DEUTSCHE NORM September 2008

DIN EN 61158-4-13

ICS 35.100.20; 35.160; 35.240.50

Ersatzvermerk
siehe unten

Industrielle Kommunikationsnetze – Feldbusse – Teil 4-13: Protokollspezifikation des Data Link Layer (Sicherungsschicht) – Typ 13-Elemente (IEC 61158-4-13:2007); Englische Fassung EN 61158-4-13:2008, nur auf CD-ROM

Industrial communication networks –
Fieldbus specifications –
Part 4-13: Data-link layer protocol specification – Type 13 elements
(IEC 61158-4-13:2007);
English version EN 61158-4-13:2008, only on CD-ROM

Réseaux de communication industriels –
Spécifications des bus de terrain –
Partie 4-13: Spécification des protocoles des couches de liaison de données – Eléments de type 13 (CEI 61158-4-13:2007);
Version anglaise EN 61158-4-13:2008, seulement en CD-ROM

Ersatzvermerk

Mit DIN EN 61158-4-1:2008-09, DIN EN 61158-4-2:2008-09, DIN EN 61158-4-3:2008-09, DIN EN 61158-4-4:2008-09, DIN EN 61158-4-7:2008-09, DIN EN 61158-4-8:2008-09, DIN EN 61158-4-11:2008-09, DIN EN 61158-4-12:2008-09, DIN EN 61158-4-14:2008-09, DIN EN 61158-4-16:2008-09, DIN EN 61158-4-17:2008-09, DIN EN 61158-4-18:2008-09 und DIN EN 61158-4-19:2008-09 Ersatz für DIN EN 61158-4:2005-05
Siehe jedoch Beginn der Gültigkeit

Gesamtumfang 88 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

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Beginn der Gültigkeit

Die von CENELEC am 2008-02-01 angenommene EN 61158-4-13 gilt als DIN-Norm ab 2008-09-01.

Daneben darf DIN EN 61158-4:2005-05 noch bis 2011-02-01 angewendet werden.

Nationales Vorwort

Mit DIN EN 61158-4-1:2008-09, DIN EN 61158-4-2:2008-09, DIN EN 61158-4-3:2008-09, DIN EN 61158-4-4:2008-09, DIN EN 61158-4-7:2008-09, DIN EN 61158-4-8:2008-09, DIN EN 61158-4-11:2008-09, DIN EN 61158-4-12:2008-09, DIN EN 61158-4-14:2008-09, DIN EN 61158-4-16:2008-09, DIN EN 61158-4-17:2008-09, DIN EN 61158-4-18:2008-09 und DIN EN 61158-4-19:2008-09 Ersatz für DIN EN 61158-4:2005-05.

Vorausgegangener Norm-Entwurf: E DIN EN 61158-400:2006-11.

Für diese Norm ist das nationale Arbeitsgremium K 956 „Feldbus“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE (www.dke.de) zuständig.

Die enthaltene IEC-Publikation wurde vom SC 65C „Industrial networks“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (maintenance result date) unverändert bleiben soll, das auf der IEC-Website unter „http://webstore.iec.ch“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation
– bestätigt,
– zurückgezogen,
– durch eine Folgeausgabe ersetzt oder
– geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnittsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als Europäische Norm EN 60068 durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Einführung

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 61158 legen eine Anzahl von Feldbus-Protokolltypen fest.

Die vorliegende Norm legt das Protokoll des Data Link Layer für Typ 13-Elemente fest (ETHERNET Powerlink). Dieser war in den unten aufgeführten früheren Ausgaben nicht enthalten.

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Änderungen

Gegenüber DIN EN 61158-4:2005-05 wurden folgende Änderungen vorgenommen:

a) Streichung des Typ 6-Feldbusses und des Platzhalters für einen Data Link Layer des Typ 5-Feldbusses wegen zu geringer Marktbedeutung;

b) Hinzufügung von weiteren Feldbustypen;

c) Aufteilung in mehrere Teile, jeweils als 4-1, 4-2, …, 4-19 benummert.

Frühere Ausgaben

DIN V 19245-1: 1988-04
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/A1: 2002-11
DIN EN 50170/A2: 2000-08
DIN EN 50170/A3: 2002-11
DIN EN 61158-4: 2005-05

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EUROPÄISCHE NORM

EUROPEAN STANDARD

NORME EUROPÉENNE

EN 61158-4-13

Februar 2008

ICS 35.100.20; 25.040.40

Ersatz für EN 61158-4:2004 (teilweise)

Deutsche Fassung

Industrielle Kommunikationsnetze – Feldbusse – Teil 4-13: Protokollspezifikation des Data Link Layer (Sicherungsschicht) – Typ 13-Elemente

(IEC 61158-4-13:2007)

Industrial communication networks – Fieldbus specifications – Part 4-13: Data-link layer protocol specification – Type 13 elements
(IEC 61158-4-13:2007)

Réseaux de communication industriels – Spécifications des bus de terrain – Partie 4-13: Spécification des protocoles des couches de liaison de données – Eléments de type 13
(CEI 61158-4-13:2007)

Diese Europäische Norm wurde von CENELEC am 2008-02-01 angenommen. Die CENELEC-Mitglieder sind gehalten, die CEN/CENELEC-Geschäftsordnung zu erfüllen, in der die Bedingungen festgelegt sind, unter denen dieser Europäischen Norm ohne jede Änderung der Status einer nationalen Norm zu geben ist.

