

PD IEC/PAS 62953:2015



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# Industrial communication networks — Fieldbus specifications

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# PUBLICLY AVAILABLE SPECIFICATION PRE-STANDARD

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**Industrial communication networks – Fieldbus specifications**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

ICS 25.040.40; 35.100.01

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS  
SPECIFICATIONS AND PROFILES – ADS-NET**

## FOREWORD

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|-------------|------------------|
| 65C/787/PAS | 65C/799/RVD      |

Following publication of this PAS, which is a pre-standard publication, the technical committee or subcommittee concerned may transform it into an International Standard.

This PAS shall remain valid for an initial maximum period of 3 years starting from the publication date. The validity may be extended for a single period up to a maximum of 3 years, at the end of which it shall be published as another type of normative document, or shall be withdrawn.

## INTRODUCTION

This PAS contains the ADS-net fieldbus specifications and profiles (Communication profile CP 20/1 ADS-net/ $\mu$ SNETWORK-1000, CP 20/2 ADS-net/NX) for inclusion in the IEC 61158 series as well as IEC 61784-2.

The intention is to make this technical content available immediately, while a corresponding new work item proposal (NP) has been launched. If the NP is accepted, this contents will be included in the next editions of the IEC 61158 series and of IEC 61784-2.

This PAS contains the relevant ADS-net (Type 25) elements for the DL and AL services and protocols and information with references to:

- IEC 61158-1:2014
- IEC 61158-2:2014
- IEC 61784-2:2014

The present IEC PAS is structured in the same way as the IEC 61158 series and IEC 61784-2:

- IEC PAS 62953-3-25 is intended to become a future IEC 61158-3-25;
- IEC PAS 62953-4-25 is intended to become a future IEC 61158-4-25;
- IEC PAS 62953-5-25 is intended to become a future IEC 61158-5-25;
- IEC PAS 62953-6-25 is intended to become a future IEC 61158-6-25;
- IEC PAS 62953-2 is intended to be merged into a revised version of IEC 61784-2:2014.

## **INCLUDED SUBPARTS**

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

Industrial communication networks – Fieldbus specifications – Part 4-25: Data-link layer protocol specification – Type 25 elements

Industrial communication networks – Fieldbus specifications – Part 5-25: Application layer service definition – Type 25 elements

Industrial communication networks – Fieldbus specifications – Part 6-25: Application layer protocol specification – Type 25 elements

CPF20 input for IEC 61784-2: Industrial communication networks – Profiles – Part 2: Additional fieldbus profiles for real-time networks based on ISO/IEC 8802-3

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## 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 PAS 62953 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 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 standard 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 standard 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 standard does not specify individual implementations or products, nor does it constrain the implementations of data-link entities within industrial automation systems.

There is no conformance of equipment to this data-link layer service definition standard. Instead, conformance is achieved through implementation of the corresponding data-link protocol that fulfills the Type 25 data-link layer services defined in this standard.

## 2 Normative references

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

IEC PAS 62953-4-25, *Industrial communication networks – Fieldbus specifications – Part 4-25: Data-link layer protocol specification – Type 25 elements*

IEC PAS 62953-5-25, *Industrial communication networks – Fieldbus specifications – Part 5-25: Application layer service definition – Type 25 elements*

IEC PAS 62953-6-25, *Industrial communication networks – Fieldbus specifications – Part 6-25: Application layer protocol specification – Type 25 elements*

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

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

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

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and Physical Layer specifications*

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

## 3 Terms, definitions, symbols and abbreviations

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

### 3.1 Reference model terms and definitions

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

|               |                                                                                                         |                  |
|---------------|---------------------------------------------------------------------------------------------------------|------------------|
| <b>3.1.1</b>  | <b>DL-address</b>                                                                                       | [ISO/IEC 7498-3] |
| <b>3.1.2</b>  | <b>DL-address-mapping</b>                                                                               | [ISO/IEC 7498-1] |
| <b>3.1.3</b>  | <b>called-DL-address</b>                                                                                | [ISO/IEC 7498-3] |
| <b>3.1.4</b>  | <b>calling-DL-address</b>                                                                               | [ISO/IEC 7498-3] |
| <b>3.1.5</b>  | <b>centralized multi-end-point-connection</b>                                                           | [ISO/IEC 7498-1] |
| <b>3.1.6</b>  | <b>DL-connection</b>                                                                                    | [ISO/IEC 7498-1] |
| <b>3.1.7</b>  | <b>DL-connection-end-point</b>                                                                          | [ISO/IEC 7498-1] |
| <b>3.1.8</b>  | <b>DL-connection-end-point-identifier</b>                                                               | [ISO/IEC 7498-1] |
| <b>3.1.9</b>  | <b>DL-connection-mode transmission</b>                                                                  | [ISO/IEC 7498-1] |
| <b>3.1.10</b> | <b>DL-connectionless-mode transmission</b>                                                              | [ISO/IEC 7498-1] |
| <b>3.1.11</b> | <b>correspondent (N)-entities</b><br>correspondent DL-entities (N=2)<br>correspondent Ph-entities (N=1) | [ISO/IEC 7498-1] |
| <b>3.1.12</b> | <b>DL-duplex-transmission</b>                                                                           | [ISO/IEC 7498-1] |
| <b>3.1.13</b> | <b>(N)-entity</b><br>DL-entity (N=2)<br>Ph-entity (N=1)                                                 | [ISO/IEC 7498-1] |
| <b>3.1.14</b> | <b>DL-facility</b>                                                                                      | [ISO/IEC 7498-1] |
| <b>3.1.15</b> | <b>flow control</b>                                                                                     | [ISO/IEC 7498-1] |
| <b>3.1.16</b> | <b>(N)-layer</b><br>DL-layer (N=2)<br>Ph-layer (N=1)                                                    | [ISO/IEC 7498-1] |

|               |                                                                |                         |
|---------------|----------------------------------------------------------------|-------------------------|
| <b>3.1.17</b> | <b>layer-management</b>                                        | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.18</b> | <b>DL-local-view</b>                                           | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.19</b> | <b>DL-name</b>                                                 | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.20</b> | <b>naming-(addressing)-domain</b>                              | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.21</b> | <b>peer-entities</b>                                           | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.22</b> | <b>primitive name</b>                                          | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.23</b> | <b>DL-protocol</b>                                             | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.24</b> | <b>DL-protocol-connection-identifier</b>                       | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.25</b> | <b>DL-protocol-data-unit</b>                                   | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.26</b> | <b>DL-relay</b>                                                | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.27</b> | <b>reset</b>                                                   | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.28</b> | <b>responding-DL-address</b>                                   | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.29</b> | <b>routing</b>                                                 | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.30</b> | <b>segmenting</b>                                              | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.31</b> | <b>(N)-service</b>                                             | <b>[ISO/IEC 7498-1]</b> |
|               | DL-service (N=2)<br>Ph-service (N=1)                           |                         |
| <b>3.1.32</b> | <b>(N)-service-access-point</b>                                | <b>[ISO/IEC 7498-1]</b> |
|               | DL-service-access-point (N=2)<br>Ph-service-access-point (N=1) |                         |
| <b>3.1.33</b> | <b>DL-service-access-point-address</b>                         | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.34</b> | <b>DL-service-connection-identifier</b>                        | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.35</b> | <b>DL-service-data-unit</b>                                    | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.36</b> | <b>DL-simplex-transmission</b>                                 | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.37</b> | <b>DL-subsystem</b>                                            | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.38</b> | <b>systems-management</b>                                      | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.39</b> | <b>DLS-user-data</b>                                           | <b>[ISO/IEC 7498-1]</b> |

