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Industrial communication networks – Fieldbus specifications – Part 3-25: Data-link layer service definition – Type 25 elements

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IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

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Part 3-25: Data-link layer service definition – Type 25 elements

FOREWORD

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International Standard IEC 61158-3-25 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation.

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

FDIS	Report on voting
65C/945/FDIS	65C/954/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

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

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

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- withdrawn,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

A bilingual version of this publication may be issued at a later date.

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 3-25: Data-link layer service definition – Type 25 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 International Standard defines in an abstract way the externally visible service provided by the Type 25 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 document is to define the services provided to

- the Type 25 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 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 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 fulfils the Type 25 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 IEC 61784-1 and IEC 61784-2 are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

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

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

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

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

IEEE Std 802.1Q, *IEEE Standard for Local and metropolitan area networks – Bridges and Bridged Networks;* available at http://www.ieee.org [viewed 2018-09-17]

3 Terms, definitions, symbols, abbreviations and conventions

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

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

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

3.1 Reference model terms and definitions

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

3.1.1 DL-address [ISO/IEC 7498-3]

3.1.2 DL-address-mapping [ISO/IEC 7498-1]

3.1.3 called-DL-address [ISO/IEC 7498-3]

3.1.4 calling-DL-address [ISO/IEC 7498-3]

3.1.5 centralized multi-end-point-connection [ISO/IEC 7498-1]

3.1.6 DL-connection [ISO/IEC 7498-1]

3.1.7 DL-connection-end-point [ISO/IEC 7498-1]

3.1.8 DL-connection-end-point-identifier [ISO/IEC 7498-1]

3.1.9 DL-connection-mode transmission [ISO/IEC 7498-1]

3.1.10 DL-connectionless-mode transmission [ISO/IEC 7498-1]

3.1.11 correspondent (N)-entities
correspondent DL-entities (N=2)
correspondent Ph-entities (N=1) [ISO/IEC 7498-1]

3.1.12 DL-duplex-transmission [ISO/IEC 7498-1]

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

3.1.14 DL-facility [ISO/IEC 7498-1]

3.1.15 flow control [ISO/IEC 7498-1]

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

3.1.17 layer-management [ISO/IEC 7498-1]

3.1.18 DL-local-view [ISO/IEC 7498-3]

3.1.19 DL-name [ISO/IEC 7498-3]

3.1.20 naming-(addressing)-domain [ISO/IEC 7498-3]

3.1.21 peer-entities [ISO/IEC 7498-1]

3.1.22 primitive name [ISO/IEC 7498-3]

3.1.23 DL-protocol [ISO/IEC 7498-1]

3.1.24 DL-protocol-connection-identifier [ISO/IEC 7498-1]

3.1.25 DL-protocol-data-unit [ISO/IEC 7498-1]

3.1.26 DL-relay [ISO/IEC 7498-1]

3.1.27 reset [ISO/IEC 7498-1]

3.1.28 responding-DL-address [ISO/IEC 7498-3]

3.1.29 routing [ISO/IEC 7498-1]

3.1.30 segmenting [ISO/IEC 7498-1]

3.1.31 (N)-service
DL-service (N=2)
Ph-service (N=1) [ISO/IEC 7498-1]

3.1.32 (N)-service-access-point
DL-service-access-point (N=2)
Ph-service-access-point (N=1) [ISO/IEC 7498-1]

3.1.33 DL-service-access-point-address [ISO/IEC 7498-3]

3.1.34 DL-service-connection-identifier [ISO/IEC 7498-1]

3.1.35 DL-service-data-unit [ISO/IEC 7498-1]

3.1.36 DL-simplex-transmission [ISO/IEC 7498-1]

3.1.37 DL-subsystem [ISO/IEC 7498-1]

3.1.38 systems-management [ISO/IEC 7498-1]

3.1.39 DLS-user-data [ISO/IEC 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 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

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 Terms and definitions

3.3.1
blocking
port state at which the port does not participate in frame communication

3.3.2
class
identifier that designates the communication range of the RCL frames and the other frames

3.3.3
control communication
acyclic data communication for high time-critical applications

3.3.4
cyclic communication
periodic data communication for real-time communication

3.3.5
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

3.3.6
DLSAP
distinctive point at which DL-services are provided by a single DL-entity to a single higher-layer entity

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

3.3.7
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 1 to entry: 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.

3.3.8
(individual) DLSAP-address
DL-address that designates only one DLSAP within the extended link

Note 1 to entry: A single DL-entity may have multiple DLSAP-addresses associated with a single DLSAP.

3.3.9
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 communicate, one with another, either directly or with the assistance of one or more of those intervening DL-relay entities

3.3.10
frame
denigrated synonym for DLPDU

3.3.11
group DL-address
DL-address that potentially designates more than one DLSAP within the extended link

Note 1 to entry: 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.