Auf dem letzten Stand befindliche Listen dieser nationalen Normen mit ihren bibliographischen Angaben sind beim Zentralsekretariat oder bei jedem CENELEC-Mitglied auf Anfrage erhältlich.

Diese Europäische Norm besteht in drei offiziellen Fassungen (Deutsch, Englisch, Französisch). Eine Fassung in einer anderen Sprache, die von einem CENELEC-Mitglied in eigener Verantwortung durch Übersetzung in seine Landessprache gemacht und dem Zentralsekretariat mitgeteilt worden ist, hat den gleichen Status wie die offiziellen Fassungen.

CENELEC-Mitglieder sind die nationalen elektrotechnischen Komitees von Belgien, Bulgarien, Dänemark, Deutschland, Estland, Finnland, Frankreich, Griechenland, Irland, Island, Italien, Lettland, Litauen, Luxemburg, Malta, den Niederlanden, Norwegen, Österreich, Polen, Portugal, Rumänien, Schweden, der Schweiz, der Slowakei, Slowenien, Spanien, der Tschechischen Republik, Ungarn, dem Vereinigten Königreich und Zypern.

CENELEC

Europäisches Komitee für Elektrotechnische Normung
European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique

Zentralsekretariat: rue de Stassart 35, B-1050 Brüssel

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Vorwort

Der Text des Schriftstücks 65C/474/FDIS, zukünftige 1. Ausgabe von IEC 61158-4-13, ausgearbeitet von dem SC 65C „Industrial networks“ des IEC/TC 65 „Industrial-process measurement, control and automation“, wurde der IEC-CENELEC Parallelen Abstimmung unterworfen und von CENELEC am 2008-02-01 als EN 61158-4-13 angenommen.

Dieser und die weiteren Teile der Normenreihe EN 61158-4 ersetzen EN 61158-4:2004.

Gegenüber EN 61158-4:2004 wurden die folgenden Änderungen durchgeführt:

– Streichung des Typ 6-Feldbusses und des Platzhalters für einen Data Link Layer des Typ 5-Feldbusses wegen zu geringer Marktbedeutung;
– Hinzufügung von weiteren Feldbustypen;
– Aufteilung in mehrere Teile, jeweils als 4-1, 4-2, …, 4-19 benummert.

Nachstehende Daten wurden festgelegt:

– spätestes Datum, zu dem die EN auf nationaler Ebene durch Veröffentlichung einer identischen nationalen Norm oder durch Anerkennung übernommen werden muss (dop): 2008-11-01

– spätestes Datum, zu dem nationale Normen, die der EN entgegenstehen, zurückgezogen werden müssen (dow): 2011-02-01

ANMERKUNG Die Anwendung einiger der aufgeführten Protokolltypen wird durch die Inhaber der Rechte an geistigem Eigentum hieran eingeschränkt. Die Zusage zur begrenzten Freigabe ihrer Rechte an geistigem Eigentum durch die Inhaber erlaubt in jedem Fall die Anwendung eines bestimmten Data Link Layer-Protokolls zusammen mit einem Physical Layer- und einem Application Layer-Protokoll in Typzusammenstellungen, die in der Normenreihe EN 61784 angegeben sind. Die Anwendung der verschiedenen Protokolltypen in anderen Zusammenstellungen erfordert möglicherweise die Erlaubnis des jeweiligen Inhabers der Rechte an dem entsprechenden geistigen Eigentum.

Der Anhang ZA wurde von CENELEC hinzugefügt.

Anerkennungsnotiz

Der Text der Internationalen Norm IEC 61158-4-13:2007 wurde von CENELEC ohne irgendeine Abänderung als Europäische Norm angenommen.

In der offiziellen Fassung sind unter „Literaturhinweise“ zu den aufgelisteten Normen die nachstehenden Anmerkungen einzutragen:

IEC 61158-5-13	ANMERKUNG	Harmonisiert als EN 61158-5-13:2008 (nicht modifiziert).
IEC 61158-6-13	ANMERKUNG	Harmonisiert als EN 61158-6-13:2008 (nicht modifiziert).
IEC 61784-2	ANMERKUNG	Harmonisiert als EN 61784-2:2008 (nicht modifiziert).

