INTERNATIONAL STANDARD

ISO 15765-2

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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 gest ionnaire 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 documents 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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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

This third edition cancels and replaces the second edition (ISO 15765-2:2011), which has been technically revised.

ISO 15765 consists of the following parts, under the general title *Road vehicles — Diagnostic communication over Controller Area Network (DoCAN)*[1)]:

— *Part 1: General information and use case definition*

— *Part 2: Transport protocol and network layer services*

— *Part 4: Requirements for emissions-related systems*

1) ISO 15765-3 Implementation of unified diagnostic services (UDS on CAN) has been withdrawn and replaced by ISO 14229-3 Road vehicles — Unified diagnostic services (UDS) — Part 3: Unified diagnostic services on CAN implementation (UDSonCAN)

Introduction

This part of ISO 15765 has been established in order to define common requirements for vehicle diagnostic systems implemented on a controller area network (CAN) communication link, as specified in ISO 11898-1. Although primarily intended for diagnostic systems, it also meets requirements from other CAN-based systems needing a network layer protocol.

To achieve this, it is based on 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 as shown in Table 1.

Table 1 — Enhanced and legislated on-board diagnostics specifications applicable to the OSI layers

<table>
<tr><th>OSI 7 layers [a]</th><th>Vehicle-manufacturer-enhanced diagnostics</th><th colspan="2">Legislated OBD
(on-board diagnostics)</th><th colspan="2">Legislated WWH-OBD
(on-board diagnostics)</th></tr>
<tr><td>Application
(layer 7)</td><td>ISO 14229-1,
ISO 14229-3</td><td colspan="2">ISO 15031-5</td><td colspan="2">ISO 27145-3, ISO 14229-1</td></tr>
<tr><td>Presentation
(layer 6)</td><td>Vehicle manufacturer specific</td><td colspan="2">ISO 15031-2,
ISO 15031-5,
ISO 15031-6,
SAE J1930-DA,
SAE J1979-DA,
SAE J2012-DA</td><td colspan="2">ISO 27145-2, SAE 1930-DA,
SAE J1979-DA,
SAE J2012-DA,
SAE J1939-DA (SPNs),
SAE J1939-73
Appendix A (FMIs)</td></tr>
<tr><td>Session (layer 5)</td><td colspan="5">ISO 14229-2</td></tr>
<tr><td>Transport protocol
(layer 4)</td><td rowspan="2">ISO 15765-2</td><td rowspan="2">ISO 15765-2</td><td rowspan="4">ISO 15765-4</td><td rowspan="2">ISO 15765-4,
ISO 15765-2</td><td rowspan="4">ISO 27145-4</td></tr>
<tr><td>Network (layer 3)</td></tr>
<tr><td>Data link (layer 2)</td><td>ISO 11898-1</td><td>ISO 11898-1</td><td>ISO 15765-4,
ISO 11898-1</td></tr>
<tr><td>Physical (layer 1)</td><td>ISO 11898-1,
ISO 11898-2,
ISO 11898-3,
or
vehicle manufacturer specific</td><td>ISO 11898-1,
ISO 11898-2</td><td>ISO 11898-1,
ISO 11898-2</td></tr>
<tr><td colspan="6">[a] 7 layers according to ISO/IEC 7498-1 and ISO/IEC 10731</td></tr>
</table>

The application layer services covered by ISO 14229-3 have been defined in compliance with diagnostic services established in ISO 14229-1 and ISO 15031-5 but are not limited to use only with them. ISO 14229-3 is also compatible with most diagnostic services defined in national standards or vehicle manufacturer's specifications.

For other application areas, ISO 15765 can be used with any CAN physical layer.

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

Part 2: Transport protocol and network layer services

1 Scope

This part of ISO 15765 specifies a transport protocol 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. It has been defined in accordance with the diagnostic services established in ISO 14229-1 and ISO 15031-5 but is not limited to use with them and is also compatible with most other communication needs for in-vehicle networks.

ISO 11898-1 specifies variable length CAN frames with a maximum payload size dependent on the protocol device used. A CLASSICAL CAN protocol device can transmit/receive frames with payload sizes ranging from 0 bytes to 8 bytes per frame. A CAN FD (flexible data rate) protocol device can transmit/receive frames with payload sizes from 0 bytes to 64 bytes. A CAN FD protocol device is also capable of transmitting/receiving CLASSICAL CAN frames.

