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Ersatz für
DIN EN 61158-4-19:2015-09
Siehe Anwendungsbeginn

**Industrielle Kommunikationsnetze –
Feldbusse –
Teil 4-19: Protokollspezifikation des Data-Link Layer
(Sicherungsschicht) – Typ 19-Elemente
(IEC 61158-4-19:2019);
Englische Fassung EN IEC 61158-4-19:2019, nur auf CD-ROM**

Industrial communication networks –
Fieldbus specifications –
Part 4-19: Data-link layer protocol specification – Type 19 elements
(IEC 61158-4-19:2019);
English version EN IEC 61158-4-19:2019, only on CD-ROM

Réseaux de communication industriels –
Spécifications des bus de terrain –
Partie 4-19: Spécification du protocole de la couche liaison de données – Eléments de
type 19
(IEC 61158-4-19:2019);
Version anglaise EN IEC 61158-4-19:2019, seulement en CD-ROM

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DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE

Anwendungsbereich

Anwendungsbereich für die von CENELEC am 2019-05-23 angenommene Europäische Norm als DIN-Norm ist 2020-08-01.

Für DIN EN 61158-4-19:2015-09 besteht eine Übergangsfrist bis 2022-05-23.

Nationales Vorwort

Vorausgegangener Norm-Entwurf: E DIN EN 61158-400:2017-12.

Dieser Entwurf betrifft auch die Normen DIN EN IEC 61158-4-2:2020-08, DIN EN IEC 61158-4-3:2020-08, DIN EN IEC 61158-4-4:2020-08, DIN EN IEC 61158-4-12:2020-08, DIN EN IEC 61158-4-21:2020-08, DIN EN IEC 61158-4-24:2020-08 und DIN EN IEC 61158-4-25:2020-08.

Für dieses Dokument ist das nationale Arbeitsgremium K 956 „Industrielle Kommunikation“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik in DIN und VDE (www.dke.de) zuständig.

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Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die Englische Fassung der EN IEC 61158-4-19 veröffentlicht. Zu deren Abschnitt 1, der den Anwendungsbereich festlegt und Abschnitt 3 (außer Unterabschnitte 3.1, 3.3, 3.4 und 3.5), der die Begriffe festlegt, wurde eine Übersetzung angefertigt und als informativer Nationaler Anhang NA der vorliegenden Norm hinzugefügt. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

Das Original-Dokument enthält Bilder in Farbe, die in der Papierversion in einer Graustufen-Darstellung wiedergegeben werden. Elektronische Versionen dieses Dokuments enthalten die Bilder in der originalen Farbdarstellung.

Ein Feldbus ist ein digitaler serieller Datenbus für die Kommunikation zwischen Geräten der industriellen Automatisierungstechnik wie beispielsweise Messeinrichtungen, Stellgliedern, Reglern und speicherprogrammierbaren Steuerungen. Die Normen der Reihe DIN EN IEC 61158 legen eine Anzahl von Feldbus-Protokolltypen fest. Die vorliegende Norm legt das Protokoll des Data-Link Layer für die einzelnen Typen fest.

Änderungen

Gegenüber DIN EN 61158-4-19:2015-09 wurden folgende Änderungen vorgenommen:

- a) Verbesserung der Hotplug und Redundanz-Eigenschaften;
- b) Verbesserung der Phasenumschaltung und der Fehlerbehandlung;
- c) sonstige redaktionelle Verbesserungen.

Frühere Ausgaben

DIN V 19245-1: 1988-01
DIN 19245-1: 1991-04
DIN 19245-2: 1991-04
DIN EN 50170/1: 1997-07
DIN EN 50170/2: 1997-07
DIN EN 50170/3: 1997-07
DIN EN 50254: 1999-07
DIN EN 50170/A2: 2000-08
DIN EN 50170/A1: 2002-11
DIN EN 50170/A3: 2002-11
DIN EN 61158-4: 2005-05
DIN EN 61158-4-19: 2008-09, 2013-01, 2015-09

Nationaler Anhang NA (informativ)

Auszugsweise Übersetzung

Reihenfolge und Inhalt der folgenden Abschnitte sind identisch mit denen in den jeweiligen Abschnitten der Englischen Fassung.

EINLEITUNG

Dieses Dokument gehört zu einer Normenreihe, die zur Erleichterung der Verbindung von Komponenten von Automatisierungssystemen erstellt wurde. Es ist mit anderen Normen der Reihe verbunden, wie durch das in IEC 61158-1 beschriebene „dreischichtige“ Feldbus-Referenzmodell definiert.

