

Light in the Diagnostics Tunnel

Vector makes processes transparent

Diagnostics is becoming more and more important - not only in managing the rising share of electronics in the automobile, but also in accelerating development processes. Vector Informatik GmbH offers a number of tools designed to simplify the development of electronic control unit software. Diagnostics functionality continues to play an increasingly more important role here.



Figure 1: Diagnostics in the Motor Vehicle

The following factors contribute to the enormous rise in the significance of diagnostics:

- The complexity of individual electronic control units (ECUs) is increasing rapidly, because they contain more and more functions and more powerful processors. Proper diagnostics tools are needed to manage this complexity while meeting the same shorter development cycles. These tools should be able to detect, analyze and correct errors in structures.
- Today the number of ECUs in the vehicle often reaches 50 to 70 units. This makes the aggregate interconnections more complex, and without as-

sistance it is hardly possible any longer to localize and correct errors in the total system. Automobile producers and suppliers have a common interest in minimizing expensive service work, recall actions and claims.

- The increasing miniaturization of ECUs no longer leaves any room for external test equipment. The only solution is to access the ECU's internal system data over the bus system.
- Increasingly diverse variants require reliable mechanisms which permit clear identification of a ECU variant. This task is becoming increasingly important due to the potentials of flash programming (end-of-line and/or in service).

The classic usage of diagnostics functions involved reading-out error messages from error memory at a service department. Today diagnostics functions are also used in production, e.g. for end-of-line testing of individual systems or the total vehicle. For example, this is how insertion contacts and wiring are tested. In the future automotive producers and suppliers will use diagnostics functions earlier during development to support functional development. To achieve this it is necessary to develop diagnostics software in parallel to the actual functional development.

In practice diagnostics functions may be implemented flexibly. Some of the options are listed below:

- Read-out error memory entries (when and under what circumstances did an error occur?)
- Read-out actual values (e.g. momentary RPM)
- Check ECU inputs/outputs and manipulate them (e.g. valve functions, blower levels)
- Reprogram the ECU ("Flash"), update the ECU software
- Modify the ECU configuration

Looking for Do-It-Alls

CANdela (CAN diagnostics environment for lean applications) is the process-oriented development environment from Vector Informatik with which all relevant diagnostics properties can be described and maintained in one tool. Its core is a comprehensive, uniform database which automotive producers and ECU suppliers can call upon over the entire development process. CANdela supports all important process steps from specification and documentation to implementation of ECU software to data exchange with test tools. This guarantees troublefree and quick development of diagnostics functions even when the subdivision of work assignments for processes is extreme. Supplemental synergistic effects result from CANdela's close interaction with other development tools from Vector.

The diverse and strict requirements the diagnostics user places on software tools in development, production and service can only be satisfied with a variety of special tools. Therefore in the field of diagnostics Vector is concentrating on the development area, that is the CANdela development environment is primarily designed for the needs of automotive producers and suppliers. Consequently CANdela was jointly developed with two motor vehicle producers and one agricultural machine producer to implement the target group requirements in a practice-based manner.

To better understand the requirements profile of CANdela the development process (V-Model) should be explained first. The automotive producer specifies in one or more documents how diagnostics should be implemented in its vehicles. In this general diagnostics specification, although it is based on international standards, there may be large or small differences between the requirements of different vehicle producers.

ECU-specific diagnostics specifications are created based on the general diagnostics specification. Depending on the cooperation model these ECU-specific specifications are either created by the vehicle producer or by

the supplier.

Since the underlying specifications are for the most part formulated in textual language there is often a certain amount of leeway for interpretation.

Generally the ECU supplier creates a supplemental requirements specification in which requirements are described from the supplier's perspective and are supplemented by the supplier's own special needs. This second perspective that results is seldom identical to that of the automotive producer given the leeway for interpretation. Often a tedious coordination phase is needed until differences between the OEM specification and requirements specification are resolved. Afterwards the supplier develops diagnostics software for the ECU and documents it. Finally the automotive producer integrates the ECU in the vehicle.

For each change in diagnostics functions the V-Model must be run through again. Besides the large number of versions and possible inconsistencies that might result the considerable time expended for each new iteration is another disadvantage.