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

This part of ISO 15765 provides the transport protocol and network layer services to support different application-layer implementations 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 ISO 15031,

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

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

The transport protocol specifies an unconfirmed communication.

NOTE This part of ISO 15765 does not determine whether CLASSICAL CAN, CAN FD or both are recommended or required to be implemented by other standards referencing this part of ISO 15765.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 — Part 1*

ISO 11898-1:2015[2)], *Road vehicles — Controller area network (CAN) — Part 1: Data link layer and physical signalling*

2) The dated reference is to the first version of ISO 11898-1 that includes the definition of CAN FD. Versions after the dated reference are also valid. Future dated references are valid for CAN FD.

3 Terms, definitions and abbreviated terms

3.1 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.

3.1.1
CAN frame data length
CAN_DL
physical length of CAN frame data/payload in bytes

Note 1 to entry: See Table 3.

3.1.2
transmit data link layer data length
TX_DL
configures the maximum usable payload length in bytes of the data link layer in the transmitter for the application that implements the network layer as defined in this part of ISO 15765

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

3.1.3
Received data link layer data length
RX_DL
retrieved maximum usable payload length in bytes of the data link layer in the receiver for the application that implements the network layer as defined in this part of ISO 15765

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

3.2 Abbreviated terms

For the purposes of this part of ISO 15765, the following abbreviated terms apply.

BRS	bit rate switch
BS	BlockSize
CAN	controller area network
CAN_DL	CAN frame data link layer data length in bytes
CAN FD	controller area network with flexible data rate and larger payload as defined in ISO 11898-1
CLASSICAL CAN	controller area network with static data rate and up to 8 data bytes as defined in ISO 11898-1
CF	ConsecutiveFrame
CTS	continue to send
DLC	CAN frame data link layer data length code
DoCAN	diagnostic communication over CAN
ECU	electronic control unit
FC	FlowControl
FF	FirstFrame
FF_DL	FirstFrame data length in bytes
FMI	failure mode indicator
FS	FlowStatus
Mtype	message type
N/A	not applicable

N_AE	network address extension
N_AI	network address information
N_Ar	network layer timing parameter Ar
N_As	network layer timing parameter As
N_Br	network layer timing parameter Br
N_Bs	network layer timing parameter Bs
N_ChangeParameter	network layer service name
N_Cr	network layer timing parameter Cr
N_Cs	network layer timing parameter Cs
N_Data	network data
N_PCI	network protocol control information
N_PCItype	network protocol control information type
N_PDU	network protocol data unit
N_SA	network source address
N_SDU	network service data unit
N_TA	network target address
N_TAtype	network target address type
N_USData	network layer unacknowledged segmented data transfer service name
NW	network
NWL	network layer
OBD	on-board diagnostics
OSI	Open Systems Interconnection
PCI	protocol control information
RX_DL	received data link layer data length in bytes
SF	SingleFrame
SF_DL	SingleFrame data length in bytes
SN	SequenceNumber
SPN	suspect parameter number
ST_{min}	SeparationTime minimum
TX_DL	transmit data link layer data length in bytes
UDS	unified diagnostic services
WWH-OBD	world-wide harmonized OBD

4 Conventions

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

5 Document overview

Figure 1 illustrates the most applicable application implementations utilizing the DoCAN protocol.

