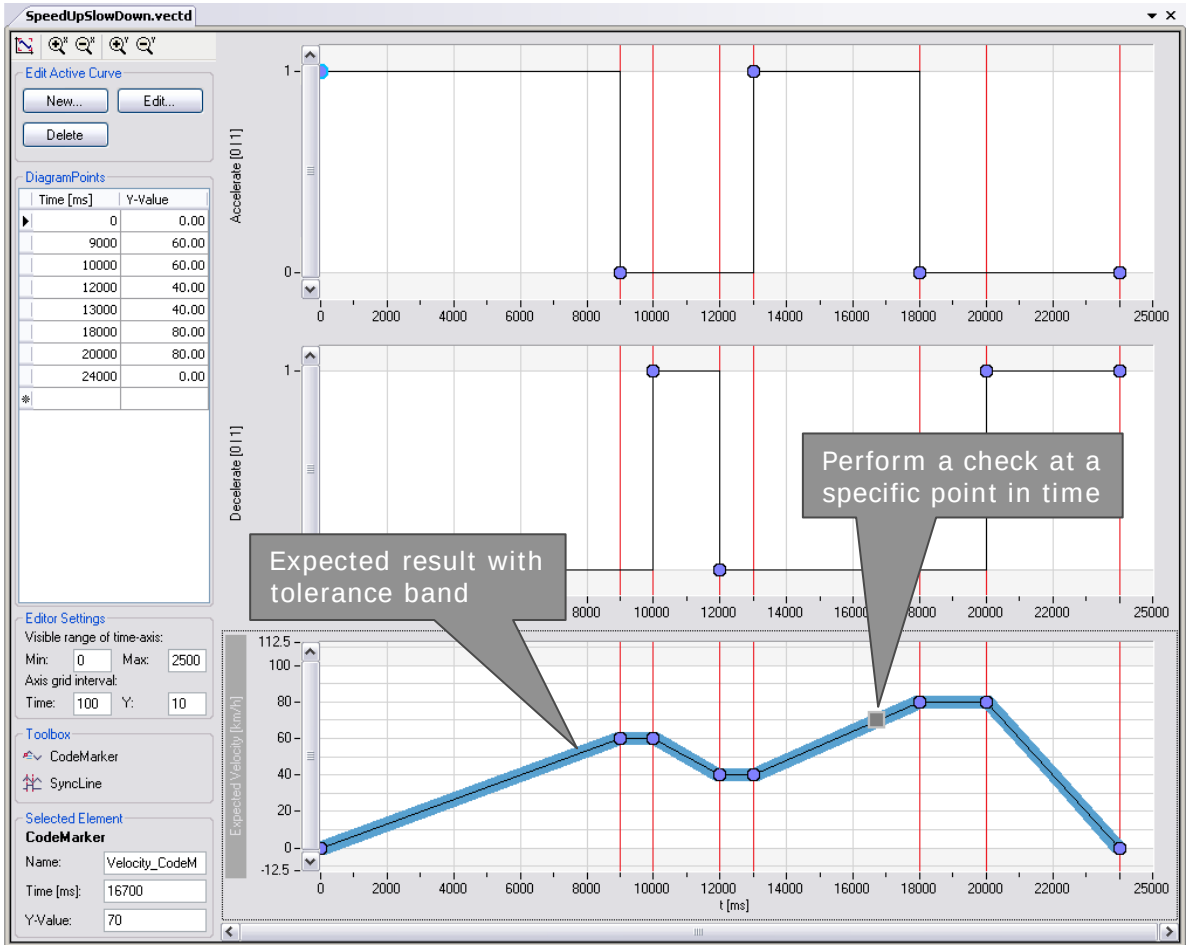
- Test sequence diagram for an clear and concise representation
- Direct calls to CAPL and C# test cases and functions possible
- Test coverage easily to be reviewed
- Easy reuse of test sequence parts



- Test automation with Timing Diagrams for expected SUT behavior *

  Features:

  - Design of time synchronized test by integrating checks into wave forms at specific points
  - Define wave forms of expected results with tolerances
  - Interactive definition of expected results directly based on measured values



