

Digital data communications for measurement and control — Fieldbus for use in industrial control systems

Part 3: Data link service definition

The European Standard EN 61158-3:2004 has the status of a
British Standard

ICS 25.040; 35.100.20; 35.240.50

National foreword

This British Standard is the official English language version of EN 61158-3:2004. It is identical with IEC 61158-3:2004. It, together with BS EN 61158-2:2004, BS EN 61158-4:2004, BS EN 61158-5:2004, BS EN 61158-6:2004 and BS EN 61784-1:2004, supersedes BS EN 50170:1997 and BS EN 50254:1999, which are withdrawn.

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English version

**Digital data communication for measurement and control -
Fieldbus for use in industrial control systems
Part 3: Data link service definition
(IEC 61158-3:2003)**

Communications numériques pour les
systèmes de mesure et de commande -
Bus de terrain utilisés dans les systèmes
de commande industriels
Partie 3: Définition des services
de la couche de liaison de données
(CEI 61158-3:2003)

Digitale Datenkommunikation
in der Leittechnik -
Feldbus für industrielle Leitsysteme
Teil 3: Definition der Dienste
der Sicherungsschicht (Data Link Layer)
(IEC 61158-3:2003)

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Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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Foreword

The text of the International Standard IEC 61158-3:2003, prepared by SC 65C, Digital communications, of IEC TC 65, Industrial-process measurement and control, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 61158-3 on 2004-03-16.

This European Standard, together with EN 61158-2:2004, EN 61158-4:2004 to EN 61158-6:2004 and EN 61784-1:2004, supersedes EN 50170:1996 + A1:2002 (+ corr. Aug. 2002) + A2:1999 + A3:2002 (+ corr. Aug. 2002) and EN 50254:1998.

The following dates were fixed:

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at national level by publication of an identical
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- latest date by which the national standards conflicting
with the EN have to be withdrawn (dow) 2007-04-01

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

IEC 61158-2	NOTE Harmonized as 61158-2:2004 (not modified).
IEC 61158-5	NOTE Harmonized as 61158-5:2004 (not modified).
IEC 61158-6	NOTE Harmonized as 61158-6:2004 (not modified).
IEC 61784	NOTE Part 1 harmonized as 61784-1:2004 (not modified).

Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61158-3:2003 was approved by CENELEC as a European Standard without any modification.

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0 Introduction

0.1 General

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, which is based in part on the Basic Reference Model for Open Systems Interconnection. Both Reference Models subdivide the area of standardization for interconnection into a series of layers of specification, each of manageable size.

The Data Link Service is provided by the Data Link Protocol making use of the services available from the Physical Layer. This part of the IEC 61158 series defines the Data Link Service characteristics that the immediately higher-level protocol may exploit. The relationship between the International Standards for Fieldbus Data Link Service, Fieldbus Data Link Protocol, Fieldbus Application Protocol and Systems Management is illustrated in Figure 1.

NOTE Systems Management, as used in this standard, is a local mechanism for managing the layer protocols

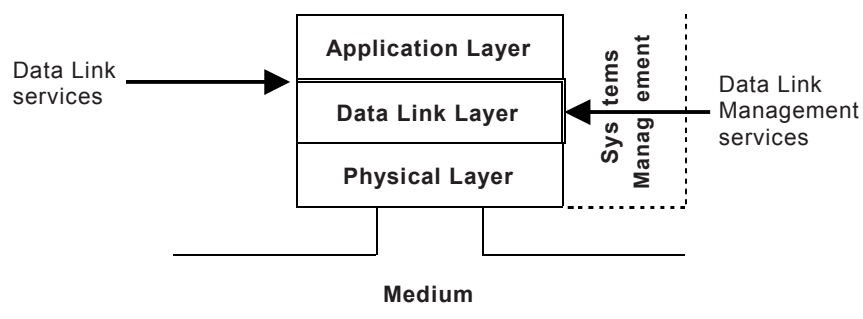


Figure 1 – Relationship of IEC 61158-3 to other fieldbus layers and to users of the Fieldbus Data Link Service

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 Service defined in this standard is a conceptual architectural service, independent of administrative and implementation divisions.

0.2 Nomenclature for references within this standard

Clauses, including annexes, can be referenced in their entirety, including any subordinate subclauses, as “Clause N” or “Annex N”, where N is the number of the clause or letter of the annex.

Subclauses can be referenced in their entirety, including any subordinate subclauses, as “N.M” or “N.M.P” and so forth, depending on the level of the subclause, where N is the number of the subclause or letter of the annex, and M, P and so forth represent the successive levels of subclause up to and including the subclause of interest.

When a clause or subclause contains one or more subordinate subclauses, the text between the clause or subclause heading and its first subordinate subclause can be referenced in its entirety as “N.0” or “N.M.0” or “N.M.P.0” and so forth, where N, M and P are as above. Stated differently, a reference ending with “.0” designates the text and figures between a clause or subclause header and its first subordinate subclause.

DIGITAL DATA COMMUNICATIONS FOR MEASUREMENT AND CONTROL – FIELDBUS FOR USE IN INDUSTRIAL CONTROL SYSTEMS –

Part 3: Data Link Service definition

1 Scope and object

1.1 Overview

This part of IEC 61158 provides 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 part of IEC 61158 defines in an abstract way the externally visible service provided by the Fieldbus Data Link Layer in terms of

- a) the primitive actions and events of the service;
- 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 part of IEC 61158 is to define the services provided to

- 1) the various types of Fieldbus Application Layer at the boundary between the Application and Data Link Layers of the Fieldbus Reference Model, and
- 2) Systems Management at the boundary between the Data Link Layer and Systems Management of the Fieldbus Reference Model.

Seven distinct types of services are defined in this part of IEC 61158; each has a corresponding protocol in IEC 61158-4. The seven distinct types of DL-service are:

Type 1 — A DL-service which provides a superset of those services expected of OSI Data Link Protocols as specified in ISO/IEC 8886.

Type 2 — A DL-service which provides both a connected and a connectionless subset of those services specified in ISO/IEC 8886.

Type 3 — A DL-service which provides a connectionless subset of those services specified in ISO/IEC 8886.

Type 4 — A DL-service which provides a connectionless subset of those services specified in ISO/IEC 8886.

NOTE 1 This part of IEC 61158 does not define a Type 5 Data Link service. Other parts of IEC 61158 define a Type 5 Application Layer service and protocol. The designation Type 5 is reserved in this part of IEC 61158 to maintain numbering consistency with the other parts of IEC 61158.

Type 6 — A DL-service which provides both a connected and a connectionless subset of those services provided by OSI Data Link Protocols as specified in ISO/IEC 8886.

Type 7 — A DL-service which provides both a connected and a connectionless subset of those services provided by OSI Data Link Protocols as specified in ISO/IEC 8886.

Type 8 — A DL-service which provides a connection-oriented subset of those services specified in ISO/IEC 8886.

NOTE 2 Many of these Types of service are suitable for use with multiple higher-layer protocols. In addition to the potential ability of these types of Data Link service to support unrelated Types of Fieldbus Application Layer protocol, some of these Types of Data Link service also may be able to support:

- a) the OSI Network Layer at the boundary between the Network and Data Link Layers of the OSI Basic Reference Model
- b) the IETF (IP) Network Layer
- c) the Smart Transducer Interface for Sensors and Actuators as defined in IEEE 1451.2.

