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Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) —

Part 2:
Transport protocol and network layer services

Véhicules routiers — Communication de diagnostic sur gestionnaire de réseau de communication (DoCAN) —

Partie 2: Protocole de transport et services de la couche réseau

Reference number
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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

This fourth edition cancels and replaces the third edition (ISO 15765-2:2016), which has been technically revised.

The main changes are as follows:

— restructured the document to achieve compatibility with OSI 7-layers model;

— introduced T_Data abstract service primitive interface to achieve compatibility with ISO 14229-2;

— moved all transport layer protocol-related information to Clause 9;

— clarification and editorial corrections.

A list of all parts in the ISO 15765 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The ISO 15765 series defines common requirements for vehicle diagnostic systems using the controller area network (CAN), as specified in the ISO 11898 series.

The ISO 15765 series presumes the use of external test equipment for inspection, diagnostics, repair and other possible use cases connected to the vehicle.

This document defines the requirements to enable the in-vehicle CAN network to successfully establish, maintain and terminate communication with the devices externally connected to the diagnostic link connector.

This document has been structured according to the open systems interconnection (OSI) basic reference model, in accordance with ISO/IEC 7498-1 and ISO/IEC 10731, which structures communication systems into seven layers. When mapped on this model, the OSI layer 4 and OSI layer 3 framework requirements specified or referenced in the ISO 15765 series are structured according to Figure 1, which shows the related documents of OSI layer 4 and OSI layer 3.

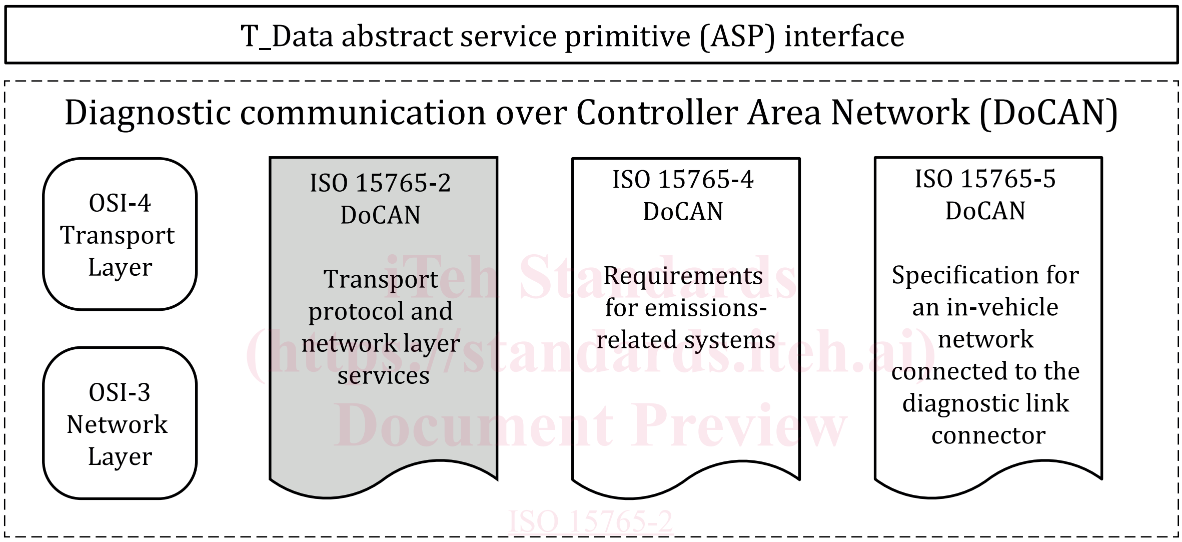


Figure 1 — DoCAN document reference according to the OSI model

Road vehicles — Diagnostic communication over Controller Area Network (DoCAN) —

Part 2: Transport protocol and network layer services

1 Scope

This document specifies a transport and network layer protocol with transport and network layer services tailored to meet the requirements of CAN-based vehicle network systems on controller area networks as specified in ISO 11898-1.

The diagnostic communication over controller area network (DoCAN) protocol supports the standardized abstract service primitive interface as specified in ISO 14229-2 (UDS).