* Planned for 2014

ECU test, simulation and analysis

Vector Testing Solution: vTESTstudio

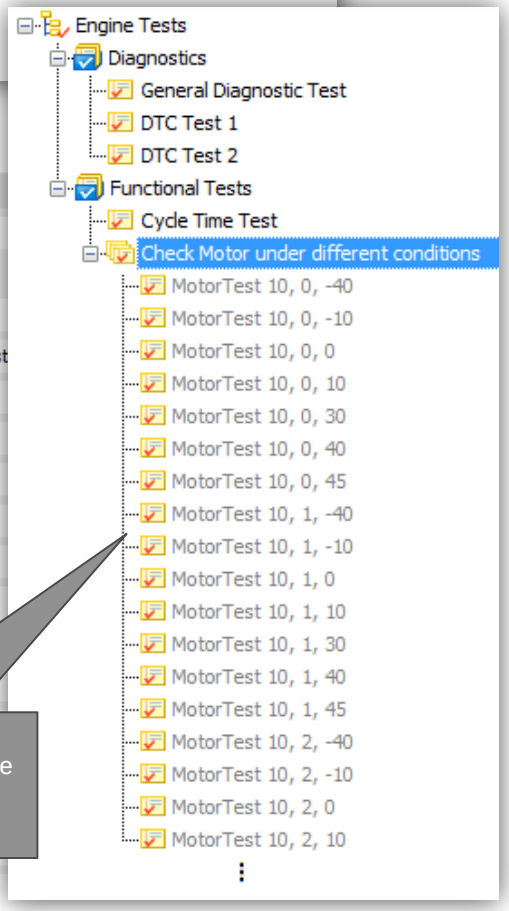
- Quick definition of a large number of test cases to increase test coverage
- Combinations
  - Sequential
  - All possible permutations
- Value definitions
  - Lists of values
  - Value ranges
- Direct use of parameters from parameter files as test case parameters

```
public static void MotorTest(
   [Values(10, 11, 12, 13)] int voltage,
   [Range(0, 127, 1)] uint dtc,
   [Values(SysPars.TemperatureList.AttrUsageId)] int temperature)
{
   //...
}
```

Parameter access in coding and table-style editor

Parameter Values

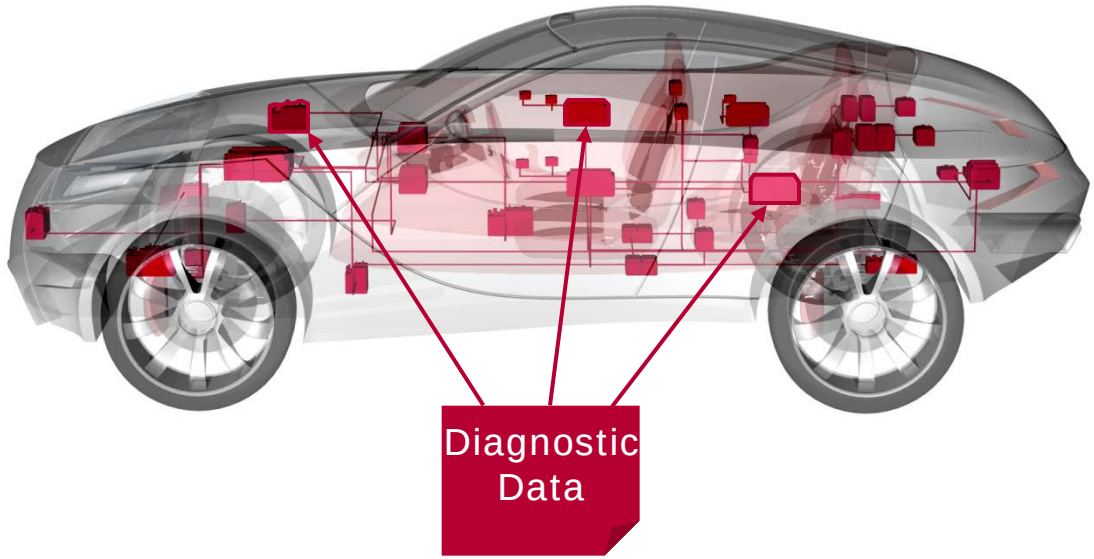
Combinatorics:	Combinatorial		
Name:	**voltage**	**dtc**	**temperature**
Value Source:	Value List	Range	Parameter List
Range/List:		[min=0, max=127, i...	TemperatureList
	10	0	-40
	11	1	-10
	12	2	0
	13	3	10
	Add...	4	30
		5	40
		6	45
		7	
Use property...:	*CtrlVar Dependencies*		
Caption:	Check Motor		



Generated test execution tree, loaded in CANoe. Single generated test cases can be started individually.