Where the scope of addressing is adequate, some of these Types of Data Link service also may be able to support

- d) an OSI Transport Layer Protocol.

NOTE 3 Use of some of these protocol types is restricted by their copyright holders. In all cases a particular Data Link protocol Type can be used without restriction when coupled with the same Type Physical Layer and Application Layer protocols, or with other combinations as specified in IEC 61784. Use of the various protocol Types in other combinations may require permission of their respective copyright holders.

1.2 Specifications

The principal objective of this part of IEC 61158 is to specify the characteristics of conceptual Data Link 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. It is this latter objective which gives rise to the diversity of services standardized in this part of IEC 61158, and the corresponding protocols standardized in IEC 61158-4.

This specification may 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, and
- b) the correlation of paired request and confirm, or indication and response, primitives.

1.3 Conformance

This part of IEC 61158 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 Service definition standard. Instead, conformance is achieved through implementation of conforming Data Link protocols that fulfill any given Type of Data Link Services as defined in this part of IEC 61158.

1.4 Scope of type-specific clauses and subclauses

The different Types of Data Link services defined by this standard are each presumed self-consistent, but in general are unrelated to the other Types of service.

Where a clause or subclause heading explicitly designated one or more Types, that clause or subclause applies only to that (those) Type(s) and all references within that clause or subclause are with respect to that (those) Type(s).

Where a clause does not explicitly designate specific Types, or neither a subclause nor its containing clause explicitly designate specific Types, then that material is presumed to apply to multiple Types.

2 Normative references

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

ISO/IEC 7498, *Information technology – Open Systems Interconnection – Basic Reference Model*

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model — Basic Reference Model: The Basic Model*

ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model — Basic Reference Model: Naming and addressing*

ISO/IEC 8886:1996, *Information technology – Open Systems Interconnection – Data Link Service Definition*

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

IEC 61158-4:2003, *Digital data communications for measurement and control – Fieldbus for use in industrial control systems – Part 4: Data link protocol specification*

IEEE Std 1451.2:1997, *A Smart Transducer Interface for Sensors and Actuators – Transducer to Microprocessor Communication Protocols and Transducer Electronic Data Sheets (TEDS) Formats*

3 Terms and definitions

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

3.1 Reference model terms and definitions

This part of IEC 61158 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	DL-connection	[7498-1]
3.1.7	DL-connection-end-point	[7498-1]
3.1.8	DL-connection-end-point-identifier	[7498-1]
3.1.9	DL-connection-mode transmission	[7498-1]
3.1.10	DL-connectionless-mode transmission	[7498-1]
3.1.11	correspondent (N)-entities correspondent DL-entities (N=2) correspondent Ph-entities (N=1)	[7498-1]
3.1.12	DL-duplex-transmission	[7498-1]
3.1.13	(N)-entity DL-entity (N=2) Ph-entity (N=1)	[7498-1]
3.1.14	DL-facility	[7498-1]
3.1.15	flow control	[7498-1]
3.1.16	(N)-layer DL-layer (N=2) Ph-layer (N=1)	[7498-1]
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	peer-entities	[7498-1]
3.1.22	primitive name	[7498-3]
3.1.23	DL-protocol	[7498-1]
3.1.24	DL-protocol-connection-identifier	[7498-1]

3.1.25	DL-protocol-data-unit	[7498-1]
3.1.26	DL-relay	[7498-1]
3.1.27	reset	[7498-1]
3.1.28	responding-DL-address	[7498-3]
3.1.29	routing	[7498-1]
3.1.30	segmenting	[7498-1]
3.1.31	(N)-service DL-service (N=2) Ph-service (N=1)	[7498-1]
3.1.32	(N)-service-access-point DL-service-access-point (N=2) Ph-service-access-point (N=1)	[7498-1]
3.1.33	DL-service-access-point-address	[7498-3]
3.1.34	DL-service-connection-identifier	[7498-1]
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	DL-user-data	[7498-1]

3.2 Service convention terms and definitions

This part of IEC 61158 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 DL-user-optional-facility**
- 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 Common Data Link Service terms and definitions

NOTE Many definitions are common to more than one protocol type; they are not necessarily used by all protocol types.

For the purpose of this part of IEC 61158, the following definitions also apply:

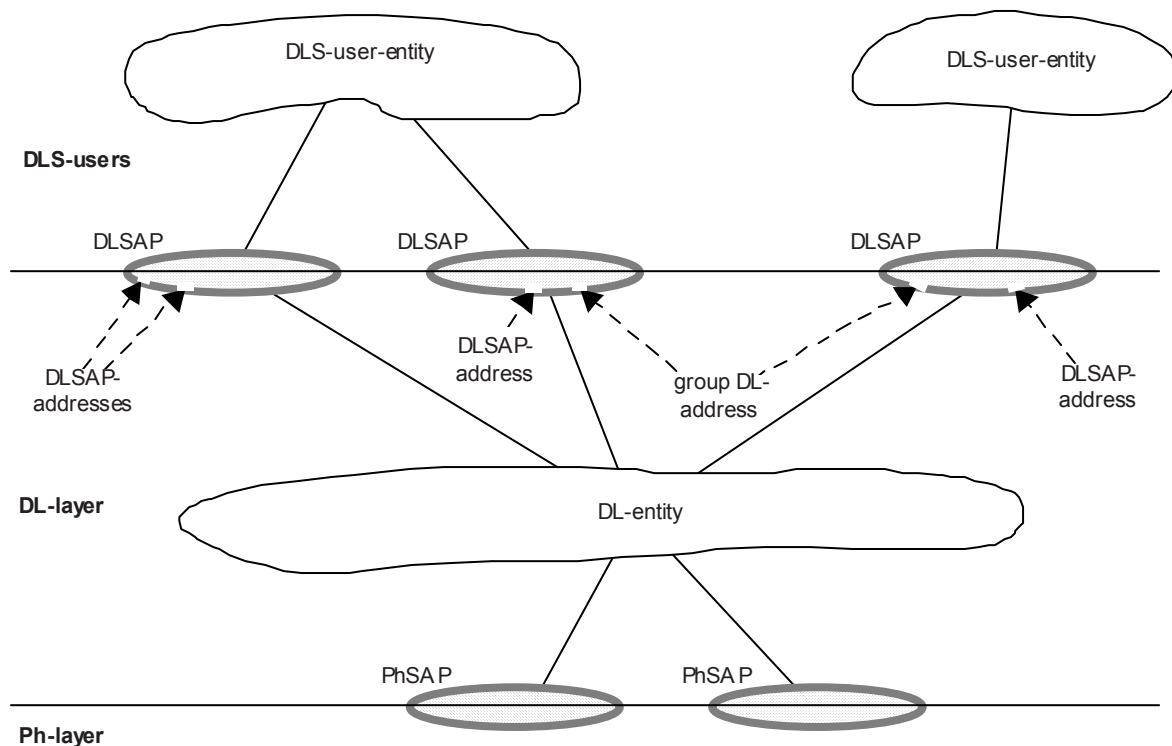
3.3.1 DL-segment, link, local link

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

3.3.2 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. (See Figure 2.)