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INTRODUCTION

This part of IEC 61158 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/TR 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 standard 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 standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 4-13: Data-link layer protocol specification – Type 13 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 standard 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) procedures for giving communications opportunities to all participating DL-entities, sequentially and in a cyclic manner for deterministic and synchronized transfer at cyclic intervals up to one millisecond;
c) procedures for giving communication opportunities available for time-critical data transmission together with non-time-critical data transmission without prejudice to the time-critical data transmission;
d) procedures for giving cyclic and acyclic communication opportunities for time-critical data transmission with prioritized access;
e) procedures for giving communication opportunities based on standard ISO/ IEC 8802-3 medium access control, with provisions for nodes to be added or removed during normal operation;
f) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this standard, 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

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

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61158-3-13, *Industrial communication networks – Fieldbus specifications – Part 3-13: Data-link layer service definition – Type 13 elements*

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 8802-3:2000, *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*

ISO/IEC 10731, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

3 Terms, definitions, symbols and abbreviations

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

3.1 Reference model terms and definitions

This standard 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:

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3.1.30 segmenting [7498-1]

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3.1.35 DL-service-data-unit [7498-1]

3.1.36 DL-simplex-transmission [7498-1]

3.1.37 DL-subsystem [7498-1]

3.1.38 systems-management [7498-1]

3.1.39 DLS-user-data [7498-1]

3.2 Service convention terms and definitions

This standard also makes use of the following terms defined in ISO/IEC 10731 as they apply to the data-link layer:

3.2.1 acceptor

3.2.2 asymmetrical service

3.2.3 confirm (primitive);
requestor.deliver (primitive)

3.2.4 deliver (primitive)

3.2.5 DL-confirmed-facility

3.2.6 DL-facility

3.2.7 DL-local-view

3.2.8 DL-mandatory-facility

3.2.9 DL-non-confirmed-facility

3.2.10 DL-provider-initiated-facility

3.2.11 DL-provider-optional-facility

3.2.12 DL-service-primitive;
primitive

3.2.13 DL-service-provider

3.2.14 DL-service-user

3.2.15 DLS-user-optional-facility

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3.2.16 indication (primitive); acceptor.deliver (primitive)

3.2.17 multi-peer

3.2.18 request (primitive); requestor.submit (primitive)

3.2.19 requestor

3.2.20 response (primitive); acceptor.submit (primitive)

3.2.21 submit (primitive)

3.2.22 symmetrical service

3.3 Data-link service terms and definitions

3.3.1

async-only CN
CN that is accessed only by polling

3.3.2

asynchronous period
second part of the Type 13 cycle, starting with a start of asynchronous (SoA) frame

3.3.3

basic Ethernet mode
mode that provides legacy Ethernet communication

3.3.4

continuous
communication class where isochronous communication takes place every cycle (the opposite to multiplexed)

3.3.5

controlled node (CN)
network node without the ability to manage the SCNM mechanism

3.3.6

cycle state machine
state machine that controls the data-link layer cycle and is itself controlled by the NMT state machine which determines the current operating mode

3.3.7

cycle time
time between two consecutive start of cyclic (SoC) frames

NOTE The Cycle Time includes the time for data transmission and some idle time before the beginning of the next cycle.

3.3.8

DLCEP-address
DL-address which designates either

a) one peer DL-connection-end-point, or

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b) one multi-peer publisher DL-connection-end-point and implicitly the corresponding set of subscriber DL-connection-end-points where each DL-connection-end-point exists within a distinct DLSAP and is associated with a corresponding distinct DLSAP-address

3.3.9

DL-segment, link, local link
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

3.3.10

DLSAP
distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

NOTE This definition, derived from ISO/IEC 7498-1, is repeated here to facilitate understanding of the critical distinction between DLSAPs and their DL-addresses.

3.3.11

DL(SAP)-address
either an individual DLSAP-address, designating a single DLSAP of a single DLS-user, or a group DL-address potentially designating multiple DLSAPs, each of a single DLS-user.

NOTE This terminology is chosen because ISO/IEC 7498-3 does not permit the use of the term DLSAP-address to designate more than a single DLSAP at a single DLS-user.

3.3.12

(individual) DLSAP-address
DL-address that designates only one DLSAP within the extended link

NOTE A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP. (See Figure 1.)