Tools for the complete diagnostic development process:

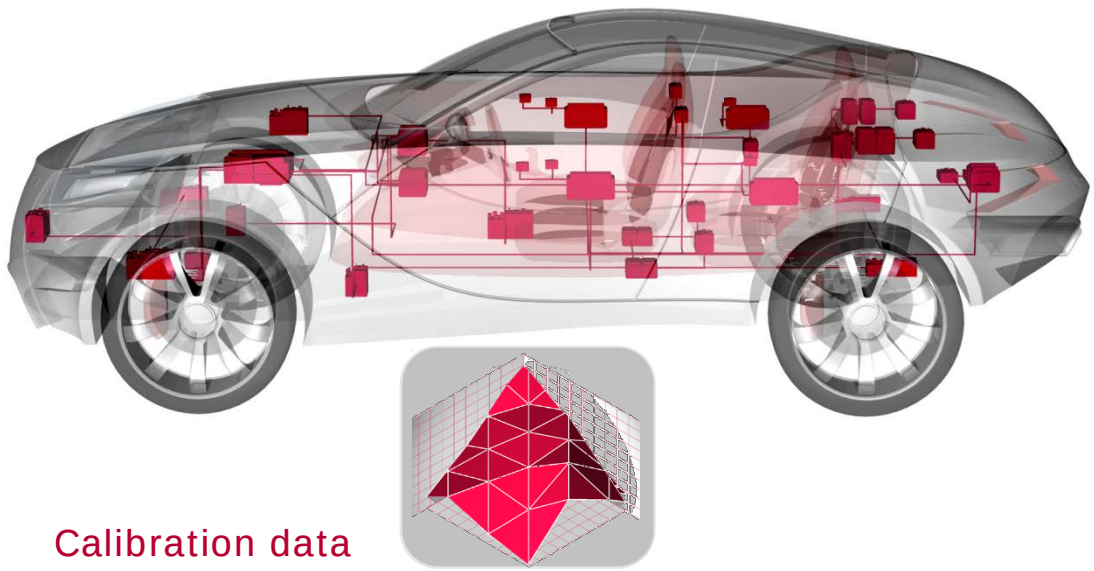
- Specification
- Integration
- Validation and test
- ODX data exchange and migration



