CANoe is an all-round tool for the development, testing and analysis of networks and ECUs. It supports the user during the entire development process, from planning to startup. CANoe’s versatile functions and configuration options are used by network designers, development engineers and test engineers at OEMs and suppliers.

At the beginning of the development process CANoe is used to create simulation models that emulate the behavior of the ECUs. Over the course of ECU development these models serve globally as a foundation for analysis, testing and integration of bus systems and ECUs. As a result, problems are detected and corrected early.

Graphic and text-based evaluation windows are provided to evaluate the results.

CANoe contains the Test Feature Set for easy and automated execution of tests. It is used to model and execute sequential test flows with automatic generation of a test report. Also available in CANoe is the Diagnostic Feature Set for diagnostic communication with the ECU.

**Functions**

The basic functions of CANoe are:

- Use of network describing data bases (e.g. DBC, FIBEX, LDF, NCF, MOST Function Catalog)
- Simulation of complete systems and remaining bus simulation via modelling
- Analyzing the bus communication
- Test of complete networks and single control units
- Diagnostic communication via KWP2000 and UDS; also used as a full diagnostic tester
- User programmable with integrated C-like CAPL programming language to support simulation, analysis and testing
- User-customized interfaces can be created to control the simulation and tests or display analysis data

**Special functions**

- For critical real-time relevant simulations, CANoe operation is distributed between two PCs, whereby the simulation and test core runs under Windows CE or Windows XP Embedded.
- Numerous auxiliary modules simplify adaptation to OEM-specific services and protocols (Transport Protocols, Network Management, Interaction Layer, etc.).
- Diagnostics can be parameterized by ODX 2.0.1. Also supported: Physical and functional addressing.
- CANoe supports model development in MATLAB and Statemate.

CANoe supports the following bus systems:

- Bus systems: CAN, LIN, MOST, FlexRay, J1587
- CAN-based protocols: J1939, NMEA 2000, ISO 11783, CANopen, MCnet, GMLAN, CANaerospace

The CANoe user interface with control and display panels, analysis windows and the Diagnostic Console
Options extending functional features include: Visualization of GPS vehicle position, execution of formal tests for diagnostic implementation (DiVa) and a runtime environment for OSEK-OS applications.

Integration of digital and analog I/O modules as well as measurement hardware enables processing of real signal values in simulations and test environments.

Open software interfaces such as Microsoft COM facilitate integration in different system environments.

**Testing ECUs and Networks**

One of the primary use cases of CANoe is the testing of ECUs and networks. Examples include: Verification of individual development steps, checking of prototypes, and performance of regression and conformity tests. To implement test tasks simply and flexibly the integrated Test Feature Set consists of the following components:

- Sequential test flows are implemented in CANoe in XML or CAPL test modules that are sub-organized in test groups and test cases. Test modules can be executed at any time during a measurement. In XML modules, tests may be assembled from predefined test patterns and are easy to parameterize by input and output vectors. CAPL test modules are programmed and include a very flexible test flow control. System states can be monitored in parallel to the test execution, such as conformance to cycle times of individual messages.

These constraints are automatically incorporated into the test evaluation.

- The Test Service Library contains a collection of prepared test functions that simplify the process of setting up tests. They are used in CAPL and XML test modules and can be parameterized from the database. For example it is possible to monitor: Cycle times of messages, reaction time of an ECU between the receipt of a message and the sending of response message, validity of signal values and diagnostic parameters. To evaluate the quality of tested ECUs, various statistical values are output from tests, including the number of deviations reported over the testing period. In the Test Service Library are also functions included that simplify stimulation of ECUs.

- During the execution of a test module an extensive test record is generated. For example, the names of the test cases already executed and individual test results are noted. The test record can be supplemented with user-defined information. CANoe writes the results to a flexible XML file that can be further processed. An XSLT stylesheet can be used to adapt the output format of the test record.

- CANoe can manage any desired number of test environments in parallel in the Test Setup Window. A test environment contains test modules and additional function blocks for test execution. The test environments are saved independent of the system configuration and can therefore be used in different projects.

**New Functions of Version 6.0**

- CANoe RealTime supports the real-time capable runtime environment Windows CE whose deterministic time management is a prerequisite for precise simulation of FlexRay systems or real-time capable test sequences.

- Besides CANdelaStudio files (CDD), the Diagnostic Feature Set can now also be parameterized via ODX 2.0.1 description files. This makes it easier to integrate CANoe in different diagnostic tool chains.

- The Diagnostic Feature Set now also supports functional addressing to send out diagnostic services.