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 2 – Relationships of DLSAPs, DLSAP-addresses and group DL-addresses

3.3.3 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

3.3.4 (individual) DLSAP-address

DL-address that designates only one DLSAP within the extended link. A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP

3.3.5 extended link

DL-subnetwork, consisting of the maximal set of links interconnected by DL-relays, sharing a single DL-name (DL-address) space, in which any of the connected DL-entities may communicate, one with another, either directly or with the assistance of one or more of those intervening DL-relay entities

NOTE An extended link may be composed of just a single link

3.3.6 frame

denigrated synonym for DLPDU

3.3.7 group DL-address

DL-address that potentially designates more than one DLSAP within the extended link. A single DL-entity may have multiple group DL-addresses associated with a single DLSAP. A single DL-entity also may have a single group DL-address associated with more than one DLSAP

3.3.8 node

single DL-entity as it appears on one local link

3.3.9 receiving DLS-user

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

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

3.3.10 sending DLS-user

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

3.4 Type 1: Additional Data Link Service terms and definitions

NOTE For historic reasons, some of the following definitions are more extensive than is common to the Definition clauses of other IEC standards.

3.4.1 bridge, DL-router

DL-relay entity which performs selective store-and-forward and routing functions.

- a) to connect two or more separate DL-subnetworks (links) to form a unified DL-subnetwork (the extended link); and
- b) to provide a means by which two end systems can communicate, when at least one of the end systems is periodically inattentive to the interconnecting DL-subnetwork,

and also provides time synchronization among the links to which it is forwarding

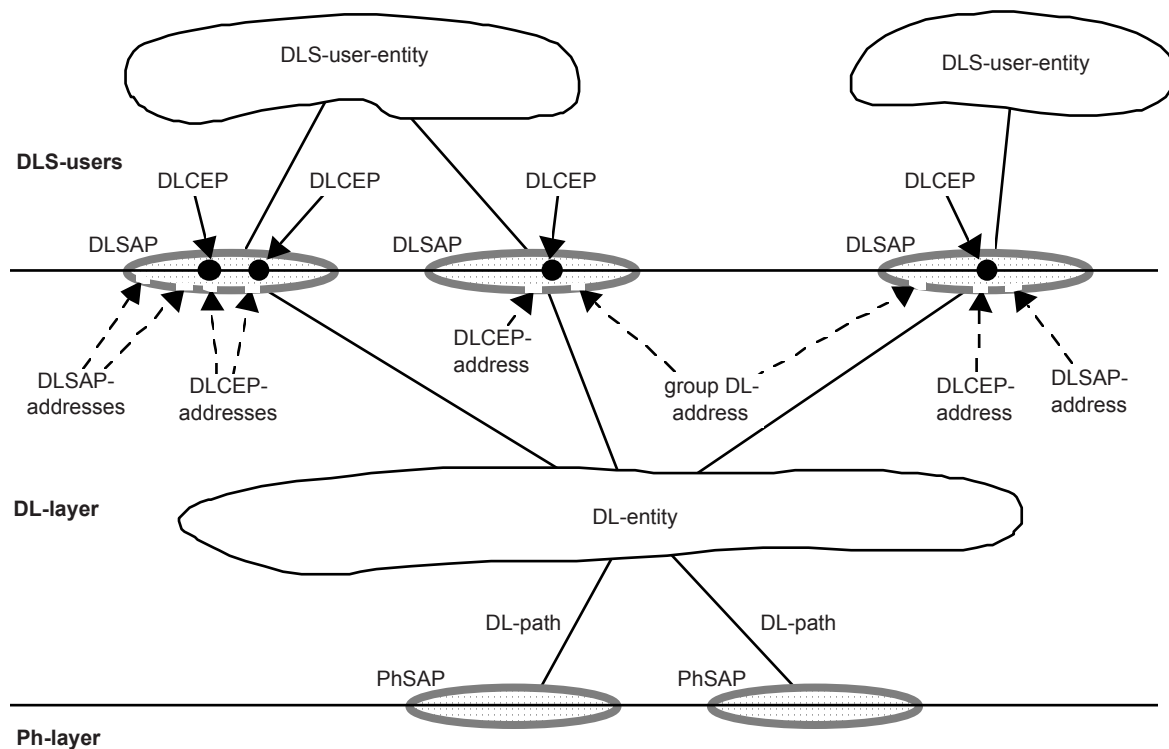
3.4.2 DLCEP-address

DL-address which designates either

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

NOTE This is an extension of the use of DL-addresses beyond that specified in ISO/IEC 7498-3. (See Figure 3.)



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. A DLCEP-address also designates a specific point of information flow (its DLCEP) within the DLSAP.

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

NOTE 4 This figure also shows the relationships of DL-paths and PhSAPs.

Figure 3 – Relationships of DLCEPs and DLCEP-addresses to DLSAPs, DLSAP-addresses and group DL-addresses

3.4.3 DLSEP-address

DL-address which designates a DL-scheduling-end-point within a DLE

NOTE This is an extension of the use of DL-addresses beyond that specified in ISO/IEC 7498-3. (See Figure 3.)

3.4.4 initiator

DLE role in which a DLE sends a DLPDU to a peer responder DLE, which immediately sends a reply DLPDU back to the initiator DLE (and potentially to other DLEs) as part of the same transaction.

NOTE Some prior national standards have referred to this role as a “master” role

3.4.5 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)

NOTE 1 A multi-peer DLC always provides asymmetrical service. It may also be negotiated to provide only DL-simplex service, either from the publisher to the subscribers, or from the subscribers to the publisher. In this last case, the characterizations as publisher and subscriber are misnomers.

NOTE 2 The publishing DLS-user may need to employ control of its publishing rate, because a subscribing DLS-user cannot exert either flow or rate control on its publishing peer entity. Similar considerations apply to subscribing DLS-users with respect to their sending DLSUs to the publishing DLS-user

3.4.6 peer DLC

point-to-point DL-connection offering DL-duplex-transmission between two peer DLS-users where each can be a sending DLS-user, and each as a receiving DLS-user may be able to exert flow control on its sending peer

NOTE A peer DLC is negotiated to provide either symmetrical service or asymmetrical service. A peer DLC may also be negotiated to provide only DL-simplex service

3.4.7 responder

DLE role in which a DLE sends a DLPDU as an immediate reply to a DLPDU received from a peer initiator DLE, all as part of a single transaction

NOTE Some prior national standards have referred to this role as a “slave” role

3.4.8 timeliness, DL-timeliness

attribute of a datum which provides an assessment of the temporal currency of that datum. This attribute is of particular importance in sampled-data systems, which may need to make decisions based on the timeliness, or lack of timeliness, of current data samples.

As a general rule, timeliness is a user attribute which can be affected negatively by the various layers of the data transport system. That is, a datum which was timely when the requesting user presented it to a data communications subsystem for transmission may become untimely due to delays in the communications subsystem.

DL-timeliness is an attribute of a DLS-user datum relating the timing of a DLS-user/DLE interaction which writes or reads that datum to one or more other (earlier) DLS-user/DLE interactions.

NOTE These concepts also support migration from previous national standards

3.4.9 transaction

single DLPDU, or a sequence of two immediately consecutive related DLPDUs, resulting from a single DLS-user request

NOTE 1 The DLE sending the first DLPDU of the transaction is known as the initiator; the DLE which sends the second DLPDU of the transaction, if any, is known as the responder.

NOTE 2 A DL-entity can be both an initiator and a responder in the same transaction.