Our Portfolio

ECU Calibration

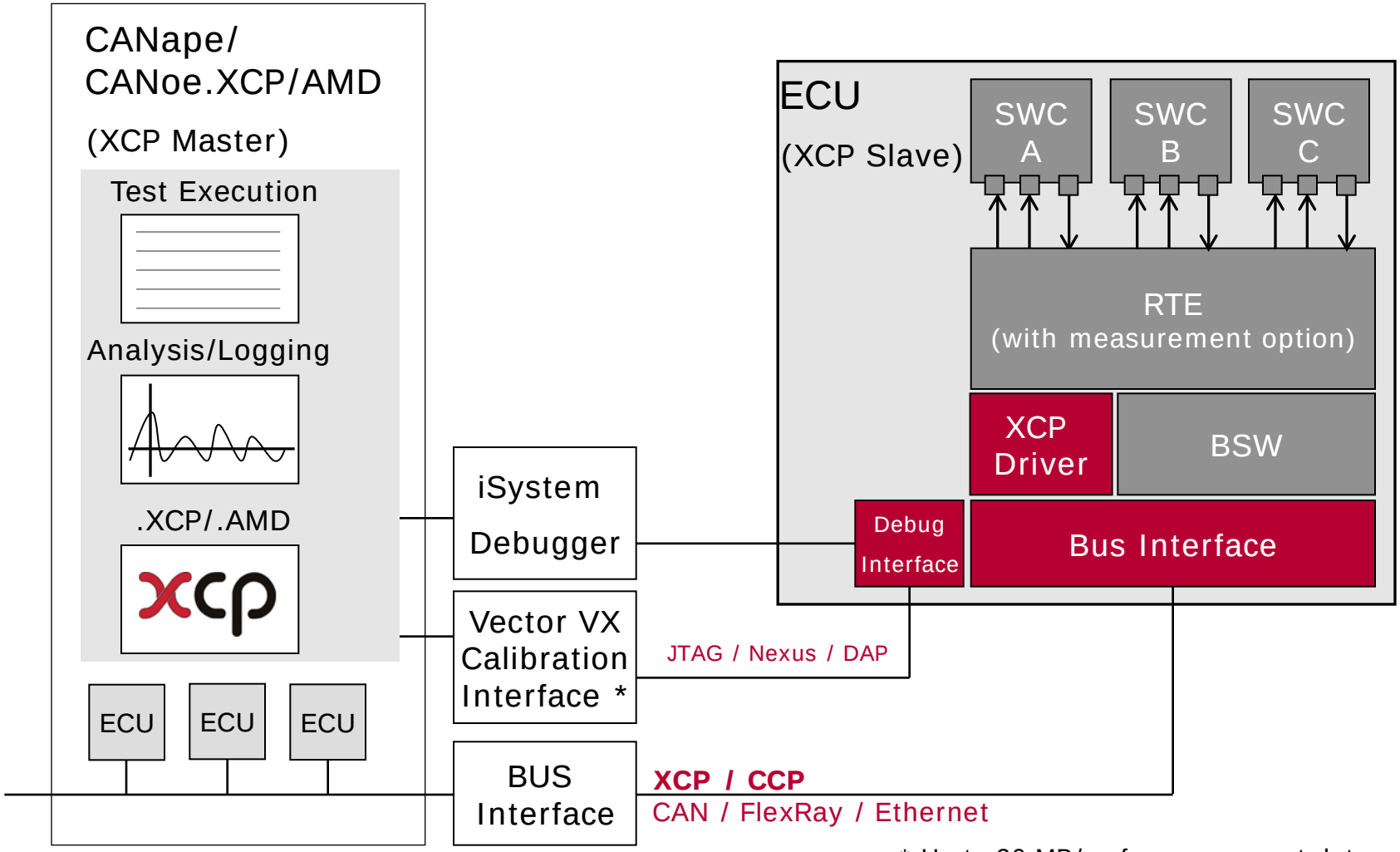
- Tools for acquiring measurement data and changing parameters in the ECU during runtime
- Goal is the optimization of the ECU algorithms



Calibration data

XCP access to ECU internal Data

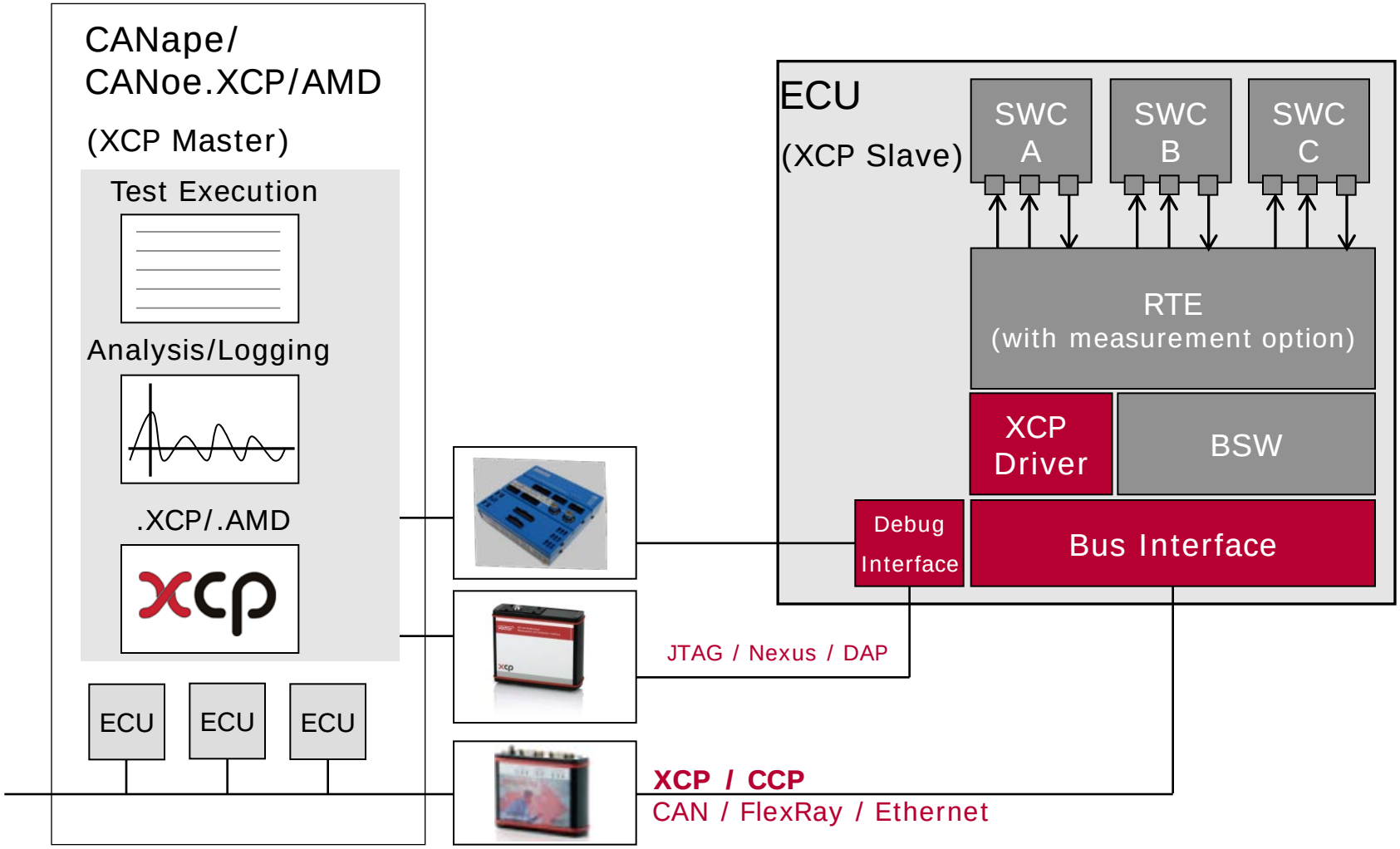
- Access to ECU via bus or calibration interface (XCP, CCP, VX)