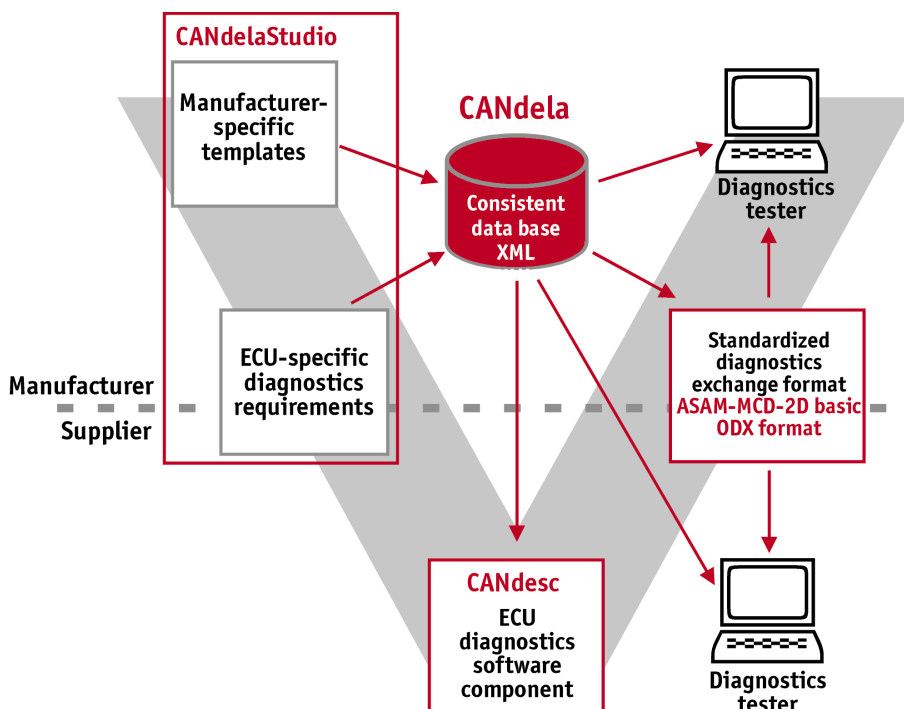


Figure 2: Diagnostics Development Process (V-Model)

Everything from One Base

Vector has therefore intentionally conceived of CANdela as a profile tool:

- The underlying data model is very extensive to satisfy all of the requirements of the various automotive producers.
- There is a so-called document template for each vehicle producer which is a prefilled model. This contains a formal description of all requirements of the diagnostics implementation which are specific to the vehicle producer.
- Each ECU diagnostics description is based on such a document template. The user only needs to add the ECU-specific portions. Consistency with producer data is automatically assured.
- CANdelaStudio is the tool for editing the CANdela ECU descriptions. It has an intuitive user interface which even occasional users working in nondiagnostics areas can quickly learn to use. The complexity of the model is transparent to the user.
- Document templates and ECU descriptions are saved in XML format.

Today document templates are developed by Vector in cooperation with vehicle producers. These templates are individually adapted to the specific interests of the vehicle producers regarding terminology and presentation. Already contained in these document templates are the standardized diagnostics protocol, producer-specific data and important application cases. It is only necessary to input ECU-specific data in words, formulas or numbers.

Document templates describe diagnostics functions on a higher abstract level from the perspective of the system expert. Actual utilization of diagnostics is emphasized, not the diagnostics protocol itself. The user may choose from a number of allowable protocol services assigned to each application case. The entire diagnostics process is considerably simplified by this standardization.

Currently a tool is being developed which can be used on-site at the producer or supplier to create and edit document templates.

Once a ECU diagnostics description has been defined and created with the help of CANdelaStudio, a table-based and textual specification in RTF format can be generated by the press of a button. This specification contains all important information of the CANdela database. Depending on the ECU's functional content the printout of this specification may range from about 30 to 80 pages in length.