## **3.2 Service convention terms and definitions**

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

- 3.2.1** **acceptor**
- 3.2.2** **asymmetrical service**
- 3.2.3** **confirm (primitive);**  
requestor.deliver (primitive)

- 3.2.4 deliver (primitive)**
- 3.2.5 DL-confirmed-facility**
- 3.2.6 DL-facility**
- 3.2.7 DL-local-view**
- 3.2.8 DL-mandatory-facility**
- 3.2.9 DL-non-confirmed-facility**
- 3.2.10 DL-provider-initiated-facility**
- 3.2.11 DL-provider-optional-facility**
- 3.2.12 DL-service-primitive;**  
primitive
- 3.2.13 DL-service-provider**
- 3.2.14 DL-service-user**
- 3.2.15 DLS-user-optional-facility**
- 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

#### DL-segment, link, local link

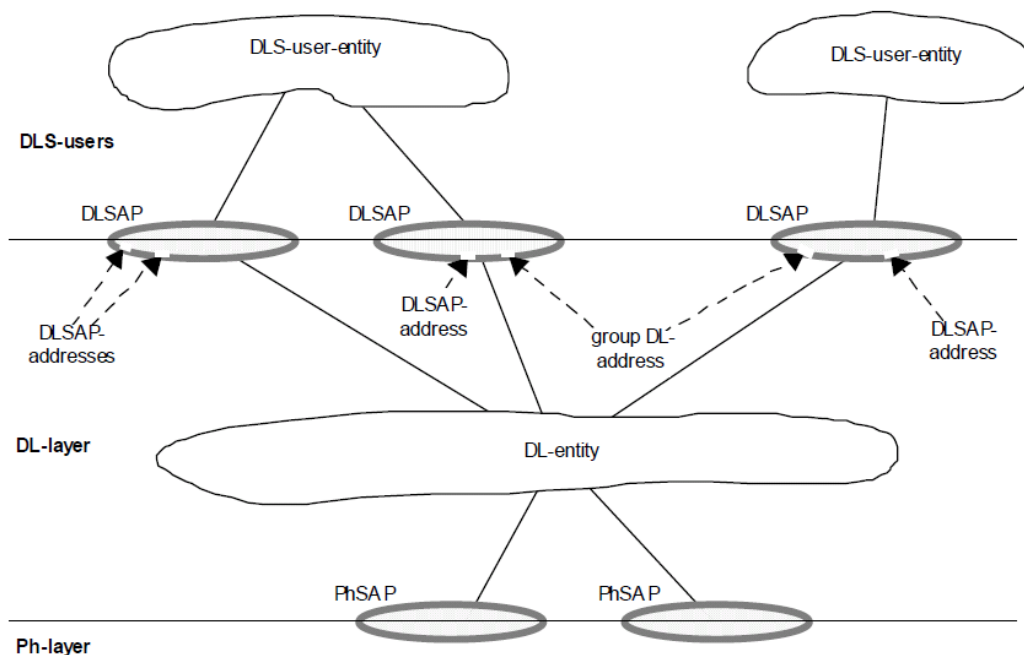
single DL-subnetwork in which any of the connected DLEs may communicate directly, without any intervening DL-relaying, whenever all of those DLEs that are participating in an instance of communication are simultaneously attentive to the DL-subnetwork during the period(s) of attempted communication

### 3.3.7

#### 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.



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

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

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

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

### 3.3.8

#### 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.

**3.3.9****(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.

**3.3.10****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

**3.3.11****frame**

denigrated synonym for DLPDU

**3.3.12****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.

**3.3.13****information communication**

acyclic data communication for low time-critical applications

**3.3.14****node**

single DL-entity as it appears on one local link

**3.3.15****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

**3.3.16****ring control (RCL) communication**

non-real-time communication for control and reconfiguration in type 25 DLL network using RCL frames

**3.3.17****sending DLS-user**

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

**3.3.18****station**

node

**3.3.19****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.

|              |                                                                   |
|--------------|-------------------------------------------------------------------|
| <b>DL-</b>   | Data-link layer (as a prefix)                                     |
| <b>DLC</b>   | DL-connection                                                     |
| <b>DLCEP</b> | DL-connection-end-point                                           |
| <b>DLE</b>   | DL-entity (the local active instance of the data-link layer)      |
| <b>DLL</b>   | DL-layer                                                          |
| <b>DLM</b>   | DL-management                                                     |
| <b>DLME</b>  | DL-management Entity (the local active instance of DL-management) |
| <b>DLMS</b>  | DL-management service                                             |
| <b>DLPCI</b> | DL-protocol-control-information                                   |
| <b>DLPDU</b> | DL-protocol-data-unit                                             |
| <b>DLS</b>   | DL-service                                                        |
| <b>DLSAP</b> | DL-service-access-point                                           |
| <b>DLSDU</b> | DL-service-data-unit                                              |
| <b>EGA</b>   | Edge-A node                                                       |
| <b>EGB</b>   | Edge-B node                                                       |
| <b>FIFO</b>  | First-in first-out (queuing method)                               |
| <b>ISL</b>   | Isolate node                                                      |
| <b>ITM</b>   | Intermediate node                                                 |
| <b>LCA</b>   | Loop condition alert (Type 25 frame type)                         |
| <b>LCC</b>   | Loop condition check (Type 25 frame type)                         |
| <b>LCN</b>   | Loop condition notify (Type 25 frame type)                        |
| <b>LLD</b>   | Logical link down                                                 |
| <b>LLU</b>   | Logical link up                                                   |
| <b>LNA</b>   | Loop notify answer (Type 25 frame type)                           |
| <b>NNB</b>   | No neighborhood state                                             |
| <b>OSI</b>   | Open systems interconnection                                      |
| <b>Ph-</b>   | Physical layer (as a prefix)                                      |
| <b>PhE</b>   | Ph-entity (the local active instance of the Physical layer)       |
| <b>PhL</b>   | Ph-layer                                                          |
| <b>PhS</b>   | Ph-service                                                        |
| <b>PLD</b>   | Physical link down                                                |
| <b>PLU</b>   | Port A (B) link up state                                          |
| <b>QoS</b>   | Quality-of-service                                                |
| <b>RCL</b>   | Ring control                                                      |
| <b>RCLC</b>  | RCL communication control                                         |
| <b>RHE</b>   | Rapid hello (Type 25 frame type)                                  |
| <b>RT</b>    | Real time                                                         |
| <b>RTC</b>   | RT communication control                                          |
| <b>SCR</b>   | Station condition report (Type 25 frame type)                     |
| <b>TRC</b>   | Transmit/Receive control                                          |
| <b>WLU</b>   | Wait link up state                                                |

### 3.5 Common conventions

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

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

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

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

- the request primitive's input parameters;
- the request primitive's output parameters;
- the indication primitive's output parameters;
- the response primitive's input parameters;
- 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.