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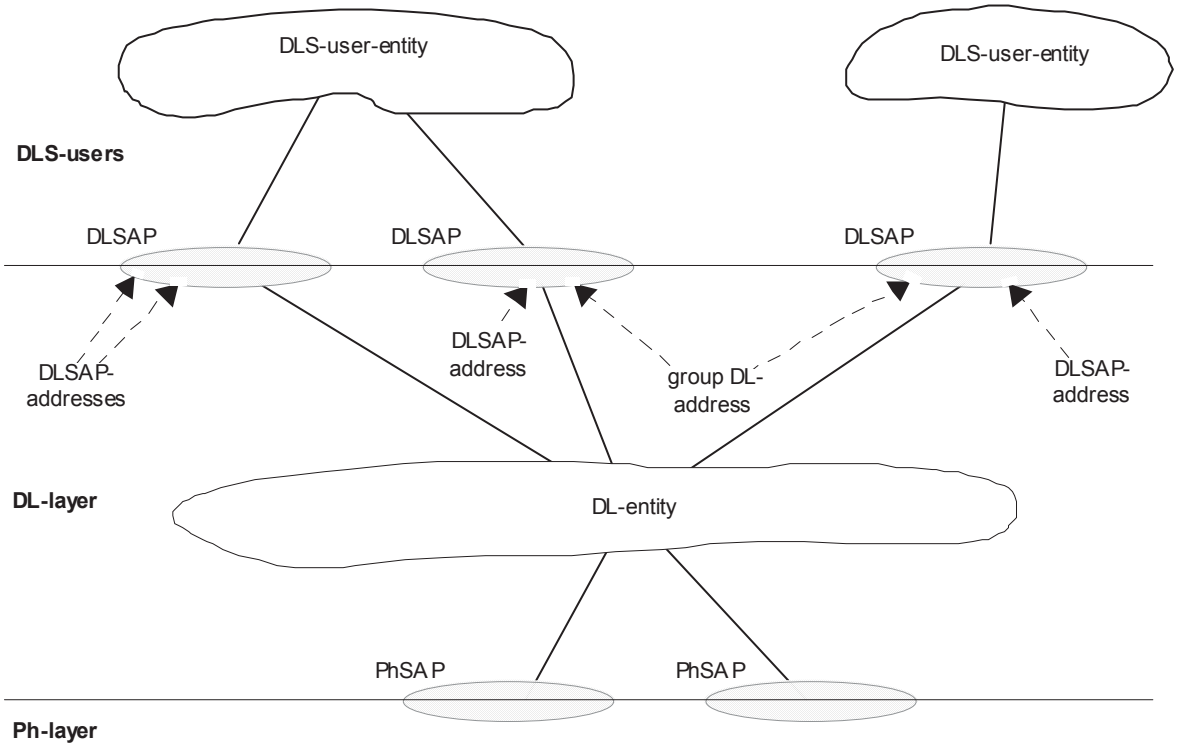

NOTE 1 DLSAPs and PhSAPs are depicted as ovals spanning the boundary between two adjacent layers.

NOTE 2 DL-addresses are depicted as designating small gaps (points of access) in the DLL portion of a DLSAP.

NOTE 3 A single DL-entity may have multiple DLSAP-addresses and group DL-addresses associated with a single DLSAP.

Figure 1 – Relationships of DLSAPs, DLSAP-addresses and group DL-addresses

3.3.13

Type 13 fieldbus cycle
fixed time interval consecutively repeated which is organized by the MN

3.3.14

Type 13 fieldbus node ID
unique number within one Type 13 network used to addres a Type 13 fieldbus node

3.3.15

frame
denigrated synonym for DLPDU

3.3.16

isochronous data
data which is transmitted every cycle (or every nth cycle in case of multiplexed isochronous data)

3.3.17

isochronous period
period within each cycle that offers deterministic operation through being reserved for the exchange of (continuous or multiplexed) isochronous data

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3.3.18

legacy Ethernet
Ethernet as standardized in ISO/IEC 8802-3 (non-deterministic operation in non-time-critical environments).

3.3.19

managing node
node that can manage the SCNM mechanism

3.3.20

multiplexed
communication class where cyclic communication takes place in such a way that m nodes are served in s cycles (an alternative to continuous)

3.3.21

multiplexed timeslot
timeslot assigned to multiplexed isochronous data and shared among multiple nodes

3.3.22

multipoint connection
connection from one node to many nodes.

NOTE Multipoint connection allows data transfer from a single publisher to many subscriber nodes.

3.3.23

multi-peer DLC
centralized multi-end-point DL-connection offering DL-duplex-transmission between a single distinguished DLS-user known as the publisher or publishing DLS-user, and a set of peer but undistinguished DLS-users known collectively as the subscribers or subscribing DLS-users, where the publishing DLS-user can send to the subscribing DLS-users as a group (but not individually), and the subscribing DLS-users can send to the publishing DLS-user (but not to each other).

3.3.24

NetTime
clock time of the MN as distributed to all CNs within the SoC frame.

3.3.25

network management
management functions and services that perform network initialization, configuration and error handling

3.3.26

node
single DL-entity as it appears on one local link

3.3.27

PollRequest
frame which is used in the isochronous part of a communications cycle

3.3.28

PollResponse
frame which is used in the isochronous part of a communications cycle to respond to a PollRequest frame

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3.3.29

process data object
object for isochronous data exchange between nodes

3.3.30

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

3.3.31

receiving DLS-user
DL-service user that acts as a recipient of DLS-user-data

NOTE A DL-service user can be concurrently both a sending and receiving DLS-user.