3.5 Type 2: Additional Data Link Service terms and definitions

3.5.1 application

function or data structure for which data is subscribed or published

3.5.2 behavior

indication of how the object responds to particular events. Its description includes the relationship between attribute values and services

3.5.3 bridge, DL-router

DL-relay entity which performs selective store-and-forward and routing functions to connect two or more separate DL-subnetworks (links) to form a unified DL-subnetwork (the extended link)

3.5.4 cyclic

term used to describe events which repeat in a regular and repetitive manner

3.5.5 device

physical hardware connection to the link

NOTE A device may contain more than one node.

3.5.6 DL-subnetwork

series of nodes connected by PhEs and, where appropriate, DL-routers

3.5.7 DLPDU

Data Link Protocol Data unit

NOTE A DLPDU consists of a source MAC ID, zero or more Lpackets, and an FCS, as transmitted or received by an associated PhE.

3.5.8 error

discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

3.5.9 fixed tag

two octet identifier (tag) which identifies a specific service to be performed by either

- a) that receiving node on the local link which has a specified MAC ID, or
- b) all receiving nodes on the local link.

NOTE Identification of the target node(s) is included in the two octet tag

3.5.10 frame

denigrated synonym for DLPDU

3.5.11 generic tag

three octet identifier (tag) which identifies a specific piece of application information

3.5.12 guardband

time slot allocated for the transmission of the moderator DLPDU

3.5.13 link

collection of nodes with unique MAC IDs. Ph-segments connected by Ph-repeaters make up a link; links connected by DL-routers make up an extended link (sometimes called a local area network)

3.5.14 Lpacket

well-defined sub-portion of a DLPDU containing (among other things)

- a) a fixed tag or a generic tag, and
- b) DLS-user data or, when the tag has DL-significance, DL-data

3.5.15 moderator

the node with the lowest MAC ID that is responsible for transmitting the moderator DLPDU

3.5.16 moderator DLPDU

a DLPDU transmitted by the node with the lowest MAC ID for the purpose of synchronizing the nodes and distributing the link configuration parameters

3.5.17 multipoint DLC

centralized multi-end-point DL-connection offering DL-simplex-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). A multipoint DLC always provides asymmetrical service.

3.5.18 node

logical connection to a local link, requiring a single MAC ID

NOTE A single physical device may appear as many nodes on the same local link. For the purposes of this protocol, each node is considered to be a separate DLE.

3.5.19 peer-to-peer DLC

point-to-point DL-connection offering DL-simplex-transmission between a single distinguished sending DLS-user and a single distinguished receiving DLS-user

NOTE A peer-to-peer DLC always provides asymmetrical service.

3.5.20 rogue

a node that has received a moderator DLPDU that disagrees with the link configuration currently held by this node

3.5.21 scheduled

data transfers that occur in a deterministic and repeatable manner on predefined NUTs.

3.5.22 tMinus

the number of NUTs before a new set of link configuration parameters are to be used

3.5.23 tone

the instant of time which marks the boundary between two NUTs

3.5.24 unscheduled

data transfers that use the remaining allocated time in the NUT after the scheduled transfers have been completed

3.6 Type 3: Additional Data Link Service terms and definitions**3.6.1 acknowledgement DLPDU**

reply DLPDU that contains no DLSDU

3.6.2 bit time

time to transmit one bit

3.6.3 clock synchronization

represents a sequence of interactions to synchronize the clocks of all time receivers by a time master

3.6.4 controller_type

hardware class of the communications entity

3.6.5 data DLPDU

DLPDU that carries a DLSDU from a local DLS-user to a remote DLS-user

3.6.6 DL_status, DLM_status

status that specifies the result of the execution of the associated request

3.6.7 GAP

range of station (DLE) DL-addresses from this station (TS) to its successor (NS) in the logical token ring, excluding stations above HSA

3.6.8 isochronous mode

constant cycle of messages from a time master for synchronization of other stations

3.6.9 local DLE

DLE in a current master station that initiates the current transaction

3.6.10 local DLS-user

DLS-user that initiates the current service

3.6.11 publisher

transmitter of messages for consumption by subscribers

3.6.12 region/segment address

address extension that identifies a particular fieldbus subnetwork

3.6.13 remote DLE

addressed DLE of a service request (that is, the intended receiving DLE of any resulting request DLPDU)

3.6.14 remote DLS-user

addressed DLS-user of a service request (that is, the intended receiver of any resulting indication primitive)

3.6.15 reply DLPDU

DLPDU transmitted from a remote DLE to the initiating (local) DLE, and possibly other DLEs

NOTE When the remote DLE is a Publisher, the reply DLPDU also can be sent to several remote DLEs.

3.6.16 request DLPDU

DLPDU that carries either a request for data or a DLSDU or both from a local DLS-user to a remote DLS-user

3.6.17 response DLPDU

reply DLPDU that carries a DLSDU from a remote DLS-user to local DLS-user

3.6.18 station

master or slave device containing a DLE

3.6.19 subscriber

receiver of messages produced by a publisher

3.6.20 time event

message that represents a trigger for a moment of time

3.6.21 time master

device which is able to send clock synchronization messages

3.6.22 time receiver

fieldbus device able to be time synchronized by a time master

3.6.23 token passing

medium access method, in which the right to transmit is passed from master station to master station in a logical ring

3.7 Type 4: Additional Data Link Service terms and definitions

3.7.1 broadcast-node-address

used to send broadcasts to all DLEs on a Link

NOTE 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

3.7.2 destination-DL-route

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

NOTE This includes both the destination DLSAP and a local component meaningful to the destination DLS-user.

3.7.3 DL-route-element

an octet, holding a Node DL-address or an address used by the DLS-user

3.7.4 DLS-user address

uniquely identifies a DLS-user locally

3.7.5 full DL-route

the combination of a destination-DL-route and a source-DL-route

3.7.6 maximum indication delay

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 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.

3.7.7 maximum retry time

indicates to the DLE for how long time retransmission of the request may be performed, as a result of Wait acknowledges from the remote DLE or DLS-user

3.7.8 no-confirm-node-address

indicates that a request or response is Unconfirmed

NOTE The value of the No-Confirm-Node-address is 0

3.7.9 node-address

uniquely identifies a DLE on a Link

NOTE The value of a Node-address can be in the range of 0-127. The values 0, 126 and 127 are reserved for special purposes

3.7.10 normal class device

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

NOTE Such a device can act as a server (responder) and as a client (requestor) – this is also called a peer.

3.7.11 service-node-address

an address reserved for service purposes only

NOTE 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 their receipt may or may not be acknowledged. The Service-Node-Address can be used on Links with only two DLEs — the requesting Normal class DLE and the responding Simple or Normal class DLE. The value of the Service-Node-Address is 127.

3.7.12 simple class device

device which replies to requests from normal class devices

NOTE Such a device can act as a server or responder only

3.7.13 source-DL-route

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

3.8 Type 6: Additional Data Link Service terms and definitions

3.8.1 Additional definitions related to IEEE Std 1451.2

3.8.1.1 TEDS

Transducer Electronic Data Sheet. Non-volatile memory that stores the configuration of a smart field device

3.8.1.2 transducer

sensor or an actuator

3.8.1.3 trigger

signal from a smart NCAP that can trigger synchronized internal or external actions, on the local or extended link

3.8.2 Variations on the common definitions of 3.1 through 3.4

3.8.2.1 bridge, DL-relay

DL-relay entity which performs synchronization between links (buses) and may perform selective store-and-forward and routing functions to connect two or more separate DL-subnetworks (links) to form a unified DL-subnetwork (the extended link)

3.8.2.2 DLCEP-address

see 3.4.2

3.8.2.3 peer DLC, GP channel

point-to-point DL-connection offering DL-duplex-transmission between two peer DLS-users where each can be a Calling DLS-user and each can be a Called DLS-user

NOTE A peer DLC is configured to provide either Confirmed or Acknowledged service

3.8.2.4 multi-peer DLC

multi-end-point DL-connection offering DL-simplex-transmission between a single distinguished DLS-user, known as the **publisher** or **publishing** DLS-user, and a set of one or more peer distinguished 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)

NOTE A multi-peer DLC always provides DL-simplex service, from the publisher to the subscribers.