3.3.12
information communication
acyclic data communication for low time-critical applications

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

3.3.14
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.

3.3.15
ring control (RCL) communication
non-real-time communication for control and reconfiguration in Type 25 DLL network using RCL frames

3.3.16
sending DLS-user
DL-service user that acts as a source of DLS-user-data

3.3.17
station
synonym for node

3.3.18
station address
identifier address that designates the node of Type 25 network

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
DLM	DL-management
DLME	DL-management Entity (the local active instance of DL-management)
DLMS	DL-management service
DLPCI	DL-protocol-control-information
DLPDU	DL-protocol-data-unit
DLS	DL-service
DLSAP	DL-service-access-point
DLSDU	DL-service-data-unit
EGA	Edge-A node
EGB	Edge-B node
FIFO	First-in first-out (queuing method)
ISL	Isolate node
ITM	Intermediate node
LCA	Loop condition alert (Type 25 frame type)

LCC	Loop condition check (Type 25 frame type)
LCN	Loop condition notify (Type 25 frame type)
LLD	Logical link down
LLU	Logical link up
LNA	Loop notify answer (Type 25 frame type)
NNB	No neighborhood state
OSI	Open systems interconnection
Ph-	Physical layer (as a prefix)
PhE	Ph-entity (the local active instance of the Physical layer)
PhL	Ph-layer
PhS	Ph-service
PLD	Physical link down
PLU	Port A (B) link up state
QoS	Quality-of-service
RCL	Ring control
RCLC	RCL communication control
RHE	Rapid hello (Type 25 frame type)
RT	Real time
RTC	RT communication control
SCR	Station condition report (Type 25 frame type)
TRC	Transmit/Receive control
WLU	Wait link up state

3.5 Common 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;
– 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

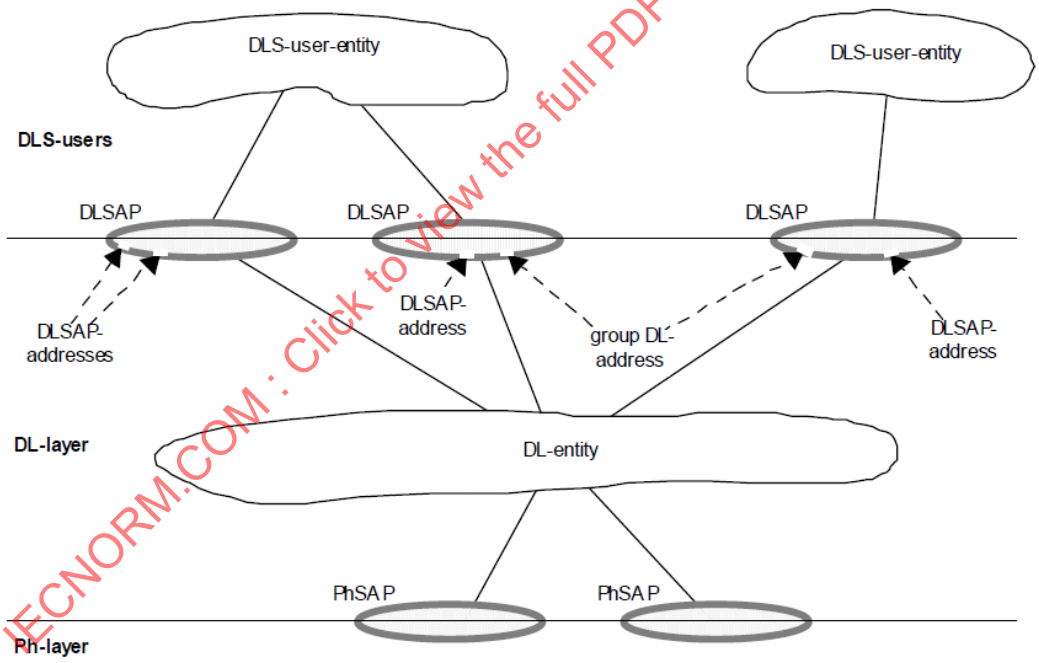
(=) indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table;

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.

Figure 1 shows the relationships of DLSAPs, DLSAP-addresses and group DL-addresses.



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 can have multiple DLSAP-addresses and group DL-addresses associated with a single DLSAP.

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

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 Type 25 conventions

The following notation, a shortened form of the primitive classes defined in 3.2, is used in the figures.

req request primitive

ind indication primitive

cnf confirm primitive (confirmation)

rsp response primitive

4 DL services and concepts

4.1 Overview

This document specifies the Type 25 data-link services for the ISO/IEC/IEEE 8802-3 based real-time Ethernet. The Type 25 services extend Ethernet according to the ISO/IEC/IEEE 8802-3 standard with mechanism to control frame flow with IEEE 8021Q VLAN. The ring topology shall be used in Type 25 network. Type 25 network controls the data traffic and without needs time sharing or node synchronization.