3.3.32

sending DLS-user
DL-service user that acts as a source of DLS-user-data

3.3.33

service data object
object for asynchronous data exchange between nodes

3.3.34

slot communication network management
mechanism which ensures that there are no collisions during physical network access of any of the networked nodes, thus providing deterministic communication via legacy Ethernet

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3.4 Symbols and abbreviations

3.4.1 ASnd	Asynchronous send (frame type)
3.4.2 CN	Controlled node
3.4.3 DL-	Data-link layer (as a prefix)
3.4.4 DLC	DL-connection
3.4.5 DLCEP	DL-connection-end-point
3.4.6 DLE	DL-entity (the local active instance of the data-link layer)
3.4.7 DLL	DL-layer
3.4.8 DLPCI	DL-protocol-control-information
3.4.9 DLPDU	DL-protocol-data-unit
3.4.10 DLM	DL-management
3.4.11 DLME	DL-management entity (the local active instance of DL-management)
3.4.12 DLMS	DL-management service
3.4.13 DLS	DL-service
3.4.14 DLSAP	DL-service-access-point
3.4.15 DLSDU	DL-service-data-unit
3.4.16 FIFO	First-in first-out (queuing method)
3.4.17 MN	Managing node
3.4.18 NMT	Network management
3.4.19 OSI	Open systems interconnection
3.4.20 PDO	Process data object
3.4.21 Ph-	Physical layer (as a prefix)
3.4.22 PhE	Ph-entity (the local active instance of the physical layer)
3.4.23 PhL	Ph-layer
3.4.24 PReq	PollRequest (frame type)
3.4.25 PRes	PollResponse (frame type)
3.4.26 RTE	Real time Ethernet
3.4.27 SCNM	Slot communication network management
3.4.28 SDO	Service data object
3.4.29 SoA	Start of asynchronous (frame type)
3.4.30 SoC	Start of cyclic (frame type)

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3.5 Common conventions

This standard uses the descriptive conventions given in ISO/IEC 10731.

The service model, service primitives, and time-sequence diagrams used are entirely abstract descriptions; they do not represent a specification for implementation.

Service primitives, used to represent service user/service provider interactions (see ISO/IEC 10731), convey parameters that indicate information available in the user/provider interaction.

This standard uses a tabular format to describe the component parameters of the DLS primitives. The parameters that apply to each group of DLS primitives are set out in tables throughout the remainder of this standard. Each table consists of up to six columns, containing the name of the service parameter, and a column each for those primitives and parameter-transfer directions used by the DLS:

- The request primitive's input parameters;
- The request primitive's output parameters;
- The indication primitive's output parameters;
- The response primitive's input parameters; and
- The confirm primitive's output parameters.

NOTE The request, indication, response and confirm primitives are also known as requestor.submit, acceptor.deliver, acceptor.submit, and requestor.deliver primitives, respectively (see ISO/IEC 10731).

One parameter (or part of it) is listed in each row of each table. Under the appropriate service primitive columns, a code is used to specify the type of usage of the parameter on the primitive and parameter direction specified in the column:

M Parameter: mandatory for the primitive.

U Parameter: a User option, and may or may not be provided depending on the dynamic usage of the DLS-user. When not provided, a default value for the parameter is assumed.

C Parameter is conditional upon other parameters or upon the environment of the DLS-user.

(Blank) Parameter is never present.

Some entries are further qualified by items in brackets. These may be

a) a parameter-specific constraint
(=) indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table.

b) an indication that some note applies to the entry
(n) indicates that the following note n contains additional information pertaining to the parameter and its use.

In any particular interface, not all parameters need be explicitly stated. Some may be implicitly associated with the DLSAP at which the primitive is issued.

In the diagrams which illustrate these interfaces, dashed lines indicate cause-and-effect or time-sequence relationships, and wavy lines indicate that events are roughly contemporaneous.

3.6 Additional conventions

In the diagrams which illustrate the DLS and DLM interfaces, dashed lines indicate cause-and-effect or time-sequence relationships between actions at different stations, while solid lines with arrows

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indicate cause-and-effect time-sequence relationships which occur within the DLE-provider at a single station.

The following notation, a shortened form of the primitive classes defined in 3.5, is used in the figures and tables.

req	request primitive
ind	indication primitive
cnf	confirm primitive (confirmation)
res	Response primitive

4 Overview of the DL-protocol

4.1 Overview

A Type 13 fieldbus extends Ethernet according to the ISO/IEC 8802-3 standard with mechanisms to transfer data with predictable timing and precise synchronizationto meet timing demands typical for high-performance automation and motion applications. It does not change basic principles of the Fast Ethernet Standard ISO/IEC 8802-3 but extends it towards real-time Ethernet. Thus it is possible to leverage and continue to use any standard Ethernet silicon, infrastructure component or test and measurement equipment like a network analyzer.

4.2 General description

4.2.1 General

Type 13 fieldbus provides mechanisms to achieve the following.

- Transmit time-critical data in precise isochronous cycles. Data exchange is based on a publish/subscribe relationship.
- Synchronize networked nodes with high accuracy.
- Transmit less time-critical data asynchronously on request. Asynchronous data communication can be used to transfer IP-based protocols like TCP or UDP and higher layer protocols such as HTTP, FTP,...

