



CANape

Product information

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Product information and technical data on CANape options are provided in separate documents.

1 Overview

1.1 Introduction

CANape (CAN Application Programming Environment) was created to optimize algorithms in ECUs. To do this, you change the parameters in the ECU at runtime. By measuring the signals, you directly record the effects of the change.

CANape offers a comprehensive solution for ECU developers and application engineers. The solution spectrum ranges from measuring a wide variety of signals and objects, calibrating and managing parameters in ECUs, to accessing bus data and ADAS sensors, to automated data analysis.

Derived from CANape, further tools are available to you:

- > **vSignalyzer** offers the same extensive options as CANape for visualizing data and provides functions for manual and automated analysis and reporting.
- > **vMeasure exp** is measurement software that makes it easy to acquire physical parameters, internal signals of ECUs and signals sent over the vehicle bus.
- > **CANape log** is a software and hardware package that has been optimized for logging applications. It lets users copy a CANape measurement configuration directly and execute it as an automated logger.

1.2 The Advantages at a Glance

- > Open and flexible platform, since it is based on standards
- > Acquire measurement data time-synchronously from a wide variety of sources and then store the data in compact ASAM standard format (MDF/MF4).
- > Conveniently calibrate parameters, manage them locally or transfer them directly to server-based or cloud-based calibration data management systems.
- > High-performance connection to controllers and sensors (radar, LIDAR, video, etc.) with outstanding measurement data rates.
- > Reliable ADAS logging solution for entire studies including visualization of point clouds, video data, etc.
- > Easy to integrate analog measurement technology with very high sampling rates.
- > Online calculations of specific data, e.g. active power of an inverter in an electric vehicle.
- > Open interfaces for hardware integration with third-party suppliers.
- > Evaluation of measurement data – from simple visualization to fully automated data evaluation including report generation.
- > Visualization of Simulink/Stateflow models.
- > Access to measured variables and parameters in the Simulink model without instrumentation of the model.
- > Rapid prototyping platform as efficient runtime environment for code and models.
- > Complete solution, e.g., because A2L files can be generated directly from the linker-map file, and powerful tools like ASAP2 Studio are already integrated.
- > 64-bit architecture enables use of the PC's entire RAM memory. This makes it easy to read in very large databases.
- > Automate processes in CANape using the internal programming language "CASL". Extend the range of functions with your. own libraries from Simulink, for example.

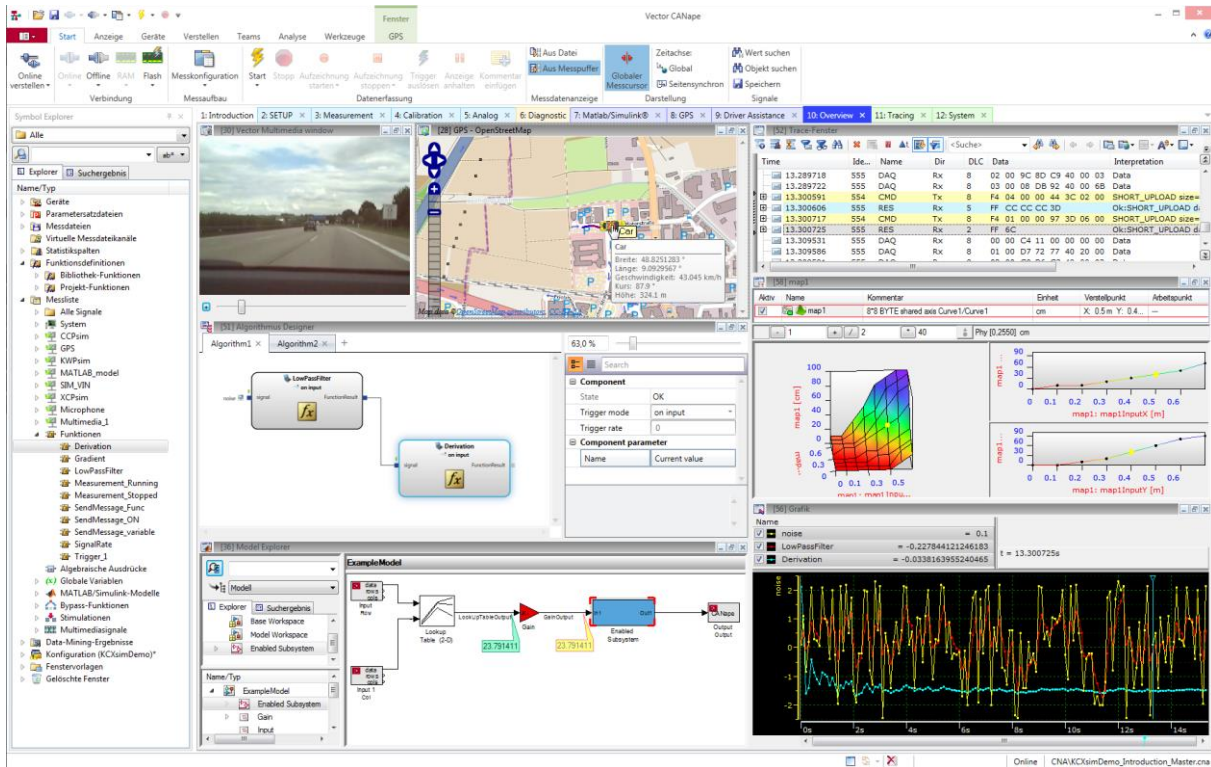


Figure 1: CANape user interface that allows simultaneous use of multiple configurations.

1.3 Areas of Application

CANape is an all-round tool for ECU calibration. CANape is a convenient and reliable tool for handling all tasks in this area –

- > from functional software development to rapid prototyping solutions and finally a production-ready ECU.
- > At the workstation, test bench or on test drives.
- > In data logging, parameter calibration, ECU and vehicle diagnostics, or verification and visualization of object detection algorithms for driver assistance systems.

1.4 Properties

The primary field of application of CANape is to optimize the parameterization (calibration) of electronic control units (ECUs). Calibrate parameters and simultaneously record signals during the running measurement. The communication between CANape and the ECUs is done over protocols such as XCP or through microcontroller-specific interfaces using VX1000 measurement and calibration hardware. CANape offers diagnostic access, bus analysis and the integration of analog measurement instrumentation, video data and GPS data. Calibration data management and features that simplify the evaluation of measurement data for users – including data management and reporting – make CANape a comprehensive tool for ECU calibration.

1.5 System Requirements

Component	Recommended	Minimum:
Processor	Intel Core i5 3.0 GHz or higher	Intel Core 2 Duo 2.6 GHz
Memory (RAM)	16 GB (Special tasks may lead to higher system requirements. Please contact CANape Support regarding this.)	8 GB
Hard drive space	≥ 2.0 GB (depending on the options used and the necessary operating system components)	
Screen resolution	1920 x 1080 or higher	1024 x 768
Graphics card	DirectX 9.0c or higher	
Operating System	Windows 10, 8.1 (64-bit)	

1.6 Functional Extension by Adding More Options

- > Option Driver Assistance for verifying object detection algorithms in the development of driver assistance systems (ADAS) including high-performance data acquisition from ADAS sensors.
- > Option vCDM for easy sharing of parameter sets within a team.
- > Option vMDM for interconnecting CANape and vMDM (Vector Measurement Data Management) to provide measurement data and analyze it.
- > Option Bypassing is a powerful complete solution for bypassing when used together with the VN8900 network interface and VX1000 measurement and calibration hardware. At the model's runtime on the VN8900 real-time hardware, the necessary input data is acquired from the ECU via the VX1000 system, XCP on Ethernet, XCP on CAN, CAN, FlexRay or I/O.
- > Option Thermodynamic State Charts for displaying thermodynamic state diagrams, and informative data for online and offline analysis.
- > Option MCD3 extends CANape by adding the ASAM MCD-3 V1.0 automation interface for measuring and calibrating test benches.

1.7 License Conditions

1.7.1 CANape as a Single User Solution

CANape is a single user solution that is used on Windows computers. Various licensing methods are available for it. To determine the type of licensing that best fits your needs, please contact your authorized Vector sales partner.

1.7.2 Automation and Remote Access

In addition to Section 2.1 of the "End User License Agreement for Vector Standard Software Products" or Section 2.1 and Section 2.2 of the "Enterprise Licensing Terms and Conditions for Vector Standard Software Products", the following usage scenarios shall be deemed permitted: "Automation of CANape or remote access to CANape is permitted with a Device License if CANape is operated to access a real system (e.g. at a test station or in a server environment) with Vector hardware (VN, VP, VX etc.)".

1.8 Further Information

Various CANape documents are available online. With the demo version you get sample configurations for the various application areas as well as a detailed help feature with descriptions of all CANape functions. In addition, you will find valuable know-how in the form of technical articles, product videos and application notes. You can find more information at the [CANape website](#).

2 Basic functions

The basic functions of CANape include:

- > Time-synchronous, real-time acquisition of all input parameters.
- > High-performance acquisition of the data of a total vehicle with sensors for ADAS development, e.g., video, LIDAR and radar sensors, bus data, ECU data and much more.
- > The function library "eMobilityAnalyzer" calculates all relevant data of an electric drive at runtime (at up to 1MHz sampling rate).
- > Visualization of detected objects in video windows and map representations with graphic symbols.
- > Online calibration via CCP/XCP, real-time stimulation and bypassing via XCP.
- > Offline calibration of HEX and other binary file formats.
- > Powerful management of calibration data, comparison and merging of parameter sets using vCDMstudio. For groups ranging from small teams to globally distributed enterprises, the database-supported vCDM platform is the optimal solution for professionally managing calibration data.
- > Seamlessly integrated diagnostics via UDS, DoIP and KWP2000. Support of certificates and other security mechanisms.

