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Unified Diagnostic Services

White Paper – WP1903

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White Paper
Unified Diagnostic Services

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Table of Contents

References

http://profiles.sae.org/79697328210/

1. What is diagnostic communication?

Diagnostic communication is communication between a vehicle or mobile machine and external test equipment (tester). Actually, the communication does not take place between the tester and the vehicle or machine, but at a certain point in time, between the tester and one specifically selected electronic control unit (ECU).

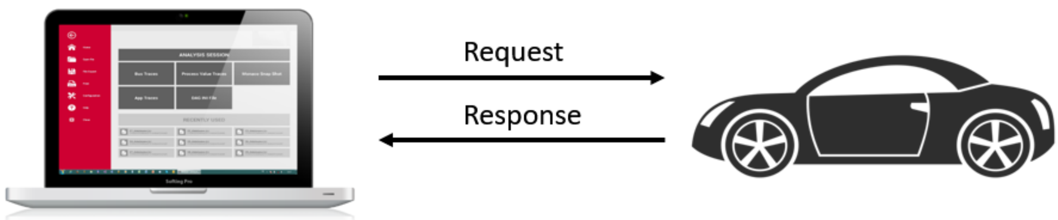


Figure WP1303-01: Diagnostic service requests and responses

For the purpose of diagnostic communication, the tester (TST) sends a diagnostic service request to the ECU and receives the diagnostic service response from the ECU (Figure WP1303-01).

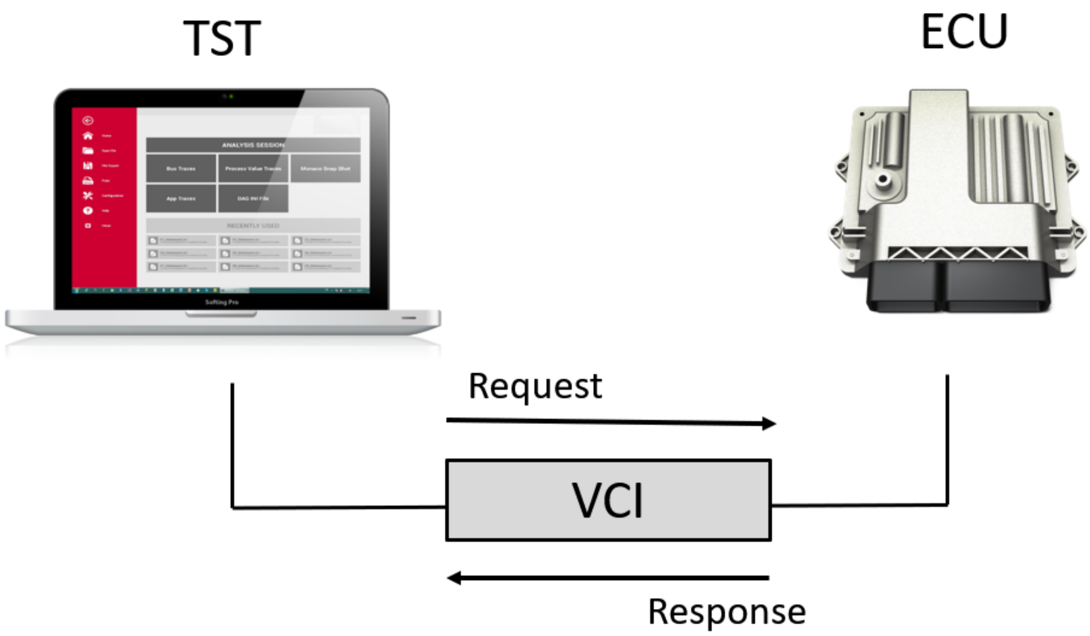


Figure WP1903-02: Components of a diagnostic communication System

To do so, tester (TST) and vehicle (ECU) must be connected to each other by a Vehicle Communication Interface (VCI). Figure WP1303-02 shows the components of a generic diagnostic communication system.

2. Diagnostic communication in the OSI Model

The OSI Model structures data communication systems in seven layers. In the context of this White Paper, "UDS" is an OSI Model application layer protocol. "CAN" is specified as OSI model physical and data link layer protocols. The concatenations "UDS on CAN" and "UDS on IP" are diagnostic *protocol stacks* that consist of several, independently specified OSI model layers. Other examples are "KWP on K-Line" or "OBD on CAN". Figure WP1903-03 shows how the diagnostic communication protocol stacks "UDS on CAN" and "UDS on IP" are mapped to the OSI Model.

