Diagnostics 4.0 – The Answer to Increased Networking

Vehicle diagnostics has been working the same for years: Plug in an adapter and use an expert system to localize the problem. The fault will then be rectified on the basis of the data gained. Updating ECU functions takes place in exactly the same way. In comparison to this procedure, considerable time and cost savings will be able to be made in the future for both functionalities with the extension of the vehicle into the cloud. And this will also lead to a considerable improvement in diagnostic quality.

Vehicles today are a highly complex network of electronic control units, ECUs, which work together using very different bus systems and gateways. The responsibility for subcomponents, such as brakes, lights and seats, is shared between the manufacturer and supplier, resulting in even more complexity, and is now making the entire vehicle system almost unmanageable in terms of manufacturing and repairs.

Current trends in legislation and function add-ons represent both an opportunity and a risk at the same time. Services such as eCall and driver assistance systems are already opening the vehicle up to the outside today via an interface. This will increase even further in the future with standardization measures such as "Extended Vehicle" and the major trend of autonomous driving. Because of this, the overall complexity of the vehicle is rising significantly and is likely to encompass systems to which manufacturers no longer have direct access. At the same time, this development is also enabling far-reaching improvements in terms of availability, maintenance and the quality assurance of vehicles.

In the future this will result in additional opportunities for vehicle diagnostics over the entire lifestyle from engineering and manufacturing through to after-sales service. The actual repair to the vehicle will still be carried out by the mechanic in the repair

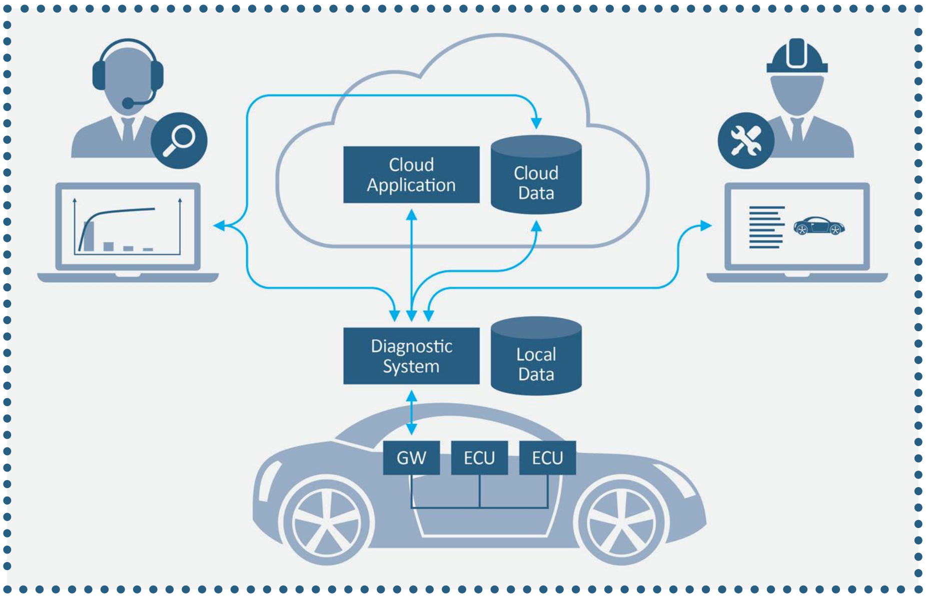

Figure 1: Flexible coverage of different use cases (© Softing)

- Data Access in Series Vehicles
The cyclical reading out of data from customer vehicles makes it possible to monitor aging processes using very large sampling numbers. This makes repairs before they become necessary ("anticipatory service") just as possible as quality improvements for the series.
- Software Update Over the Air Interface
The software is "repaired" in a customer's garage. This reduces the number of recalls and the customer does not have to drive to the repair shop.

shop localizing the fault with an expert system which detects most of the faults using fault search tress and algorithms. But if the mechanic gets to a sticking point, he can consult an expert who can switch to the vehicle by remote access and execute more detailed analyses. A specially trained expert could, for example, be based in a technical center or in the regional organization of the manufacturer.
In vehicle engineering, there are numerous scenarios in which such remote access could represent significant savings: In the case of test units, which have to be accessed by several people responsible for ECUs and which are set up only once; for prototypes, whose status can be read out at any time from the office; with test fleets in which a diagnostic expert does not have to travel in every vehicle, but a single engineer monitors the entire test fleet using remote access.

With the Cloud into a New Dimension

Cloud diagnostics offers the opportunity to use a completely new form of diagnostics with a comparable infrastructure. In this process, the diagnostic application works independently within the cloud with one or more vehicles. What are referred to as campaigns specify beforehand which vehicles are to be used for which actions. The possible uses are many and varied:

- Vehicle ECG During Engineering
  With the cyclical reading out of the fault memory of a test fleet, troubleshooting and the overall status can be checked automatically.