- > Full access to a vehicle's OBD data.
- > Offline measurement data evaluation – ranging from manual evaluation to automated data mining with the integrated functional language CASL (Calculation and Scripting Language) or DLLs generated by the user. DLLs can be generated from manual code or from Simulink models.
- > Runtime environment for Software-in-the-Loop solutions – algorithms which are later run in the ECU can be linked as DLLs in CANape.
- > Fast and secure flashing of binary files and parameter sets.
- > Automation interface for measuring and calibrating over C-API, COM, ASAP3, ASAM MCD-3 MC or iLinkRT.
- > Integration of analog measurement instrumentation, e.g., over CAN and Ethernet.
- > Universal I/O interface for integrating any desired measurement systems by individual drivers. The integration includes configuration as well as the actual transmission of the measurement data.
- > Automation of sequences using the integrated functional language CASL (Calculation And Scripting Language)
- > Integrated function library enables such features as real-time evaluations, the calculation of virtual signals at runtime and filtering of noisy signals.
- > Convenient visualization of Simulink and Stateflow models includes display of values, navigation through model levels, search mechanisms and direct calibration of parameters.
- > Direct coupling between CANape and Simulink for measuring and calibrating models at runtime
- > Direct access from MATLAB to ECU data via the CANape API
- > Easy to create and integrate user-specific display elements and controls.
- > Visualization of the vehicle's current GPS position on electronic maps (also for offline use) simplifies the interpretation of logged measurement data significantly.
- > Extensive functionalities for printing and reporting.

3 Measurement Data Acquisition

CANape acquires internal ECU measurement parameters synchronous to ECU processes via the CCP and XCP measurement and calibration protocols. Measurement data of the ECUs is logged time-synchronous to other measured (from serial bus systems, GPS, video or other measuring instruments) and is displayed on a wide variety of forms. The multi-recorder concept lets users configure different measurements and start and stop them independently of one another. Each recorder saves measurement values to a separate file.

Features of measurement data acquisition and visualization in CANape:

- > The MDF 4.1 measurement data format from ASAM supports measurement files with no size limitations and offers compression of measurement data.
- > CAN bus messages may be recorded in either BLF or MDF 4.x format.
- > Analysis of bus communication in the Trace window,
- > Various window types and user-definable panels are available for graphic display.
- > Structures defined in the ECU source code can be used as measurement objects.
- > Virtual signals can be calculated online using the internal script language or with MATLAB/Simulink models by logically combining real parameters from a wide variety of sources.
- > Extensive trigger options for data logging including pre-trigger and post-trigger times (also for audio and video).
- > Time-synchronous acquisition of scalar values, arrays, structures, and objects.
- > Decryption of encrypted CAN messages.
- > Configuration of Vector Fleet Loggers for CCP and XCP measurements including seed & key handling.

- > The VX1000 measurement and calibration hardware can achieve data rates of more than 100 Mbyte/s for XCP and radar raw data from the ECU or sensors, depending on the interface used.
- > Video sensors are acquired by video grabbers (e.g., video interfaces of the VX1161 series).
- > Easy integration of video cameras via USB or Ethernet.
- > Reliable and time-synchronous documentation of driving situations via video and image recording without keyboard input.
- > Detailed display of DAQ list utilization (XCP, CCP) in the measurement configuration.
- > Optimized DAQ lists configuration enables maximum data transfer regardless of data types.

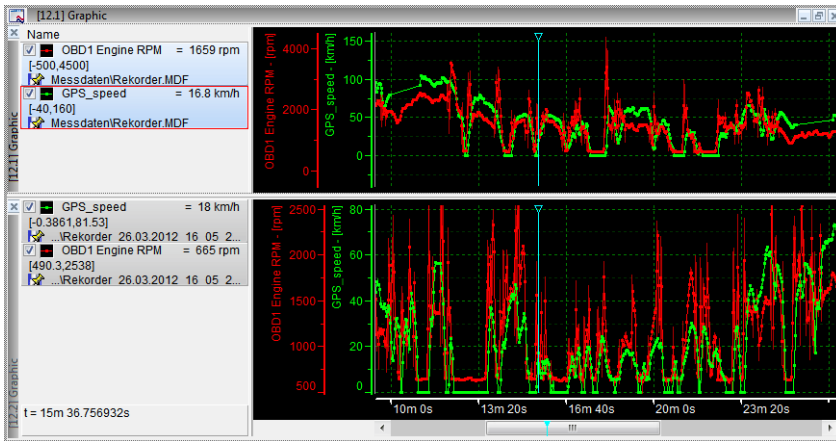


Bild 1: You can visualize and compare signals from different measurement files in one or more windows.

3.1 Distributed High-Performance Recorder (DHPR)

Large amounts of data may need to be acquired and logged, especially in the field of ADAS development and autonomous driving. A DHPR is used to integrate the different Ethernet protocols of the sensors into CANape and log them synchronous to the other sources. The solution is scalable. If a computer's performance is insufficient, more computers can be connected over Ethernet, and the DHP recorders can be distributed among the computers. The solution is managed from CANape, so the user does not need to make any special provisions for this. As usual, configuration, starting, stopping and trigger control are all handled centrally from CANape.

- > DHPR achieves optimal utilization of PC resources.
- > The measurement data is distributed to different storage media.
- > Time-synchronous distribution of the measuring tasks to several PCs Visualization of control signals of the distributed measurement recorders.
- > Just one CANape license is needed for all the computers that are used.

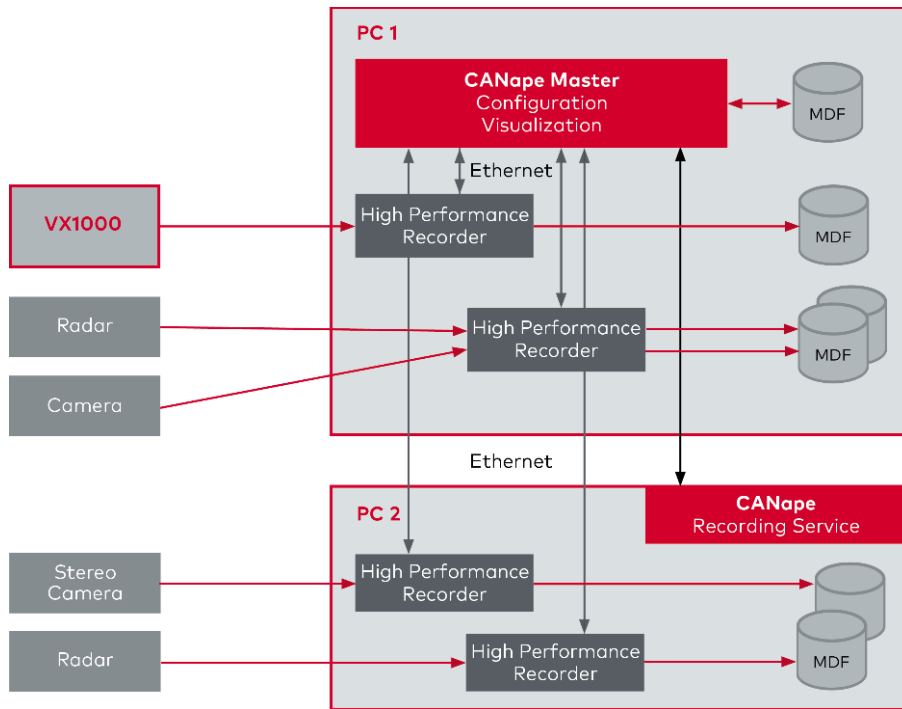


Figure 2: Scalable, decentralized recorder solution for very high data rates in the ADAS environment (more than 1 GByte/s).

3.2 Measurement and Calibration Hardware Offers Top Transfer Rates

The VX1000 system is a modular solution for accessing internal ECU data. A POD (Plug On Device) is connected directly to the microcontroller via its debugging or data trace interface (Aurora, DAP2, Nexus, JTAG, etc.). The controller's data is routed to the VX1000 base module over the POD and is converted to an XCP-on-Ethernet data stream.

Use of the standardized XCP-on-Ethernet protocol allows you to connect to other measurement and calibration tools along with CANape. Depending on the controller used, the measurements hardly affect the controller's execution time at all.

Depending on the VX1000 base module used, network and streaming interfaces are also available.



Figure 3: Hardware of the VX1000 family – high-performance measurement data processing modules with XCP-on-Ethernet interfaces.

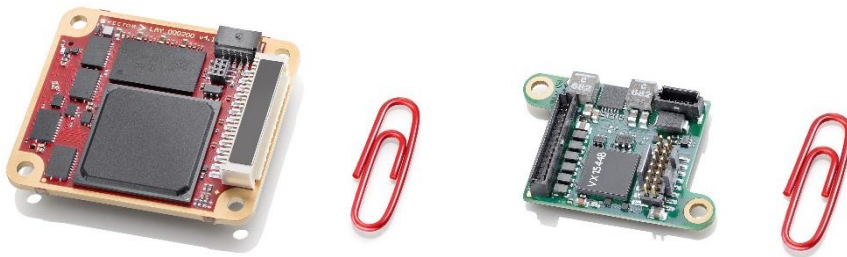


Figure 4: The VX1000 measurement hardware interface with the controller via a compact POD (Plug-On Device).