This document specifies the data-link services that are the extension part of the ISO/IEC/IEEE 8802-3 based data-link layer.

4.2 Types of DLS

4.2.1 General

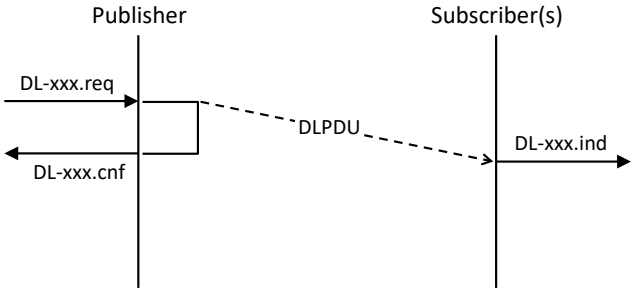
The DLS provides the following service primitives for data transmission and reception:

- RCL communication (for the ring network control and reconfiguration),
- RT communication (for the cyclic, control, and information communication).

The RCL communication controls and reconfigures the Type 25 network and it is non-real-time communication. The RT communication has three types of communication, cyclic, control, and information communication. In cyclic communication, nodes transmit periodically the cyclic communication frames and it guarantees the real-time communication among all nodes on Type 25 network. Control and Information communication are acyclic communication on Type 25 network. Control communication is used in high time-critical acyclic communication. Information communication is used in low time-critical acyclic communication. Control and information communication are non-real-time communication.

4.2.2 Primitive of the RCL communication and RT communication

The sequence of primitives for the RCL communication and RT communication services are shown in Figure 2.



NOTE The method by which a cnf primitive is correlated with its corresponding preceding req primitive is a local matter. See 1.2.

Figure 2 – Sequence diagram of RCL communication and RT communication services

4.3 Detailed description of the RCL communication service

4.3.1 Sequence of primitives

These RCL communication service primitives and the parameters are summarized in Table 1, the primitive sequence is shown in Figure 2.

Table 1 – Primitives and parameters used on the RCL communication service

Function	Location	Primitive	Direction	Parameter
Transmit DLSDU	Publisher	DL-RCL.req	To DLE	S_add PortNum Frame_pri RCL_type DLSDU
Confirm DLSDU transmission	Publisher	DL-RCL.cnf	From DLE	Status
Receive DLSDU	Subscriber(s)	DL-RCL.ind	From DLE	S_add PortNum Frame_pri RCL_type DLSDU

4.3.2 Transmit / Receive DLSDU

4.3.2.1 Function

DL-RCL request allows the DLS-user to transfer data for ring control and reconfiguration.

4.3.2.2 Types of primitives and the parameters of the Transmit / Receive DLSDU

Table 2 indicates the parameters of transmit DLSDU service.

Table 2 – Transmit DLSDU primitives and parameters

DL-RCL	Request	Indication	Confirm
Parameter name	Input	Output	Output
S_add	M	M (=)	
Port_Num	M	M	
Frame_pri	M	M (=)	
RCL_type	M	M (=)	
DLSDU	M	M (=)	
Status			M
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. See 1.2.			

4.3.2.2.1 S_add

The S_add (Source address) parameter specifies the DL-address of the publisher DLE.

4.3.2.2.2 PortNum

The PortNum parameter indicates the port identification for sending and receiving DLSDU. DLE have three types PortNum, A, B, and Both. In the case of PortNum is “Both”, the node transmits the DLSDU to both port A and port B. When node receives DLSDU, the parameter indicating the received port tells whether it is A or B.

4.3.2.2.3 Frame_pri

The Frame_pri parameter specifies the priority with IEEE 802.1Q VLAN on Type 25 network. In RCL communication service, this value is constant indicating the DLSDU for RCL communication.

4.3.2.2.4 RCL_type

The RCL type parameter specifies the frame type for the Type 25 network ring control and reconfiguration. For ring network control, Type 25 network has frames of several types. The frame types are distinguished by the function and communication area.

4.3.2.2.5 DLSDU

This parameter specifies the DLS-user data that is transferred by the DLE.

4.3.2.2.6 Status

This parameter specifies the DLS-user to determine whether the requested service was provided successfully, or failed due to a particular reason. The possible value conveyed in this parameter is as follows:

a) “success”;

b) “failure”.

4.4 Detailed description of the RT communication service

4.4.1 Sequence of primitives

The RT communication service primitives and the parameters are summarized in Table 3, the primitive sequence is shown in Figure 2.