3.8.2.5 master DLCEP

peer DLCEP which controls the direction of data transfers on a GPC channel

3.8.2.6 slave DLCEP

peer DLCEP which may only initiate data transfers on a GPC channel when authorized by the Master peer DLCEP

3.8.3 Additional definitions

3.8.3.1 1WAY method:

channel which can only support a one-way flow of data

3.8.3.2 2WAY method

channel which can support a two-way flow of data

3.8.3.3 active nodes and channels

nodes and channels that are able to communicate on the local link

NOTE Active nodes have No-Comm-Node equal 0. Active channels have No-Comm-Node and No-Comm-Channel both equal 0

3.8.3.4 aliasing

any difference between the Time Stamps placed on a Event by two different DLEs

3.8.3.5 assembly (reassembly)

process of combining separate grains in the proper order to recreate a DLSDU as it was presented at the remote sending DLS

3.8.3.6 LBL (Log-Bus-Length)

base-2 logarithm of the number of slots in one Bus-cycle

3.8.3.7 BL $\neq$ BSS

referenced parameter can take on all values from 0 up to Bus Length, but excluding all Bus-Sync-slot numbers

3.8.3.8 bogus node

DLE found by the Conductor during startup that is not listed on the Node List

3.8.3.9 buffer-queue

memory area used for communicating DLS-user-data between the DLS-user and DLE in a local node for one direction of a channel, which may take the form of either a buffer or a FIFO (first-in first-out) limited-depth queue

3.8.3.10 bus-config

dynamic set of values that determine the timing of the bus in one installation

3.8.3.11 bus-configuration

dynamic set of values of Bus-Config, node, channel, trigger and forwarding-entity parameters that applies to one installation

3.8.3.12 bus-cycle

uniform progression of slots from 0 to the Bus-Cycle-Length

NOTE Each DLE maintains a sense of the current slot (a counter), which it uses to synchronize all Real-time actions.

3.8.3.13 bus-cycle-length

number of slots in a Bus-Cycle

NOTE It is always equal a power of 2 equal to $2^{L_{BL}}$. It's value is a configuration issue.

3.8.3.14 bus-end-sync-slot

last or "cycle-closing" slot of a bus cycle

NOTE The Conductor uses it to synchronize the bus cycle counter of all other active DLEs with the Conductor's own bus cycle.

3.8.3.15 bus-sync-period

number of slots between bus sync slots

3.8.3.16 bus-sync-slot

variable duration slot used by the Conductor to fine tune synchronization of the slot clocks of all other active DLEs with the Conductor's slot-clock

NOTE The first Bus-Sync-slot is at Bus-Sync-Period slots.

3.8.3.17 bus-time

common sense of communications system time that is shared by all DLEs on the extended link

3.8.3.18 called DLS-user

higher-layer entity that accepts the transfer of DLS-User-Data

3.8.3.19 calling DLS user

higher-layer entity that initiates the transfer of DLS-User-Data

3.8.3.20 CD-semaphore

interlocked signaling mechanism that controls which DLS-user can transmit next on a GPC channel, that is, which specifies the Channel Direction

3.8.3.21 channel (DLC)

set of equally spaced slots per Bus-Cycle that conveys either:

- a) measurements or control signals that can be received by one or more DLS-users using the SCAN or EXSCAN channel classes, or
- b) interactions between two specific DLS-users using the GPC or GPA channel classes, or
- c) messages between DLMS-users using the DLM-connectionless service

3.8.3.22 channel method (QoS building block)

attribute that determines one aspect of the fundamental operation of a channel. It applies to all the slots of one channel on a local or extended link

3.8.3.23 channel direction method

determines the allowed direction(s) of data flow on the channel

3.8.3.24 channel class

collection of channel-methods that together define the total operation and QoS of a channel

3.8.3.25 channel selector

identifies any slot during which data for a particular channel is or should be present on the local link

3.8.3.26 conductor

the DLE that is synchronizing all traffic on a bus, and which may also configure all DLEs and channels on that bus

NOTE The Conductor does not schedule traffic as does a Type 1 Link Active Scheduler (LAS).

3.8.3.27 configuration database

contains the configured values of the DLE parameters for each DLE channel, trigger and half-forwarding-port for one usage (experiment/batch/process) of the bus

3.8.3.28 configured nodes

DLEs that have been successfully configured per the Node List

3.8.3.29 conformance-class

fixed set values of parameters that are defined as an integrated set and which apply to multiple installations

3.8.3.30 data

generic term used to refer to any information carried over a fieldbus

3.8.3.31 data field

atomic DLSDU carried by the UNITARY method

3.8.3.32 data-packaging method

attribute that determines whether DLSDUs sent on the channel will be granulated or not

3.8.3.33 destination DLSAP

DLSAP that accepts the transfer of a message using the DLM-connectionless method

3.8.3.34 DL-buffer identifier

local identifier for the data passed in a buffer by the associated primitive, shared by the DLS provider and DLS-user

3.8.3.35 DL-Event-time

time at which an Event occurred, as calculated by the Conductor

3.8.3.36 DL-queue identifier

local identifier for the data passed in a queue by the associated primitive, shared by the DLS provider and DLS-user, or by the DLMS provider and DLMS-user

3.8.3.37 DLC-identifier, channel-ID

Identifier for one Channel (DLC) from within all Channels on a local link

NOTE The value of the Channel-ID is equal to the relative index of the first slot (after the Bus-cycle-End slot) assigned to this channel.

3.8.3.38 DLM-connectionless service

service used for bus configuration with less integrity than GPC or GPA connection mode services, in which the DLS does not relate any DLM-connectionless DLPDU to any other DLPDU or make any retry attempt on detection of an error

3.8.3.39 DLMS-user

user of the DL-Management service, generally, of the DLM bus configuration service

3.8.3.40 DLMSDU

service data unit sent or received by a DLMS-user, generally, with structure and content specified by this standard

3.8.3.41 DLSDU-length

length in octets of an item of DLS-user-data

3.8.3.42 forwarding-bridge-DLE

DLE that synchronizes the bus cycles and slot clocks for two or more connected local links, and which can be configured to forward DLSDUs among the connected links

3.8.3.43 general purpose acknowledged (GPA) class

Provides reliable communications for higher layer protocols that depend on classical one-way DL-data-delivery.

3.8.3.44 general purpose confirmed (GPC) class

channel which provides reliable communications for higher layer protocols that depend on classical one-way DL-data-delivery

3.8.3.45 grain: (partial DLSDU)

channel which provides reliable communications for higher layer protocols that depend on classical two-way DL-data-delivery

3.8.3.46 GRANULAR channel

channel which can perform Granulation and Assembly.

3.8.3.47 GRANULAR method

channel on which each DLSDU is transferred in one or more Grains.