3.3 Supported Measurement systems for Analog/Digital Measurement Parameters

The following measurement systems can be integrated in CANape:

- > Vector I/O solutions in the various network interfaces.
- > All measurement and high-voltage modules from CSM which are connected to the PC over CAN or Ethernet.
- > Depending on the PC hardware used, it is possible to connect up to 40 1-MHz channels for acquiring voltage and current values, e.g., in the electric motor environment. Different data is calculated together online, and you get precise information about the input and output power levels of your inverter.
- > All measurement data acquisition devices connected over the CAN bus, e.g., devices from the companies CSM, CAETEC, IMC or IPETRONIK
- > ETAS measurement module series ES400 and ES600
- > Mx-SENS 8 over XCP on Ethernet from IPETRONIK.
- > Analog and digital measurement cards of the DAQmx series
- > DEWE-xxx and DEWE2 from DEWETRON
- > QuantumX and SoMat eDAQ from HBM
- > ADwin systems from the company Jäger Computergesteuerte Messtechnik
- > KiBox from Kistler
- > Inertial systems from GeneSys and OXTS for vehicle dynamics and position measurements

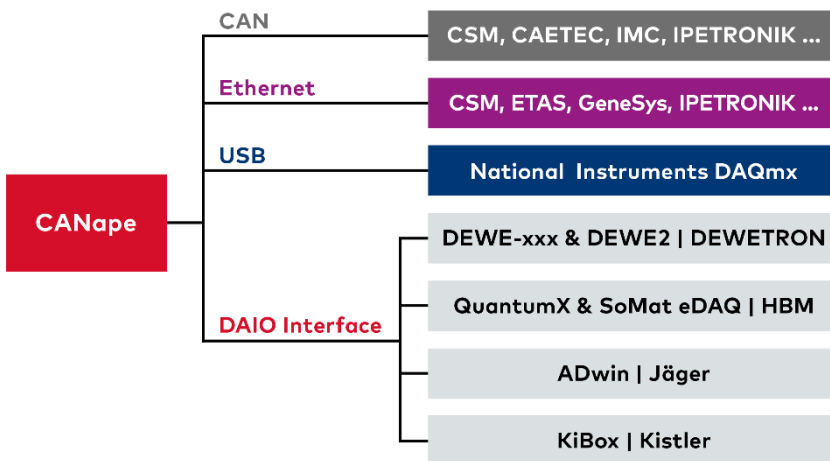


Figure 5: CANape supports many measurement solutions from a wide variety of producers. The DAIO interface is an open interface for interfacing to nearly any input and output systems.

An open interface is available so that you can integrate other measurement systems. The DAIO (digital/analog IO) interface for high-performance measurement solutions. You can create the drivers needed for this yourself. In development, Vector can support you with sample programs, documentation, and services.

4 Measurement Data Management and Evaluation of Measurement Data

CANape offers you many different options for user-friendly processing and evaluating the data of previous measurements, either manually or automatically. For instance, the measurement data management system in CANape supports indexing of the metadata and adaptive filtering to select the right data. Metadata is information such as the name of the vehicle, name of the project, etc. During recording, CANape writes this information directly into the measurement files.

Before an evaluation, you can then select files based on metadata and measurement conditions of specific variables. An example would be if you only wanted to analyze those files in which a specific vehicle was logged, and the engine speed was greater than 4,000 rpm in second gear.

Various methods are available as evaluation options.

- > Different measurement data formats are supported in import and export (e.g., ASCII, ATFX, BLF, CSV, GLX, XLS, TDMS). CANape works directly in the MDF/MF4, HDF5 and Excel formats without conversion.
- > The supplied function libraries offer extensive options for logical and arithmetic evaluation.
- > You can develop your own evaluation functions. Whether it is through the integrated CASL functional language, your own C/C++ code or with Simulink models.
- > Script-driven, automated evaluation of measurement files.
- > Conveniently search and analyze numerous measurement files and large files from the data mining user interface.
- > Conveniently link search conditions to efficiently describe and execute complex analyses.
- > Signals are displayed over time axis or in an XY view.
- > Manually search through signal responses using zoom and search functions as well as measurement cursors.
- > Compare measurement events with a superimposed display of events. If there are measurement files that were logged time-synchronously using GPS receivers, you can easily compare the data of different vehicles.
- > Insert comments for offline analysis.
- > Use customizable print templates.
- > Import and export different measurement file formats.
- > Export sequences from measurement files with synchronous video segments.
- > Easy to handle measurement files with the measurement file manager.

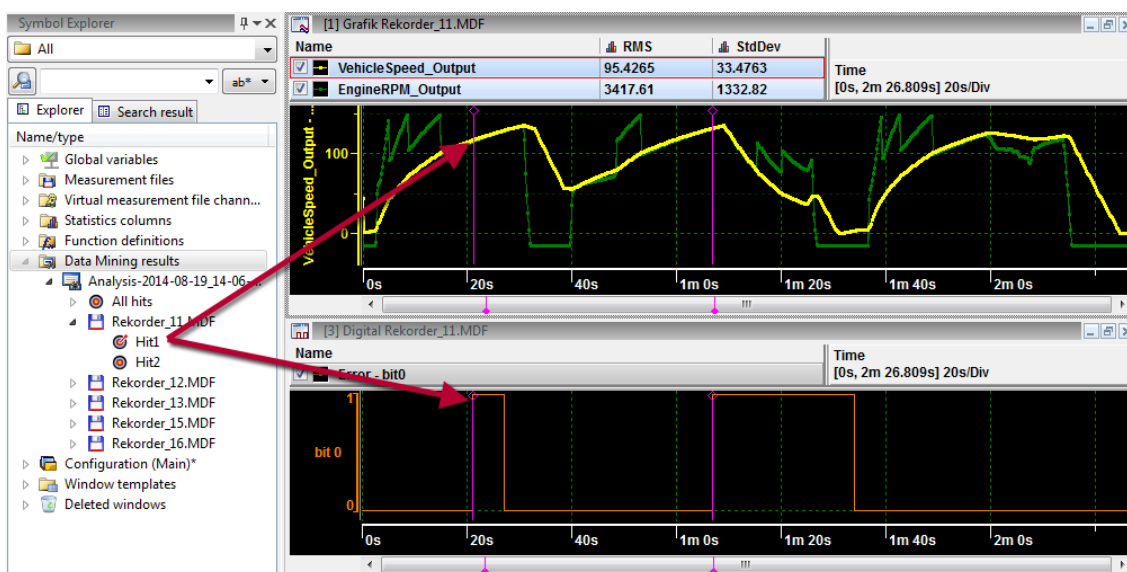


Figure 6: Convenient data mining user interface to automatically evaluate measurement data.

No programming skills are needed to execute fully created evaluations. You also do not need any programming skills to create evaluations in cases that are limited to the use of existing mathematical functions. However, programming skills are required to create elaborate, complex evaluations.

Method of analysis		Create analysis	Use analysis
Automated data analysis		Programming skills necessary	Programming skills not necessary
Mathematical functions	new	Programming skills not necessary	
	existing		
Visualization, manual analysis		Programming skills not necessary	

Figure 7: Programming skills are only needed for extensive evaluations.

4.1 Searching for and Finding Measurement Files

You can use extensive search and filter options to find the right measurement files for your evaluations.

The vMDM Explorer integrated in CANape gives you a search engine for your measurement data. You can search according to the type of information: Measurement file comments, events, signals, min. and max. values and many more. To avoid having to search through all possible measurement files in every search query, the vMDM search engine builds upon an index. Search queries can then be answered quickly and efficiently from the index contents. Measurement files are considered which have the extensions MDF, MF4 and DAT (ETAS Inca measurement data format which corresponds to MDF format).

Indexing can be performed locally on the PC or in the vMDM cloud solution. The local solution is already part of the CANape installation and does not require any further licensing.

For large quantities of data, the vMDM cloud solution is available.