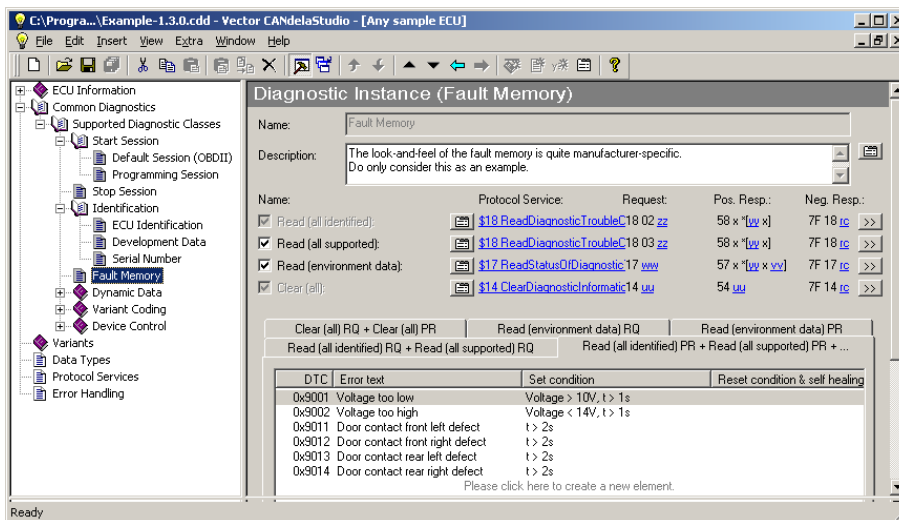


Figure 3: CANdelaStudio – Intuitive Editing of a ECU Diagnostics Description

A target group concept is also included in CANdela. Project participants (e.g. from development, production, customer service or suppliers) will only have predefined contents displayed. This is intended to limit the informational content of the specification or documentation, and to support the selection of relevant information. In the meantime CANdela has broadened its scope internationally. For example, Japanese script is now supported, and the specification can be stored simultaneously in different languages.

Likes Contacts

It has been demonstrated that ECU diagnostics operates that much more troublefree if requirements from production and customer service are also allowed to flow into the ECU software design process. To allow these diagnostics functions to be integrated in the ECU as early as possible it would first be necessary to implement the producer-specific diagnostics protocol; generally this is quite time-consuming and expensive. Past experience has shown that the development of functions always gets priority over diagnostics.

With CANdela this state of affairs is improved. All services and subfunctions are already formally described in the diagnostics database. This opens up the possibility of using a suitable generator to automatically generate - in parallel to functional development - the source text modules for implementation of diagnostics in the ECU. The diagnostics software component CANdesc, which is generated from the CANdela database, has already been successfully implemented in a number of automotive ECUs which are soon to be released for mass production.

To improve data exchange between development partners the automotive and supplier industries are striving for an open and uniform data description. The ASAM Working Group is working on the ODX (Open Diagnostics Exchange) standard and plans to complete its work by the end of this year. As part of this initiative Vector has created a ODX draft version that is based on experiences and requirements gathered from practice. The exchange involves exporting information from the CANdela diagnostics data description in ODX format. Some automotive producers plan to use ODX to provide data to their diagnostics test systems for end-of-line testing or to use ODX as an exchange format for parameterizing different test systems.

Stays with the Family

Vector also provides tailor-made products for users who do not participate directly in the development of diagnostics functions but want to access ECUs over the diagnostics interface. Development tools such as CANoe/DENoe, CANalyzer/DENalyzer and the measurement and application tool CANape Graph MC+D will soon be equipped with a wide array of basic diagnostics functions. Previously these tools could be used to conduct error analysis or interpret diagnostics messages based on the KWP2000 protocol.

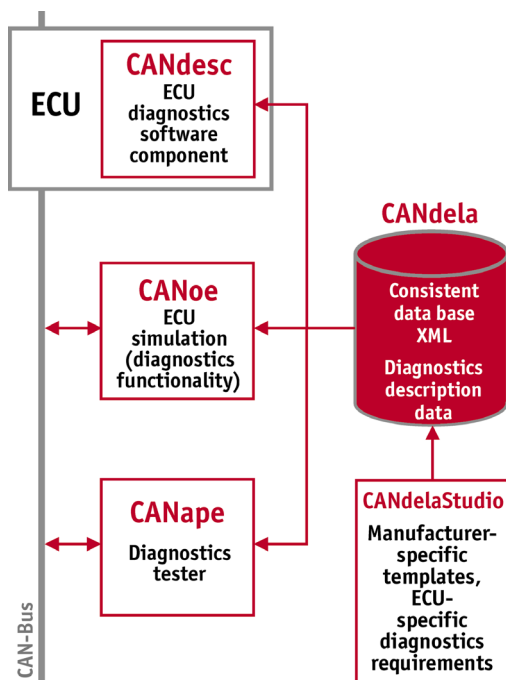


Figure 4: Vector Diagnostics Tool Chain

The basic idea is that in the future the customer will want to read-out error memory or test the ECU over the diagnostics interface without needing to switch tools. This is how Vector is reacting to the trend that in development departments besides the usual simulation and bus analysis activities diagnostics functions are also becoming important. The elegance of the Vector idea is that it just involves a tool expansion and does not necessitate a separate supplemental tool.