Das Datenverbindungsprotokoll stellt den Datenverbindungsdienst bereit, indem es die Dienste nutzt, die in der physikalischen Schicht verfügbar sind. Das vorrangige Ziel dieses Dokuments ist es, eine Reihe von Regeln für die Kommunikation zu erstellen, die sich auf die Verfahren beziehen, die von den Peer Data-Link Entities (DLE) zum Zeitpunkt der Kommunikation durchzuführen sind. Diese Regeln für die Kommunikation sollen eine stabile Grundlage für die Weiterentwicklung bilden, damit sie einer Vielzahl von Zwecken dienen können:

- a) als Leitfaden für Implementierer und Konstrukteure;
- b) zur Verwendung bei der Prüfung und Beschaffung von Ausrüstung;
- d) als Teil einer Vereinbarung über die Zulassung von Systemen in der offenen Systemumgebung;
- c) als eine Erweiterung des Verständnisses von zeitkritischer Kommunikation innerhalb der OSI.

Dieses Dokument befasst sich insbesondere mit der Kommunikation und dem Zusammenwirken von Sensoren, Effektoren und anderen Automatisierungsgeräten. Durch die Verwendung dieses Dokuments zusammen mit anderen Normen, die innerhalb der OSI- oder Feldbus-Referenzmodelle vorhanden sind, können andernfalls inkompatible Systeme in beliebiger Kombination zusammenarbeiten.

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DE 102 00 502 4759.8-32	[BR]	Verfahren zur Laufzeitkorrektur in einer Kommunikationsstruktur
DE 102 37 097	[RI]	Korrektur von Signallaufzeiten in verteilten Kommunikationssystemen

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Germany

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1 Anwendungsbereich

1.1 Allgemeines

Der Data-Link Layer stellt grundlegende zeitkritische Messaging-Kommunikationen zwischen Geräten in einem Automatisierungsumfeld bereit.

Dieses Protokoll stellt Kommunikationsmöglichkeiten für alle teilnehmenden Data-Link-Instanzen bereit:

- a) synchron startend zyklisch, entsprechend einem vorab festgelegten Plan und
- b) zyklisch oder azyklisch asynchron, wie jeden Zyklus durch jede dieser Data-Link-Instanzen angefordert.

Somit kann dieses Protokoll als eines charakterisiert werden, das zyklischen oder azyklischen Zugang asynchron bereitstellt, aber mit einem synchronen Neustart jedes Zyklus.

1.2 Spezifikationen

Dieses Dokument legt fest:

- a) Verfahren für den rechtzeitigen Transfer von Daten und Steuerinformationen von einer Data-Link-Benutzerinstanz zu einer Peer-Benutzerinstanz und unter den Data-Link-Instanzen, die den verteilten Data-Link-Dienstanbieter bilden;
- b) die Struktur der Feldbus-DLPDU, die für den Transfer von Daten und Steuerinformationen durch das Protokoll dieses Dokuments verwendet werden, und deren Darstellung als physische Schnittstelleneinheiten.

1.3 Verfahren

Die Verfahren sind definiert hinsichtlich:

- a) der Interaktionen zwischen Peer-DL-Instanzen (DLE, DL-entities) über den Austausch von Feldbus-DLPDU;
- b) der Interaktionen zwischen einem DL-Dienst-(DLS, DL-service)-Anbieter und einem DLS-Benutzer in demselben System über den Austausch von DLS-Primitiven;
- b) der Interaktionen zwischen einem DLS-Anbieter und einem Ph-Dienstanbietern in demselben System über den Austausch von Ph-Dienstprimitiven.

1.4 Anwendbarkeit

Diese Verfahren sind anwendbar auf Kommunikationsvorgänge zwischen Systemen, die zeitkritische Kommunikationsdienste innerhalb des Data-Link Layer des OSI- oder Feldbus-Referenzmodells unterstützen und die die Fähigkeit des Durchverbindens in einem Umfeld der Kommunikation offener Systeme erfordern.

Profile stellen eine einfache multiattributive Einrichtung zum Zusammenfassen des Vermögens einer Implementierung bereit und somit die Anwendbarkeit auf verschiedene zeitkritische Kommunikationsanforderungen.

1.5 Konformität

Dieses Dokument legt außerdem Konformitätsanforderungen für Systeme fest, die diese Verfahren umsetzen. Dieser Teil dieses Dokuments enthält keine Prüfungen zum Darlegen der Erfüllung solcher Anforderungen.

3 Begriffe, Symbole, Abkürzungen und Vereinbarungen

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe, Symbole, Abkürzungen und Vereinbarungen.

ISO und IEC stellen terminologische Datenbanken für die Verwendung in der Normung unter den folgenden Adressen bereit:

- IEC Electropedia: verfügbar unter <http://www.electropedia.org/>
- ISO Online Browsing Platform: verfügbar unter <http://www.iso.org/obp>

3.2 Zusätzliche Typ-19-Begriffe

Für die Anwendung dieses Dokuments gelten die folgenden Begriffe.