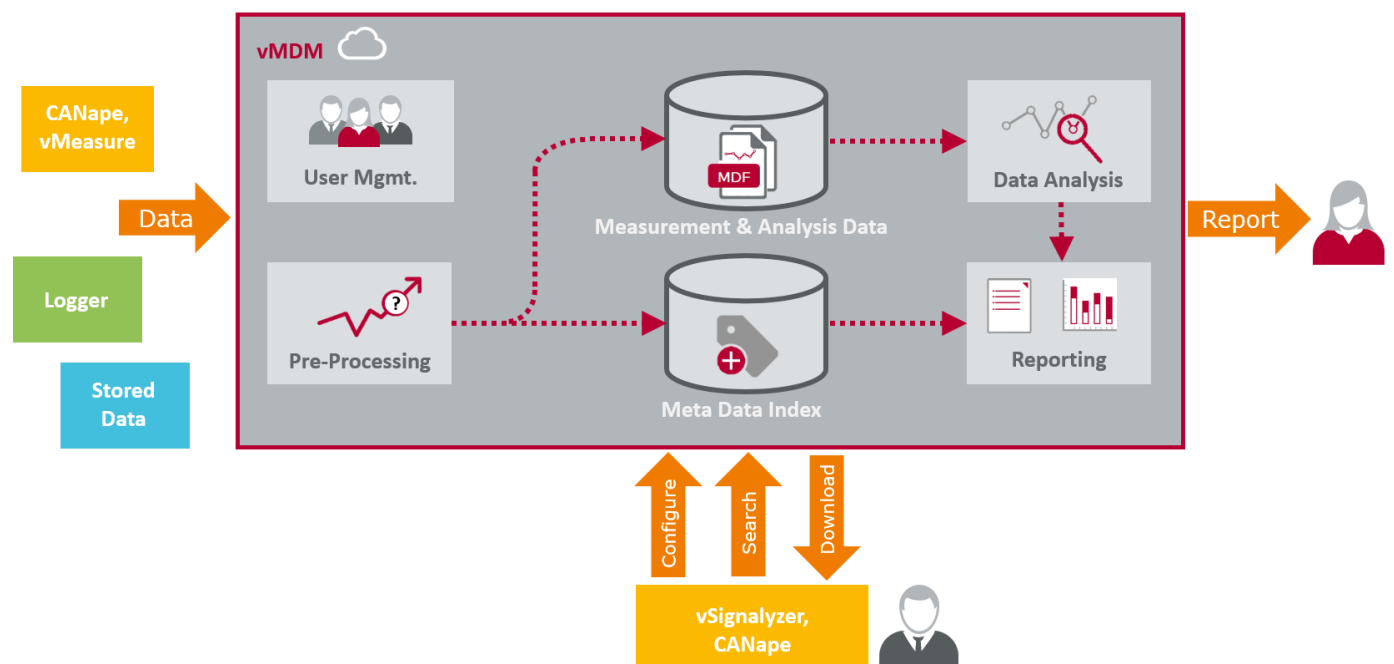


Figure 8: Overview of the most important vMDM components

With the extra Option vMDM, CANape can communicate with the vMDM as a client application.

5 Logging Solution with CANape log

CANape log is the powerful combination of the CANape calibration and measurement tool with the Vector logger hardware and part of the new Vector Smart Logger family. Use your CANape project unchanged in development and directly in testing. There is no configuration step for the logger and therefore no source of errors. It is a robust and easy-to-use solution for time-

synchronous, high-performance recording of measurement data from a wide variety of sources. You benefit from CANape's wide range of functions, very high data rates and flexible scalability as a standalone logger in the automotive environment, especially for ADAS development.

CANape log supports two operating modes. In each operating mode you access the vehicle buses, ADAS sensors and ECUs connected to the logger hardware.

Standalone Mode

CANape log performs measurement and recording autonomously and automatically. To monitor the autonomously running measurement, the driver uses a web-based application on his smartphone or tablet. In addition to status outputs, such as data rate and available memory, individual signal values can also be visualized. Interrupting and resuming the recording is also possible via the mobile devices.

Interactive mode

With a laptop and CANape installed on it, you can connect to CANape log via Ethernet at any time. This means that the full CANape interface is available to you on the laptop. You then work with CANape as usual while the project is running on the logger hardware. There is no need to change the cabling.

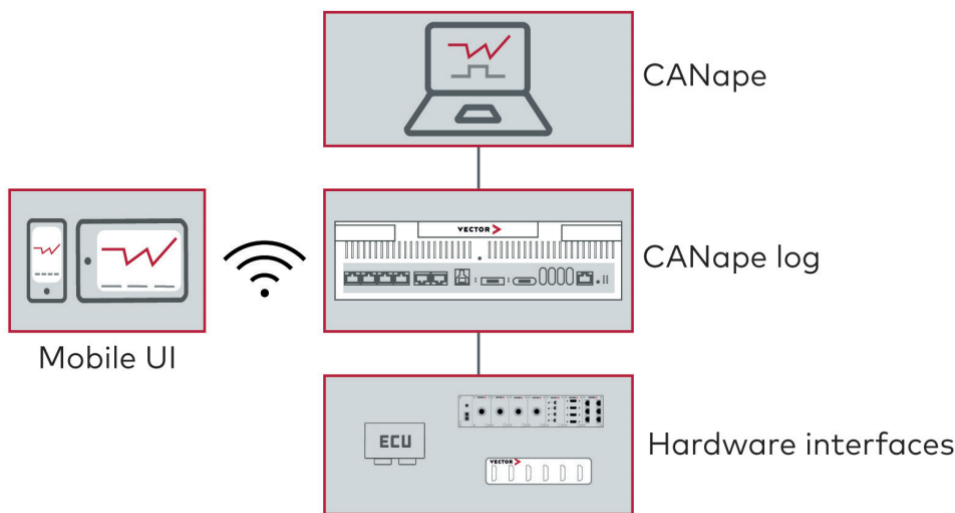


Figure 9: CANape log is a member of the new Vector Smart Logger family. The powerful combination of CANape and dedicated logger hardware enables time-synchronous and high-performance logging of measurement data.

Depending on the application, different hardware platforms are available: VN8911, VP6400 and VP7400. Please refer to the data sheet for technical details.

6 Development of Driver Assistance Systems

CANape supports time-synchronous recording of radar, LIDAR, video, inertial and vehicle data. Reference cameras also record environmental conditions and supply video data.

Option Driver Assistance lets developers of ADAS systems log and visualize sensor data in different windows. The sensors are connected over DHPRs (see [DHPR](#)).

In the video window, the sensor data is superimposed as graphic objects (e.g., rectangles and lines) over the video image of the reference camera in perspective. It is also visualized in a side view or from a bird's eye perspective. Based on the video image, you can verify the acquired data and thereby evaluate the system's reliability and operating safety, regardless of whether it is a radar system like ACC, a lane departure warning system or a parking assistant.

The scenes window that is available was specially designed for displaying the point clouds of the LIDAR systems.



Figure 10: Option Driver Assistance – Object verification for checking algorithms in the development of driver assistance systems.

6.1 Dynamic Object Acquisition

A special aspect that must be considered in acquiring objects such as traffic signs and road signs in the environment is that the number and positions of objects change dynamically during a measurement. This is a very different situation than in the case of signals, which are typically configured before a measurement and are always present during the measurement.

To simplify interactions with objects, they are defined in CANape together with their properties and are linked to measurement parameters. Then the user only needs to be concerned about the objects and not the individual measurement parameters.

7 E-Mobility Analysis in a High-Voltage Network

The new eMobilityAnalyzer function library is the centerpiece of scalable measurement solutions in the high-voltage field. Decentralized acquisition of voltage and current signals by CSM measurement modules, at sampling rates of up to 1 MHz, can be used for online calculation of relevant parameters of the powertrain, HV components and the electrical system. Among other things, you can calculate efficiency and the effective power, apparent power and reactive power very precisely.

8 Status Monitoring

Status monitoring assists in troubleshooting and functionally monitoring systems by analyzing states, state transitions and events that originate from different information sources, e.g., the ECU, bus, I/O, etc. An area of special focus here is the analysis of AUTOSAR ECUs that contain a lot of software components. The design of status monitoring is similar to that of a logic analyzer. Among other things, it is able to monitor the states of AUTOSAR runnables and analyze binary signals in a user-friendly way.

9 Calibration and Parameter Setting

Parameter values are displayed either alphanumerically or graphically. User-definable panels make it possible to customize the user interface in its display and calibrate characteristic parameters. Calibration of characteristic parameters has the following functionality:

- > You can set parameter values either online in the ECU's memory or offline in the cache of CANape. The offline mode enables pre- or post-processing of ECU parameters without a connection to the ECU.
- > Calibration of parameters runs in parallel to measurement data acquisition.
- > All parameters of an ECU can be calibrated in a single window, the Parameter Explorer. Structures with parameters can all be calibrated in the Parameter Explorer.

- > A parameter set can be generated from the measurement file which contains parameter values valid at the specific time of measurement.
- > Merging of parameter sets into new version levels and reintroduction of the data into software development through C-, H- or MATLAB M-files.
- > Parameter set files are managed in vCDMstudio.
- > Parameter set files can be loaded and then visualized and processed in calibration windows. This means that it is also possible to perform batch operations on parameter set files.

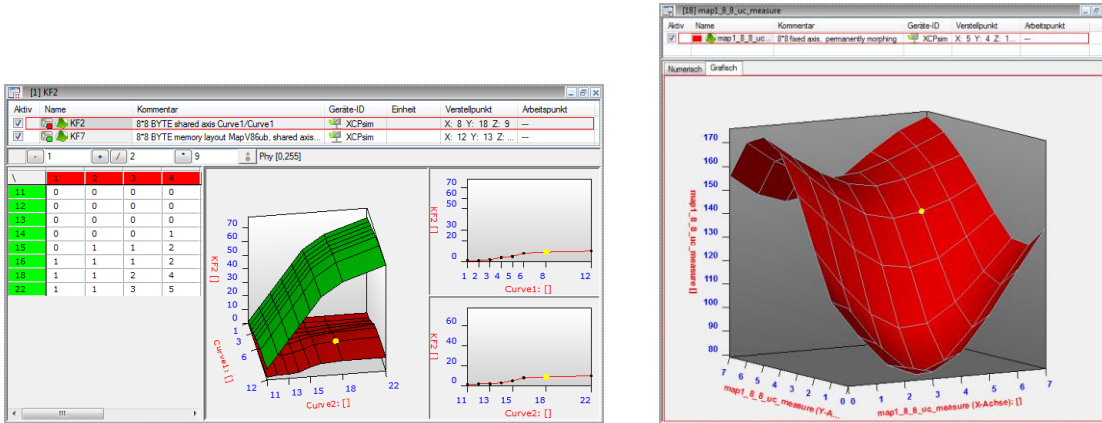


Figure 11: Numeric and graphic calibration windows make it easy to modify characteristic curves and maps.