NOTE When the Calling DLS-user on a GRANULAR channel submits DLSDUs longer than the data "payload" of the DLPDUs now in use on this bus (that is, the DLSDU-length exceeds the configured max-data-length of the bus), the DLE **granulates** (segments) each DLSDU into multiple DLPDUs. Each grain carries a one octet header that allows reconstruction by the called DLE of the original submitted DLSDU. The receiving DLE assembles the grains and validates the DLSDU before delivery to the Called DLS-user..

3.8.3.48 granulation (segmentation)

see 3.8.3.47

3.8.3.49 HLP (higher level protocol)

a DLS-user protocol

3.8.3.50 HLP-PDU

protocol information conveyed by the DLE between two or more communicating DLS-users which are using the same HLP

3.8.3.51 host

DLE that can become a Conductor and synchronize operation of a bus, and which may source and/or sink “data” on a local or extended link

3.8.3.52 I/O channel

hardware interface to a “real world” transducer

NOTE This concept maps directly onto the “data transfer” channels of the protocol.

3.8.3.53 local link

single bus with a single Conductor

3.8.3.54 low order part of a data item

least significant (written as rightmost) octets/bits of the item

3.8.3.55 max-data-length

maximum length of the data field of any DLPDU which may be transmitted on an extended link

NOTE max-data-length is an element of Bus-Config

3.8.3.56 max-DLSDU-buffer-size

maximum buffer size for the conformance-class in use on this Bus

3.8.3.57 max-DLSDU-length

maximum buffer size for the conformance-class in use on a bus

3.8.3.58 max-DLE-group-address

maximum number of Group DLE addresses per local link

3.8.3.59 max-net-level

maximum depth of the nest of real links

3.8.3.60 max-time-stamp

maximum number of time-stamp buffers and messages that can be present in one DLSAP

3.8.3.61 max-trigger

maximum number of triggers that can be present in one DLSAP

3.8.3.62 message

single event or upper level protocol triggered transmission of a DLSDU

3.8.3.63 missing node

node that is listed on the Node-List that can NOT communicate on this local link

3.8.3.64 net-ID, link-address

hierarchical identification of the subnetwork on which a DLE resides in the real network topology, identifying the local link as seen from the TOP level (L0) of the extended link looking DOWN, used by DLM-connectionless services

3.8.3.65 node

generic term for the DLE, sometimes also including its associated DLS- or DLMS-user

3.8.3.66 node-list

list that contains the bus configuration information for each node, channel, half-forwarding-port and trigger which should be active on the local link

3.8.3.67 non-retentive buffer (queue of depth one)

buffer (equivalently, a queue of depth one) for which DLSDU (or DLMSDU) presence is cleared immediately after the contained DLS-user-data has been transmitted by the DLE or read by the DLS-user (or DLMS-user)

3.8.3.68 num-time-stamp

number of time-stamp-buffers present in a DLSAP

3.8.3.69 offset slot, channel-ID

starting slot number for designating a specified channel

3.8.3.70 parameter set by DL-Management

a parameter specified by the Profile currently in use or by the Bus-Configuration process

3.8.3.71 protocol Information field

either the DLPDU field (in Transfer DLPDUs) or Bus-PDU field (in Bus-Sync DLPDUs)

3.8.3.72 publisher DLSAP

DLCEP that attempts to transmit a DLPDU in each slot assigned to a specific channel on a multi-peer DLC

3.8.3.73 QoS-set

selector that identifies, for one DLCEP, a specific set of QoS options selected from those specified for the conformance-class in use, thereby implicitly restricting the set of DLCEPs that can support a specific DLS-user in a matching role, that is, those DLCEPs that can participate in a specified DLS-user protocol

3.8.3.74 retentive-buffer

buffer for which transmission or reading of the DLSDU does not cause the DLE to empty the buffer, where the sending DLS-user clears the buffer by writing to it and the receiving DLE overwrites the value in the buffer when it receives a new DLSDU

3.8.3.75 scan-rate

number of slots per second assigned to a channel

3.8.3.76 slot

basic unit of time allocation on a bus

3.8.3.77 source DLSAP

DLSAP that initiates the transfer of a message using the DLM-connectionless method

3.8.3.78 subscriber DLCEP

DLCEP that attempts to receive the DLPDUs present in the slots assigned to a specific channel on a multi-peer DLC

3.8.3.79 system

extended link with all of its attached DLEs

3.8.3.80 system manager

agent which sets up the system configuration in the node list and monitors configuration and operation of the system

3.8.3.81 synchronizer-DLE

synchronizes the Bus-Cycles and Slot-Clocks between 2 or more local links, but does not support data transfers between local links

3.8.3.82 time stamp

attribute of a datum which provides the bus time at which the underlying event was detected by the submitting DLS-user

3.8.3.83 time-stamping of Events

recording a time-stamp concurrent with an external signal and appending the recorded time-stamp to a later transmitted Event message

NOTE The time stamp appended to the message may be approximately concurrent with the time the relevant Event occurred, even if the Event message is transmitted much later.

3.8.3.84 transmission Delay

any unwanted delay in transmitting transducer readings

3.8.3.85 transparent data conveyance

guarantee that for each DLPDU transmitted, the called DLS-user receives either an error indication or exactly the "data" submitted by the calling DLS-user

3.8.3.86 UNITARY Method:

channel on which a complete DLSDU is always transferred in a single Transfer DLPDU.

3.8.3.87 VID (of a DLE)

externally visible identification of a DLE and its contained objects, identical to the DLE's DLEA and used by DLM-connectionless services

3.8.3.88 virtual topology

connection mode topology assigned by the Bus-configuration DLMS-user, which need not map directly to physical topology.

3.9 Type 7: Additional Data Link Service terms and definitions**3.9.1 acknowledgement response DLPDU**

information that the recipient of an acknowledged message emits in order to signal either the proper reception of the message or the lack of available resources to store the message, received by the DLE on the local link that emitted the message which requested the acknowledgement

3.9.2 basic cycle

sequence of scanning by the Bus Arbitrator of:

- a) a set of DLCEP-identifiers for variables, requests, and cyclical application messages,
- b) plus a window provided for aperiodic exchanges,
- c) plus a window provided for message services,
- d) plus a window provided for synchronization

3.9.3 basic transaction

succession of DLPDUs related to a single DL-service instance

3.9.4 bus arbitrator (BA)

DLE that controls each data producer's right to access the medium

NOTE At any given instant one and only one Bus Arbitrator is active in each DL-segment of a DL-subnetwork.

3.9.5 control field

portion of an emitted or received DLPDU that gives the nature of the data exchanged and the type of exchange

3.9.6 destination address

three octets specifying the DL-segment of the DLE to whom the message is sent, and the destination DLSAP's sub-address within the local link

3.9.7 DL-segment, local link

set of devices that respect the DL-protocol and that are interconnected through a PhL. Only one Bus Arbitrator is active on a single DL-segment

3.9.8 DLCEP-identifier

two octets specifying a link-local DLCEP-identifier associated with a system variable. A DLCEP-identifier uniquely designates a single DL-accessible variable within the local link

3.9.9 DLCEP-identifier DLPDU

information that a Bus Arbitrator emits to allocate the local link to a data publisher for the purpose of exchanging a variable

3.9.10 end of message transaction indication DLPDU

information that the source entity of a message emits in order to return link access control to the Bus Arbitrator at the end of a message transaction

3.9.11 identified variable (or simply "variable")

DLL system variable for which an associated DLCEP-identifier has been defined

3.9.12 invalid DLCEP-identifier

a DLCEP-identifier not recognized locally

3.9.13 macrocycle

set of basic cycles needed for all cyclical DLCEP-identifiers to be scanned

3.9.14 message DLPDU identifier

information that a Bus Arbitrator emits to allocate the medium to a source DLE for a message transfer

3.9.15 message response DLPDU

information that a data publisher emits in response to a message identifier DLPDU. This information is received and retained by the desired destination entity or entities

3.9.16 periodic scanning of variables

action by the Bus Arbitrator that guarantees the cyclical exchange of variables

NOTE This is the basic principle of the Type 7 DL-service and protocol.