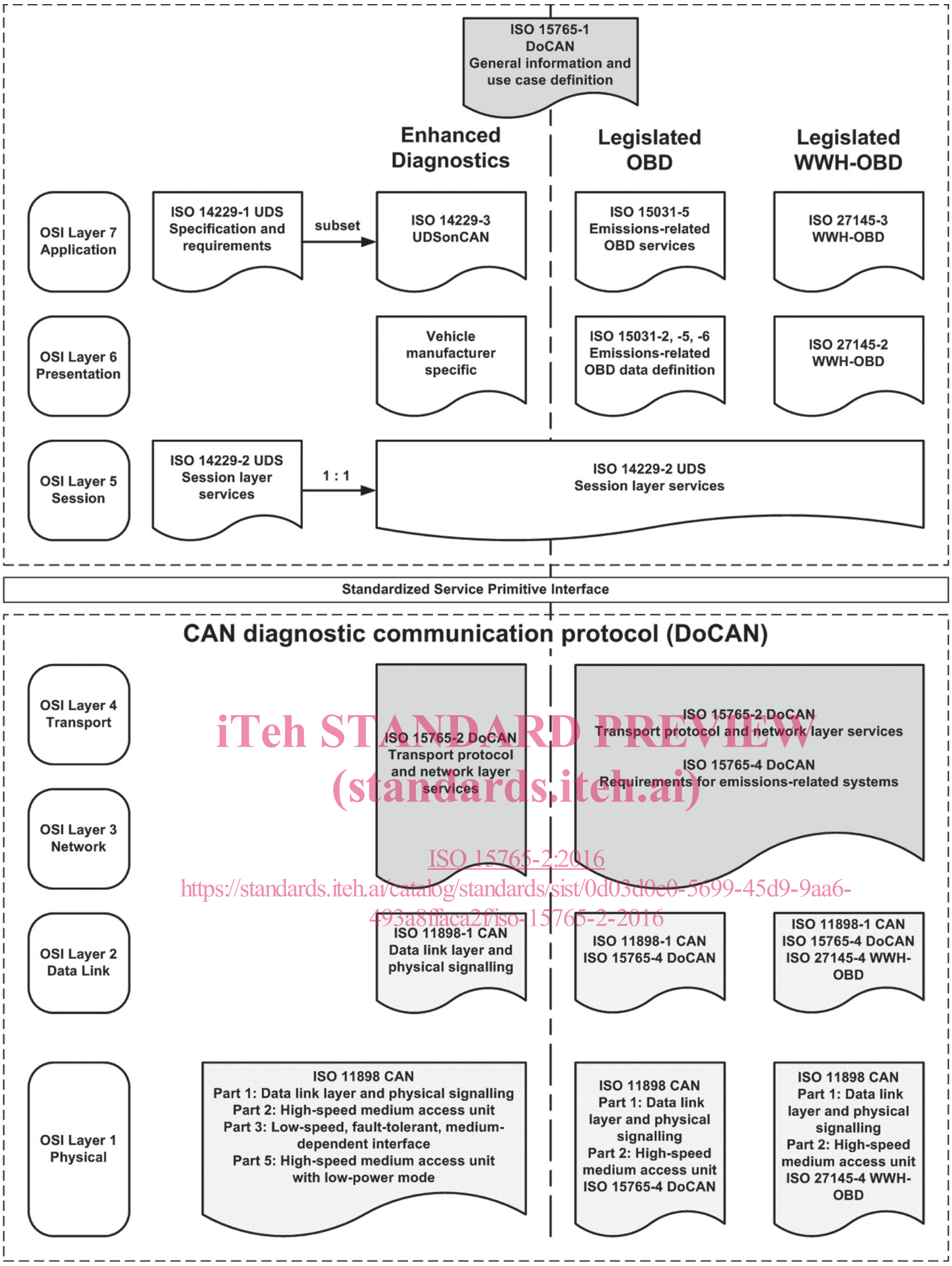


Figure 1 — DoCAN document reference according to the OSI model

6 ISO 11898-1 CAN data link layer extension

6.1 CLASSICAL CAN and CAN FD frame feature comparison

ISO 11898-1 CLASSICAL CAN frames support payload lengths up to a maximum of 8 bytes. ISO 11898-1 CAN FD frames support payload lengths up to a maximum of 64 bytes. Therefore, the segmented transfer of data using FirstFrame (FF), FlowControl (FC) and ConsecutiveFrame (CF) type frames needs to be implemented with a variable configurable payload length without changing the original protocol concept. The SF frame type has also been adapted to support the increased payload length allowed with CAN FD frames.

Table 2 outlines the different features of the CAN frame types provided by ISO 11898-1.