9.1 Calibration Data Management (vCDMstudio)

A parameter set contains the values of parameters specified in the ECU description file. The integrated vCDMstudio manages these parameter sets and supports different file formats. CANape offers the following functionality here:

- > Parameter sets are saved in symbolic, address-independent parameter set files. This makes processing independent of the ECU program revision level at which the parameter set was generated.
- > Visualize and edit the contents of parameter sets
- > Open multiple parameter sets simultaneously for comparing, merging or editing.
- > Automation interface for merging, exporting and comparing parameter set files.
- > Generate flashable binary files from parameter sets.
- > Supports XML-based PaCo format and CDF format, in which additional meta information can be saved for each parameter value, e.g., maturity, value history, author, date and comments.
- > Interpolation in copying characteristic curves and maps with different numbers of reference points.
- > Smart filter mechanisms for defining views of parameter sets.
- > Generate reports in different formats, including for Excel.
- > Export and import of configurations.

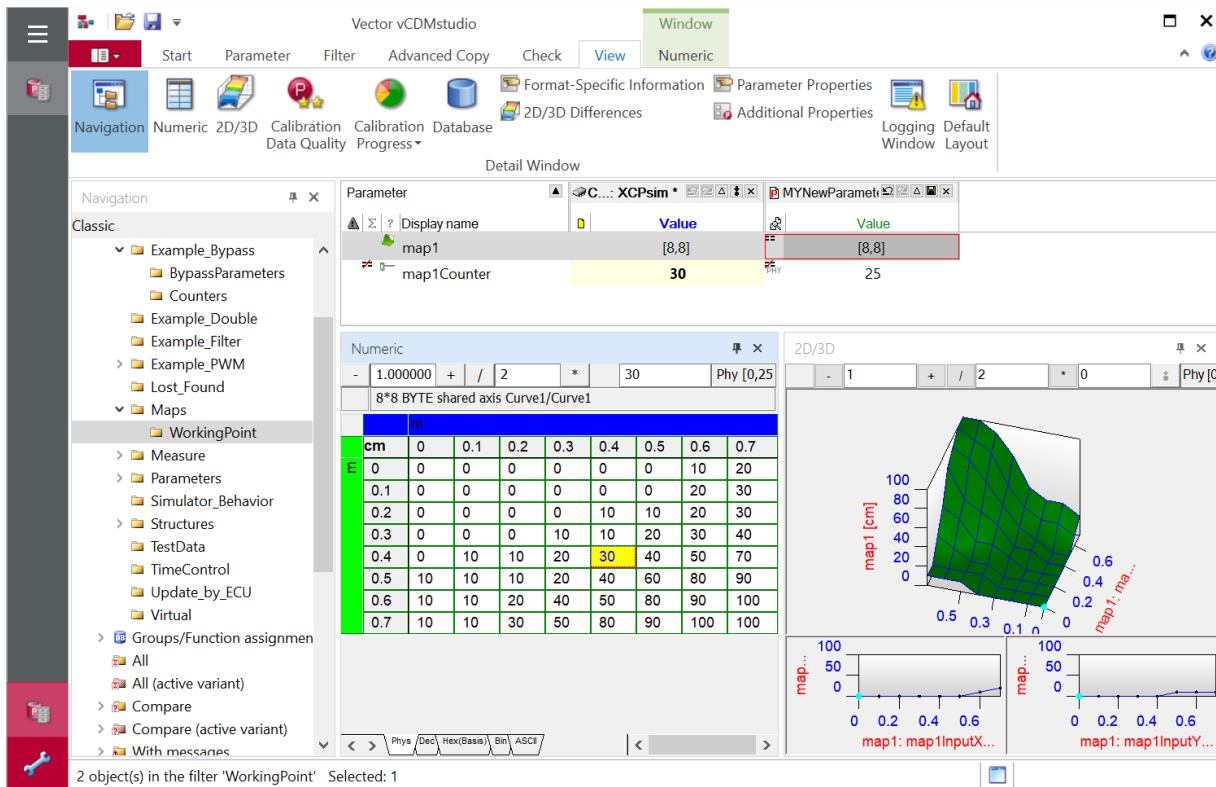


Figure 12: vCDMstudio lets you manage the extensive parameter sets of your ECUs easily and with traceability at all times.

9.2 Easy Collaboration on Parameter Sets Within a Team

Calibration is teamwork. Therefore, it is necessary to have a way to easily share parameter sets between team members and edit them together. Sharing on a pure file level creates the risk that parameter values could be lost when conflicts occur. The vCDM solution manages on the parameter level and not the file level. It indicates and resolves any conflicts. Nothing is lost.

- > CANape Option vCDM lets you assure easy and loss-free sharing of parameters within your team. Access is directly from CANape without involving any other application.
- > Each authorized user can access the data levels, edit them locally and compare them with the central data level.
- > Any conflicts resulting from changes to the same parameter by multiple users are indicated and resolved.
- > Server-based mobile database solution, e.g., for use in vehicle trials without access to the central CDM system.

This means that the team is always working with the same data level.

An existing vCDM server or a new installation can be used to store the data level centrally. Or you can use the Vector Cloud solution, in which Vector assumes responsibility for all operations.

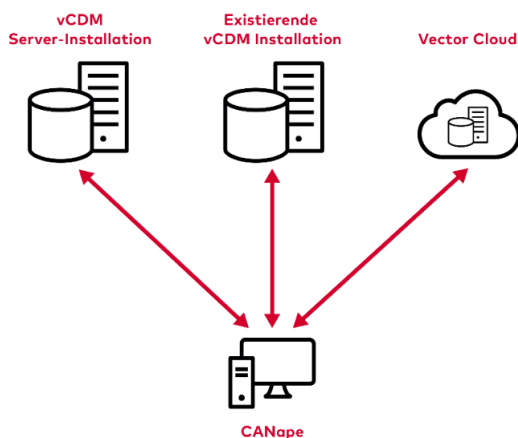


Figure 13: Cloud and on-premises solutions for calibration data management.

9.3 Server or Cloud Based Calibration Data Management with vCDM

In calibrating generated data (program and data levels, description files, documentation), the stand-alone software tool vCDM (Vector Calibration Data Management) can be used to manage the data in a database and save it for re-use across projects. The high complexity of calibration projects can be overcome reliably by managing variants, versions, and configurations.

Without having to switch between tools, you can download your work packets from the database directly into CANape, and afterwards it is easy to deliver finished parameter set files back into the database system.

Vector also offers vCDM as a cloud or software-as-a-service solution. In this case, Vector handles all operations. This relieves your IT department and simplifies work on shared data levels in team collaborations that can extend across companies.

10 Flashing

Flashing of new program versions is supported – over CCP/XCP and over diagnostic protocols.

The simplest way to do diagnostic-based flashing is to use vFlash projects. This flash tool from Vector supports more than 50 different flash specifications with user-friendly templates. It was designed for all users at automotive OEMs and suppliers whose tasks include (re-)programming of ECUs. vFlash lets them flash ECUs very efficiently in the laboratory, at programming stations, in a laboratory vehicle or in a road vehicle. ECU-specific process sequences are implemented in vFlash projects. In CANape, you can select them and use them directly for flashing.

11 Support of Model-Based Software Development

CANape interacts with the tool chain from MathWorks in numerous ways.

Basic functionality in CANape:

- > Export measurement files in MAT formats (e.g., the HDF5-based Format 7.3).
- > Export parameter files in M-script (to transfer parameter values to the workspace).
- > Export A2L file and parameter file as M-script (for initial creation of predefined A2L objects in the workspace).
- > Visualize Simulink/Stateflow models in CANape to conveniently search for objects, display measured values and calibrate parameters.
- > Over the C-API of CANape, MATLAB can get read and write access to object information from ECUs, buses, etc., and it can control CANape remotely. M-script functions are available in MATLAB for this purpose.
- > The code for CANape can be generated from models using the "Simulink Coder" generator. After compiling and linking, DLLs are available which CANape can use as a runtime environment. In code generation, an XCP slave is automatically integrated, so that the DLLs can also be measured and calibrated over XCP.

11.1 Rapid Prototyping with Simulink

Use CANape as measurement, parameterization, and visualization tool for models in Simulink. During function development, the data is transferred to CANape at runtime of the model in Simulink via XCP-on-Ethernet protocol. In this way you access the variables in Simulink just as if the application were running in an ECU.