3.2.1

Rundsendung

(en: broadcast)

Übertragung an alle Geräte in einem Netzwerk ohne Bestätigung durch die Empfänger

3.2.2

Kommunikationszyklus

(en: communication cycle)

festgelegte Zeitdauer zwischen zwei Master-Synchronisationstelegrammen, in der Echtzeit-Telegramme über den RT-Kanal und Nicht-Echtzeit-Telegramme über den IP-Kanal übertragen werden

3.2.3

Steuereinheit

(en: control unit)

Steuergerät (z. B. eine SPS wie in IEC 61131 festgelegt)

3.2.4

Steuerwort

(en: control word)

zwei aufeinanderfolgende Oktette im Master-Datentelegramm, Befehle für das adressierte Gerät enthaltend

3.2.5

Querkommunikation

(en: cross communication)

direkter Multicast-Datentransfer zwischen Geräten

3.2.6

Zyklusdauer

(en: cycle time)

Dauer eines Kommunikationszyklus

3.2.7

zyklische Kommunikation

(en: cyclic communication)

periodischer Austausch von Telegrammen

3.2.8

zyklische Daten

(en: cyclic data)

Teil eines Telegramms, dessen Bedeutung sich während einer zyklischen Operation des Netzwerks nicht ändert

3.2.9

zyklischer Betrieb

(en: cyclic operation)

Betrieb, bei dem die Geräte in dem Kommunikationsnetzwerk in feststehenden, konstanten Zeitintervallen nacheinander adressiert und abgefragt werden

3.2.10

Gerät

(en: device)

Slave im Kommunikationsnetzwerk (z. B. ein Antriebssystem nach IEC 61800-7 (alle Teile), E/A-Stationen nach IEC 61131 (alle Teile))

3.2.11

Feld für Geräteadresse

(en: device address field)

Adressfeld (acht Bit), das die Adresse des Gerätes enthält

3.2.12

Gerätesteuerung

(en: device control)

vier aufeinanderfolgende Oktette im Master-Datentelegramm, die Befehle für jedes Gerät enthalten

3.2.13

Gerätestatus

(en: device status)

vier aufeinanderfolgende Oktette im Bestätigungstelegramm, die Statusinformationen für jedes Gerät enthalten

3.2.14

Kennung der DLE-Station

(en: DLE station identifier)

einer DLE zugewiesene Netzwerkadresse

3.2.15

Slot der DLE-Station

(en: DLE station slot)

Einheit (Granularität von eins) positionsabhängiger Zuordnung (für ein zyklisches Datenfeld), von der eine DLE eine oder mehrere belegen kann, beschrieben durch den Bereich beginnend bei der Kennung der DLE-Station mit einer Länge, die der konfigurierten Anzahl von belegten Slots entspricht

3.2.16

Element

(en: element)

Teil von IDN - jede IDN weist 7 Elemente auf, wobei jedes Element eine spezifische Bedeutung hat (z. B. Nummer, Name, Daten)

3.2.17

EtherTyp

(en: EtherType)

Teil des Typ-19-spezifischen Telegramm-Headers

3.2.18

Weiterleitung

(en: forwarding)

Modus, in dem ein Gerät ein empfangenes Telegramm entweder verändert oder unverändert an den anderen Port weiterleitet

3.2.19

Identifikationsnummer

(en: identification number)

IDN

Kennzeichnung von Betriebsdaten, unter der ein Datenblock mit seinem Attribut, seinem Namen, seiner Einheit, seinen minimalen und maximalen Eingabewerten und den Daten aufbewahrt wird

3.2.20

Linie

(en: line)

Linienstruktur

(en: line structure)

Netzwerktopologie, bei der das Übertragungsmedium von Station zu Station in Form einer Linie geleitet wird; die Informationen werden in einer Richtung vom Master zum letzten Slave der Linie übertragen und strömen anschließend in der umgekehrten Reihenfolge über alle Slaves zum Master zurück (CP16/3)

3.2.21

Schleifenschaltung

(en: loopback)

Modus, in dem ein Gerät ein empfangenes Telegramm entweder verändert oder unverändert an denselben und an den anderen Port weiterleitet

3.2.22

Master

(en: master)

Knoten, der den anderen Knoten (d. h. den Slaves) das Recht zur Übertragung zuweist

3.2.23

Master-Datentelegramm

(en: master data telegram)

MDT

Telegramm, in das der Master seine Daten einfügt

3.2.24

Master-DLE

(en: master DLE)

DLE, die die Funktionen eines Netzwerk-Masters ausführt

3.2.25

Master-Synchronisationstelegramm

(en: master synchronization telegram)

MST

Telegramm oder Teil eines Telegramms, in das/den der Master ein Zeitsynchronisationssignal einfügt

3.2.26

MDT0-Telegramm

(en: MDT0 telegram)

Telegramm, mit dem der Master seine Synchronisationsdaten sowie alle seine Echtzeitdaten oder Teile davon an die Slaves überträgt

3.2.27

Teilnehmer

(en: participant)

Knoten, der mit dem Netzwerk verbunden ist

3.2.28

Physical Layer

(en: physical layer)

erste Schicht des ISO-OSI-Referenzmodells

3.2.29

Protokoll

(en: protocol)

