Standardized Vehicle Diagnostics over Ethernet

Due to ever more complex electronic systems and the constantly growing volume of data in vehicles, vehicle access for diagnostics and ECU programming has to be correspondingly efficient. For this purpose, communication based on Ethernet technology has been specified with Diagnostics over Internet Protocol (DoIP). This article shows how DoIP is positioned in the software structure of a diagnostic tester and provides insight into fundamental characteristics of the diagnostic protocol.

Ethernet-based communication enables new concepts in vehicle diagnostics. For example direct vehicle access from the tester is now possible even without a VCI and the integration of the diagnostic interface into the IT infrastructure is considerably simplified. This can take place both using a LAN cable or alternatively via WLAN in the case of mobile applications.

The block diagram (Fig. 1) provides an overview of the fundamental elements of a diagnostic tester based on standardized modules. Normally the vehicle is accessed via a Vehicle Communication Interface (VCI) connected with the workstation often over USB, WLAN or LAN. In the past, proprietary protocols and KWP were used as communication protocols. Nowadays, the UDS (Unified Diagnostic Services) protocol tends to be used. It supports all established bus systems, such as CAN, K-Line, FlexRay and also Ethernet. The core of the system is an MVCI diagnostic server compliant with the ISO 22900 standard, which, among other things, defines the communication parameters and converts the byte stream coming from the D-PDU API into physical values. The operations are controlled over ODX files created using an authoring system. With a D-Server, an OTX runtime system can

Figs: Softing Automotive Electronics

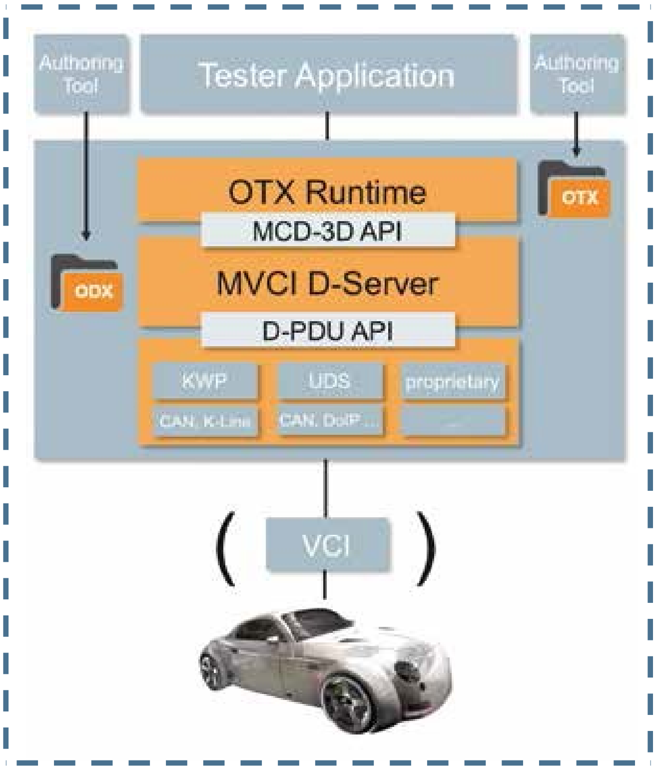

Fig. 1: Tester technology.

relieve the application from dealing with test sequences, because it works also data-driven using OTX files provided by an authoring system.

Diagnostics over Internet Protocol (DoIP)

By using standardized interfaces and data formats, processing is less prone to errors and reuse over the entire life cycle of a vehicle is considerably more efficient. DoIP has been taken into consideration in all relevant standards used as the basis for diagnostic tester components. The specification for OTX (Open Test sequence eXchange, ISO 13209) allows for an extension for creating test sequences when using DoIP. An MCD-3D API compliant with ISO 22900-3 has to be used as a programming interface for the diagnostic server.
It must fulfill ASAM MCD-3D 3.0.

VCIs are accessed via the programming interface D-PDU API in compliance with ISO 22900-2, which includes an amendment for DoIP. DoIP is part of the UDS specification, the most widespread standard for diagnostic communication. ISO 14229-5 specifies the Application Layer and ISO 13400 defines the Transport Layer.

Besides CAN, DoIP is due to be incorporated in the definition of the worldwide standard WWH-OBD (World Wide Harmonized OBD, ISO 27145).

Comparison with DiagOnCAN

At this point, there follows a comparison of the fundamental characteristics of DoIP with commonly used diagnostics over the CAN bus. The standard Ethernet physical layer is used as a transmission medium for DoIP. This does not permit a bus structure like CAN. A switch is required for every network node. A fundamental difference is the bit rate with 100 Mbit/s for DoIP and 500 kbit/s for the transmission with CAN. In Ethernet-based communication, there are likely to be greater latency times than with CAN, »