### 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.

|            |                                  |
|------------|----------------------------------|
| <b>req</b> | request primitive                |
| <b>ind</b> | indication primitive             |
| <b>cnf</b> | confirm primitive (confirmation) |
| <b>rsp</b> | response primitive               |

## 4 DL services and concepts

### 4.1 Overview

This standard specifies the Type 25 data-link services for the ISO/IEC 8802-3 based real-time Ethernet. The Type 25 services extend Ethernet according to the ISO/IEC 8802-3 standard with mechanism to control frame flow with IEEE 802.1Q VLAN. The ring topology shall be use in type 25 network. Type 25 network controls the data traffic and without needs time sharing or node synchronization.

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

### 4.2 Types of DLS

#### 4.2.1 General

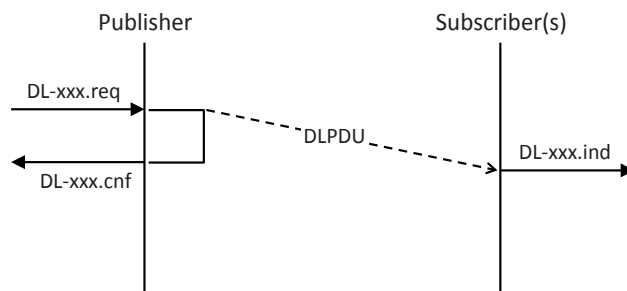
The DLS provides the following service primitives for data transmission and reception:

- 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 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<br>PortNum<br>Frame_pri<br>RCL_type<br>DLSDU |
| Confirm DLSDU transmission | Publisher     | DL-RCL.cnf | From DLE  | Status                                             |
| Receive DLSDU              | Subscriber(s) | DL-RCL.ind | From DLE  | S_add<br>PortNum<br>Frame_pri<br>RCL_type<br>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 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<br>S_add<br>Frame_pri<br>DLSDU |
| Confirm DLSDU transmission                             | Publisher     | DL-RTC.cnf | From DLE  | Status                               |
| Receive DLSDU                                          | Subscriber(s) | DL-RTC.ind | From DLE  | D_add<br>S_add<br>Frame_pri<br>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 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 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**

This clause 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) Reset;
- b) Set value;
- c) Get value;
- d) RCL stop;
- e) RCL start;
- f) Node status;
- g) Event.

Each service is defined as following subclauses.

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

### 5.3.2 Reset

The DLMS-user utilizes this service to make DL-management to reset the DLE. A reset is equivalent to power on. The DLMS-user receives a confirmation thereof.

### 5.3.3 Set value

The DLMS-user utilizes this service to assign new values to the variables of the DLE. The DLMS-user receives confirmation that the specified variables have been set to the new values.

### 5.3.4 Get value

This service allows the DLMS-user to read variables of the DLE. The response of the DL management returns the actual value of the specified variables.

### 5.3.5 RCL stop

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

### 5.3.6 RCL start

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

### 5.3.7 Node status

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

### 5.3.8 Event

DL-management utilizes this service to inform the DLMS-user about certain events or error in the DLL.

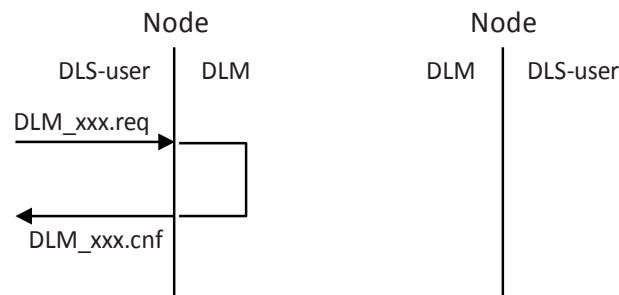
## 5.4 Overview of interactions

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

**Table 5 – Transmit DLSDU primitives and parameters**

| Service     | Primitive         | Parameter                                             |
|-------------|-------------------|-------------------------------------------------------|
| Reset       | DLM_Reset.req     | (<none>)                                              |
|             | DLM_Reset.cnf     | (out DLM_status)                                      |
| Set value   | DLM_Set.req       | (in Variable-name, Desired-value)                     |
|             | DLM_Set.cnf       | (out DLM_status)                                      |
| Get value   | DLM_Get.req       | (in Variable-name)                                    |
|             | DLM_Get.cnf       | (out DLM_status, Current-value)                       |
| 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)                     |
| Event       | DLM_Event.ind     | (out DLM_event identifier, Additional_info)           |

The temporal relationships of the DL-management primitives are shown in Figure 3 and Figure 4.



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

**Figure 3 – Reset, Set value, and Get value services**

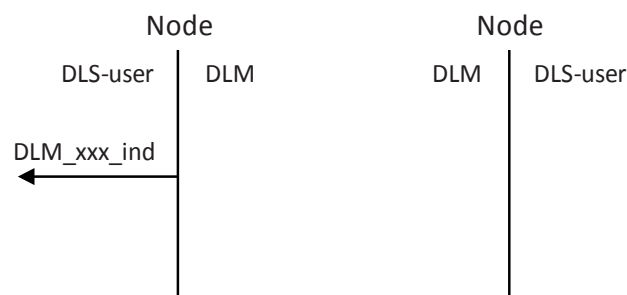


**Figure 4 – Event service**

## 5.5 Detail specification of service and interactions

### 5.5.1 Reset

#### 5.5.1.1 Function

The DLM\_Reset request primitive causes DLMS to reset the DLE. The DLE is assumed in the “Offline” status, and the reset is carried out in the same manner as in the “power on” procedure; all the DLE variables are cleared. The DLMS user receives the DLM\_Reset confirmation primitive along with the status of the result whether it was a success or a failure.

#### 5.5.1.2 Type of primitives and parameters of the Reset

##### 5.5.1.2.1 General

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

**Table 6 – DLM\_Reset primitives and parameters**

| DLM_Reset                                                                                                                                 | Request | Confirm |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|
| Parameter name                                                                                                                            | Input   | Output  |
| DLM_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. |         |         |

#### 5.5.1.2.2 DLM\_status

This parameter allows the DLMS-user to determine whether the requested DLMS was provided successfully, or failed for the reason specified. The value conveyed in this parameter is as follows:

- a) "OK – successfully completed";
- b) "Failure – terminated before completion".

### 5.5.2 Set value

#### 5.5.2.1 Function

This service is used to assign new values to the variables of the DLE. The DLMS-user receives confirmation that the specified variables have been set to the new values.

#### 5.5.2.2 Type of primitives and parameters of the Set value

##### 5.5.2.2.1 General

Table 7 indicates the primitives and parameters of the Set value service. This is a local service.