Vereinbarung über die Datenformate, Zeitabfolgen und die Fehlerkorrektur im Datenaustausch von Kommunikationssystemen

3.2.30

Echtzeitdaten

(en: real-time data)

Teil des Telegramms, dessen Bedeutung sich während einer zyklischen Operation der Schnittstelle nicht ändert

3.2.31

RT-Kanal

(en: RT channel)

festgelegtes Zeitfenster innerhalb des Kommunikationszyklus, in dem die CPF16-Echtzeitletelegramme weitergeleitet werden

3.2.32

Dienstkanal

(en: service channel)

SVC

Nicht-Echtzeit-Übertragung von Informationen über den RT-Kanal auf Anforderung des Masters hin

3.2.33

Slave

(en: slave)

Knoten, dem das Recht zur Übertragung durch den Master zugewiesen wird

3.2.34

Slave-DLE

(en: slave DLE)

DLE, die die Funktionen eines Netzwerk-Slaves ausführt

3.2.35

Station

(en: station)

Knoten, der mit dem Netzwerk verbunden ist

3.2.36

Statuswort

(en: status word)

zwei aufeinanderfolgende Oktette im Bestätigungstelegramm, die Statusinformationen eines Geräts enthalten

3.2.37

S-0-nnnn

(en: S-0-nnnn)

Kennzeichnung von IDN

3.2.38

Telegramm

(en: telegram)

DLPDU

3.2.39

Topologie

(en: topology)

physische Netzwerkarchitektur in Bezug auf die Verbindung zwischen den Stationen des Kommunikationssystems

3.2.40

Topologieindex

(en: topology index)

Position eines Slaves in einem Typ-19-Netz unter Verwendung einer Nummerierung mit aufsteigender Reihenfolge (en: daisy chain numeration), startend mit dem Wert 1 am ersten Slave nach dem Master

English Version

Industrial communication networks - Fieldbus specifications -
Part 4 -19: Data-link layer protocol specification -
Type 19 elements
(IEC 61158-4-19:2019)

Réseaux de communication industriels - Spécifications des
bus de terrain - Partie 4-19: Spécification du protocole de la
couche liaison de données - Eléments de type 19
(IEC 61158-4-19:2019)

Industrielle Kommunikationsnetze - Feldbusse -
Teil 4-19: Protokollspezifikation des Data-Link Layer
(Sicherheitsschicht) - Typ 19-Elemente
(IEC 61158-4-19:2019)

This European Standard was approved by CENELEC on 2019-05-23. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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European foreword

The text of document 65C/946/FDIS, future edition 4 of IEC 61158-4-19, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61158-4-19:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-02-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-05-23

This document supersedes EN 61158-4-19:2014.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 61158-4-19:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 61131 series	NOTE	Harmonized as EN 61131 series.
IEC 61158-1	NOTE	Harmonized as EN 61158-1.
IEC 61158-3-19	NOTE	Harmonized as EN 61158-3-19.
IEC 61158-5-16	NOTE	Harmonized as EN 61158-5-16.
IEC 61158-5-19	NOTE	Harmonized as EN 61158-5-19.
IEC 61158-6-16	NOTE	Harmonized as EN 61158-6-16.
IEC 61158-6-19	NOTE	Harmonized as EN 61158-6-19.
IEC 61784-1	NOTE	Harmonized as EN 61784-1.
IEC 61784-2	NOTE	Harmonized as EN 61784-2.
IEC 61800-7 series	NOTE	Harmonized as EN 61800-7 series.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61158-4-16	2007	Industrial communication networks - Fieldbus specifications - Part 4-16: Data-link layer protocol specification - Type 16 elements	EN 61158-4-16	2008
ISO 8601	-	Data elements and interchange formats — Information interchange — Representation of dates and times		-
ISO/IEC 7498-1	-	Information technology - Open Systems-Interconnection - Basic reference model: The basic model		-
ISO/IEC 7498-3	-	Information technology - Open Systems-Interconnection - Basic reference model: Naming and addressing		-
ISO/IEC/IEEE 8802-3-	-	Information technology – Telecommunications- and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet		-
IEEE Std 802.3	-	IEEE Standard for Information technology — Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications		-
RFC 779	-	The TCP - Maximum Segment Size and Related Topics		-

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INTRODUCTION

This document is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC 61158-1.

The data-link protocol provides the data-link service by making use of the services available from the physical layer. The primary aim of this document is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer data-link entities (DLEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

- a) as a guide for implementors and designers;
- b) for use in the testing and procurement of equipment;
- c) as part of an agreement for the admittance of systems into the open systems environment;
- d) as a refinement to the understanding of time-critical communications within OSI.

This document is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this document together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

NOTE Attention is drawn to the fact that use of the associated protocol type(s) is restricted by its (their) intellectual-property-right holder(s). In all cases, the commitment to limited release of intellectual-property-rights made by the holder(s) of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in Type combinations as specified explicitly in the profile parts. Use of the various protocol type(s) in other combinations may require permission from their respective intellectual-property-right holders.