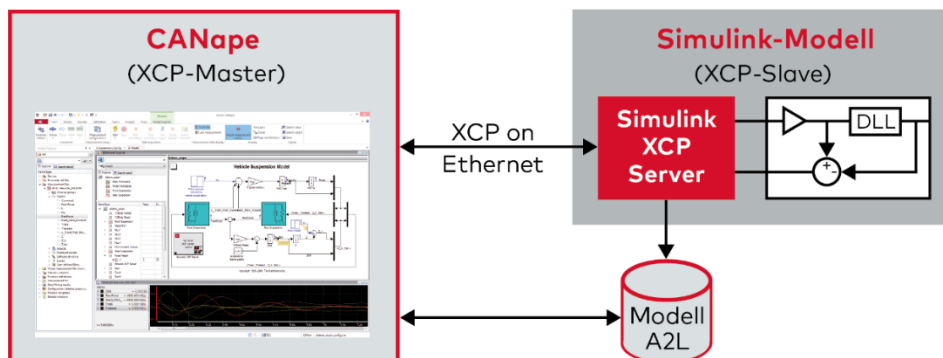


Figure 14: Simulink runtime is not the same as real time. CANape adapts fully to the time response of the model.

After one computation cycle, you can analyze the data in CANape and modify the parameters of your model directly in CANape with the help of parameterization capabilities such as calibration windows and vCDMstudio. Afterwards, the next computation cycle runs with the new parameterization. Since the computation of models often runs faster than in real time (depending on their complexity and computing power), short iteration cycles can be achieved. If DLLs are running within the Simulink model, measurement and calibration parameters within the DLLs can be accessed over XCP.

11.2 Rapid Prototyping on PC Platforms

CANape enables the use of standard PCs in place of cost-intensive rapid prototyping hardware. Functional development is performed with MATLAB/Simulink. After code generation and the compiler run, the Simulink model can be run as a DLL in CANape on any computer. Even without the use of code generators, DLL generation can make use of existing code or code generated by TargetLink from a supplied C++ project. Over XCP, it is then possible to access all internal model measurement variables and parameters (including integrated binary components). To stimulate the algorithms, you use both the current measurement values and the contents of already logged measurement files.

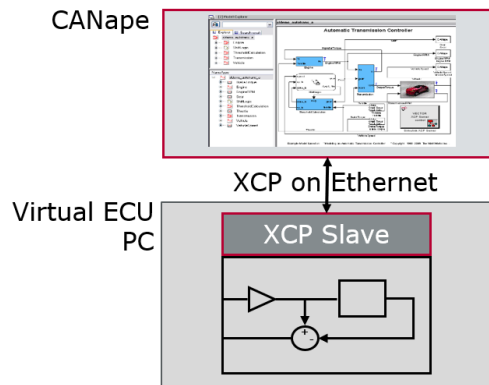


Figure 15: A virtual ECU runs as a DLL in CANape or as an EXE on a PC.

11.3 Visualization of Simulink/Stateflow models.

The Simulink Model Explorer lets you visualize the Simulink/Stateflow model directly in CANape – regardless of the code's runtime environment. The link between the model and the A2L file makes it easy for you to navigate directly through the model and access parameters and measurement values.

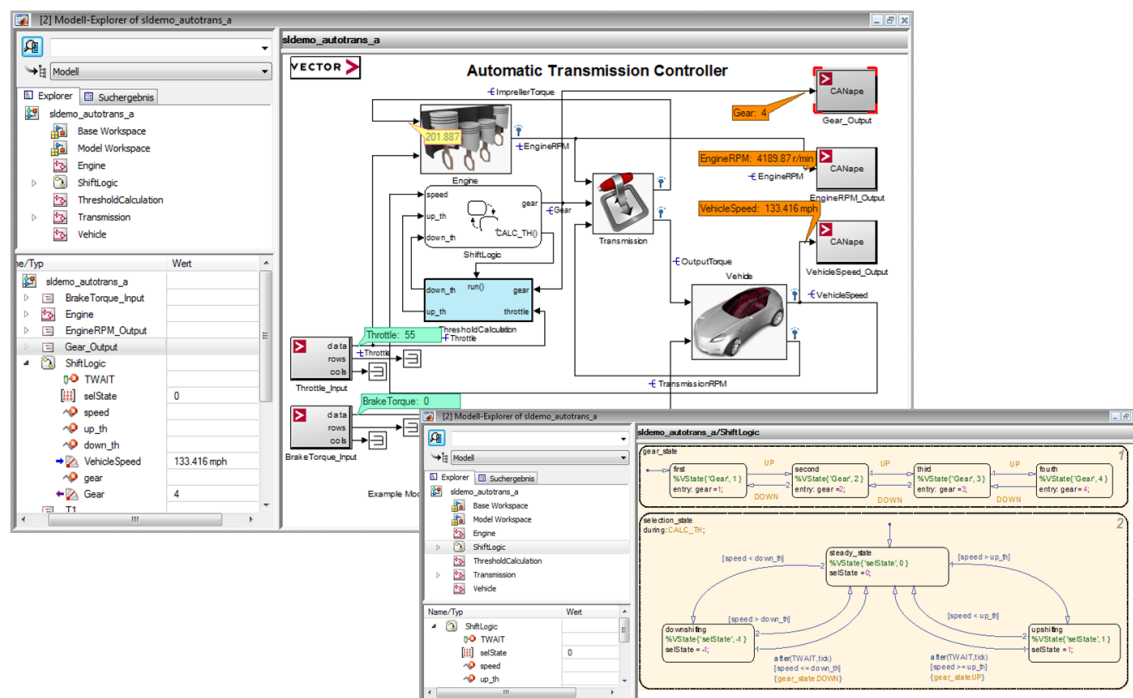


Figure 16: Integrated Model Explorer to display Simulink and Stateflow models.

In the Algorithm Designer, you can graphically link existing DLLs to signals and to one another.

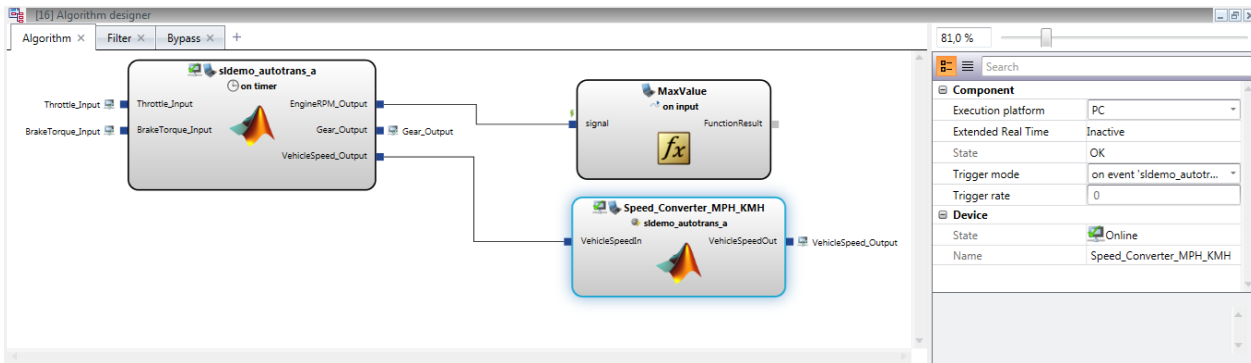


Figure 17: Existing DLLs and CANape functions are shown graphically with their inputs and outputs. The method for linking ports to signals or to other ports is similar to the method used in Simulink.

12 Bypassing

You can perform PC-based bypassing using the XCP mechanisms DAQ/STIM. Here, the input parameters of the specific ECU function are measured over XCP. On the PC, the Simulink model is used to calculate the output variables, and they are transferred back into the ECU time-synchronously by XCP stimulation. To ensure short roundtrip times, the bypass is computed at the Vector network interface with the integrated VN8900 real-time computer and measurement, and stimulation access is via the VX1000 hardware.

It is possible to simultaneously calculate multiple bypass functions for different ECUs or the same ECU on the VN8900. The VN8900 can also be used as a stand-alone solution. First, the bypass is configured with CANape and is downloaded to the VN8900. After disconnecting the VN8900 from CANape, the VN8900 then performs the calculation autonomously. This stand-alone use is limited to one ECU.

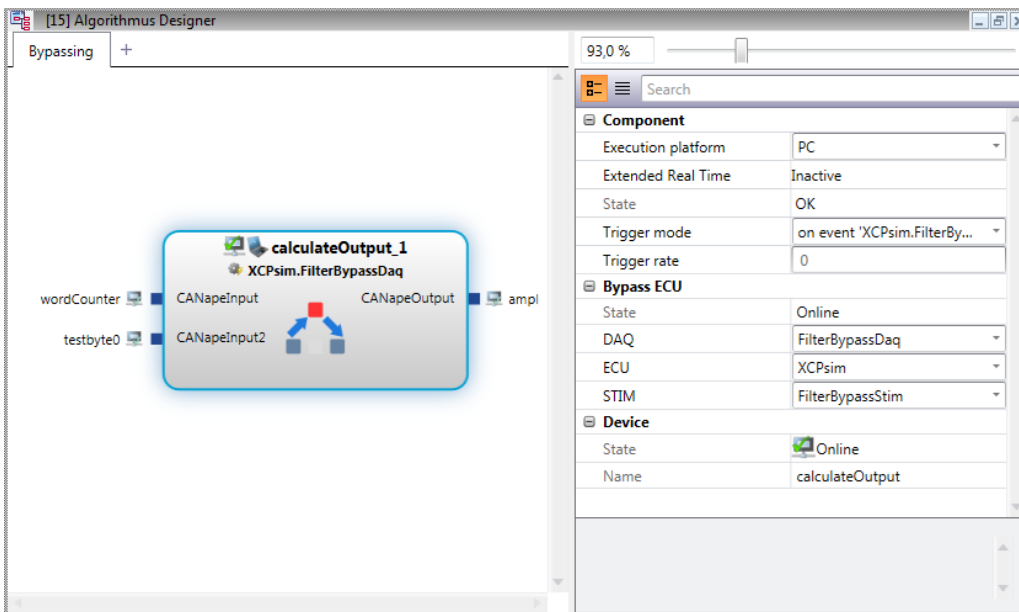


Figure 18: You can manage signal allocations for the bypass.