**Table 7 – DLM\_Set primitives and parameters**

| DLM_Set                                                                                                                                   | Request | Confirm |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|
| Parameter name                                                                                                                            | Input   | Output  |
| Variable-name                                                                                                                             | M       |         |
| Desired-value                                                                                                                             | M       |         |
| DLM_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. |         |         |

##### 5.5.2.2.2 Variable-name

This parameter specifies the variable within the DLE whose value is set. The selectable variables and their permitted values or value ranges are defined in the corresponding part of IEC PAS 62953-4-25.

##### 5.5.2.2.3 Desired-value

This parameter specifies the desired value for the selected variable.

##### 5.5.2.2.4 DLM\_status

This parameter allows the DLMS-user to determine whether the requested DLMS was provided successfully, or failed for the reason specified. The value conveyed in this parameter is as follows:

- a) "OK – success – the variable could be updated";
- b) "Failure – the variable does not exist or could not assume the new value";
- c) "Failure – invalid parameters in the request".

### 5.5.3 Get value

#### 5.5.3.1 Function

This service can be used to read the value of a DLE variable. The response of the DLMS returns the actual value of the specified variable.

#### 5.5.3.2 Type of primitives and parameters of the Set value

##### 5.5.3.2.1 General

Table 8 indicates the primitives and parameters of the Get value service. This is a local service.

**Table 8 – DLM\_Get primitives and parameters**

| DLM_Get                                                                                                                                   | Request | Confirm |
|-------------------------------------------------------------------------------------------------------------------------------------------|---------|---------|
| Parameter name                                                                                                                            | Input   | Output  |
| Variable-name                                                                                                                             | M       |         |
| Current-value                                                                                                                             |         | M       |
| DLM_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. |         |         |

##### 5.5.3.2.2 Variable-name

This parameter specifies the variable within the DLE whose value is set. The selectable variables and their permitted values or value ranges are defined in the corresponding part of IEC PAS 62953-4-25.

##### 5.5.3.2.3 Current-value

This parameter is present when the status parameter indicates that the requested service was performed successfully. This parameter specifies the current value of the selected variable.

##### 5.5.3.2.4 DLM\_status

This parameter allows the DLMS-user to determine whether the requested DLMS was provided successfully, or failed for the reason specified. The value conveyed in this parameter is as follows:

- a) "OK – success – the variable could be read";
- b) "Failure – the variable does not exist or could not be read";
- c) "Failure – invalid parameters in the request".

### 5.5.4 RCL stop

#### 5.5.4.1 Function

This service informs the DLMS-user to stop the RCL frames transmission.

#### 5.5.4.2 Type of primitives and parameters of the RCL stop

##### 5.5.4.2.1 General

Table 9 indicates the primitives and parameters of the RCL stop service. This is a local service.

**Table 9 – DLM\_RCL\_STOP primitives and parameters**

| DLM_RCL_STOP   | Indication |
|----------------|------------|
| Parameter name | Output     |
| RCL_Indtype    | M          |

##### 5.5.4.2.2 RCL\_Indtype

This parameter specifies the RCL type of the requested RCL frames for the DLMS-user due to the change of the node status.

#### 5.5.5 RCL start

##### 5.5.5.1 Function

This service is used to inform the DLMS-user about starting the RCL frames.

#### 5.5.5.2 Type of primitives and parameters of the RCL start

##### 5.5.5.2.1 General

Table 10 indicates the primitives and parameters of the RCL start service. This is a local service.

**Table 10 – DLM\_RCL\_START primitives and parameters**

| DLM_RCL_START  | Indication |
|----------------|------------|
| Parameter name | Output     |
| RCL_Indtype    | M          |
| RCL_IndDA      | M          |
| RCL_IndPri     | M          |
| RCL_IndPort    | M          |

##### 5.5.5.2.2 RCL\_Indtype

This parameter specifies the RCL type of the requested RCL frames for the DLMS-user due to the change of the node status.

##### 5.5.5.2.3 RCL\_IndDA

This parameter specifies the DL-address of the requested RCL frames for the DLMS-user due to the change of the node status.

##### 5.5.5.2.4 RCL\_IndPri

This parameter specifies the priority with VLAN of the requested RCL frames for the DLMS-user due to the change of the node status.

#### 5.5.5.2.5 RCL\_IndPort

This parameter specifies the transmission port of the requested RCL frames for the DLMS-user due to the change of the node status.

#### 5.5.5.3 Node status

##### 5.5.5.3.1 General

Table 11 indicates the primitives and parameters of the Node status service. This is a local service.

**Table 11 – DLM\_RCL\_START primitives and parameters**

| DLM_Node_ST    | Indication |
|----------------|------------|
| Parameter name | Output     |
| Node_ST        | M          |
| PortA_ST       | M          |
| PortB_ST       | M          |

##### 5.5.5.3.2 Node\_ST

This parameter contains the node status (ISL/EGA/EGB/ITM) for the DLMS-user due to the change of the node status.

##### 5.5.5.3.3 PortA\_ST

This parameter contains the status of port A on own node for the DLMS-user due to the change of the node status.

##### 5.5.5.3.4 PortB\_ST

This parameter contains the status of port B on own node for the DLMS-user due to the change of the node status.

#### 5.5.6 Event

##### 5.5.6.1 Function

This service is used to inform the DLMS-user about certain internal events or errors to the DLS provider.

##### 5.5.6.2 Type of primitives and parameters of the Event

##### 5.5.6.2.1 General

Table 12 indicates the primitives and parameters of the Event service. This is a local service.

**Table 12 – DLM\_Event primitives and parameters**

| <b>DLM_Event</b>       | <b>Indication</b> |
|------------------------|-------------------|
| Parameter name         | Output            |
| DLM_event identifier   | M                 |
| Additional_information | C                 |

**5.5.6.2.2 DLM\_event identifier**

This parameter specifies the primitive or composite event within the DLE whose occurrence is being announced.

**5.5.6.2.3 Additional\_information**

This field contains device profile or vendor specific additional information.

## Bibliography

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IEC 61158-2:2014, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

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## INDUSTRIAL COMMUNICATION NETWORKS - FIELDBUS SPECIFICATIONS –

### Part 4-25: Data-link layer protocol specification - Type 25 elements

#### 1 Scope

##### 1.1 General

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

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

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

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

##### 1.2 Specifications

This standard specifies

- a) procedures for the timely transfer of data and control information from one data-link user entity to a peer user entity, and among the data-link entities forming the distributed datalink service provider;
- b) procedures for giving communications opportunities to all participating DL-entities, sequentially and in a cyclic manner for deterministic and synchronized transfer at cyclic intervals up to one millisecond;
- c) procedures for giving communication opportunities available for time-critical data transmission together with non-time-critical data transmission without prejudice to the time-critical data transmission;
- d) procedures for giving cyclic and acyclic communication opportunities for time-critical data transmission with prioritized access;
- e) procedures for giving communication opportunities based on standard ISO/IEC 8802-3 medium access control, with provisions for nodes to be added or removed during normal operation;
- f) the structure of the fieldbus DLPDUs used for the transfer of data and control information by the protocol of this standard, and their representation as physical interface data units.