The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed that compliance with this document may involve the use of patents concerning Type 19 elements and possibly other types given in this document as follows:

DE 102 00 502 4759.8-32	[BR]	Verfahren zur Laufzeitkorrektur in einer Kommunikationsstruktur
DE 102 37 097	[RI]	Korrektur von Signallaufzeiten in verteilten Kommunikationssystemen

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-19: Data-link layer protocol specification – Type 19 elements

1 Scope

1.1 General

The data-link layer provides basic time-critical messaging communications between devices in an automation environment.

This protocol provides communication opportunities to all participating data-link entities

- a) in a synchronously-starting cyclic manner, according to a pre-established schedule, and
- b) in a cyclic or acyclic asynchronous manner, as requested each cycle by each of those data-link entities.

Thus this protocol can be characterized as one which provides cyclic and acyclic access asynchronously but with a synchronous restart of each cycle.

1.2 Specifications

This document specifies

- a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed data-link service provider;
- b) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this document, and their representation as physical interface data units.

1.3 Procedures

The procedures are defined in terms of

- a) the interactions between peer DL-entities (DLEs) through the exchange of fieldbus DLPDUs;
- b) the interactions between a DL-service (DLS) provider and a DLS-user in the same system through the exchange of DLS primitives;
- c) the interactions between a DLS-provider and a Ph-service provider in the same system through the exchange of Ph-service primitives.

1.4 Applicability

These procedures are applicable to instances of communication between systems which support time-critical communications services within the data-link layer of the OSI or fieldbus reference models, and which require the ability to interconnect in an open systems interconnection environment.

Profiles provide a simple multi-attribute means of summarizing an implementation's capabilities, and thus its applicability to various time-critical communications needs.

1.5 Conformance

This document also specifies conformance requirements for systems implementing these procedures. This part of this document does not contain tests to demonstrate compliance with such requirements.

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.

NOTE All parts of the IEC 61158 series, as well as IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

IEC 61158-4-16:2007, *Industrial communication networks – Fieldbus specifications – Part 4-16: Data-link layer protocol specification – Type 16 elements*

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

ISO/IEC 7498-3, *Information technology – Open Systems Interconnection – Part 3: Basic Reference Model: Naming and addressing*

ISO/IEC/IEEE 8802-3, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Standard for Ethernet*

ISO 8601, *Data elements and interchange formats – Information interchange – Representation of dates and times*

IEEE Std 802.3, *IEEE Standard for Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications*

Internet Engineering Task Force (IETF), *Request for Comments (RFC): RFC 879, The TCP Maximum Segment Size and Related Topics* (available at <<http://www.ietf.org/rfc/rfc0879.txt>>) [viewed 2018-09-13]

3 Terms, definitions, symbols, acronyms, abbreviations and conventions

For the purposes of this document, the following terms, definitions, symbols, acronyms, abbreviations and conventions apply.

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

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1 Reference model terms and definitions

This document is based in part on the concepts developed in ISO/IEC 7498-1 and ISO/IEC 7498-3, and makes use of the following terms defined therein.

3.2 Additional Type 19 terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.2.1

broadcast

transmission to all devices in a network without any acknowledgment by the receivers

3.2.2

communication cycle

fixed time period between two master synchronization telegrams in which real-time telegrams are transmitted in the RT channel and non-real-time telegrams are transmitted in the IP channel

3.2.3

control unit

control device (for example, a PLC as specified in the IEC 61131)

3.2.4

control word

two adjacent octets inside the master data telegram containing commands for the addressed device

3.2.5

cross communication

direct multicast data transfer between devices

3.2.6

cycle time

duration of a communication cycle

3.2.7

cyclic communication

periodic exchange of telegrams

3.2.8

cyclic data

part of a telegram, which does not change its meaning during cyclic operation of the network

3.2.9

cyclic operation

operation in which devices in the communication network are addressed and queried one after the other at fixed, constant time intervals

3.2.10

device

a slave in the communication network, (for example, a power drive system as defined in IEC 61800-7 (all parts), I/O stations as defined in IEC 61131 (all parts))

3.2.11

device address field

address field (eight bits) containing the address of the device

3.2.12

device control

four adjacent octets inside the master data telegram containing commands for each device

3.2.13

device status

four adjacent octets inside the acknowledge telegram containing status information for each device

3.2.14

DLE station identifier

network address assigned to a DLE

3.2.15

DLE station slot

unit (granularity of one) of position dependent mapping (for cyclic data field) of which a DLE may occupy one or more, delineated by the range beginning at the DLE station identifier with a length equal to the configured number of occupied slots

3.2.16

element

part of IDNs – each IDN has 7 elements, whereas each one has a specific meaning (for example: number, name, data)