Table 2 — CAN frame feature comparison

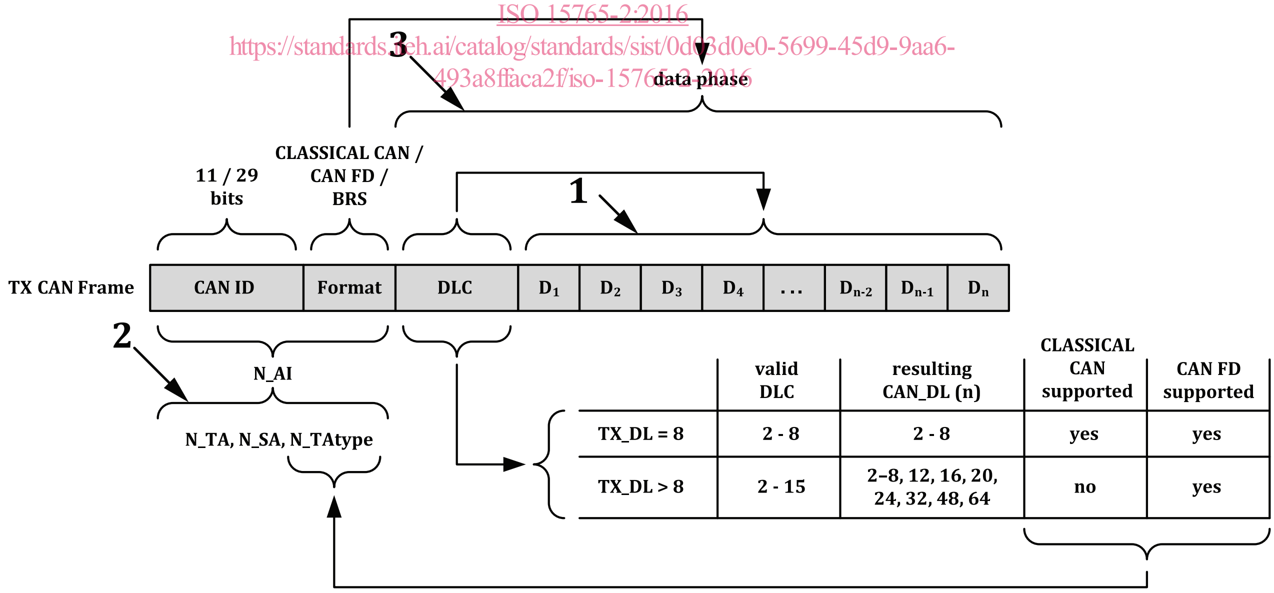
RefNo	Feature	CLASSICAL CAN	CAN FD
#1	Payload length 0..8 bytes Data length code (DLC) 0..8	Yes	Yes
#2	Payload length 8 bytes Data length code (DLC) 9..15[a]	Yes	No
#3	Payload length 12..64 bytes[b] Data length code (DLC) 9..15	No	Yes
#4	Different bit rates supported for the arbitration and data phases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

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

[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 3 and 10.4.2.3.

6.2 Illustration of CAN parameters for transport protocol and network layer services

Figure 2 shows the mapping of CAN parameters onto the network/transport layer addressing information N_AI. It illustrates the validity and applicability of network/transport layer parameters and the resulting support of CLASSICAL CAN vs. 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 N_AI parameter onto the CAN frame differs.



Key

1 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

2 the shown N_AI mapping is an example for normal and normal fixed addressing only

3 the bit rate switch (BRS) in the 'Format' information defines the transmission speed of the data phase

Figure 2 — Illustration of CAN parameters for network layer services

Table 3 — CLASSICAL CAN/CAN FD data length comparison table

Data length code (DLC)	CLASSICAL CAN 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 CLASSICAL CAN, the DLC values 9..15 are automatically reduced to the value of 8 which leads to the maximum possible CAN_DL for CLASSICAL CAN.

6.3 Additional requirements for CAN FD

If a CAN FD protocol device is used, this part of ISO 15765 can be configured to create either CLASSICAL CAN or CAN FD type frames. When CAN FD type frames are enabled for the data link layer, two new options need to be supported as follows.

a) The BRS bit which is part of a CAN FD frame and is used to determine if the data phase is to be transmitted at a different bit rate than the arbitration phase. The bitrate of the data phase is defined to be equal or higher than the arbitration bitrate. Bit rate switching does not influence the transport protocol itself (see Figure 2).

b) The maximum allowed payload length (CAN_DL, 8 .. 64 bytes); see Table 3.

Accommodating different maximum payload length values requires the addition of a new configuration variable "transmit data link layer data length" (TX_DL) for the transmitting node as specified in 9.5.

The configurable TX_DL value acts as a switch and upper bound for the valid CAN frame data lengths (CAN_DL) for the transmitting node.