Type 13 fieldbus manages the network traffic in a way that there are dedicated time-slots for isochronous and asynchronous data (see Figure 2). It takes care that always only one networked device gains access to the network media. Thus transmission of isochronous and asynchronous data will never interfere and precise communication timing is guaranteed. The mechanism is called slot communication network management (SCNM). SCNM is managed by one particular networked device – the Managing Node (MN) – which includes the MN functionality. All other nodes are called controlled nodes (CN).

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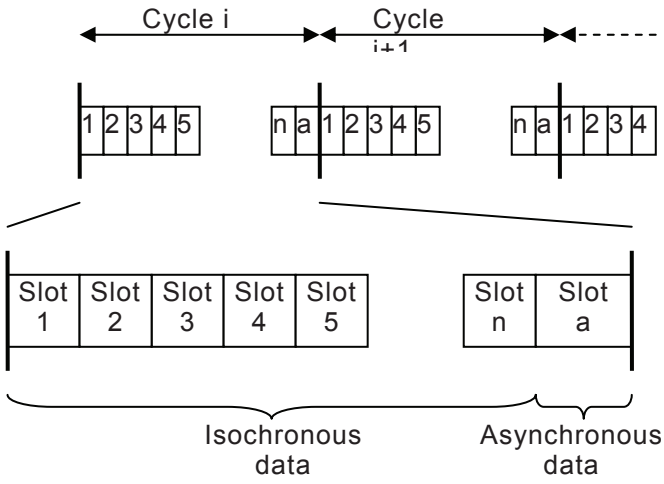

Figure 2 – Slot communication network management

Network access is managed by a master, the Type 13 fieldbus managing node (MN). A node is only being able to be granted the right to send data on the network via the MN. The central access rules preclude collisions; therefore a Type 13 network is therefore deterministic.

CNs are passive bus nodes; they only send when requested by the MN.

4.2.2 Overview of the medium access control and transmission protocol

Overview of the data frames flow on the medium is shown in Figure 3.

Data exchange between nodes occurs cyclically. It is required that the repetition occurs in a fixed interval, called Type 13 fieldbus cycle. The following time phases exist within one Type 13 fieldbus cycle.

- Isochronous phase
- Asynchronous phase
- Idle phase

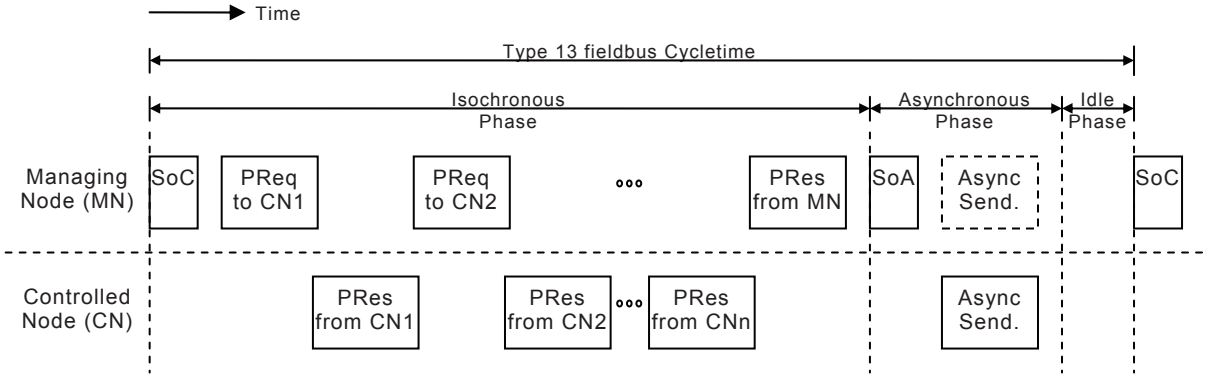

Figure 3 – Overall flow of data frames during one cycle

4.2.2.1 Isochronous phase

The DLL shall provide the opportunity of transferring data to each node in a sequential order and within a predetermined time period. At the beginning of an Type 13 fieldbus cycle, the MN shall send a SoC frame to all nodes via Ethernet multicast. The sending and receiving time of this frame is the basis for the common timing of all the nodes. Only the SoC frame is generated on a periodic

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basis. The generation of all other frames is event controlled (with additional time monitoring per node).

The MN starts the isochronous data exchange after the SoC frame has been sent. A PReq frame is sent to every configured and active node. The accessed node responds by a PRes frame.

Both the PReq and the PRes frames shall transfer application data. The MN shall only send PReq data to one CN per frame. PReq transfer is dedicated to data relevant for the addressed CN only. In contrast, the PRes frame is received by all nodes. This makes communication relationships possible according to the producer/consumer model.