Table 3 – Primitives and parameters used on the RT communication service

Function	Location	Primitive	Direction	Parameter
Transmit DLSDU	Publisher	DL-RTC.req	To DLE	D_add S_add Frame_pri DLSDU
Confirm DLSDU transmission	Publisher	DL-RTC.cnf	From DLE	Status
Receive DLSDU	Subscriber(s)	DL-RTC.ind	From DLE	D_add S_add Frame_pri DLSDU
NOTE In this table, time increases from top to bottom.				

4.4.2 Transmit / Receive DLSDU

4.4.2.1 Function

DL-RT request allows the DLS-user to transfer data based on ISO/IEC/IEEE 8802-3. In RT communication, there are three communication types: cyclic, control, and information communication. Type 25 network distinguishes each type of communication by DLSDU parameters.

4.4.2.2 Types of primitives and the parameters of the Transmit / Receive DLSDU

Table 4 indicates the parameters of DLSDU transmission service.

Table 4 – Transmit DLSDU primitives and parameters

DL-RT	Request	Indication	Confirm
Parameter name	Input	Output	Output
D_add	M	M (=)	
S_add	M	M (=)	
Frame_pri	M	M (=)	
DLSDU	M	M (=)	
Status			M
NOTE The method by which a confirm primitive is correlated with its corresponding preceding request primitive is a local matter. See 1.2.			

4.4.2.2.1 D_add

The D_add (Destination address) parameter specifies the DL-address of the subscriber DLE. It may be individual or multicast (including broadcast) address. Cyclic communication uses the dedicated multicast address indicating the cyclic communication.

4.4.2.2.2 S_add

The S_add (Source address) parameter specifies the DL-address of the publisher DLE.

4.4.2.2.3 Frame_pri

The Frame_pri parameter specifies the priority with IEEE 802.1Q VLAN on Type 25 network. This value differs among communication types, which are cyclic, control and information communication.

4.4.2.2.4 DLSDU

This parameter specifies the DLS-user data that is transferred by the DLE.

4.4.2.2.5 Status

See 4.3.2.2.6.

5 DL management services

5.1 General

Clause 5 defines the interface between a DLE and a DL-management user (DLMS-user).

5.2 Facilities of the DLMS

DL-management organizes the initialization, configuration, event and error handling between the DLMS-user and the logical functions in the DLE. The following functions are provided to the DLMS-user:

a) Reset of the local DLE;

b) Request for and modification of the actual operating parameters and of the counters of the local DLE;

c) Notification of unexpected events, errors, and status changes, both local and remote;

d) Request for identification and for the DLSAP configuration of the local DLE.

5.3 Service of the DL-management

5.3.1 Overview

DL-management provides the following services to DLMS-user:

a) RCL stop;

b) RCL start;

c) Node status;

Each service is defined as following subclauses.

NOTE DLMS-user can use this service only when the DLE adopts configurable time slot.

5.3.2 RCL stop

This service is an indicator to stop the designated type RCL frames to DLMS-user.

5.3.3 RCL start

This service is an indicator to start the designated type RCL frames to DLMS-user.

5.3.4 Node status

This service indicates the status of the node and ports to DLMS-user.

5.4 Overview of interactions

The DL-management services and their primitives are summarized in Table 5.

Table 5 – Transmit DLSDU primitives and parameters

Service	Primitive	Parameter
RCL stop	DLM_RCL_STOP.ind	(out RCL_Indtype)
RCL start	DLM_RCL_START.ind	(out RCL_Indtype, RCL_IndDA, RCL_IndPri, RCL_IndPort)
Node status	DLM_Node_ST.ind	(out Node_ST, PortA_ST, PortB_ST)

The temporal relationships of the DL-management primitives are shown in Figure 3.

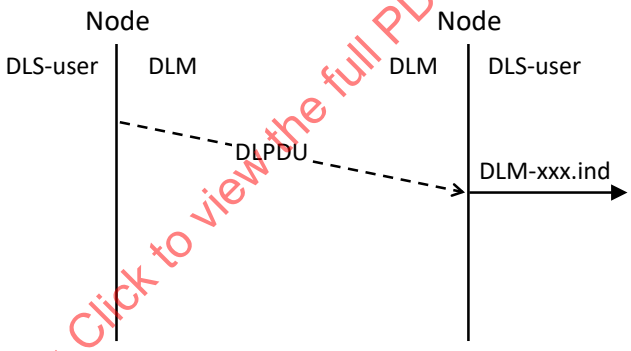


Figure 3 – Sequence diagram of DL-management services

5.5 Detail specification of service and interactions

5.5.1 RCL stop

5.5.1.1 Function

This service informs the DLMS-user to stop the RCL frames transmission. It occurs to receive DLSDU of RCL communication from other nodes.

5.5.1.2 Type of primitives and parameters of the RCL stop

5.5.1.2.1 General

Table 6 indicates the primitives and parameters of the RCL stop service. This is a local service.