In their next release CANoe and CANape Graph MC+D will contain the so-called "Diagnostics Feature Set" which incorporates diagnostics functions such as read-out of error memory, ECU identification characteristics, and the execution of other diagnostics services. Moreover, parameters, raw values and physical values may be read, and parameter values may be modified. The script language of CANoe and CANape Graph is similarly being expanded to include special diagnostics commands. This allows the user to utilize diagnostics services in the user's own configurations to address and test the ECU with the help of the diagnostics interface.

The data of the CANDela description file serve as a foundation for the Diagnostics Feature Set. Its "look and feel" and functional content are identical for all products.

The user must first select the CANDela description file that matches the ECU in order to be able to use the ECU-specific diagnostics functions. This description file was either created by the user or by others using CANDelaStudio. The information it contains are then available in the tool being used. The user controls the diagnostics functions in CANape Graph MC+D, CANDito and CANoe in a way that is identical to that of user windows. The error memories or consoles are set up and structured in the same way, for example.

The new CANDito product is being added to the CANape product line. It focuses on diagnostics tester functionality. Besides the Diagnostics Feature Set CANDito has full measurement functionality that has long proven effective in the CANape and CANape Graph products. CANDito is primarily intended for users who wish to analyze diagnostics and measurement signals over the CAN bus or using analog test equipment modules. This additional diagnostics functionality will make the CANape Graph product a fully capable MC+D (Measurement, Calibration and Diagnostics) tool.

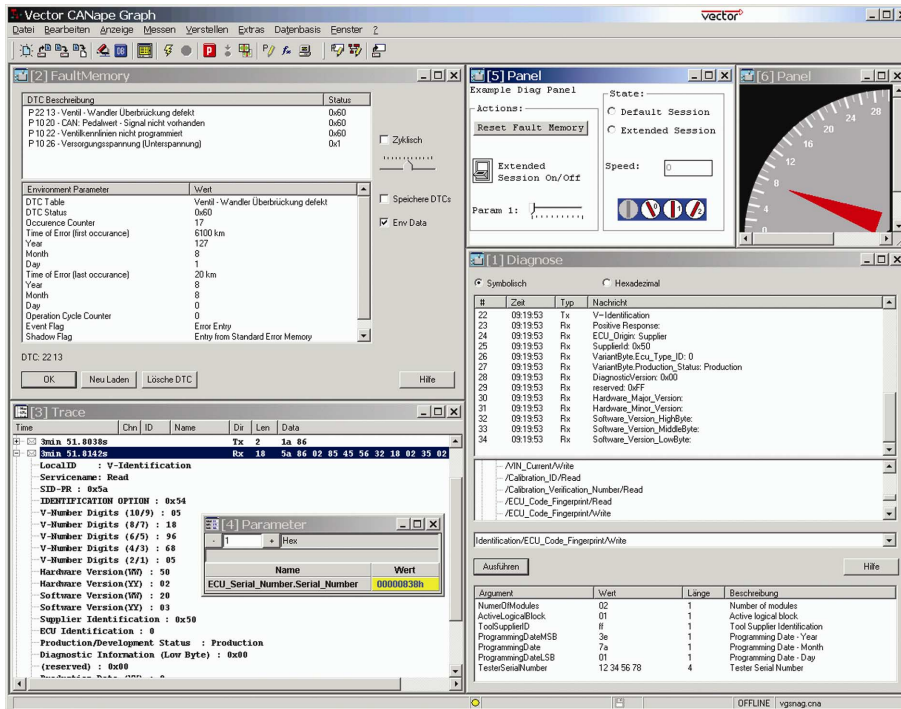


Figure 5: Diagnostics Window in CANape Graph MC+D

With the integration of diagnostics functionality in CANoe the ECU developer not only gets rest-of-bus simulation capability, but also other capabilities for developing and verifying individual functions of the ECU software.

Summary

Vector has recognized the growing demands on diagnostics software and offers development tools that are tailor-made for various user groups. CANdela is a complete product for all those who want to develop and implement diagnostics functions. The Diagnostics Feature Set to be included in the next releases of CANape Graph, CANDito and CANoe is intended for users who - in addition to their previous requirements - also need supplemental diagnostics functions. It permits access to ECUs over the diagnostics interface, e.g. to read-out error memory or identification characteristics or to read and modify parameters. By integrating these supplemental diagnostics functionalities in the proven and widely used tools from Vector they

can be operated in a familiar way. The time-consuming learning curve for a new tool is eliminated, and the user can begin to work with it effectively immediately.

15,018 characters

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Figure 2: Diagnostics Development Process (V-Model)

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Figures: Vector Informatik GmbH, Stuttgart

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