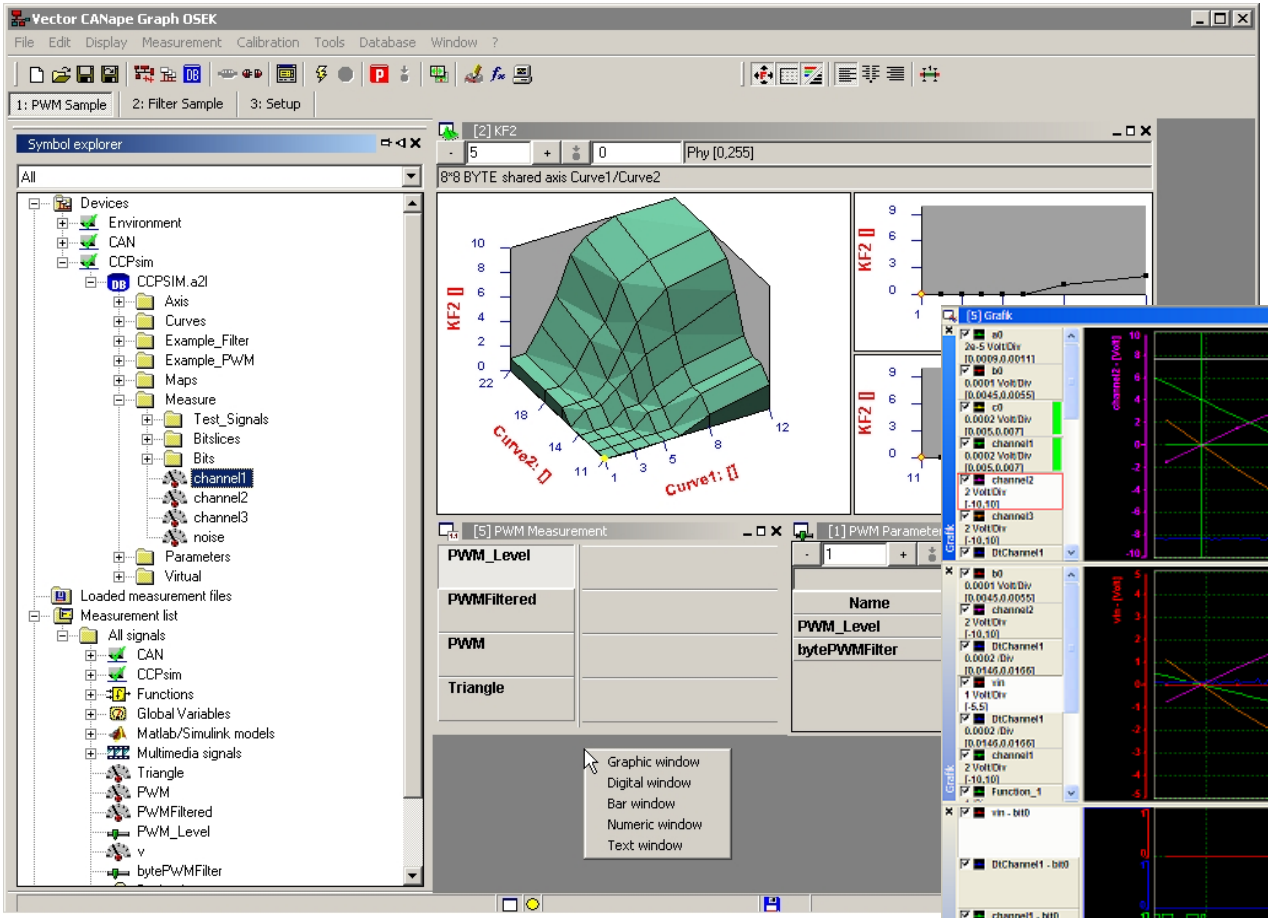
* Up to 30 MB/s of measurement data possible