The PReq / PRes procedure is repeated for each configured and active isochronous CN. The order in which CNs are polled is beyond the scope of this standard. When all configured and active isochronous CNs have been processed, the MN may send a multicast PRes frame to all nodes. This frame is dedicated to transfer data relevant for groups of CNs.

The isochronous phase is calculated from start of the SoC frame to start of the SoA frame.

The size and the length of the Type 13 fieldbus cycle is predominantly affected by the size of the isochronous phase. When configuring the Type 13 fieldbus cycle, the sum of the times required by the PReq / PRes accesses to each configured CN shall be taken into account. Use of the multiplexed access technology reduces the amount of time.

Continuous and multiplexed access operates in parallel during one Type 13 fieldbus cycle. The apportionment of the isochronous phase to continuous and multiplexed slots is configuration specific and not scope of this standard.

Although the multiplexed nodes are not processed in each cycle, they can monitor the entire data transfer of the continuous nodes.

In case of MN cycle loss, the multiplexed access sequence is continued on a per time base, after the cycle loss error phase is over.

4.2.2.2 Asynchronous phase

In the asynchronous phase of the Type 13 fieldbus cycle, access to the network is permitted to be granted to one CN or to the MN for the transfer of a single asynchronous message only.

There are two types of asynchronous frames available:

- the ASnd frame (Async Send);
- a Legacy Ethernet message.

If no asynchronous message transmission request is pending at the MN scheduling queues, the MN shall issue a SoA without assignment of the right to send to any node. No ASnd frame and no legacy Ethernet message will follow the SoA frame in this case.

The SoA frame is the first frame in the asynchronous phase and is a signal to all CNs that all isochronous data have been exchanged during the isochronous phase.

In case of an Type 13 fieldbus ASnd frame, the user data may contain following data, depending upon application.

- Ident Data: To identify inactive CNs and/or to query the identification data of a CN
- Status Data: To request the current status and detailed error information of a node

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- NMT Data: To assign the asynchronous slot to a node that has indicated a pending NMTCommand / NMTRequest
- Unspecified Data: To assign the asynchronous slot to a node that has indicated a pending transmit request. Unspecified data communication may be used to transfer peer to peer communication with access to the object dictionary of a device, IP-based protocols like TCP or UDP and higher layer protocols such as HTTP, FTP, …

In case of a legacy Ethernet message, the data could contain any legal Ethernet frame. The message is forwarded to the application without any further interpretation.

The asynchronous phase is calculated from the start of SoA to the end of the asynchronous response.

4.2.2.3 Idle phase

The idle phase is the remaining time interval between the end of the asynchronous phase and the beginning of the next cycle. During the idle Phase, all network components are “waiting" for the beginning of the following cycle. The duration of the idle phase may be 0.

4.3 Service assumed from the PhL

This subclause describes the assumed physical service (PhS) and the constraints used by the DLE. The Physical Service is assumed to provide the following service primitives specified by ISO/IEC 8802-3, Clause 2.

The assumed primitives of PhS are

- MA_DATA.request
- MA_DATA.indication

The temporal relationship of the primitives is shown in Figure 4.

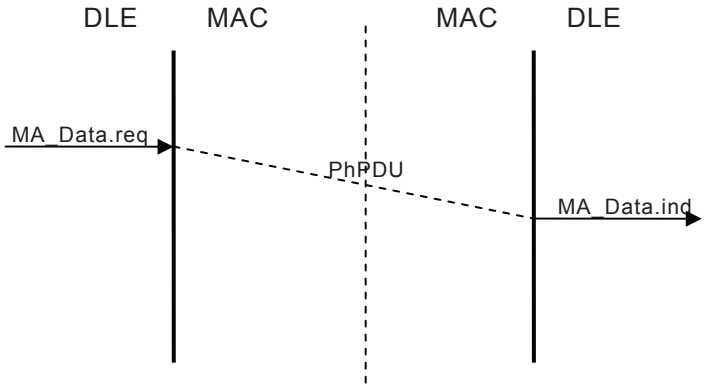

Figure 4 – Interaction of PhS primitives to DLE

The MA_DATA request primitive defines the transfer of data from a MAC client entity to a single peer entity or multiple peer entities in the case of group addresses.

The MA_DATA indication primitive defines the transfer of data from the MAC sublayer entity (through the optional MAC control sublayer, if implemented) to the MAC client entity or entities in the case of group addresses.

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4.4 DLL architecture

The Type 13 fieldbus DLL is modeled as a combination of control components of cycle state machine (CSM), isochronous transmission TX/RX control (ITC), asynchronous transmission TX/RX control (ATC), asynchronous slot scheduler (ASS), exception signaling (ES), NMT signaling (NS) and DLL management interface.

The cycle state machine as the primary control component provides the function for deterministic medium access control cooperating for reliable and efficient support of higher-level data transfer services. According responsibility assignment for MN and CN the primary responsibility for CN is

- to handle communication within an Type 13 fieldbus cycle;
- to track the order of the frames received within a cycle and reacts according to the described dataflow;
- to generate an error event in case of a detected communication error;
- to hold up communication regardless to any errors.