##### 1.3 Procedures

The procedures are defined in terms of

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

## 1.4 Applicability

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

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

## 1.5 Conformance

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

## 2 Normative references

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

IEC PAS 62953-3-25, *Industrial communication networks – Fieldbus specifications – Part 3-25: Data-link layer service definition – Type 25 elements*

IEC PAS 62953-5-25, *Industrial communication networks – Fieldbus specifications – Part 5-25: Application layer service definition – Type 25 elements*

IEC PAS 62953-6-25, *Industrial communication networks – Fieldbus specifications – Part 6-25: Application layer protocol specification – Type 25 elements*

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

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

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

ISO/IEC 8802-3:2000, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and Physical Layer specifications*

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

IEEE 802.1D-2004, IEEE Standard for Local and metropolitan area networks – Media access control (MAC) Bridges, available at <<http://www.ieee.org>>

IEEE 802.1Q-2005, IEEE Standard for Local and metropolitan area networks – Virtual Bridged Local Area Networks, available at <<http://www.ieee.org>>

### 3 Terms, definitions, symbols and abbreviations

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

#### 3.1 Reference model terms and definitions

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

|               |                                               |                         |
|---------------|-----------------------------------------------|-------------------------|
| <b>3.1.1</b>  | <b>DL-address</b>                             | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.2</b>  | <b>DL-address-mapping</b>                     | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.3</b>  | <b>called-DL-address</b>                      | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.4</b>  | <b>calling-DL-address</b>                     | <b>[ISO/IEC 7498-3]</b> |
| <b>3.1.5</b>  | <b>centralized multi-end-point-connection</b> | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.6</b>  | <b>DL-connection</b>                          | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.7</b>  | <b>DL-connection-end-point</b>                | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.8</b>  | <b>DL-connection-end-point-identifier</b>     | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.9</b>  | <b>DL-connection-mode transmission</b>        | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.10</b> | <b>DL-connectionless-mode transmission</b>    | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.11</b> | <b>correspondent (N)-entities</b>             | <b>[ISO/IEC 7498-1]</b> |
|               | correspondent DL-entities (N=2)               |                         |
|               | correspondent Ph-entities (N=1)               |                         |
| <b>3.1.12</b> | <b>DL-duplex-transmission</b>                 | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.13</b> | <b>(N)-entity</b>                             | <b>[ISO/IEC 7498-1]</b> |
|               | DL-entity (N=2)                               |                         |
|               | Ph-entity (N=1)                               |                         |
| <b>3.1.14</b> | <b>DL-facility</b>                            | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.15</b> | <b>flow control</b>                           | <b>[ISO/IEC 7498-1]</b> |
| <b>3.1.16</b> | <b>(N)-layer</b>                              | <b>[ISO/IEC 7498-1]</b> |
|               | DL-layer (N=2)                                |                         |
|               | Ph-layer (N=1)                                |                         |

|               |                                          |                  |
|---------------|------------------------------------------|------------------|
| <b>3.1.17</b> | <b>layer-management</b>                  | [ISO/IEC 7498-1] |
| <b>3.1.18</b> | <b>DL-local-view</b>                     | [ISO/IEC 7498-3] |
| <b>3.1.19</b> | <b>DL-name</b>                           | [ISO/IEC 7498-3] |
| <b>3.1.20</b> | <b>naming-(addressing)-domain</b>        | [ISO/IEC 7498-3] |
| <b>3.1.21</b> | <b>peer-entities</b>                     | [ISO/IEC 7498-1] |
| <b>3.1.22</b> | <b>primitive name</b>                    | [ISO/IEC 7498-3] |
| <b>3.1.23</b> | <b>DL-protocol</b>                       | [ISO/IEC 7498-1] |
| <b>3.1.24</b> | <b>DL-protocol-connection-identifier</b> | [ISO/IEC 7498-1] |
| <b>3.1.25</b> | <b>DL-protocol-data-unit</b>             | [ISO/IEC 7498-1] |
| <b>3.1.26</b> | <b>DL-relay</b>                          | [ISO/IEC 7498-1] |
| <b>3.1.27</b> | <b>reset</b>                             | [ISO/IEC 7498-1] |
| <b>3.1.28</b> | <b>responding-DL-address</b>             | [ISO/IEC 7498-3] |
| <b>3.1.29</b> | <b>routing</b>                           | [ISO/IEC 7498-1] |
| <b>3.1.30</b> | <b>segmenting</b>                        | [ISO/IEC 7498-1] |
| <b>3.1.31</b> | <b>(N)-service</b>                       | [ISO/IEC 7498-1] |
|               | DL-service (N=2)                         |                  |
|               | Ph-service (N=1)                         |                  |
| <b>3.1.32</b> | <b>(N)-service-access-point</b>          | [ISO/IEC 7498-1] |
|               | DL-service-access-point (N=2)            |                  |
|               | Ph-service-access-point (N=1)            |                  |
| <b>3.1.33</b> | <b>DL-service-access-point-address</b>   | [ISO/IEC 7498-3] |
| <b>3.1.34</b> | <b>DL-service-connection-identifier</b>  | [ISO/IEC 7498-1] |
| <b>3.1.35</b> | <b>DL-service-data-unit</b>              | [ISO/IEC 7498-1] |
| <b>3.1.36</b> | <b>DL-simplex-transmission</b>           | [ISO/IEC 7498-1] |
| <b>3.1.37</b> | <b>DL-subsystem</b>                      | [ISO/IEC 7498-1] |
| <b>3.1.38</b> | <b>systems-management</b>                | [ISO/IEC 7498-1] |
| <b>3.1.39</b> | <b>DLS-user-data</b>                     | [ISO/IEC 7498-1] |

## **3.2 Service convention terms and definitions**

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

- 3.2.1** **acceptor**
- 3.2.2** **asymmetrical service**
- 3.2.3** **confirm (primitive);**  
requestor.deliver (primitive)

- 3.2.4 deliver (primitive)**
- 3.2.5 DL-confirmed-facility**
- 3.2.6 DL-facility**
- 3.2.7 DL-local-view**
- 3.2.8 DL-mandatory-facility**
- 3.2.9 DL-non-confirmed-facility**
- 3.2.10 DL-provider-initiated-facility**
- 3.2.11 DL-provider-optional-facility**
- 3.2.12 DL-service-primitive;**  
primitive
- 3.2.13 DL-service-provider**
- 3.2.14 DL-service-user**
- 3.2.15 DLS-user-optional-facility**
- 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**  
response (primitive);  
acceptor.submit (primitive)
- 3.2.20 submit (primitive)**
- 3.2.21 symmetrical service**

### **3.3 Terms and definitions**

#### **3.3.1**

##### **blocking**

a port state which does not participate in frame communication

#### **3.3.2**

##### **class**

identifiers that designate communication range of the RCL frame and the other frames