3.2.17

EtherType

part of the Type 19 specific telegram header

3.2.18

forwarding

mode by which a device passes on a received telegram to the other port, either changed or unchanged

3.2.19

identification number

IDN

designation of operating data under which a data block is preserved with its attribute, name, unit, minimum and maximum input values, and the data

3.2.20

line

line structure

network topology, in which the transmission medium is routed from station to station in the form of a line; the information is transmitted in one direction from the master down to the last slave in the line, and then flows back to the master via all the slaves in the reverse order (CP16/3)

3.2.21

loopback

mode by which a device passes on a received telegram to the same port and to the other port, either changed or unchanged

3.2.22

master

node, which assigns the other nodes (i.e., slaves) the right to transmit

3.2.23

master data telegram

MDT

telegram, in which the master inserts its data

3.2.24

master DLE

DLE that performs the functions of network master

3.2.25

master synchronization telegram

MST

telegram, or part of a telegram, in which the master inserts a time synchronization signal

3.2.26

MDT0 telegram

telegram, in which the master transmits its synchronization data, as well as parts or all of its real-time data, to the slaves

3.2.27

participant

node which is connected to the network

3.2.28

physical layer

first layer of the ISO-OSI reference model

3.2.29

protocol

convention about the data formats, time sequences, and error correction in the data exchange of communication systems

3.2.30

real-time data

part of the telegram that does not change its meaning during cyclic operation of the interface

3.2.31

RT channel

defined time slot within the communication cycle, which passes the CPF16 real-time telegrams

3.2.32

service channel

SVC

non real-time transmission of information upon master request during RT channel

3.2.33

slave

node, which is assigned the right to transmit by the master

3.2.34

slave DLE

DLE that performs the functions of network slave

3.2.35

station

node which is connected to the network

3.2.36

status word

two adjacent octets inside the acknowledge telegram containing status information of a device

3.2.37

S-0-nnnn

designation of IDNs

3.2.38

telegram

DLPDU

3.2.39

topology

physical network architecture with respect to the connection between the stations of the communication system

3.2.40

topology index

position of a slave in a Type 19 network using a daisy chain numeration starting with value 1 at the first slave after the master

3.3 Symbols

ADR	device address ($1 \leq \text{ADR} \leq 511$) adjusted directly on the device, for example using a selector switch
AT MST	header in AT
AT0...3	acknowledge telegrams
INFO	service channel information
JtScyc	jitter in tScyc
MDT0	master data telegram with synchronization data that the slaves evaluates
MDT1...3	master data telegrams without synchronization data
P1	port 1
P2	port 2
RxD	received data
SLKN	slave identification parameter, slave arrangement
SVC	service channel
t1	AT transmission starting time
t1min	shortest AT transmission starting time
t3	command value valid time
t4	feedback acquisition capture point
t5	minimum feedback processing time
tcable	time, by which the transmitted signal is delayed by the cable, for each unit of length (approx., 5 ns/m)
trep	time, by which the received signal is delayed by a forwarding slave (input-output)
tRing	time, which a master telegram needs, until it has passed through the network and reached the master again
tScyc	communication cycle time
TxD	transmitted data

3.4 Acronyms and abbreviations

AHS	service transport handshake of the device (acknowledge HS)
AT	acknowledge telegram
C-CON	connection control
C-DEV	device control
C1D	class 1 diagnostic
CP	communication phase
CPS	communication phase switching
CRC	cyclic redundancy check
CSoS	CIP Safety on SERCOS
FCS	DLDPDU check sequence
FG	Function Group
FSP	Function-specific Profile
GDP	Generic Device Profile
HP	Hot-Plug
HP0	Hot-Plug phase 0
HP1	Hot-Plug phase 1
HP2	Hot-Plug phase 2
HS	service channel handshake (see AHS and MHS)
IDN	identification number
IP	Internet protocol
MAC	media access control
MDT	master data telegram
MDT MST	header in MDT
MHS	service transport handshake of the master
MS	communication from slave to master
MST	master synchronization telegram
NRT	non real-time
P-channel	primary channel
P-telegram	primary telegram
PL	parametrization level
RT	real-time

RTC	real-time channel
RTD	real-time data in MDT or AT
S-DEV	device status
S-channel	secondary channel
S-telegram	secondary telegrama
SCH	session control header
SCP	Type 19 Communication Profile
SE	structure element
SERCOS	serial real-time communication system interface
SFD	start DLPDU delimiter
SI	structure instance
SMP	Type 19 Messaging Protocol
SVC	service channel
UCC	unified communication channel

3.5 Additional conventions

All data types are assigned identification numbers (IDNs). They include real-time data (commands and feedback values), parameters, and procedures. Most IDNs are similar to those for Type 16 (see IEC 61158-4-16, 3.6). Several IDNs relate to the application and are defined in their relevant standards (for example, IEC 61800-7-20x for Power Drive Systems).

Refer to Annex A for additional information, as well as to IEC 61158-4-16, Clause A.1 for detailed IDN specification.