This document supports different application layer protocols such as:

— enhanced vehicle diagnostics (emissions-related system diagnostics beyond legislated functionality, non-emissions-related system diagnostics);

— emissions-related on-board diagnostics (OBD) as specified in the ISO 15031 series and SAE J1979 series;

— world-wide harmonized on-board diagnostics (WWH-OBD) as specified in the ISO 27145 series; and

— end of life activation of on-board pyrotechnic devices (the ISO 26021 series).

The transport protocol specifies an unconfirmed communication.

NOTE This document does not determine whether CAN CC, CAN FD or both are recommended or required to be implemented by other standards referencing this document.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/IEC 7498-1, *Information technology — Open Systems Interconnection — Basic Reference Model: The Basic Model*

ISO 11898-1[1)], *Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signalling*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 7498-1, ISO 11898-1 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

1) Third edition under preparation. Stage at the time of publication: ISO/FDIS 11898-1:—.

3.1
CAN_DL
CAN frame data length
physical length of CAN frame data/*payload* (3.2) in bytes

Note 1 to entry: See Table 2.

3.2
payload
synonym for (CAN) data field as specified in ISO 11898-1

3.3
TX_DL
transmit data link layer data length
parameter configuring the maximum usable *payload* (3.2) length in bytes of the data link layer in the transmitter for the application that implements the network layer

Note 1 to entry: The TX_DL is a fixed configuration value on the sender side for the PDU transmission.

3.4
RX_DL
received data link layer data length
parameter retrieving the maximum usable *payload* (3.2) length in bytes of the data link layer in the receiver for the application that implements the network layer

Note 1 to entry: The RX_DL value is retrieved from the FirstFrame (FF) *CAN_DL* (3.1) of a segmented PDU and is used to verify the correct data length of ConsecutiveFrames (CF).

4 Symbols and abbreviated terms

4.1 Symbols

$C_{TL\_BUFFER\_OVFLW}$	ComParam transport layer buffer overflow
C_{TL_CFSN}	ComParam transport layer consecutive frame sequence number
C_{TL_DLC}	ComParam transport layer data length code
C_{TL_ERROR}	ComParam transport layer error
C_{TL_FCFS}	ComParam transport layer flow control flow status
C_{TL_FCBS}	ComParam transport layer flow control block size
$C_{TL\_FCFS(CTS)}$	ComParam transport layer flow control flow status continue to send
$C_{TL\_FCFS(OVFLW)}$	ComParam transport layer flow control flow status overflow
$C_{TL\_FCSTmin}$	ComParam transport layer flow control separation time minimum
$C_{TL\_FCFS(WAIT)}$	ComParam transport layer flow control flow status wait
$C_{TL\_INVALID\_FS}$	ComParam transport layer error invalid flow status
C_{TL_OK}	ComParam transport layer ok
$C_{TL\_RX\_ON}$	ComParam transport layer receiver error to indicate that the receiving entity did not accept flow control parameter changes during this segmented message reception
$C_{TL\_TIMEOUT\_A}$	ComParam transport layer timeout A sender and receiver

$C_{TL\_TIMEOUT\_Bs}$	ComParam transport layer sender timeout B sender
$C_{TL\_TIMEOUT\_Cr}$	ComParam transport layer receiver timeout C receiver
$C_{TL\_UNEXP\_PDU}$	ComParam transport layer error unexpected protocol data unit
$C_{TL\_WFT\_OVRN}$	ComParam transport layer wait frame transmissions overrun
C_{TL_WFTmax}	ComParam transport layer flow status wait frame transmissions maximum
$C_{TL\_WRONG\_PARAMETER}$	ComParam transport layer error wrong parameter
$C_{TL\_WRONG\_SN}$	ComParam transport layer error wrong segment number
$C_{TL\_WRONG\_VALUE}$	ComParam transport layer error wrong value
t	time
t_{TL_Ar}	timing parameter transport layer receiver timing value Ar
t_{TL_As}	timing parameter transport layer sender timing value As
t_{TL_Br}	timing parameter transport layer receiver timing value Br
t_{TL_Bs}	timing parameter transport layer sender timing value Bs
t_{TL_Cr}	timing parameter transport layer receiver timing value Cr
t_{TL_Cs}	timing parameter transport layer sender timing value Cs