#### **3.3.3**

##### **control communication**

non-real-time acyclic data communication for higher priority applications and node control communication

#### **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.

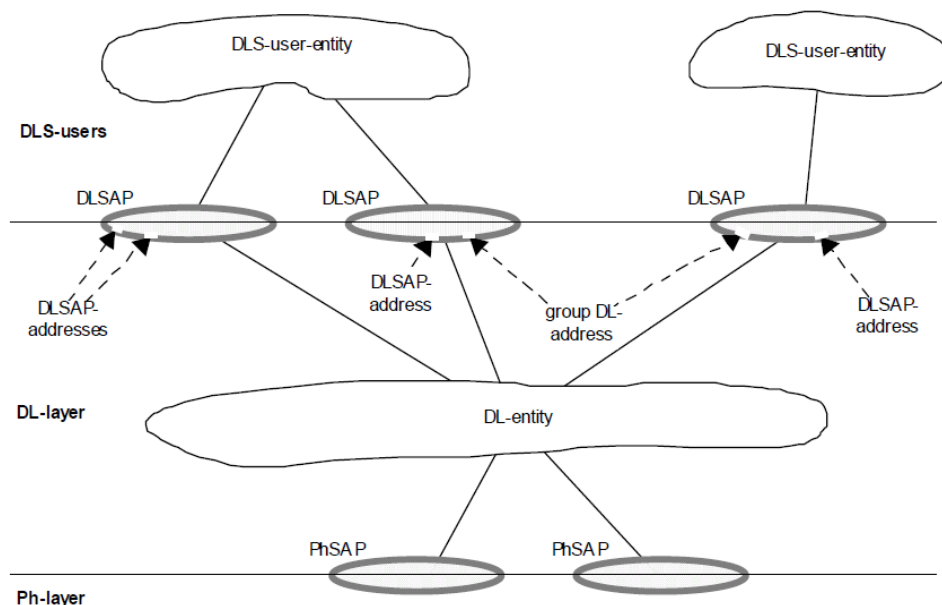
**3.3.6****DL-segment, link, local link**

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

**3.3.7****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.



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

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

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

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

**3.3.8****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.

**3.3.9****(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.

**3.3.10****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

**3.3.11****frame**

denigrated synonym for DLPDU

**3.3.12****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.

**3.3.13****information communication**

non-real-time acyclic data communication for low priority applications

**3.3.14****logical link down**

link status at which the port is in a blocking state and does not communicate all kinds of frames except RCL frames

**3.3.15****logical link up**

link status at which the port communicates all kinds of frames

**3.3.16****node**

single DL-entity as it appears on one local link

**3.3.17****physical link down**

link status at which the port does not communicate the frames due to link down status defined in ISO/IEC 8802-3

**3.3.18****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

**3.3.19****ring control (RCL) communication**

control communication of type 25 DLL ring network using RCL frames and non-real-time

**3.3.20****sending DLS-user**

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

### 3.3.21

**station node**

### 3.3.22

**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.

|               |                                                                   |
|---------------|-------------------------------------------------------------------|
| <b>DL-</b>    | Data-link layer (as a prefix)                                     |
| <b>DLC</b>    | DL-connection                                                     |
| <b>DLCEP</b>  | DL-connection-end-point                                           |
| <b>DLE</b>    | DL-entity (the local active instance of the data-link layer)      |
| <b>DLL</b>    | DL-layer                                                          |
| <b>DLM</b>    | DL-management                                                     |
| <b>DLME</b>   | DL-management Entity (the local active instance of DL-management) |
| <b>DLMS</b>   | DL-management service                                             |
| <b>DLPCI</b>  | DL-protocol-control-information                                   |
| <b>DLPPDU</b> | DL-protocol-data-unit                                             |
| <b>DLS</b>    | DL-service                                                        |
| <b>DLSAP</b>  | DL-service-access-point                                           |
| <b>DLSDU</b>  | DL-service-data-unit                                              |
| <b>EGA</b>    | Edge-A node                                                       |
| <b>EGB</b>    | Edge-B node                                                       |
| <b>FIFO</b>   | First-in first-out (queuing method)                               |
| <b>ISL</b>    | Isolate node                                                      |
| <b>ITM</b>    | Intermediate node                                                 |
| <b>LCA</b>    | Loop condition alert (Type 25 frame type)                         |
| <b>LCC</b>    | Loop condition check (Type 25 frame type)                         |
| <b>LCN</b>    | Loop condition notify (Type 25 frame type)                        |
| <b>LLD</b>    | Logical link down                                                 |
| <b>LLU</b>    | Logical link up                                                   |
| <b>LNA</b>    | Loop notify answer (Type 25 frame type)                           |
| <b>NNB</b>    | No neighborhood state                                             |
| <b>OSI</b>    | Open systems interconnection                                      |
| <b>Ph-</b>    | Physical layer (as a prefix)                                      |
| <b>PhE</b>    | Ph-entity (the local active instance of the Physical layer)       |
| <b>PhL</b>    | Ph-layer                                                          |
| <b>PhS</b>    | Ph-service                                                        |
| <b>PLD</b>    | Physical link down                                                |
| <b>PLU</b>    | Port A (B) link up state                                          |
| <b>QoS</b>    | Quality-of-service                                                |
| <b>RCL</b>    | Ring control                                                      |

|             |                                               |
|-------------|-----------------------------------------------|
| <b>RCLC</b> | RCL communication control                     |
| <b>RHE</b>  | Rapid hello (Type 25 frame type)              |
| <b>RT</b>   | Real time                                     |
| <b>RTC</b>  | RT communication control                      |
| <b>SCR</b>  | Station condition report (Type 25 frame type) |
| <b>TRC</b>  | Transmit/Receive control                      |
| <b>WLU</b>  | Wait link up state                            |

### 3.5 Common conventions

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

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

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

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

- the request primitive's input parameters;
- the request primitive's output parameters;
- the indication primitive's output parameters;
- the response primitive's input parameters;
- 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.

### 3.6 Additional Type 25 conventions

#### 3.6.1 Primitive conventions

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

|            |                                  |
|------------|----------------------------------|
| <b>req</b> | request primitive                |
| <b>ind</b> | indication primitive             |
| <b>cnf</b> | confirm primitive (confirmation) |
| <b>rsp</b> | response primitive               |

#### 3.6.2 State machine conventions

The protocol sequences are described by means of state machines.

In state diagrams, states are represented as boxes and state transitions are shown as arrows.

Names of states and transitions of the state diagram correspond to the names in the state table. The textual listing of the state transitions is structured as shown in Table 1.

**Table 1 – State transition descriptions**

| # | Current state | Event<br>/condition<br>=> actions | Next state |
|---|---------------|-----------------------------------|------------|
|---|---------------|-----------------------------------|------------|

**Table 2 – Descriptions of state machine elements**

| Description element                 | Meaning                                                                                                                             |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|
| #                                   | Number of the transition.                                                                                                           |
| Current state,<br>Next state        | Names of the originating state and the target state of transition.                                                                  |
| Event                               | Name or description of the trigger event that fire the transition.                                                                  |
| /conditions                         | Boolean expression, which must be true for the transition to be fired.                                                              |
| =>actions                           | List of assignments and service or function invocations. The action should be atomic. The preceding "=>" is not part of the action. |
| NOTE “*/ conditions” may be omitted |                                                                                                                                     |

The conventions used in the state machines are shown in Table 3.