3.9.17 published identified variable

variable that corresponds to a DLCEP-identifier for which the DLE emits data

3.9.18 request DLPDU identifier

the information that a Bus Arbitrator emits to allocate the medium to the initiator of an explicit request for a buffer transfer

3.9.19 request response DLPDU

the information that the initiator of an explicit request for a buffer transfer emits in response to a request identifier DLPDU. This information is received by the Bus Arbitrator

3.9.20 source address

three octets specifying the local link-id of the entity sending the message, and the source DLSAP's sub-address within the local link

3.9.21 subscribed identified variable

variable that corresponds to a DLCEP-identifier for which the DLE receives data

3.9.22 triggered message scanning

function of a Bus Arbitrator that makes it possible to transfer messages

3.9.23 triggered periodic scanning of messages

function of a Bus Arbitrator that makes it possible to request triggered message exchanges cyclically

3.9.24 triggered periodic scanning of variables

function of a Bus Arbitrator that makes it possible to request triggered variable transfers cyclically

3.9.25 triggered scanning of variables

function of a Bus Arbitrator that makes possible the non-cyclical exchange of variables

3.9.26 turnaround time

time interval between reception or emission of the last MAC symbol of a DLPDU, signaled by a SILENCE indication from the PhL, and the reception or emission of the first MAC symbol of the subsequent DLPDU, signaled by an ACTIVITY indication from the PhL, both as measured in a given station

3.9.27 variable response DLPDU

information that a data producer emits in response to a DLCEP-identifier DLPDU, which also alerts data consumers to the relevance of the immediately time-proximate DLPDU.

3.10 Type 8: Additional Data Link Service terms and definitions

3.10.1 device

slave or master

3.10.2 device code

two octets which characterize the properties of a slave

3.10.3 DL-segment

group of slaves in consecutive order

3.10.4 DL-segment level

nesting level number of a DL-segment

3.10.5 master

DL-entity controlling the data transfer on the local link and initiating the medium access of the slaves by starting the DLPDU cycle

3.10.6 slave

DL-entity accessing the medium only after being initiated by the preceding slave or master

4 Symbols and abbreviations

4.1 Common 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.

4.1.1	DL-	Data Link layer (as a prefix)
4.1.2	DLC	DL-connection
4.1.3	DLCEP	DL-connection-end-point
4.1.4	DLE	DL-entity (the local active instance of the Data Link layer)
4.1.5	DLL	DL-layer
4.1.6	DLPCI	DL-protocol-control-information
4.1.7	DLPDU	DL-protocol-data-unit
4.1.8	DLM	DL-management
4.1.9	DLME	DL-management Entity (the local active instance of DL-management)
4.1.10	DLMS	DL-management Service
4.1.11	DLS	DL-service
4.1.12	DLSAP	DL-service-access-point
4.1.13	DLSDU	DL-service-data-unit
4.1.14	FIFO	First-in first-out (queuing method)
4.1.15	OSI	Open systems interconnection
4.1.16	Ph-	Physical layer (as a prefix)
4.1.17	PhE	Ph-entity (the local active instance of the Physical layer)
4.1.18	PhL	Ph-layer
4.1.19	QoS	Quality of service

4.2 Type 1: Additional symbols and abbreviations

4.2.1	DLSEP	DL-schedule-end-point
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4.3 Type 2: Additional symbols and abbreviations

4.3.1	MAC ID	the DL-address of a node
4.3.2	MDS	medium dependent sublayer
4.3.3	NUT	network (actually, local link) update time

NOTE The use of the term “network” in the preceding definition is maintained for historic reasons, even though the scope involved is only a portion of a single DL-subnetwork.

4.3.4	SMAX	MAC ID of the maximum scheduled node
4.3.5	Tx	transmit
4.3.6	TUI	table unique identifier
4.3.7	UCMM	unconnected message manager
4.3.8	UMAX	MAC ID of maximum unscheduled node
4.3.9	USR	unscheduled start register

4.4 Type 3: Additional symbols and abbreviations

4.4.1	ACK	Acknowledge(ment) DLPDU
4.4.2	cnf	confirm primitive
4.4.3	CS	DLS: Clock Synchronization
4.4.4	DA	Destination address of a DLPDU
4.4.5	DAE	Destination address extension(s) of a DLPDU – conveys D_SAP_index or destination Region/Segment address or both
4.4.6	DS	DL/DLM_status: Disconnected station – local DL-entity not in logical token ring or disconnected from line
4.4.7	D_SAP	Destination-service-access-point – a DLSAP which identifies the remote DLS-user.
4.4.8	D_SAP_index	Destination-service-access-point – that component of a DLSAP-address which designates a DLSAP and remote DLS-user within the remote DLE
4.4.9	DXM	Data exchange Multicast
4.4.10	EXT	Address extension bit of a DLPDU
4.4.11	FC	frame control (DLPDU type) field of a DLPDU
4.4.12	G	GAP update factor – the number of token cycles between GAP maintenance (update) cycles
4.4.13	HSA	Highest station address installed (configured) on this fieldbus
4.4.14	ind	indication primitive
4.4.15	IoM	Isochronous Mode
4.4.16	LMS	List of Master stations
4.4.17	LR	DL/DLM_status: Local resource not available or not sufficient
4.4.18	LS	DL/DLM_status: Local service not activated at DLSAP or local DLSAP not activated
4.4.19	MSRD	DLS: Send and Request Data with Multicast Reply

4.4.20	NA	DL/DLM_status: No acknowledgement/response (DL/DLM_status of the service primitive)
4.4.21	NIL	locally existing value, but not fixed by IEC 61158-3
4.4.22	NO	DL/DLM_status: Not ok
4.4.23	NR	DL/DLM_status: No response – DL/DLM-data acknowledgement negative and send data ok
4.4.24	NS	Next station, the station to which this Master will pass the token
4.4.25	OK	DL/DLM_status: Service finished according to the rules
4.4.26	RDH	DL/DLM_status: Response DL-data high and no resource for send data
4.4.27	RDL	DL/DLM_status: Response DL/DLM-data low and no resource for send data
4.4.28	req	request primitive
4.4.29	RR	DL/DLM_status: No resource for send data and no response DL-data available (acknowledgement negative) (DL/DLM_status of the service primitive)
4.4.30	RS	DL/DLM_status: No service or no remote address activated at remote-service-access-point (acknowledgement negative) (DL/DLM_status of the service primitive)
4.4.31	SA	Source address of a DLPDU
4.4.32	SAE	Source address extension(s) of a DLPDU – conveys S_SAP_index or source Region/Segment address or both
4.4.33	SC	Single character acknowledge DLPDU
4.4.34	SDA	DLS: Send Data with Acknowledge
4.4.35	SDN	DLS: Send Data with no Acknowledge
4.4.36	SRD	DLS: Send and Request Data with Reply
4.4.37	S_SAP	Source-service-access-point – a DLSAP which identifies the local DLS-user which initiates a transaction.
4.4.38	S_SAP_index	Source-service-access-point index – a component of a DLSAP-address which designates that DLSAP within the DLE at which the transaction is being initiated
4.4.39	SYN	Synchronizing bits of a DLPDU (period of IDLE) – it guarantees the specified DLPDU integrity and facilitates receiver synchronization
4.4.40	SYNCHT	Synchronization telegram, indicates the start of a new cycle in IoM
4.4.41	t_{BIT}	Bit time, DL-symbol period – the time to transmit one bit on the fieldbus ; 1/(data signaling rate in bit/s)
4.4.42	T_{CT}	Cycle Time - the requested duration for one cycle in IoM
4.4.43	T_{QUI}	Quiet time, transmitter fall time (line state uncertain time) or repeater switch time or both – the time a transmitting station needs to wait after the end of a DLPDU before enabling its receiver