4.2 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

AE	address extension
AI	address information
CAN	controller area network
CAN CC	CAN with static arbitration and data phase bit rate
CAN_DL	CAN frame data length
CAN FD	CAN with flexible data phase bit rate
CF	consecutive frame
ChangeParameter	layer service name
ComParam	communication parameter
CTS	continue to send
Data.	abstract service primitive service name
DoCAN	diagnostic communication over CAN
ECU	electronic control unit
FC	flow control

FF	first frame
FF_DL	first frame data length in bytes
FMI	failure mode indicator
Mtype	message type
N/A	not applicable
PCI	protocol control information
PCItype	protocol control information type
PDU	protocol data unit
SA	source address
SDU	service data unit
TA	target address
TAtype	target address type
NL	network layer
OBD	on-board diagnostics
OSI	Open Systems Interconnection
PCI	protocol control information
RTR	remote transmission request
RX_DL	received data link layer data length
SF	single frame
SF_DL	single frame data length in bytes
SN	sequence number
SPN	suspect parameter number
TX_DL	transmit data link layer data length
UDS	unified diagnostic services
WWH-OBD	world-wide harmonized OBD

5 Conventions

This document is based on the conventions discussed in the OSI service conventions (ISO/IEC 10731) as they apply for diagnostic services.

6 ISO 11898-1 CAN data link layer extension

6.1 CAN CC and CAN FD frame feature comparison

ISO 11898-1 specifies variable length CAN frames with a maximum payload size dependent on the protocol device used. A CAN CC protocol device can transmit/receive frames with payload sizes ranging from 0 byte to 8 byte per frame.

A CAN FD (flexible data rate) protocol device can transmit/receive frames with payload sizes from 0 byte to 64 byte. A CAN FD protocol device is also capable of transmitting/receiving CAN CC frames.

Therefore, the segmented transfer of data using FirstFrame (FF), FlowControl (FC) and ConsecutiveFrame (CF) type frames shall support a variable configurable payload length without changing the original protocol concept.

Table 1 outlines the different features of the CAN frame types provided by ISO 11898-1.

Table 1 — CAN frame feature comparison

RefNo	Feature	CAN CC	CAN FD
#1	Payload length 0 to 8 bytes: data length code (DLC) 0 to 8	Yes	Yes
#2	Payload length 8 bytes: data length code (DLC) 9 to 15[a]	Yes	No
#3	Payload length 12 to 64 bytes[b]: data length code (DLC) 9 to 15	No	Yes
#4	Different bit rates supported for the arbitration and data phases of a CAN frame	No	Yes
#5	Remote transmission request (RTR)	Yes	No

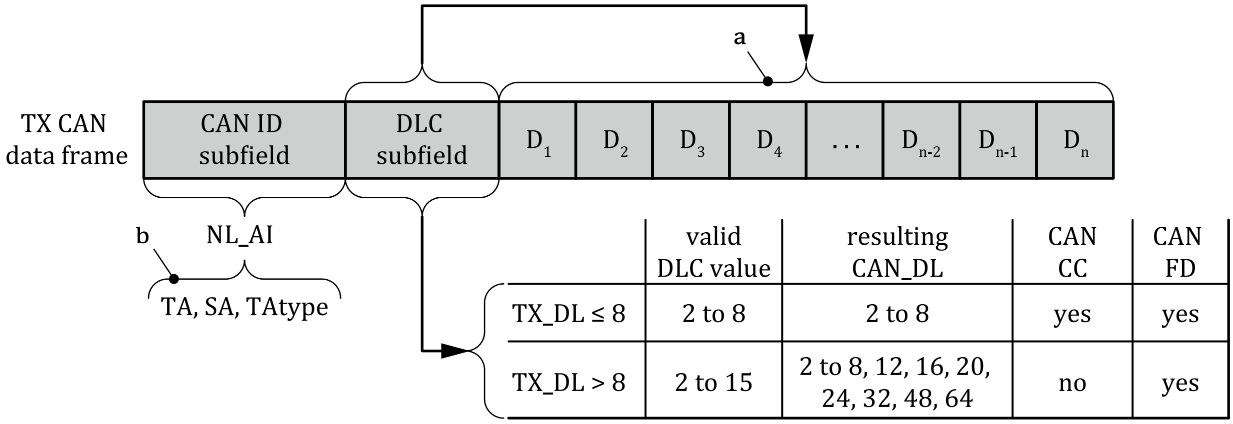
[a] For CAN CC, the DLC values 9 to 15 are automatically reduced to the value of 8 which leads to the maximum possible CAN_DL for CAN CC.