The Vector Tool Platform is a system extension for computer-based Vector network interfaces for CANape and CANoe.

Bypassing algorithms that are integrated in CANape can be outsourced to a VN8900 for execution. This significantly improves real-time behavior. Thanks to the more constant calculation time with significantly reduced maximum deviations, smaller guaranteed time limits can be adhered to and response time improved at the same time. This is a significant advantage, especially when executing time-critical bypass calculations with very low timeout tolerances.

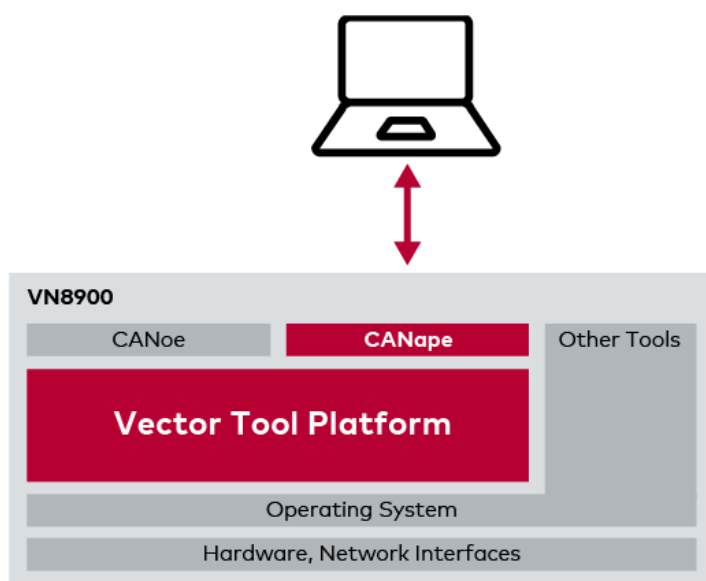


Figure 19: Improved real-time capability for bypassing with the Vector Tool Platform.

13 Integrated Functional and Script Language

The C-like functional and script language CASL (Calculation And Scripting Language) lets you compute virtual signals as well as automate sequences in CANape. The integrated editor offers a convenient development environment that includes a script debugger.

14 Automation Interfaces

CANape offers various high-performance automation interfaces which allow client applications to access ECU data, e.g., ASAM MCD-3 (MC), ASAP3, COM and a C-API. Typical applications are test benches or applications for automatic parameter calibration.

CANape Option MCD3 with its iLinkRT implementation significantly enhances transmission performance from CANape to the test bench. In this case, the measurement is configured over an ASAP3 interface, while the measurement data is transferred to the test bench computer over Ethernet.

15 Database Editors

CANape offers editors so that you can edit the various description files conveniently. They can be used for:

- > ECU description files in ASAP2 format
- > CAN description files in DBC format

As well as viewers for:

- > FlexRay description files in FIBEX format
- > LIN description files in LDF format
- > Diagnostic description files in ODX format
- > CANdela diagnostic description files in CDD format
- > Ethernet, SOME/IP, FlexRay and CAN description files in AUTOSAR System Description Format

16 Calibration Concepts

The calibration concept answers the question of how parameters can be modified in the ECU during the ECU development and calibration phases. There is not just one calibration concept; there are several. Which concept is appropriate depends primarily on the capabilities and resources of the microcontroller used.

CANape supports the following procedures:

- > Parameters in Flash
- > Parameters in RAM
- > Flash overlay
- > Dynamic flash overlay allocation
- > RAM pointer-based calibration concept per AUTOSAR
- > Single pointer concept
- > Flash pointer based calibration concept

You will find detailed information on XCP and the individual calibration concepts in the technical book "XCP – The Standard Protocol for ECU Development," which you can request, free-of-charge, from Vector: www.vector.com/xcp-buch

17 Diagnostics

Besides handling diagnostics for individual ECUs, CANape also gives the user a look at vehicle functions across ECUs by means of functional addressing. The physical interfaces CAN, FlexRay, Ethernet and K-Line are supported. The description files may exist in either ODX format or in the Vector specific CDD format. If there is no special diagnostic description file, the generic files for UDS and KWP2000 supplied with CANape offer symbolic access to functions and raw data.

As a diagnostic tester, CANape provides the following features:

- > Diagnostic console from which diagnostic functions are selected, parameterized and executed.
- > Window for displaying and processing fault memory, symbolic display of DTCs, and environmental data
- > Integrated access to measurement, calibration and diagnostic data, e.g., with visualization of fault memory entries in the Graphic window.
- > ODX-controlled flash programming.
- > Analysis of all aspects of the diagnostic communication in the trace window: Messages, transport protocol data, protocol data and diagnostic data.
- > Address-oriented access to A2L-defined ECU data over diagnostic functions.
- > Scripts for automating diagnostic sequences.
- > Easy-to-use automation interface for executing diagnostic services.
- > Functional addressing, e.g., to use a diagnostic function to query the ECU identifications of multiple ECUs.
- > Access to OBD data with specific display in the OBD window.
- > Support of DoIP (Diagnostics over Internet Protocol, ISO 13400).

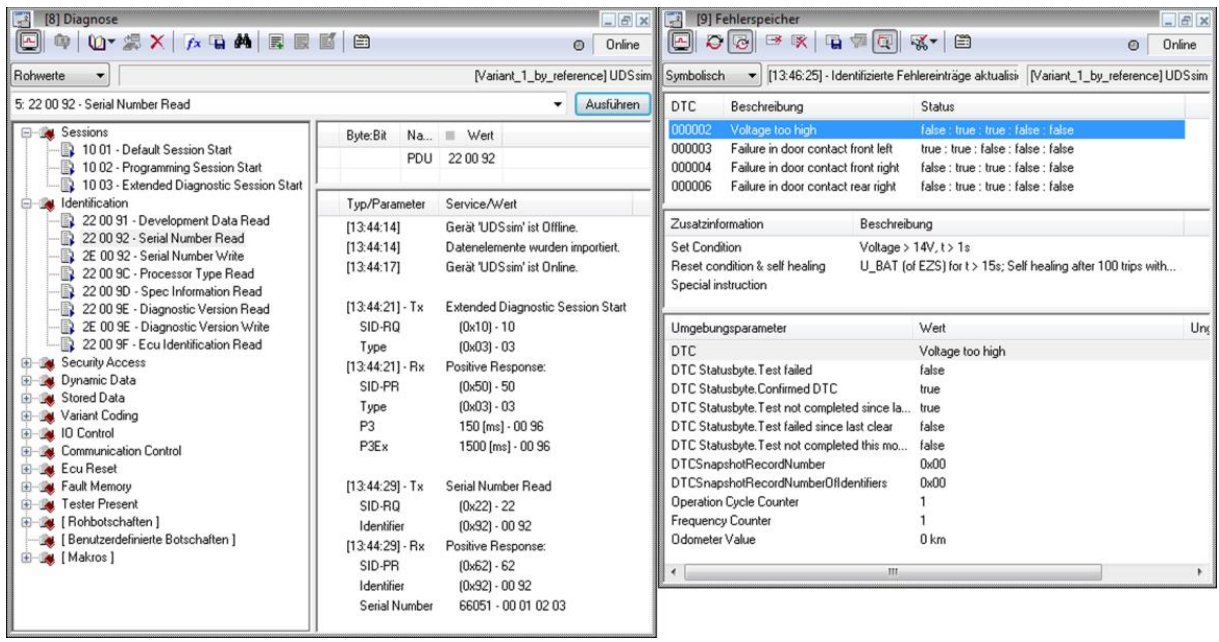


Figure 20: Structured display of diagnostic functions supported by the ECU. All diagnostic trouble codes are displayed symbolically, including environment data.

17.1 Validated Diagnostic Accesses with the Vector Security Manager

Security mechanisms in the ECU protect the vehicle and its functions against manipulation and unauthorized access. However, for test and diagnostic purposes, it must be possible for authorized persons to participate in vehicle communication during development and subsequent operation.

The Security Manager gives CANape users access to validated diagnostic data.

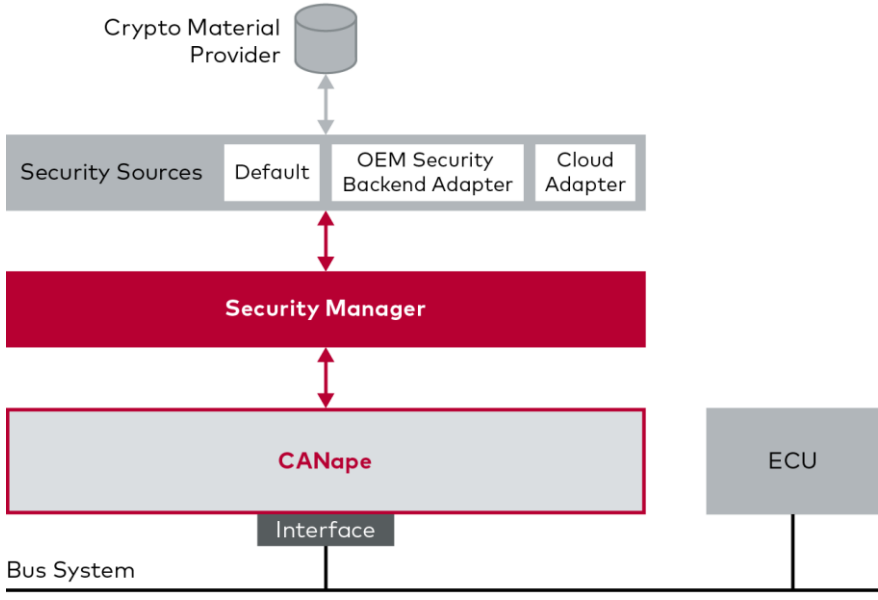


Figure 21: CANape users can access validated diagnostic data using the Security Manager.