4 DL-protocol overview

4.1 Overview

This protocol type provides a highly optimized means of interchanging fixed-length real-time data and variable-length segmented messages between a single master device and a set of slave devices, interconnected in a ring or a line topology. The ring topology provides for redundant communication paths, and in case of a fault it automatically switches to a set of two lines without disturbing the communication.

This protocol type also provides for direct real-time data transmission between slaves, inside the real-time channel (RTC), within each communication cycle.

The exchange of real-time data is totally synchronous by configuration and is unaffected by the messaging traffic.

The device addresses are set by the user, using a selector for example. Additional devices may be added whenever required, even during operation, without affecting the address selections, which already exist. The determination of the number, identity and characteristics of each device may be configured or may be detected automatically at start-up.

Slave interfaces shall be used to connect the slave devices to the network. At the physical layer, a slave represents the connection of one or more devices to the network. Logically, one slave with several devices shall act the same as several slaves with one device each.

This protocol type also provides a unified communication channel (UC channel), in which any Standard Ethernet DLPDUs can be exchanged between Type 19 devices and any other connected Ethernet network nodes.

There are two classes of Type 19 DLE:

- a) master DLE;
- b) slave DLE.

Only the master DLE is able to initiate cyclic transmission.

Type 19 telegrams are Ethernet DLPDUs according to ISO/IEC/IEEE 8802-3. Type 19 real-time telegrams shall be transmitted in the real-time part of the communication cycle time. They mainly transport input and output data, for example command and feedback values. The Type 19 header specifies two types type 19 telegrams:

- a) Master data telegram (MDT), in which the master transmits real-time data to the slaves;
- b) Acknowledge telegram (AT), in which the slaves transmit real-time data to the master and other slaves.

Other Ethernet DLPDUs can be transmitted in the UC channel.

Type 19 specifies 4 MDTs (MDT0 to MDT3). The MDTs shall be transmitted by the master and received by each slave. The MDTs shall contain all information (for example: synchronization, command values, digital outputs) which is sent from the master to the slaves through the real-time channel.

MDT0 shall always be transmitted. MDT1 through MDT3 shall be transmitted only if required depending on the configuration of the application data to be transmitted. The master shall always send the same number of MDTs during each communication cycle.

Type 19 specifies 4 ATs (AT0 to AT3). The ATs shall be transmitted by the master with the configured AT length. The AT data fields are set to 0, except the application data of cross communication. Each slave shall insert its data into its allocated data field within the AT. The ATs shall contain all information (for example: feedback values, digital inputs) which is sent from the slaves to the master as well as to other slave devices through the real-time channel.

AT0 shall always be transmitted. AT1 through AT3 shall be transmitted only if required depending on the configuration of the application data to be transmitted. The master shall always send the same number of ATs during each communication cycle.

The order of the service channels (SVC), the device control (C-DEV), the device status (S-DEV) and the connections in the Type 19 telegrams shall be configured with parameters. The lengths of connections in the MDTs and the ATs shall depend on the amount of application data and may be different for each slave depending upon configuration. The number of MDTs and ATs may also be different because of the configuration. This order generated by the configuration of the payload shall meet the following requirements.

- a) A SVC of a slave shall be transmitted within one MDT or one AT and shall not be spread into different MDTs or ATs.
- b) A connection of a slave shall be transmitted within one MDT or one AT and shall not be spread into two different MDTs or ATs.
- c) Each connection and SVC shall start at an even address in the MDT and AT.
- d) Each device control and device status shall start at an even address in the MDT and AT.

- e) All other combination of configurations of SVCs, connections, device control and device status are possible.

Devices in a Type19 network use the order of little endian for the serial transmission of data. Little endian describes the least significant bit of the least significant octet of the least significant word is sent first, followed by the rest of the bits of this octet, then by the rest of the octets of this word, and so on in the same order.

4.2 General DLPDU identification

4.2.1 Introduction

DLPDUs shall be identified as specified in Table 1.

Table 1 – Ethernet DLPDU identification

DLPDU field	Data type	Value/description
Dest MAC	octet[6]	Destination MAC address
Src MAC	octet[6]	Source MAC address
EtherType	WORD	0x88CD (Type 19)

4.2.2 Destination address (Dest MAC)

The master shall transmit DLPDUs to all slaves using the broadcast address 0xFFFF FFFF FFFF as the destination address.

4.2.3 Source address (Src MAC)

The source address shall always be the MAC address of the master.

4.2.4 EtherType

The EtherType for real-time DLPDUs shall contain the value 0x88CD, which is the unique type field number that has been allocated by the IEEE EtherType Field Registration Authority for Type 19 telegrams.

NOTE This field number refers to Type 19 communication.

4.3 General DLPDU structure

4.3.1 Introduction

The data structure in a DLPDU shall consist of the following data entries as specified in Table 2.