[b] CAN FD does not support all payload lengths between 8 bytes and 64 bytes (e.g. a CAN FD frame with 10 meaningful data bytes requires a payload length of 12 bytes); see Table 2.

6.2 Mapping of transport and network layer attributes to CAN data frames

Figure 2 shows the mapping of CAN parameters onto the data link layer addressing information NL_AI. It illustrates the validity and applicability of transport/network layer parameters and the resulting support of CAN CC versus CAN FD data link layer.

Figure 2 describes this for the example of using either normal or normal fixed addressing. For extended addressing and mixed addressing, the concept in general also applies but the mapping of the NL_AI parameter onto the CAN frame differs.



Key

[a] DLC value results in a CAN_DL value (n), which is the physical length of a CAN frame data/payload; in the receiver, CAN_DL is used to determine the sender TX_DL value.

[b] The shown NL_AI mapping is an example for normal and normal fixed addressing only.

For 11-bit CAN identifiers, the mapping of the NL_AI target address (TA) and source address (SA) into a CAN identifier is implied.

Figure 2 — Illustration of transport and network layer attributes mapping to the CAN data frame subfields

Table 2 shows the data length code value between CAN CC and CAN FD.

Table 2 — CAN CC/CAN FD data length comparison table

Data length code (DLC)	CAN CC data length (CAN_DL)	CAN FD data length (CAN_DL)
0	0	0
1	1	1
2	2	2
3	3	3
4	4	4
5	5	5
6	6	6
7	7	7
8	8	8
9	8[a]	12
10	8[a]	16
11	8[a]	20
12	8[a]	24
13	8[a]	32
14	8[a]	48
15	8[a]	64

[a] For CAN CC, the DLC values 9 to 15 are automatically reduced to the value of 8 which leads to the maximum possible CAN_DL for CAN CC.

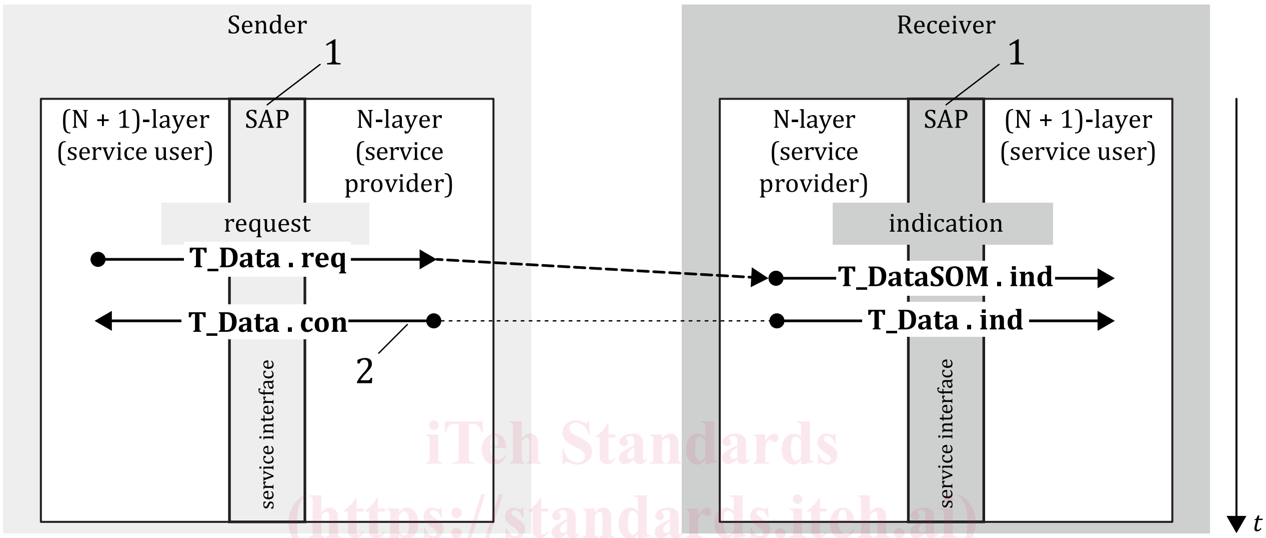
7 T_Data abstract service primitive interface definition

