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INTERNATIONAL STANDARD

Industrial communication networks – Fieldbus specifications – Part 3-4: Data-link layer service definition – Type 4 elements



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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 3-4: Data-link layer service definition – Type 4 elements

FOREWORD

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NOTE Combinations of protocol Types are specified in the IEC 61784-1 series and the IEC 61784-2 series.

IEC 61158-3-4 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

This fourth edition cancels and replaces the third edition published in 2019. This edition constitutes a technical revision.

This edition includes the following significant technical change with respect to the previous edition:

a) Use of extended data size for DLS-user data. This extension is restricted to nodes operating on a P-NET IP network.

The text of this International Standard is based on the following documents:

Draft	Report on voting
65C/1201/FDIS	65C/1242/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all the parts of the IEC 61158 series, under the general title *Industrial communication networks – Fieldbus specifications*, can be found on the IEC web site.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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.

Throughout the set of fieldbus standards, the term "service" refers to the abstract capability provided by one layer of the OSI Basic Reference Model to the layer immediately above. Thus, the data-link layer service defined in this document is a conceptual architectural service, independent of administrative and implementation divisions.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 3-4: Data-link layer service definition – Type 4 elements

1 Scope

1.1 General

This part of IEC 61158 provides common elements for basic time-critical messaging communications between devices in an automation environment. The term "time-critical" is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This document defines in an abstract way the externally visible services provided by the Type 4 fieldbus data-link layer in terms of

a) the primitive actions and events of the services;
b) the parameters associated with each primitive action and event, and the form which they take; and
c) the interrelationship between these actions and events, and their valid sequences.

The purpose of this document is to define the services provided to

- the Type 4 fieldbus application layer at the boundary between the application and data-link layers of the fieldbus reference model;
- systems management at the boundary between the data-link layer and systems management of the fieldbus reference model.

1.2 Specifications

The principal objective of this document is to specify the characteristics of conceptual data-link layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of data-link protocols for time-critical communications. A secondary objective is to provide migration paths from previously-existing industrial communications protocols.

This document can be used as the basis for formal DL-Programming-Interfaces. Nevertheless, it is not a formal programming interface, and any such interface will need to address implementation issues not covered by this specification, including

a) the sizes and octet ordering of various multi-octet service parameters;
b) the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

This document does not specify individual implementations or products, nor does it constrain the implementations of data-link entities within industrial automation systems.

There is no conformance of equipment to this data-link layer service definition standard. Instead, conformance is achieved through implementation of the corresponding data-link protocol that fulfills the Type 4 data-link layer services defined in this document.

2 Normative references

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

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

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 10731:1994, *Information technology – Open Systems Interconnection – Basic Reference Model – Conventions for the definition of OSI services*

3 Terms, definitions, symbols, abbreviated terms and conventions

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

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

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://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.

3.1.1 DL-address [7498-3]

3.1.2 DL-address-mapping [7498-1]

3.1.3 called-DL-address [7498-3]

3.1.4 calling-DL-address [7498-3]

3.1.5 centralized multi-end-point-connection [7498-1]

3.1.6 correspondent (N)-entities [7498-1]
correspondent DL-entities (N=2)
correspondent Ph-entities (N=1)

3.1.7 DL-connection [7498-1]

3.1.8 DL-connection-end-point [7498-1]

3.1.9 DL-connection-end-point-identifier [7498-1]

3.1.10 DL-connection-mode transmission [7498-1]

3.1.11 DL-connectionless-mode transmission [7498-1]

3.1.12 DL-duplex-transmission [7498-1]

3.1.13 (N)-entity [7498-1]
DL-entity (N=2)
Ph-entity (N=1)

3.1.14 DL-facility [7498-1]

3.1.15 flow control [7498-1]

3.1.16 (N)-layer [7498-1]
DL-layer (N=2)
Ph-layer (N=1)

3.1.17 layer-management [7498-1]

3.1.18 DL-local-view [7498-3]

3.1.19 DL-name [7498-3]

3.1.20 naming-(addressing)-domain [7498-3]

3.1.21 primitive name [7498-3]

3.1.22 DL-protocol [7498-1]

3.1.23 DL-protocol-connection-identifier [7498-1]

3.1.24 DL-protocol-data-unit [7498-1]

3.1.25 DL-relay [7498-1]

3.1.26 Reset [7498-1]

3.1.27 responding-DL-address [7498-3]

3.1.28 routing [7498-1]

3.1.29 segmenting [7498-1]

3.1.30 (N)-service [7498-1]
DL-service (N=2)
Ph-service (N=1)

3.1.31 (N)-service-access-point [7498-1]
DL-service-access-point (N=2)
Ph-service-access-point (N=1)

3.1.32 DL-service-access-point-address [7498-3]

3.1.33 DL-service-connection-identifier [7498-1]

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

3.1.35 DL-simplex-transmission [7498-1]

3.1.36 DL-subsystem [7498-1]

3.1.37 systems-management [7498-1]