The cycle state machine of the MN is responsible for:

- Managing the communication within an Type 13 fieldbus cycle.
- Generating the flow of the frames during an Type 13 fieldbus cycle.
- Monitoring the reaction of the CNs.
- Generating an error event in case of a detected communication error.

The data-link layer is comprised of the components listed in Table 1.

Table 1 – Data-link layer components

Components	Description
Cycle state machine (CSM)	The cycle state machine controls the Type 13 fieldbus cycle on the data-link layer. Assembles and transmits the DLPDUs, receives and disassembles the DLPDUs with the control information, and determines the timing and duration of the transmissions
Isochronous transmission TX/RX control (ITC)	Buffers and dispatches in time DLSDU received for the time-critical cyclic data transfer between the DLS-user and the SCM
Asynchronous transmission TX/RX control (ATC)	Queues and dispatches in time DLSDU received for the asynchronous data transfer between DLS-user and the SCM
Asynchronous Slot Scheduler (ASS)	The MNs asynchronous slot scheduler decides when a requested asynchronous data transfer will happen
Exception Signaling (ES)	The exception signaling signals a detected CN exception to the MN NMT
NMT Signaling (NS)	To report the current status of the NMT
DLL management interface	Holds the station management variables that belong to the DLL, and manages synchronized changes of the link parameters

The internal arrangement of these components, and their interfaces, are shown in Figure 5. The arrowheads illustrate the primary direction of the flow of data and control.

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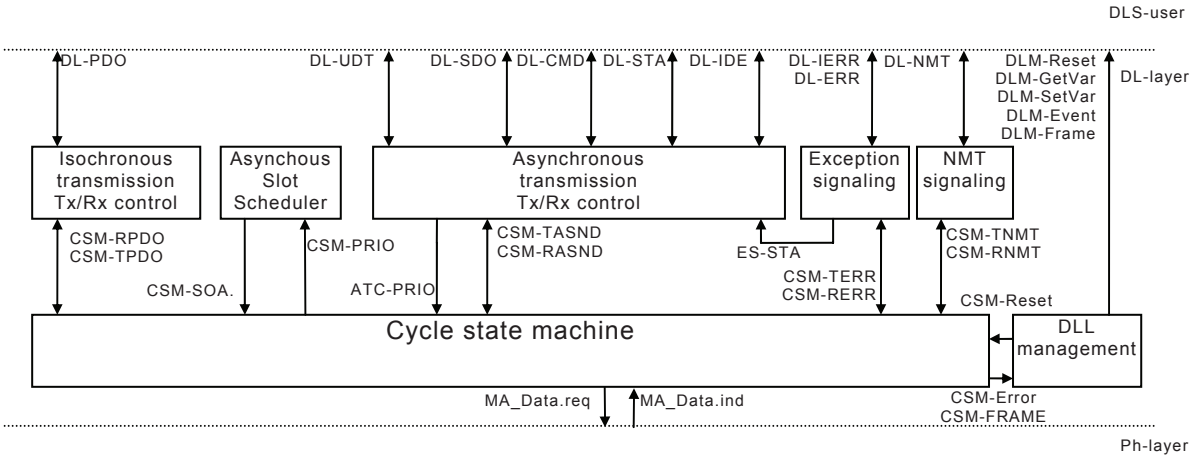

Figure 5 – Data-link layer internal architecture

4.5 Local parameters and variables

This specification uses DLS-user request parameters P(...) and local variables V(...) as a means of clarifying the effect of certain actions and the conditions under which those actions are valid, local timers T(...) as a means of monitoring actions of the distributed DLS-provider and of ensuring a local DLE response to the absence of those actions, and local counters C(...) for performing rate measurement functions.

Unless otherwise specified, at the moment of their creation or of DLE activation:

a) all variables shall be initialized to their default value, or to their minimum permitted value if no default is specified;

b) all counters shall be initialized to zero;

c) all timers shall be initialized to inactive;

DL-management may change the values of configuration variables.

4.5.1 Variables, parameter, counter and timer to support DLE function

4.5.1.1 T(ASND_TIME)

T(ASND_TIME) is used by the DLE to measure the time elapsed since last sending an ASnd frame. The value is decremented in the range of V(AsyncSlotTimeout_U32) to 0.

4.5.1.2 V(AsyncSlotTimeout_U32)

This variable holds and designates the value of the timeout time for the ASnd frame. An event is produced when the ASnd frame was not (or not completely) received within a preconfigured time. The initial value is 100 000 on power-up or reset of this node. The range of this value starts at 250.

4.5.1.3 P(C_DLL_ISOCHR_MAX_PAYL)

This parameter indicates the maximum size of PReq and PRes payload data. The value is set to 1 490.

4.5.1.4 P(C_DLL_MAX_PAYL_OFFSET)

This parameter indicates the maximum offset of Ethernet frame payload. The value is set to 1 499.

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