- In the Trace Window many functions simplify the analysis of bus communication and window configuration at runtime.

- CANstress integration in the Test Feature Set was expanded, and it now gives direct access to disturbance and trigger parameters. It is also possible to use multiple CANstress modules in the test environment.

- The Test Feature Set can be controlled via the COM interface. This means that the test engineer can have test environments and test modules automatically configured, and external programs can start test sequences and query test results.

- Integration of measurement hardware was expanded substantially; for example, it now offers block transfer for analog inputs and interrupt-capable digital inputs. As a result, it is possible to read-in many measured values or react to edges without excessive system load.
**Diagnostics**

CANoe is used in all phases of development and in the use of diagnostics in ECUs. With regard to diagnostics, first CANoe supports the developer in implementing the diagnostic functionality of an ECU. Second, it provides access to the diagnostic interface for testing ECUs.

The following approaches and functions are available for this:

> Support of ODX 2.0.1 and Vector CANdelaStudio (CDD) diagnostic descriptions for KWP2000 and UDS (ISO 14229)
> Interactive diagnostic tester with diagnostic console and error memory window (Diagnostic Feature Set)
> Analysis of diagnostic communication on the service and parameter levels in Trace, Data and Graphic windows
> Specification/integration/regression tests in CAPL and XML based on the Test Feature Set or with CANoe Option DiVa
> Simulation of the diagnostic functionality of ECUs
> Capability of accessing all levels of diagnostic communication (CAN messages, Transport Protocol and diagnostic services) for good/bad test cases.

**Simulation and Remaining Bus Simulation**

In the development of distributed communication systems with CANoe, network node models are created based on database information. The communication behavior of these models can be fully simulated and analyzed. Over the course of the subsequent development process, individual node modules can be replaced by real ECUs within this simulation. These remaining bus and environment simulations give the supplier a development and test environment for the total system as well as for individual ECUs and modules.

For many OEMs (see table) CANoe can generate models from the database that even include the graphic user interface.

**Communication Analysis**

Among other things CANoe provides the user with the following windows and blocks:

> **Measurement setup** for graphic display and parameterization of function blocks and evaluation functions
> **Trace** for listing all bus activities such as messages, error frames and remote frames. For each message it is possible to display individual signal values – even during the measurement
> **Graphic** for online display of signals transmitted in the CAN messages, e.g. speeds and temperature, over a time axis
> **Data** for displaying preselected data, e.g. numerically or as a bar chart graphic
> **Bus statistics** for global display of message rates, error rates, bus utilization and CAN controller states
> **Statistics** for displaying message rates of each identifier
> **Interactive Generator block** for stimulation of the buses and for sending out modified signals easily
> **Signal generator** for generating signal responses (sinusoidal, ramp, pulse, value list, etc.)
> **Logging/Replay** for logging and later analysis or replay of measurements

The development process with CANoe from network simulation to the real total system.
> **Trigger** and **Filter** for specific reactions to bus events and for reducing the amount of data displayed or logged

> **Write** for system messages and user-specific outputs from CAPL programs

**Access to Databases**
CANoe supports system descriptions based on the following formats: DBC (CAN), LDF (LIN), XML (MOST) and FIBEX (FlexRay). CANoe can process the following diagnostic descriptions: CDD (CANdelaStudio) and ODX 2.0.1. Information from these databases can be used and displayed symbolically in CANoe.

**CANoe RealTime**
CANoe offers the capability of executing real-time relevant simulation and test functions on a separate computer, i.e. separate from the graphic user interface. On the one hand, this makes it easier to increase the overall performance of the system if necessary. On the other hand, shorter latency times and more precise timers are obtained. In this case, configuration of the simulation and evaluation are performed on a standard PC, while the simulation runs on a dedicated computer under Windows CE or Windows XP Embedded.

**CANoe supports the following Protocols:**
> Diagnostic protocols
  - KWP2000 and UDS (ISO 14229)
> Network management (NM)
  - AUTOSAR, OSEK-NM
> Transport protocols (TP)
  - ISO/DIS 15765-2, CMDT (J1939), BAM (J1939), AMS (MOST)
> Interaction Layer (IL)
  - Vector-IL

For a summary of all currently available OEM-specific extensions, please refer to the table on the next page.