3.1.38 DLS-user-data [7498-1]

3.2 Service convention terms and definitions

This document 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 confirm (primitive);
requestor.deliver (primitive)

3.2.3 deliver (primitive)

3.2.4 DL-confirmed-facility

3.2.5 DL-facility

3.2.6 DL-local-view

3.2.7 DL-mandatory-facility

3.2.8 DL-non-confirmed-facility

3.2.9 DL-service-primitive;
primitive

3.2.10 DL-service-provider

3.2.11 DL-service-user

3.2.12 DLS-user-optional-facility

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

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

3.2.15 requestor

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

3.2.17 submit (primitive)

3.3 Data-link service terms and definitions

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

3.3.1
broadcast-node-address
address used to designate all DLEs on a link

Note 1 to entry: All DLEs on a link receive all DLPDUs where the first node-address is equal to the broadcast-node-address. Such DLPDUs are always unconfirmed, and their receipt is never acknowledged. The value of the broadcast-node-address is 126.

3.3.2
destination-DL-route
sequence of DL-route-elements, describing the complete route to the destination

Note 1 to entry: This includes both the destination DLSAP and a local component meaningful to the destination DLS-user.

3.3.3
DL-route-element
octet holding a node DL-address or an address used by the DLS-user

3.3.4
DLSAP
distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

3.3.5
DL(SAP)-address
individual DLSAP-address, designating a single DLSAP of a single DLS-user

3.3.6
DLS-user address
uniquely identifies a DLS-user locally

3.3.7
frame
denigrated synonym for DLPDU

3.3.8
full DL-route
combination of a destination-DL-route and a source-DL-route

3.3.9
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
maximum-indication-delay
time value that indicates to the DLS-user the maximum time interval for the DLS-user to prepare a response after receiving an indication requiring a response

Note 1 to entry: If the DLS-user is unable to prepare a response within maximum-indication-delay, the DLS-user is required to issue a DL-UNITDATA request with a DLSDU type indicating ACKNOWLEDGE. As a result the DLE will transmit an acknowledging DLPDU on the link.

3.3.11
maximum-retry-time
time value that indicates to the DLE for how long time retransmission of the request can be performed, as a result of Wait acknowledges from the remote DLE or DLS-user

3.3.12
no-confirm-node-address
node address which indicates that a request or response is unconfirmed

Note 1 to entry: The value of the no-confirm-node-address is 0.

3.3.13
node
single DL-entity as it appears on one local link

3.3.14
node-address
value that uniquely identifies a DLE on a link

Note 1 to entry: The value of a Node-address is in the range of 0-127. The values 0, 126 and 127 are reserved for special purposes.

3.3.15
normal class device
device which replies to requests from other normal class devices, and initiates transmissions

Note 1 to entry: Such a device can act as a server (responder) and as a client (requestor) – this is also called a peer.

3.3.16
receiving DLS-user
DL-service user that acts as a recipient of DLS-user-data

Note 1 to entry: A DL-service user can be concurrently both a sending and receiving DLS-user.

3.3.17
sending DLS-user
DL-service user that acts as a source of DLS-user-data

3.3.18
service-node-address
address reserved for service purposes only

Note 1 to entry: All DLEs on a link receive all DLPDUs where the first Node-address is equal to the service-node-address. Such DLPDUs can be Confirmed or Unconfirmed, and it is possible that their receipt can be acknowledged, or not. The service-node-address can be used on links with only two DLEs – the requesting Normal class DLE and the responding simple-class or normal-class DLE. The value of the service-node-address is 127.

3.3.19
simple-class device
device which replies to requests from normal class devices

Note 1 to entry: Such a device can act as a server or responder only.

3.3.20
source-DL-route
holds a sequence of DL-route-elements, describing the complete route back to the source

3.4 Symbols and abbreviations

NOTE Many symbols and abbreviations are common to more than one protocol Type; they are not necessarily used by all protocol Types.

DL-	Data-link layer (as a prefix)
DLC	DL-connection
DLCEP	DL-connection-end-point
DLE	DL-entity (the local active instance of the data-link layer)
DLL	DL-layer
DLPCI	DL-protocol-control-information
DLPDU	DL-protocol-data-unit
DLM	DL-management
DLME	DL-management Entity (the local active instance of DL-management)
DLMS	DL-management Service
DLS	DL-service
DLSAP	DL-service-access-point
DLSDU	DL-service-data-unit
FIFO	First-in first-out (queuing method)
OSI	Open systems interconnection

Ph-	Physical layer (as a prefix)
PhE	Ph-entity (the local active instance of the physical layer)
PhL	Ph-layer
QoS	Quality of service

3.5 Conventions

This document 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 document 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 document. 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 is mandatory for the primitive.

U parameter is a User option, and can be provided or not 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.

Items in brackets further qualify some entries. 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.