Table 2 – Data structure in a DLPDU

Data field	Data type	Value/description
Header	octet[6]	Defines the DLPDU type
Payload	octet[40-1494]	Data fields are padded (filled with 0x0), if less than 40 octets

4.3.2 DLPDU header

The DLPDU header shall specify two types of telegrams, as specified in 4.4:

- **Master data telegram (MDT):** MDTs shall transmit data from the master to the slaves;
- **Acknowledge telegram (AT):** ATs shall transmit data from the slaves to the master, as well as to other slaves within the Type 19 network.

4.3.3 DLPDU payload

All transmitted data are permitted to have arbitrary bit sequences.

Padding octets shall be added if the Type 19 data is less than 40 octets, in order to reach a total data field length of at least 46 octets.

The DLPDU payload shall be as described in 4.5 and 4.6.

4.4 DLPDU header

4.4.1 Introduction

The DLPDU header shall distinguish the various DLPDUs.

It shall be coded in the telegram whether the DLPDU is transmitted in the primary or secondary channel, whether it is an MDT or an AT, and which one (MDT0 to MDT3, respectively AT0 to AT3).

In a line topology, the master shall decide whether the telegrams are marked as primary or secondary telegrams, depending upon configuration.

The DLPDU header structure is shown in Table 3:

Table 3 – DLPDU payload header

Data field	Data type	Value/description
DLPDU type	octet[1]	See 4.4.2
Reserved	octet[1]	—
Reserved	octet[4]	—

4.4.2 DLPDU type

The DLPDU type contains the telegram type and shall be generated by the master and transmitted in every MDT and AT. Its content shall be as shown in Table 4.

Table 4 – DLPDU type

Bit number	Bit value	Description
7	—	Primary or secondary telegram
	0	Telegram on the primary channel (P-telegram)
	1	Telegram on the secondary channel (S-telegram)
6	—	MDT or AT
	0	MDT
	1	AT
5	—	Cycle CNT (used to set Type 19 time)
	0	Cycle CNT is disabled
	1	Cycle CNT is enabled (Cycle CNT is defined in MDT phase (bit 6-4))
4	—	(reserved)
3-2		(reserved for telegram number 4 to 15)
1-0	—	Telegram number
	00	Telegram number 0
	01	Telegram number 1
	10	Telegram number 2
	11	Telegram number 3

4.5 MDT DLPDU

4.5.1 MDT MST field summary

The MDT shall be as specified in Table 5. The MDT header of MDT0 is called MST.

Table 5 – MDT header

DLPDU part	Data field	Data type	Value/Description
MDT header	MDT type	octet[1]	See 4.5.3
	MDT phase	octet[1]	See 4.5.4
	MDT CRC	octet[4]	See 4.5.5

4.5.2 Evaluation of MDT header in the slaves

The MDT header shall be generated by the master and evaluated by the slaves. Each slave shall evaluate the MDT header according to Table 6. If the MDT CRC is valid, then the slave shall evaluate the MDT type and in case of MDT0 (MST) additionally the MDT phase. If the MDT CRC is invalid, then the slave shall not evaluate the MDT header and the MDT payload.

Table 6 – MDT header to be considered by the slave

	MDT type	MDT phase	MDT CRC
MDT0 = MST	Yes	Yes	Yes
MDT1	Yes	No	Yes
MDT2	Yes	No	Yes
MDT3	Yes	No	Yes

4.5.3 MDT type

Refer to 4.4.2, whereas bit #6 shall be 0.

4.5.4 MDT phase

The MDT phase shall contain the status of the Type 19 communication in CP0 to CP4. The structure is shown in Table 7.

Table 7 – MDT phase

Bit number	Bit value	Description
7	—	Communication phase switching (CPS)
	0	Current CP Communication phase (bit 3-0) contains current CP.
	1	New CP Communication phase (bit 3-0) contains the target CP for phase switching.
6-4	—	Cycle CNT (shall be enabled in MDT DLPDU type, bit 5 is set to 1)
	0-7	Value of Cycle CNT (is incremented by 1 in each communication cycle by the master)
3-0	—	Communication phase (CP)
	0000	CP0
	0001	CP1
	0010	CP2
	0011	CP3
	0100	CP4
	0101 to 1111	(reserved)

4.5.5 MDT CRC

The cyclic redundancy check (CRC) shall be used by the transmit and receive algorithms to generate a CRC value for the MDT CRC field. The MDT CRC field shall contain a 4-octet (32-bit) cyclic redundancy check (CRC) value. This value shall be computed as a function of the contents of the destination address (see 4.2.2), source address (see 4.2.3), EtherType (see 4.2.4), Type 19 type (see 4.4.2) and phase (see 4.5.4). The encoding shall be as defined by the Standard Ethernet CRC generating polynomial (see ISO/IEC/IEEE 8802-3).

The MDT CRC shall be generated by the master and transmitted in every MDT (MDT0 to MDT3). This CRC shall be evaluated in every MDT by the slave (see Table 6).