— TX_DL equal to 8:

The transport protocol behaves identical to previous versions of this International Standard based on ISO 11898-1 (CLASSICAL CAN with 8 byte payload). See RefNo #1 in Table 2. CAN Frames created by the protocol for transmission shall only use DLC values 2..8. This applies to both, CLASSICAL CAN and CAN FD type frames;

— TX_DL greater than 8:

Only ISO 11898-1 CAN FD type frames shall be used. DLC values 2..15 are allowed. See RefNo #1 and RefNo #3 in Table 2.

7 Network layer overview

7.1 General

This part of ISO 15765 specifies an unconfirmed network layer communication protocol for the exchange of data between network nodes, e.g. from ECU to ECU, or between external test equipment and an ECU. If the data to be transferred does not fit into a single CAN frame, a segmentation method is provided.

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

7.2 Services provided by network layer to higher layers

The service interface defines a set of services that are needed to access the functions offered by the network layer, i.e. transmission/reception of data and setting of protocol parameters.

Two types of service are defined.

a) Communication services:

These services, of which the following are defined, enable the transfer of up to 4 294 967 295 bytes of data.

1) N_USData.request: This service is used to request the transfer of data. If necessary, the network layer segments the data.

2) N_USData_FF.indication: This service is used to signal the beginning of a segmented message reception to the upper layer.

3) N_USData.indication: This service is used to provide received data to the higher layers.

4) N_USData.confirm: This service confirms to the higher layers that the requested service has been carried out (successfully or not).

b) Protocol parameter setting services:

These services, of which the following are defined, enable the dynamic setting of protocol parameters.

1) N_ChangeParameter.request: This service is used to request the dynamic setting of specific internal parameters.

2) N_ChangeParameter.confirm: This service confirms to the upper layer that the request to change a specific protocol has completed (successfully or not).

7.3 Internal operation of network layer

The internal operation of the network layer provides methods for segmentation, transmission with FlowControl, and reassembly. The main purpose of the network layer is to transfer messages that might or might not fit in a single CAN frame. Messages that do not fit into a single CAN frame are segmented into multiple parts, where each can be transmitted in a CAN frame.

Figure 3 shows an example of an unsegmented message transmission.

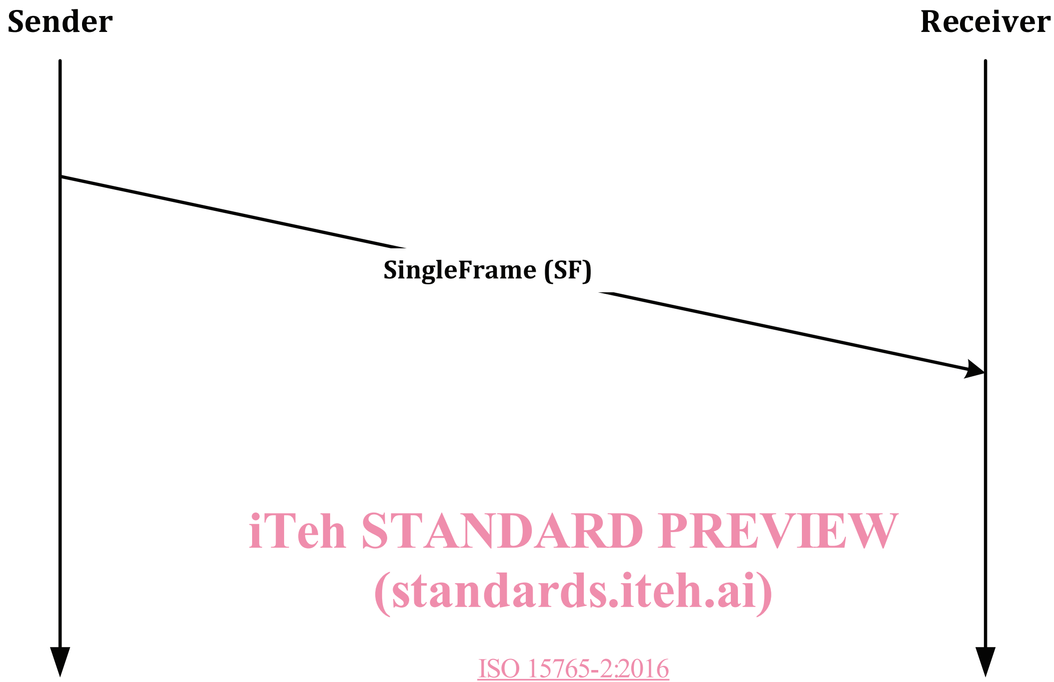


Figure 3 — Example of an unsegmented message

Figure 4 shows an example of a segmented message transmission.