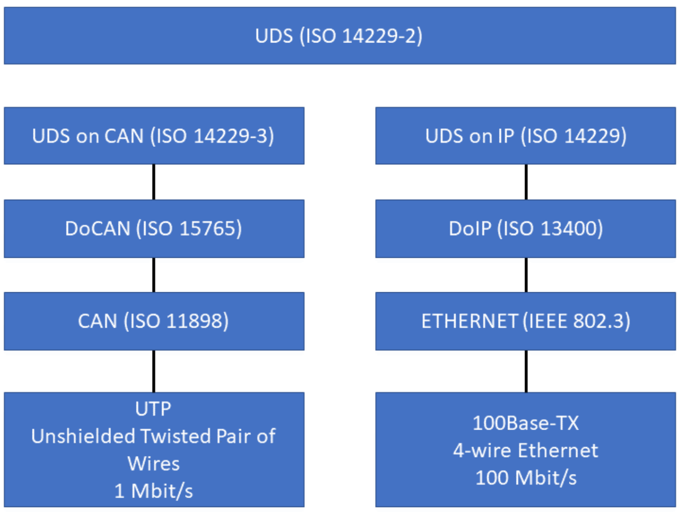


Figure WP1903-03: UDS on CAN and UDS on IP protocol stacks

3. OSI Model Application Layer Services and SIDs

Table WP1903-01 lists the 27 Unified Diagnostic Service (UDS) requests as they are specified in ISO 14229-1 (2018). Each service request comes with a uniquely assigned service identifier (SID), such as 0x10 = diagnostic session control request, 0x22 = read data by identifier request or 0x3E = tester present request. Each request has an assigned positive response, whereas the SID of a response can be calculated by adding 0x40 to the SID of the request. Table WP1903-02 shows examples. The SID of a negative response is always 0x7F.

Table WP1903-01: Services and Request SIDs according to ISO 14229-1 (2018)

SID	Service	SID	Service
0x10	Diagnostic Session Control	0x31	Routine Control
0x11	ECU Reset	0x34	Request Download
0x14	Clear Diagnostic Information	0x35	Request Upload
0x19	Read DTS Information	0x36	Transfer Data
0x22	Read Data By Identifier	0x37	Request Transfer Exit
0x23	Read Memory By Address	0x38	Request File Transfer
0x24	Read Scaling Data By Identifier	0x3E	Tester Present
0x27	Security Access	0x3D	Write Memory By Address
0x28	Communication Control	0x83	Access Timing Parameters
0x29	Authentication	0x84	Secured Data Transmission
0x2A	Read Data By Periodic Identifier	0x85	Control DTC Setting
0x2C	Dynamically Define Data Identifier	0x86	Response on Event
0x2E	Write Data By Identifier	0x87	Link Control
0x2F	Input Output Control By Identifier		
		0x7F	Negative Response SID

Table WP1903-02: Examples of request and response SIDs

Request SID	Service	Pos. Response SID
0x10	Diagnostic session control	0x50
0x22	Read data by identifier	0x62
0x31	Routine control	0x71
0x85	Control DTC settings	0xC5

4. Data Parameters and Sub-function Bytes

UDS requests and responses can be parameterized by sub-function bytes and/or data parameters. Data parameters are identified by Data Identifier (DID). Table 1903-03 shows some selected DID examples.

Table 1903-03: Examples of Data Identifier (DID) - Examples

DID	Description
0xF180	Boot software identification
0xF18C	ECU serial number
0xF190	Vehicle Identification Number (VIN)

5. Negative Responses and NRCs

If an ECU is not able to support a request, for example if it cannot deliver the requested data (0x22 = read data by identifier) or cannot process a requested action (0x11 = ECU reset) – for what reason ever – the ECU will send a negative response with the negative response SID 0x7F.

The negative response consists of three bytes: The first byte is the SID of the negative response (0x7F), the second one is the SID of the denied request. The third byte is a parameter named negative response code (NRC). The NRC contains information, why the ECU is not sending a positive response. Typical values of NRCs are listed in Table WP1903-04.

Table 1903-04: Negative Response Codes (NRC) - Examples

NRC	Comment
0x10	General reject
0x11	Service not supported
0x12	Sub-function not supported
0x22	Conditions not correct

6. UDS on CAN > DoCAN

CAN is specified in ISO 11898 and not part of this White Paper.

DoCAN is short for “Diagnostics on CAN” and specified in ISO 15765. It describes, how ISO 14229 services are transferred using the physical and data link layers of CAN.

A specific “problem” of CAN is the limited number of data bytes that fit in a single CAN frame. The Vehicle Identification Number, for example, consists of 17 bytes and does not fit in a single CAN message frame.

The request to read the VIN reads

0x[22,F1,90].

The positive response could be
0x[62,F1,90,35,48,44,31,47,56,34,31,39,38,4B,33,32,36,32,32,35], whereas the 17 data bytes

after the 0x [62,F1,90...] represent the VIN of a Harley Davidson motorcycle type FXWG MY 1981.