Safe to Use

But the remote access of vehicles also entails a significant security risk. This interface makes it possible to address a large number of vehicle functions directly, to read out information and change vehicle behavior. In the past, plugging in an interface module at least gave some protection; in the future, far more extensive security and protective measures are going to be required. The following basic protective measures must be ensured:

- Data Integrity
  Data must not be able to be modified without being noticed.
- Data Consistency
  The content of the individual data stored in a database must correspond to each other.
- Data Authenticity
  The data sources must be clearly known.

The damage potential is enormous and can very quickly amount to sums of several million euros. If, for example, performance parameters of the engine are modified, this can lead to early wear and tear and consequently to (warranty) repairs. Abusing personal data brings with it considerable penalties and so it is essential that this data be protected accordingly. Access to vehicle functions while driving could lead to death, which - aside from any ethical considerations - can mean correspondingly high penalties in the case of insufficient safeguarding.
Safeguarding has to take place on a number of different levels:

Figure 2: Different cutting points in the standardized diagnostic system
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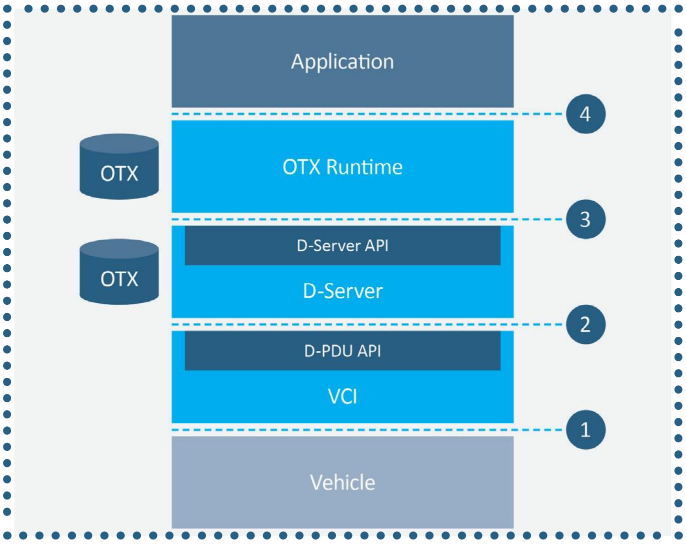

- Data
  Both stored and transmitted data have to be encrypted and protected from unauthorized access.
- Data Connections
  All data connections have to be manipulation-proof and protected from unauthorized access.
- Applications
  Both the users and the programs have to be known and identified unambiguously.

Standardized Diagnostic System – Not an Obsolete Model!

Today's diagnostic systems work very similarly in their basic setup: The vehicle is accessed via a VCI (Vehicle Communication Interface) integrated in the diagnostic system via the standardized D-PDU API. Above this interface, the data is available in hexadecimal form regardless of the diagnostic protocol. The data is processed by the D-Server which effectively acts as a kind of diagnostic operating system. With the help of the ODX data, it illustrates the diagnostic capabilities of a vehicle, executes diagnostic commands and presents results in human-readable form (e.g. "1900 rpm" instead of "0x0e2f"). To be able to process complete diagnostic tasks, several diagnostic functions are compiled into sequences. These sequences are stored, transmitted and run with the Standard OTX (Open Test Sequence Exchange); execution takes place in an independent execution layer (OTX Runtime). Representation for the user depends very much on the particular application case. Users of an engineering tester require complete access to all diagnostic functions and parametrization, whereas in a production system, diagnostics takes place virtually entirely automatically and often only individual results are presented to the operator.

Flexible Application in a Remote Scenario

When using a diagnostic system in a remote scenario, a decision has to be made on where to split the system. It is not possible to make a general recommendation as it depends on the application cases, the infrastructure, the memory extension in the vehicle and, last but not least, on the diagnostic protocol. Generally speaking, the D-Server API is not very suitable for remote access due to the large number of necessary method calls. It is also not usually possible to split at protocol level because access mechanisms and real-time requirements do not allow this.
When using a diagnostic system in a traveling vehicle it is recommended that the entire system be incorporated in the vehicle due to the changing connection quality. In this case, only diagnostic commands are then usually transferred; results are called up when the connection quality permits. When using in a stationary vehicle, the connection takes place for example over WiFi and the home network so that it could well make sense to cut at VCI level, which makes fewer demands of the memory extension. This is also generally true when using flash programming because here the transmission takes place in one direction and the individual commands are thus good to combine .

Can be Used Immediately with Optimization Potential

The individual components of the next diagnostic generation are already available. The individual application case decides on how they are split within the full system. Thanks to the use of standards and the high modularity, all kinds of use scenarios can be covered efficiently with one and the same system. The diagnostic system of the future thus integrates seamlessly into existing processes and also helps in their optimization.


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Originally published in German in the section "Measurement Technology" of the technical magazine HANSER automotive 10/2017, published by Carl Hanser, Munich, Germany