**Interfaces to other Applications**
CANoe can access the ASAM-MCD3 Server provided by CANape to verify parameter values in the existing ECUs via XCP and CCP or to integrate any desired test sequences. CANoe facilitates the integration of CANstress in test modules, which gives the user a means for generating protocol errors on the CAN bus and disturbing the bus physics during test execution. The integrated COM Server (Component Object Model) enables control of the measurement sequence by external applications and convenient data exchange with standard software, e.g. for measurement data analysis and more in-depth evaluation of the observed bus traffic.
Programmability and User-defined Control Panels
With the programming language CAPL (Communication Access Programming Language) the range of CANoe functions can be extended as much as desired.
CAPL is:
> Specialized in the description of simulation, test and analysis nodes in distributed communication systems,
> Based on C, works in an event-oriented way and supports symbolic access to all database information,
> Extendable to include user-specific or OEM-specific functions.
User-customized interfaces can be created for different types of applications with the help of graphic panels. For example, panels can be used to control the simulation and test environments or to display the analysis data from CAPL programs. Besides the standard CANoe panels, user-programmable ActiveX panels can also be integrated; they might be created in Visual Basic, for example.

Functional Extension by Supplemental Options
> DiVa (Diagnostic Integration and Validation Assistant):
Option DiVa expands CANoe into a tool for automatic generation and execution of test cases for the implementation and integration of the diagnostic protocol. Test cases are generated based on CANdela diagnostic descriptions and guarantee broad and detailed test coverage in implementing diagnostics in an ECU.
> GPS (Global Positioning System)
Option GPS offers the capability of integrating GPS information in CANoe. This information can be displayed in the analysis windows and can also be logged with other data. In addition, the current vehicle position and the driven route are shown on an electronic map in the GPS window. In the interpretation of logged measured data this information can be used to give consideration to geographical conditions.
> osCAN Library
OSEK-OS applications run in the CANoe environment with the CANoe osCAN Library. This can be used to develop ECU-specific software up to a mature development level without target hardware.
> The CANoe simulation as a runtime environment makes it possible to debug the ECU-specific code online and test it using CANoe’s many functions.

Supplied Product Components
The components that are supplied depend on the selected product variant.
The Full version contains these components in addition to CANoe itself:
> Numerous sample configurations of total systems, all installed bus system options and special use cases such as testing and diagnostics.
> Editors and display programs for different database formats, and for panels and CAPL programming.
> Installation instructions, manuals and online Help functions.
> Transport protocol (TP) per ISO/DIS 15765-2 and Interaction Layer (IL) per Vector specification.

Availability of OEM-specific extensions

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<tr>
<th></th>
<th>Audi</th>
<th>BMW</th>
<th>DC</th>
<th>Fiat</th>
<th>Ford</th>
<th>GM</th>
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</table>

The table including the OEM-specific extensions will be updated regularly. In case the OEM-specific extension you are interested in is not listed above, please contact your local Vector Support.
Other modules such as OEM-specific TP or IL and the Matlab/Simulink or Statemate interface are not included as standard components; for a free quotation contact Vector Support.

**Hardware Interfaces**

CANoe supports all hardware interfaces available from Vector. Due to the large selection of different PC interfaces (PCMCIA, USB 2.0, PCI, PCI-Express, PXI) and bus transceivers, optimal bus access is possible for any specific application.

**System Requirements**

<table>
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<tr>
<th>Component</th>
<th>Recommended</th>
<th>Minimum</th>
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<tr>
<td>Processor</td>
<td>Pentium 4/2,6 GHz</td>
<td>Pentium III/1GHz</td>
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<tr>
<td>Memory (RAM)</td>
<td>1 GB</td>
<td>512 MB</td>
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<td>Hard drive</td>
<td>200 - 600 MB (depending on option)</td>
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<tr>
<td>Screen resolution</td>
<td>1280×1024</td>
<td>1024×768</td>
</tr>
<tr>
<td>Operating system</td>
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</table>

**Product Concept and Variants**

All available bus system extensions are available individually and can be combined in any desired way. Supplemental options such as CANopen or J1939 assume support for CAN.

For special types of use at OEMs and suppliers CANoe is available in the following variants:

> With full range of functional features
> As runtime version (RUN) with unchangeable simulations, full analysis functions and simple connection and disconnection of network nodes. This variant is intended for users who need a quick and easy way to test their ECU in its interplay with a predefined remaining bus simulation.
> As Panel Execution (PEX) version with an exclusively graphical user interface. Test cases and results are controlled and presented as simply as possible without requiring special evaluation of the underlying messages.

**Training**

As part of our training program, we offer a range of classes and workshops on CANoe in our classrooms and on-site at our customers. Our latest offer: Become a CANoe Expert in 7 days.

For more information and the dates of our training courses, please visit our homepage on the Internet at: www.vector-academy.com

Test sequence for central locking system with associated test record in HTML