XCP access to ECU internal Data

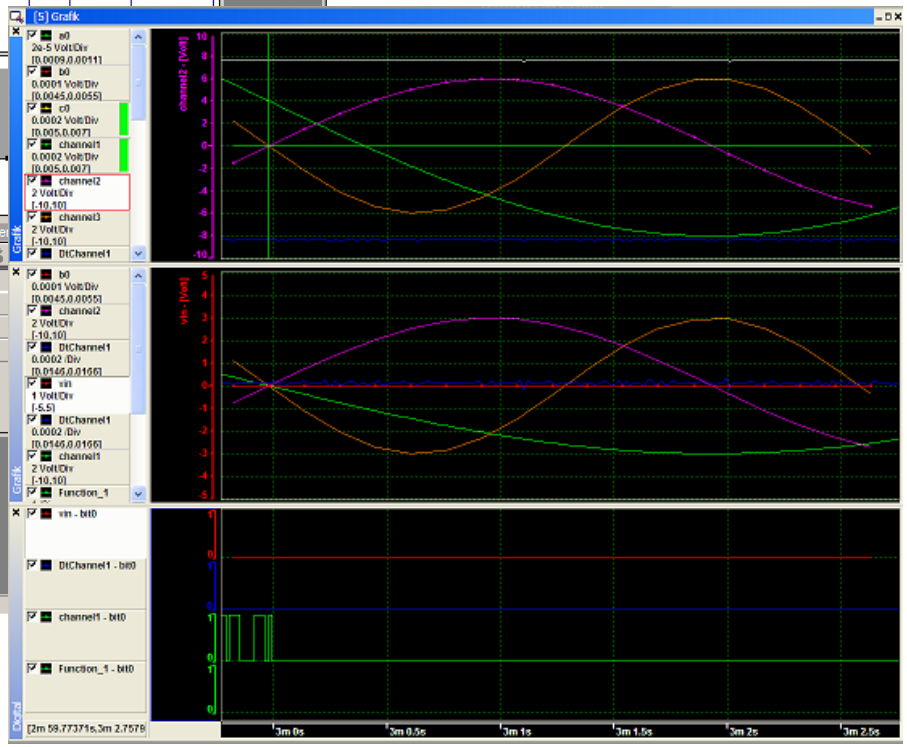
- Access to ECU via bus or calibration interface (XCP, CCP, VX)



Calibration



Measurement



Special Applications

Solutions for ...

Vector offers you complete solutions – comprising of products, services, and training - for the methods and standards used in each application area.

Solutions for:

- AUTOSAR
- FlexRay
- CAN
- LIN
- MOST
- IP
- ...

- Aerospace
- E-mobility
- Open protocols
- Flashing
- Logging
- Safety
- Special ECUs
- ...

Thank you for your attention.

For detailed information about Vector
and our portfolio please go to: www.vector.com

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