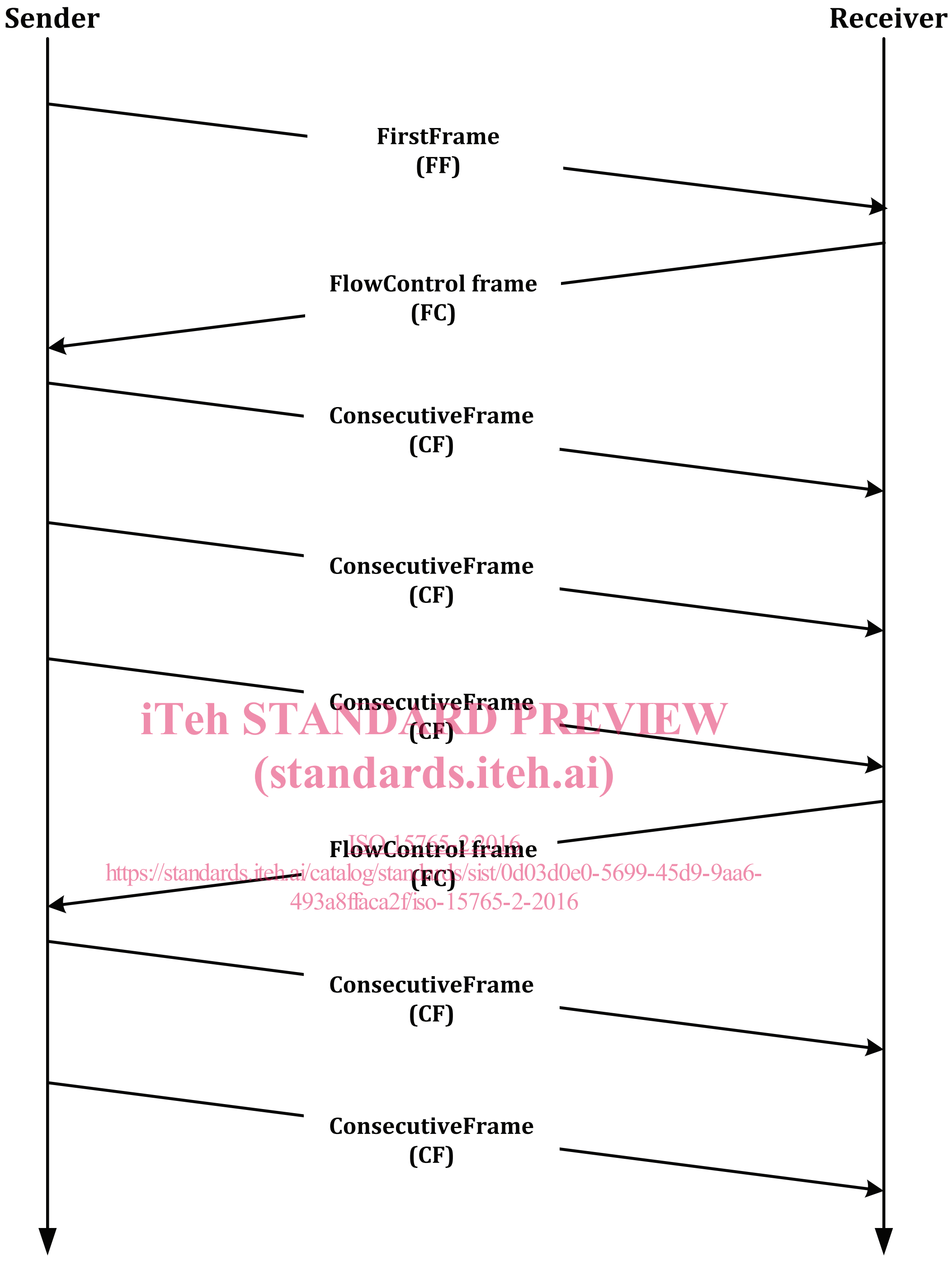


Figure 4 — Example of a segmented message

FlowControl is used to adjust the sender to the network layer capabilities of the receiver. This FlowControl scheme allows the use of diagnostic gateways and sub-networks.