18 Visualizing Vehicle Position on a Map

During in-vehicle measurements, CANape records the GPS data and visualizes the vehicle's current position on a map. In offline evaluation, the vehicle position is shown time-synchronous to the measurement data. This simplifies interpretation of the logged measurement data substantially because geographic conditions can be considered in the evaluation. The development of Car2x applications is supported by the CANape Map window, in which multiple objects can be visualized on the map.

If there are ADAS objects, they can also be drawn onto the map with precise positions.

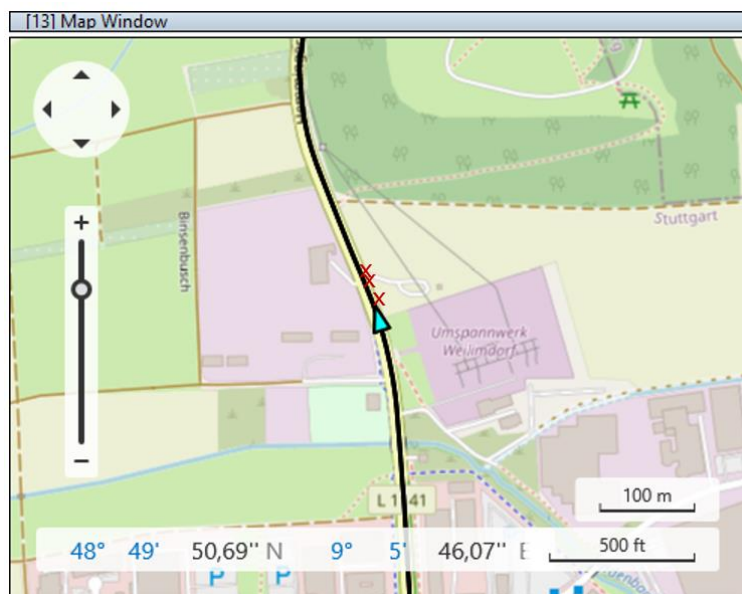


Figure 22: The total route with the current position of the vehicle is displayed. The red crosses represent detected vehicles.

18.1 Areas of Application

Certain events are much easier to classify when it is possible to synchronize the measurement data of a test drive with geographic position and to display it on a map. This is a reliable source of information to explain the behavior of your ECU, e.g., upshifting on a mountain.

18.2 Supported Map Materials

The following map materials can be used:

- > OpenStreetMap (also permits offline use of previously downloaded map materials, e.g., for test drives without an internet connection).
- > HERE
- > Shobunsha Super MappleG
- > Integrate your own maps in the form of graphics files.

18.3 Functions

- > Create user-configurable and scalable GPS display windows.
- > Display the vehicle position in the GPS window.
- > Configurable display of the track already driven. For example, the vehicle speed can be shown as a sequence of colors.
- >
- > Simultaneous visualization of geographic and vehicle-specific data in the various display windows.
- > Synchronization of the measurement cursor with the vehicle position on the map.
- > Simultaneous display of multiple vehicles (e.g., in Car2x communication) or multiple objects.
- > The level of detail in the map display changes depending on the zoom setting.

19 Hardware Interfaces and Protocols

CANape supports all standard interfaces and protocols relevant in the automotive sector (others on request) via the Vector hardware families:

- > Support of CAN, CAN FD, Ethernet, Automotive Ethernet, SOME/IP, FlexRay, LIN, SAE J1939, GMLAN and CANopen
- > CCP
- > XCP on CAN, CAN FD, FlexRay, Ethernet, Automotive Ethernet, RS232
- > AUTOSAR Debug Log and Trace (DLT) on Ethernet
- > High-speed controller interfaces like JTAG, DAP, LFAST, RTP/DMM, Nexus AUX and AURORA via the VX1000 measurement and calibration hardware from Vector.
- > Video interfaces are integrated via the frame grabbers in the VX1000 product family
- > Diagnostic protocols:
 - > KWP2000 on K-Line
 - > ISO 14230 (KWP2000 on CAN) and ISO 14229 (UDS), ISO/TF2 and VW-TP2.0 transport protocols.
 - > ISO 14229 (UDS) over FlexRay with the ISO transport protocol and the AUTOSAR and BMW transport protocols upon request.
 - > DoIP (Diagnostics over Internet Protocol, ISO 13400)
- > Integration of measurement technology and hardware interfaces from third-party manufacturers.

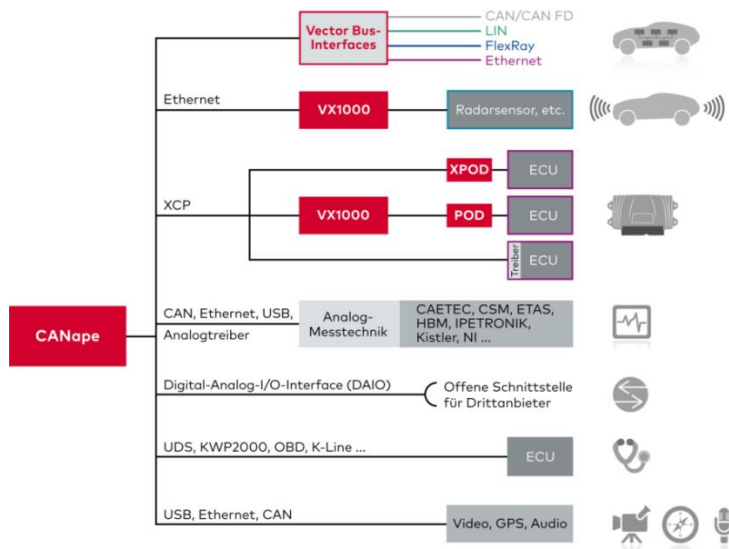


Figure 23: High flexibility based on a wide variety of hardware interfaces

19.1 Integrating ADAS Sensors via Protocol Decoders and DHPs

Radar and LIDAR sensors supply high-volume data streams and are therefore connected over Ethernet. Since the data is transmitted via manufacturer-specific protocols, CANape is integrated over DHPs. They accept the Ethernet data from the sensor, and they might interpret the data to the extent that this is necessary to visualize or save it in CANape. So, CANape is able to acquire any type of sensor data.

Video sensors supply their data primarily over specific video interfaces which are captured by frame grabbers (e.g., in VX1161) and are also routed as an Ethernet data stream. Frame grabber data is integrated in CANape over the DHP to provide sufficient PC resources for the high data rate.

19.2 ECU integration via third-party manufacturers

The FETK and xETK solutions from ETAS also support measurement and calibration via XCP on Ethernet. This makes them compatible with CANape.

The RAMScope from Yokogawa is also supported in CANape.

20 Engineering services

To allow you to concentrate fully on your ECU development activities, Vector can support you with its expertise and its tailor-made, fully-fledged solutions for your particular tasks. The range of services extends from consulting, e.g., ranging from a development process for an A2L file to placement of a field application engineer at your business site.

For more information on open interfaces in CANape for implementing customized functions, please refer to this separate [document](#) (PDF).

21 Training

In the framework of our training program, we offer various training events and workshops for our products in our seminar rooms. It is also possible to schedule an individual meeting at your company site – just contact us about this option.

You can also take advantage of our free e-learning platform at <https://elearning.vector.com/>.

21.1 CANape Fundamentals Workshop

In this workshop, you gain familiarity with CANape as a measurement and evaluation tool and as a calibration and diagnostic tool. After an introduction to the fundamentals of the XCP protocol, you configure the CANape display window to capture and display measurement data from many different sources. Afterwards, the data mining function is introduced, and you use it to automatically evaluate your measurement files. The calibration functions, data management and diagnostic functions are also on the agenda. You will find detailed information about the three-day workshop online at:

https://vector-academy.com/canape_training

21.2 XCP Fundamentals Seminar

This seminar teaches you the fundamentals of the XCP protocol. After an introduction, you can gain familiarity with models for synchronous data transfer and for calibration. The special aspects of the XCP Transport Layer are also addressed. Realistic sample sequences from practice round out the one-day seminar. You will find detailed information online at: https://vector-academy.com/xcp_training

21.3 Vector Calibration Data Management (vCDM) Seminar

Solid management of all calibration data is a prerequisite for quality and efficiency in the ECU calibration process. Specifications, software inventories, description files and documentation must always be accessible. In this seminar, you learn how vCDM can assist you in these tasks. The focus is on the practical calibration process. You will find detailed information online at:

https://vector-academy.com/vcdm_training

You will find more information on all other training events online at: www.vector-academy.de.



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