7.1 T_Data services

The Open Systems Interconnection (OSI) defines abstract service primitives (ASP) as an implementation-independent description of an interaction between a service user and a service provider. The abstract service primitives are defined for a particular service transition.

The ASP interface defines the service and parameter mappings beween OSI layers.

Figure 3 shows the `T_Data.req` (request), `T_Data.ind` (indication), `T_DataSOM.ind` (indication), and `T_Data.con` (confirmation) service interface.



Key

t time

1 service access point

2 read back from N-layer service provider

Figure 3 — T_Data.req, T_Data.ind, T_DataSOM.ind and T_Data.con service interface

7.2 T_Data interface

The ASP `T_Data` interface is independent (abstraction) of the transport protocol used in the OSI-4 layer. It connects the session layer (OSI-5) and the various transport layers (OSI-4).

The ASP `T_Data` interface shall support the services as specified in Table 3.

Table 3 — ASP `T_Data` interface

ASP	Description
`T_Data.req`	This service is used by the `T_Data` interface to request the transfer of a message.
`T_Data.ind`	This service is used to signal to the `T_Data` interface the completion of a message reception.
`T_DataSOM.ind`	This service is used to signal to the `T_Data` interface the beginning of a segmented message reception.
`T_Data.con`	This service confirms to the `T_Data` interface that the requested service has been carried out (successfully or not).

7.3 Data type definitions

This requirement specifies the data types of the abstract service primitive interface parameters.

The data types shall be in accordance to:

— `Enum` = 8-bit enumeration;

— `Unsigned Byte` = 8-bit unsigned numeric value;

— `Unsigned Word` = 16-bit unsigned numeric value;

— `Unsigned Long` = 32-bit unsigned numeric value;

— `Byte Array` = sequence of 8-bit aligned data;

— `Word Array` = sequence of 16-bit aligned data;

— `Bit String` = 8-bit binary coded.

8 Transport and network layer services

8.1 General

In order to describe the functioning of the transport and network layer, it is necessary to consider services provided to higher layers and the internal operation of the transport and network layer.

All transport and network layer services have the same general structure. To define the services, three types of service primitive are specified:

— a service request primitive, used by higher communication layers or the application to pass control information and data required to be transmitted to the network layer;

— a service indication primitive, used by the network layer to pass status information and received data to upper communication layers or the application;

— a service confirmation primitive, used by the network layer to pass status information to higher communication layers or the application.

This service specification does not specify an application programming interface but only a set of service primitives that are independent of any implementation.

All transport and network layer services have the same general format. Service primitives are written in the form:

```
service_name.type          (
                           parameter A,
                           parameter B
                           [,parameter C, ...]
                           )
```

where "service_name" is the name of the service, e.g. TL_/NL_Data, "type" indicates the type of service primitive, and "parameter A, parameter B [,parameter C, ...]" are the TL_/NL_SDU as a list of values passed by the service primitive. The square brackets indicate that this part of the parameter list is optional.

The service primitives define how a service user (e.g. diagnostic application) cooperates with a service provider (e.g. network layer). The following service primitives are specified in this document: request, indication and confirm.

— Using the service primitive request (`service_name.req`), a service user requests a service from the service provider.