**Table 3 – Conventions used in state machine**

| Convention | Meaning                                                                                   |
|------------|-------------------------------------------------------------------------------------------|
| =          | Substitution of the right side for the left side                                          |
| ==         | A logical condition to indicate an item on the left is equal to an item on the right.     |
| !=         | A logical condition to indicate an item on the left is not equal to an item on the right  |
| <          | A logical condition to indicate an item on the left is less than the item on the right    |
| >          | A logical condition to indicate an item on the left is greater than the item on the right |
| &&         | Logical “AND”                                                                             |
|            | Logical “OR”                                                                              |
| !          | Negation operator                                                                         |
| + – * /    | Arithmetic operator                                                                       |
| ++         | Increment operator                                                                        |
| --         | Decrement operator                                                                        |
| ;          | Breakpoint                                                                                |

## 4 Overview of the DL-protocol

### 4.1 General

A type 25 fieldbus is based on the ISO/IEC 8802-3 standard but extended towards real-time Ethernet. Type 25 network controls the data traffic and assigns frame priorities with IEEE 802.1Q VLAN.

NOTE Any standard Ethernet silicon, infrastructure component or test and measurement equipment such as a network analyzer is applicable to type 25 network.

### 4.2 Overview of the medium access control

#### 4.2.1 General

Type 25 network provides mechanisms to achieve the following.

- It assigns priorities to four types of frames (RCL/Cyclic/Control/Information).
- The frames in type 25 network are guaranteed real-time of cyclic communication to control the data traffic.
- It uses ISO/IEC 8802-3 standard communication without needs for special functions for RTE communication such as time sharing or node synchronization.
- The ring topology is only permitted in type 25 network. In order to control the network, it categorizes the frames into three classes according to their communication ranges.

#### 4.2.2 Network topology

The ring topology shall be use in type 25 network. The network shall be controled and reconfigured by RCL frames. Type 25 ring network does not need concept of master/slave model because each node in type 25 network reconfigures autonomously. To prevent frame loop, one section in the ring network is in the blocking state (IEEE 802.1D) and the blocked section terminates all kinds of frames except RCL frame (as illustrated in Table 2).

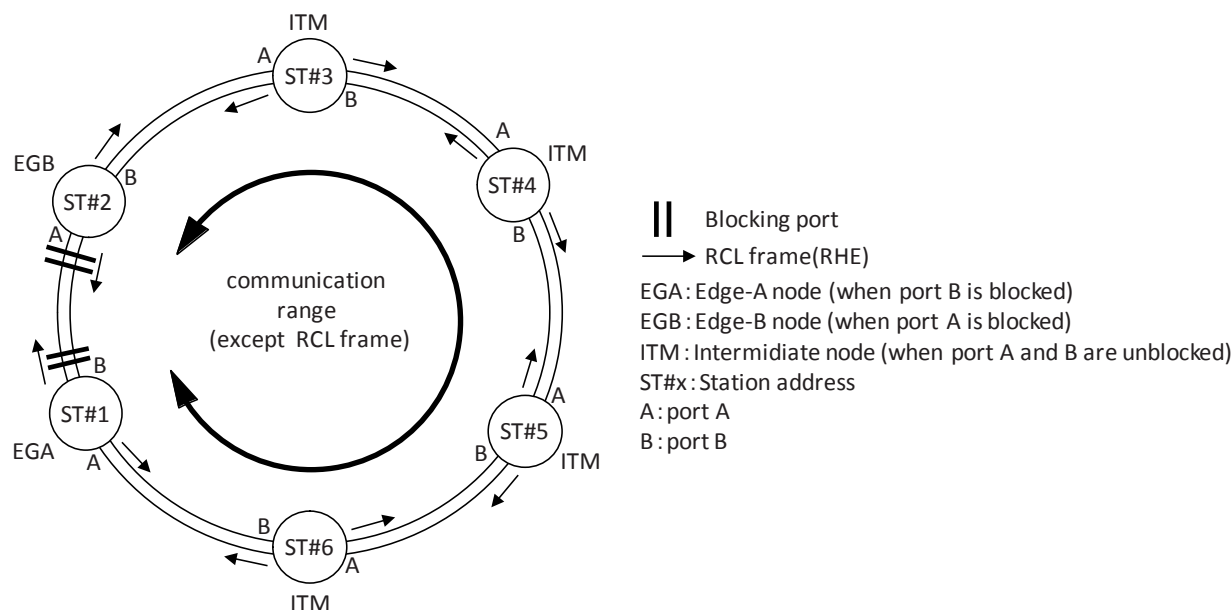


**Figure 2 – Ring control in Type 25 network**

Each node in the ring network has two ports A and B to connect to the neighboring nodes. Each node has its own station address. In type 25 network, each node has four different node states depending on the blocking status of their ports. Table 4 shows the characteristics of the node states.

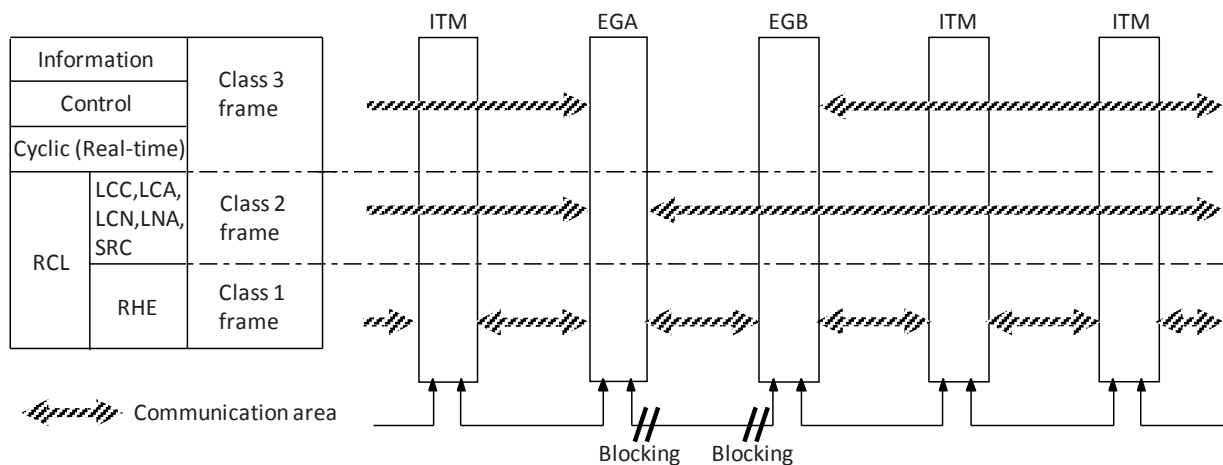
**Table 4 – Characteristics of the node states**

| Node states                                         | Abbreviation | Description                                                                                                                                                                |
|-----------------------------------------------------|--------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Isolated node                                       | ISL          | Both port A and B are blocked in this state (e.g. not connect cables to other nodes) and the node is isolated from the type 25 network.                                    |
| Edge-A node<br>(when port B is blocked)             | EGA          | Port B is blocked, port A is unblocked. The node works with Edge-A. There is only one node in a Type 25 network.                                                           |
| Edge-B node<br>(when port A is blocked)             | EGB          | Port A is blocked, port B is unblocked. The node works with Edge-B. There is only one node in a Type 25 network.                                                           |
| Intermediate node<br>(when port A, B are unblocked) | ITM          | Both port A and B are unblocked. The node works with Edge-A and Edge-B. In a Type 25 network, there are an Edge-A node and an Edge-B node. The other nodes are this state. |