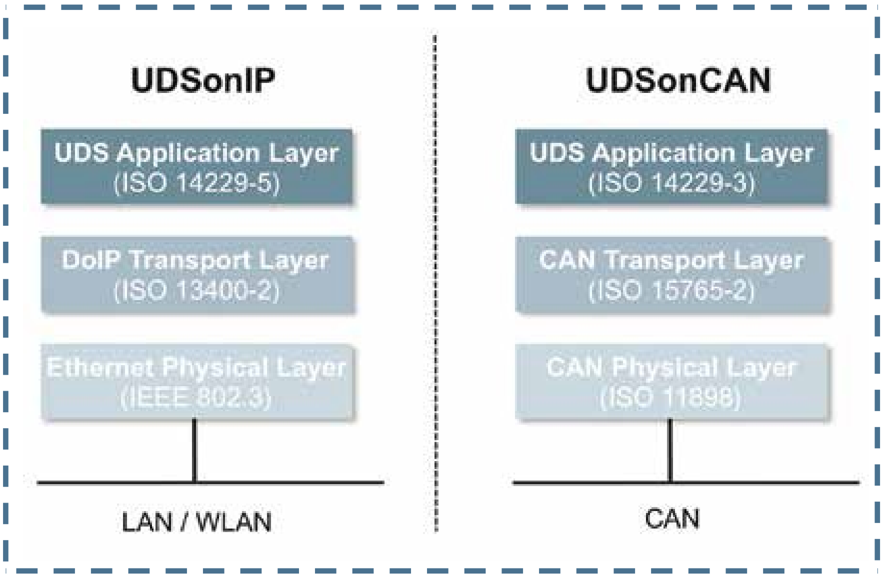

Fig. 2: Comparison of UDSonIP and UDSonCAN.

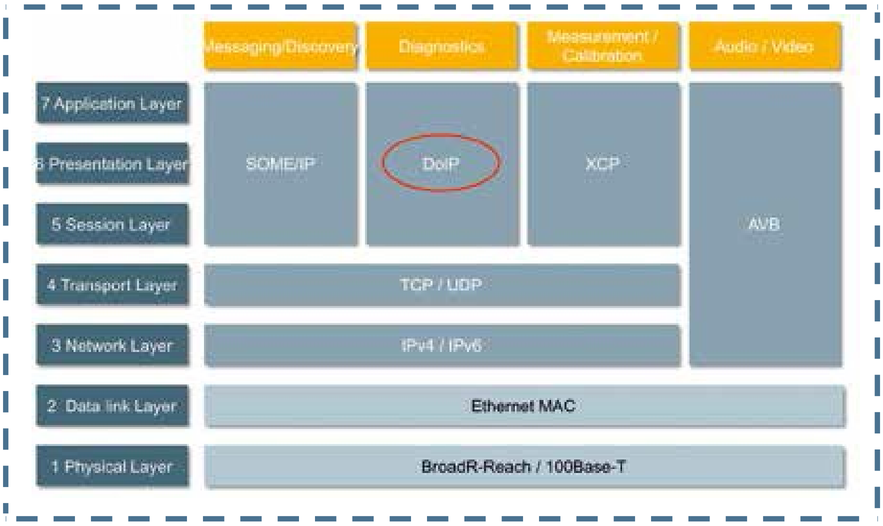

Fig. 3: DoIP in the OSI model.

which can, however, be compensated in many applications by using large data packets. Fig. 2 illustrates that in both cases there is no significant difference in the access method for the application with UDS as a diagnostic protocol.

With DoIP, ordinary UDS messages are packed in TCP/IP telegrams and can thus be transmitted over Ethernet or WLAN. This means that DoIP is used instead of DiagOnCAN as Transport Layer.

The DoIP specification stipulates several configurations or modes for accessing a DoIP-capable vehicle. In the simplest combination mode only one so called entity is accessed. In other modes, a group of entities that could be spread across several vehicles is addressed. After vehicle identification and status information have been requested and the connection established over UDP/IP, a TCP/IP connection is established using a Routing Activation Request. After a successful acknowledgment, Diagnostic Requests can be sent to any ECUs subordinate to the DoIP ECU.

DoIP in the OSI model

If you take a look at the OSI reference model, it soon becomes clear how DoIP fits into the software structure of an ECU. Fig. 3 shows a simplified version of a few fundamental applications with the subordinate software layers. Layers 5 to 7 implement the DoIP-specific protocol handling for diagnostics.

Both TCP and UDP are used as Transport Layer for vehicle identification. According to the standard, IPv6 is preferred in the Network Layer, although IPv4 is usually used for compatibility reasons. In the Data Link Layer, Ethernet MAC is used. As Physical Layer, BroadR-Reach is specified for on-board communication and standard Ethernet for off-board communication.

Vehicle access

Four data lines and an activation line are defined for vehicle access via free pins at the standard OBD connector. Considerable thought is currently going into whether a more suitable connector for higher data rates should be specified. Diagnostic access is thus easy to achieve using an Ethernet cable with an OBD connector. For mobile applications, the conversion of WLAN and LAN is conceivable with a handy OBD dongle. And for use in service, when Ethernet and the legally prescribed CAN bus are to be operated, your best option is to use a powerful VCI.

Summary

Due to the much greater bandwidth in comparison to CAN, DoIP makes it possible to handle large amounts of data which is particularly beneficial in applications with flash programming. This technology continues to be future-proof and inexpensive as you do not necessarily need diagnostic hardware. With the embedding of DoIP into a diagnostic tester based on standards, the user can benefit from the associated advantages, such as the safe and efficient creation and further processing of diagnostic data, over the entire life cycle of a vehicle.

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