Data blocks that do not fit in a single CAN frame must be segmented and sent with several, consecutive CAN frames. The description of how that works is colloquially named ISO TP, whereas TP is short for transport protocol. ISO TP for UDS on CAN is specified in ISO 15765-2.

7. UDS on IP > DoIP

Ethernet is specified in IEEE 802.3 and not part of this White Paper.

DoIP is specified in ISO 13400 and describes, how ISO 14229 services are transferred using the Internet Protocol IP and IEEE 802 Ethernet.

8. TST Technology

Figure 1903-04 shows the software components of a diagnostic tester. ODX is short for the Open Diagnostic Data Exchange format and OTX for the Open Test Sequence exchange format.

The Smart Diagnostic Engine (SDE) processes service requests and responses using the ODX data that mainly contains the specification of the diagnostic communication protocol stack and computational methods to translate hex coded diagnostic data into meaningful information. The OTX data base contains scripts that describe diagnostic sequences, e.g. for guided fault finding or flash reprogramming of a control unit.

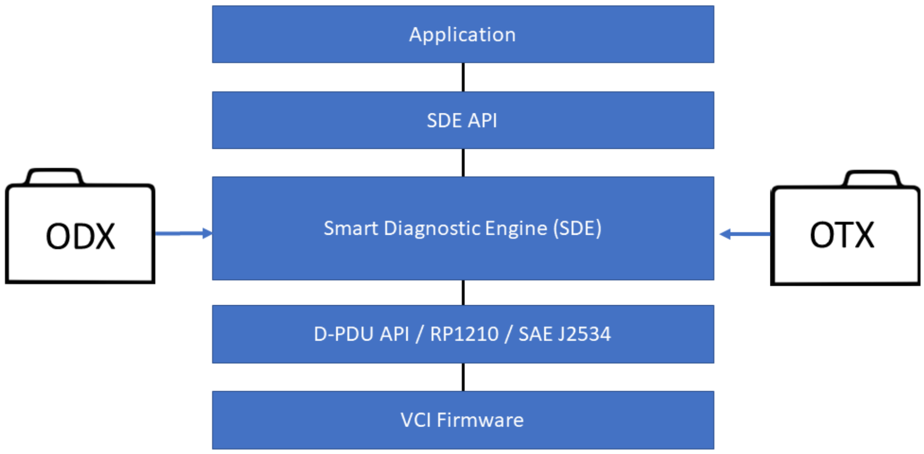


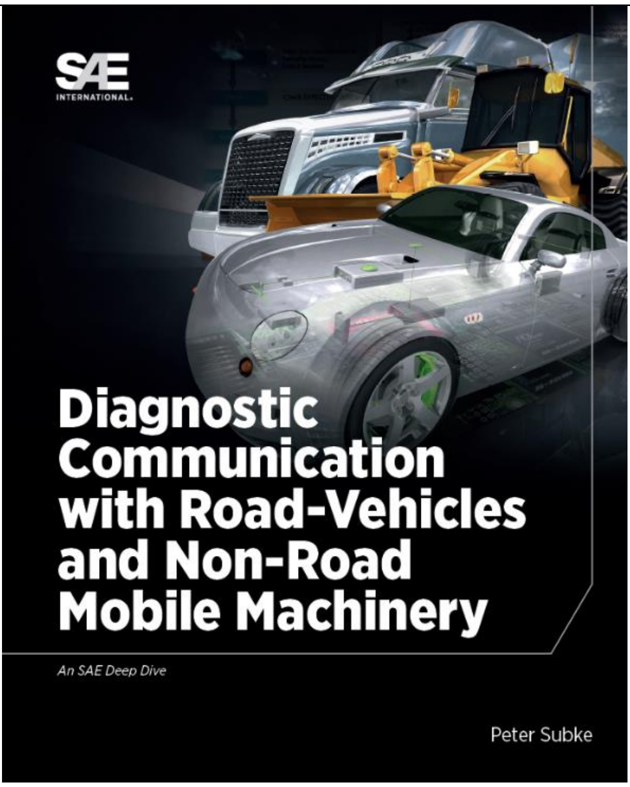
Figure WP1903-04: Software components of a diagnostic tester

The application can be software on a WIN-based PC or an APP on an Android-/iOS- based smart device.

The VCI and its firmware are connected to the SDE via one of the interfaces D-PDU API, RP1210 or SAE J2534, whereby a VCI is not necessary anymore if a regular PC with a RJ45 Ethernet port and UDS on IP are employed.

Amendment Log

Version	Date	Author	Description / Comment / Modification
01	2019-06-23	Subke	Draft



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