RCL frames are based on general ISO/IEC 8802-3 frames. These frames have different ranges of communication which are given by "class". Table 5 shows the characteristics of the frame class and Figure 3 shows the communication ranges in Type 25 network.

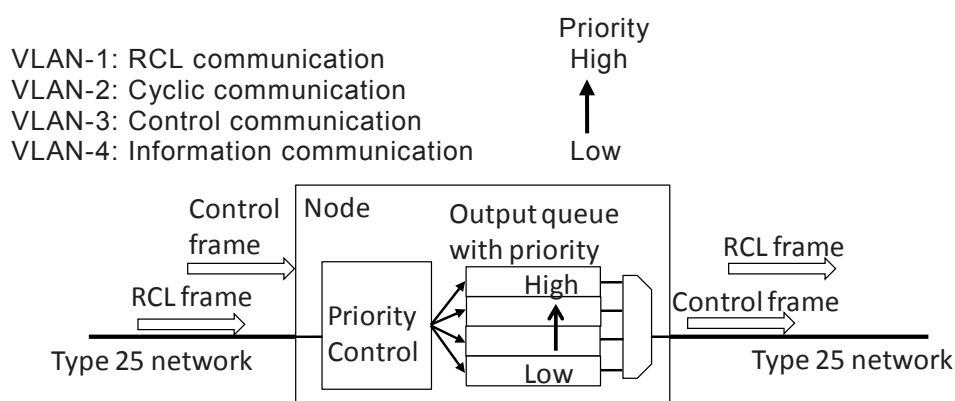
**Table 5 – Characteristic of the frame classes**

| Frame class | Description                                                                                                                                                                                                         |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Class 1     | This frame is used to communicate with the neighboring node only. It passes through blocking ports. RHE frame are RCL frames in this class.                                                                         |
| Class 2     | This frame is used to communicate around the network. This frame is able to pass through blocking ports and the Edge-A node terminates the frames. LCC, LCA, LCN, LNA, and SCR frames are RCL frames in this class. |
| Class 3     | This frame is general Ethernet frame and terminated by blocking ports. The RT frames (Cyclic, Control, Information frames) are in this class.                                                                       |

**Figure 3 – Communication ranges of Type 25 frames**

#### 4.2.3 Priority control with VLAN

The Type 25 fieldbus has a medium access control with VLAN priority in order to provide the real-time communication. Figure 4 shows the mechanism of priority control with VLAN of the Type 25 fieldbus.

**Figure 4 – Priority control with VLAN of Type 25 network**

Each node has output queues with priority. The receiving frames are put into the output queues based on their frame priorities. The frame with higher priority will be forwarded neighboring node. In this mechanism, Type 25 network guarantees real-time cyclic communication.

#### 4.2.4 The maximum delivery delay in Type 25 network

Type 25 network limits data traffic in the network to ensure real time communication. This maintains the communication delay of frames at an acceptable level. The traffic restriction of each node is determined by the total number of nodes in the network and cycle time using the node.

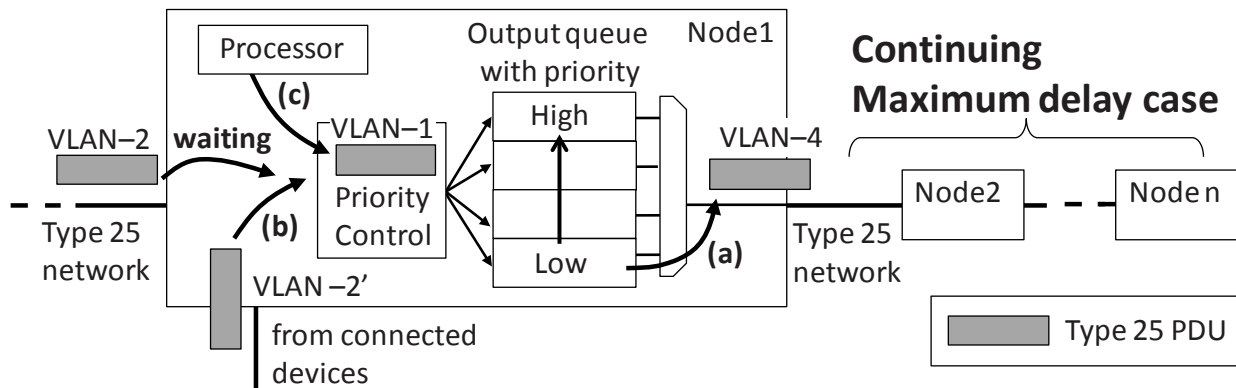


**Figure 5 – The mechanism of transmission delay in a node**

There are three causes of the delay regarding VLAN-2 (cyclic communication) frame in Type 25 network.

- VLAN-2 frame arrives at the time when the node is sending another frame. The VLAN-2 frame is forced to wait until the transmission is finished. This delay is caused by any priority frames.
- Before receiving a VLAN-2 frame, the node receives another VLAN-2 frame (VLAN-2' in Figure 5) from other ports. In this case, at the priority queue the VLAN2 frame is put after the VLAN-2' frame.
- When the VLAN-2 frame is waiting for transmission due to the causes a) and b), the node receives higher priority frames (VLAN-1 frame). Since the node will transmit the highest priority frames first, the VLAN-2 frame is forced to wait until the transmission of higher priority frames are finished.

When three causes happen all at once in a node, the maximum delay occurs. The delivery time could be calculated in the case of the maximum delay occurring at all nodes in a Type 25 network.

#### 4.2.5 Traffic control for real-time communication

Delivery time in Type 25 network is calculated based on the maximum delay time per node, the number of nodes, and the length of ring network.

The maximum delay of real-time communication (cyclic communication) between two nodes is calculated by taking into account the four delay causes shown in Figure 6. The detail of each cause is shown in IEC 61784-2 Profile 20/1.

##### 1) Stacking delay in sending node:

The delay caused by the transmission process. It depends on the implementation of the hardware and software.

##### 2) Cable segment delay:

The delay caused by transmission cable constructing ring network. It is proportional to the cable length.

##### 3) Transmission delay in transit node