4.4.44	T_{RDY}	Ready time – the time after which the transmitting master will expect a reply DLPDU
4.4.45	T_{RR}	Real rotation time – the time between the last successive receptions of the token by the observing master station
4.4.46	T_S	This station
4.4.47	T_{SDI}	Station delay of initiator – the time a master station will wait before sending successive DLPDUs
4.4.48	T_{SDR}	Station delay of responder – the actual time a responder needs to generate a reply DLPDU
4.4.49	T_{SET}	Setup time – the time between an event (for example interrupt SYN timer expired) and the necessary reaction (for example enabling a receiver)
4.4.50	T_{SH}	Time shift – the time a real isochronous cycle deviates from the requested duration for one cycle in IoM
4.4.51	T_{SL}	Slot time – the maximum time a master station waits for a reply DLPDU
4.4.52	T_{SYN}	Synchronization time – the period of IDLE before the beginning of a DLPDU after which a station enables its receiver; the required minimum inter-DLPDU idle period to guarantee DLPDU integrity and a valid DLPDU
4.4.53	T_{SYNI}	Synchronization interval time – the maximum time that a receiving station waits for the required inter-DLPDU idle period, of duration T _{SYN} , to occur before it detects a bus fault
4.4.54	T_{TR}	Target rotation time – the anticipated time for one token cycle, including allowances for high and low priority transactions, errors and GAP maintenance
4.4.55	UE	DL/DLM_status: negative acknowledgement – remote user interface error

4.5 Type 4: Additional symbols and abbreviations

none

4.6 Type 6: Additional symbols and abbreviations

4.6.1	64K	$2^{16} = 65\,536$
4.6.2	B or Q	Buffer or Queue
4.6.3	CEP_sel	a DLCEP selector within a DLE
4.6.4	ConfigDB	Configuration Data base
4.6.5	DLC	DL-connection, also, a Channel–
4.6.6	DLEA	The symbol for a DLE-address
4.6.7	SAP_sel	a DLSAP selector
4.6.8	TDMA	Time Division Multiple Access

4.7 Type 7: Additional symbols and abbreviations

4.7.1	BA	Bus Arbitrator
4.7.2	B_Dat_Cons	Buffer which contains the value of the subscribed data
4.7.3	B_Dat_Prod	Buffer which contains the value of the published data
4.7.4	B_Req1/2	Buffer containing the list of DL-identifiers that are the object of a specified explicit request for a transfer at the priority 1 (urgent) or 2 (normal)
4.7.5	RQ_Inhibit	Indicator used to manage explicit requests for buffer transfers
4.7.6	Q_IDRQ1/2	Queue for the DL-identifiers requested, received by the BA at priority 1 (urgent) or 2 (normal)
4.7.7	Q_Msg_Aper	Queue which contains messages to be emitted that are associated with aperiodic exchanges
4.7.8	Q_Msg_Cyc	Queue which contains messages to be emitted that are associated with cyclical exchanges
4.7.9	Q_Req1/2	Queue containing the list of DL-identifiers that are the object of a free explicit request for a transfer at the priority 1 (urgent) or 2 (normal)

4.8 Type 8: Additional symbols and abbreviations

none

5 Conventions

5.1 General conventions

This part of IEC 61158 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.

5.1.1 Parameters

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 part of IEC 61158 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 part of IEC 61158. 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 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.

5.2 Type 1: Additional conventions

5.2.1 Parameters

The parameter conventions of 5.1.1 are extended as follows:

The code used to specify the type of usage of the parameter on the primitive and parameter direction specified in the column is extended to include:

- CU** — parameter is a conditional User option, and may or may not be permitted depending upon other parameters or upon the environment of the DLS-user. When permitted, it may or may not be provided depending on the dynamic usage of the DLS-user. When permitted and not provided, a default value for the parameter is assumed.

The parameter-specific constraints are extended to include:

- ($\leq$) indicates that the set of parameter values has an implicit order and that the parameter's value is less than or equal to that of the parameter in the service primitive to its immediate left in the table (that is, left by one or two columns).
- ($\geq$) indicates that the set of parameter values has an implicit order and that the parameter's value is greater than or equal to that of the parameter in the service primitive to its immediate left in the table (that is, left by one or two columns).

5.2.2 Identifiers

Many of the DLS primitives specify one or more identifier parameters that are drawn from either a local DL-identifier space or a local DLS-user-identifier space. The existence and use of such identifiers in an implementation of the services specified in this part of IEC 61158 is a purely local issue. Nevertheless, these identifiers are specified explicitly in these primitives to provide a descriptive means

- a) of canceling (aborting) an outstanding request primitive before receiving its corresponding confirm primitive;
- b) for referring within a request or response primitive to persistent DL-objects, such as buffers and queues, which were created as the result of a previous DLS primitive; and
- c) for referring within an indication or confirm primitive to persistent DL-objects which were created as the result of a previous DLS primitive.

Adherence to the OSI principle of architectural layering necessitates the presumption of distinct non-intersecting identifier spaces for the DLS-provider and each separate DLS-user, because they may have non-overlapping local views. Consequently, DLS-user identifiers are required for a) and b); while DL-identifiers are required for c).

5.3 Type 2: Additional conventions

none

5.4 Type 3: 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 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 5.1, is used in the figures.

req request primitive

ind	indication primitive
cnf	confirm primitive (confirmation)

5.5 Type 4: Additional conventions

none

5.6 Type 6: Additional conventions

5.6.1 Parameters

The parameter conventions of 5.1.1 are extended to include all of those of 5.2.1. Additionally, the code used to specify the type of usage of the parameter on the primitive and parameter direction specified in the column is extended to include:

- | | | |
|----------|---|---|
| X | — | availability of the parameter is determined by DL-configuration conditions imposed by the Bus Configuration DLS-user. |
|----------|---|---|

5.6.2 Identifiers

These are identical to the identifiers described in 5.2.2.

5.7 Type 7: Additional conventions

The diagrams used to describe the sequence of primitives are composed of:

- a) Vertical lines, representing the User-DLL interface,
- b) Lines with arrows representing the time sequence of the primitives at the interface
- c) Dotted lines, defining the relationships between the primitives. When no dotted lines exist, the action is local. Two types of dotted lines are used:
 - 1) Long, crossing the service provider area to reach the remote user, defining a direct action on the remote entity
 - 2) Short, beginning or ending at the middle of the service provider area. This defines an action to or from the Bus Arbitrator.

5.8 Type 8: Additional conventions

none