BS EN IEC 61158-5-25:2019

BSI Standards Publication

Industrial communication networks - Fieldbus specifications

Part 5-25: Application layer service definition - Type 25 elements

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National foreword

This British Standard is the UK implementation of EN IEC 61158-5-25:2019. It is identical to IEC 61158-5-25:2019.

The UK participation in its preparation was entrusted to Technical Committee GEL/65/3, Industrial communications: process measurement and control, including fieldbus.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 July 2019.

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Date	Text affected

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 61158-5-25

June 2019

ICS 25.040.40; 35.100.70; 35.110

English Version

Industrial communication networks - Fieldbus specifications - Part 5-25: Application layer service definition - Type 25 elements (IEC 61158-5-25:2019)

Réseaux de communication industriels - Spécifications des bus de terrain - Partie 5-25: Définition des services de la couche application - Éléments de type 25 (IEC 61158-5-25:2019)

Industrielle Kommunikationsnetze - Feldbusse - Teil 5-25: Dienstfestlegungen des Application Layer (Anwendungsschicht) - Typ 25-Elemente (IEC 61158-5-25:2019)

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European foreword

The text of document 65C/947/FDIS, future edition 1 of IEC 61158-5-25, prepared by SC 65C "Industrial networks" of IEC/TC 65 "Industrial-process measurement, control and automation" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61158-5-25:2019.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2020-02-23
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2022-05-23

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In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 61158-1:2019 NOTE Harmonized as EN IEC 61158-1:2019 (not modified)

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 61158-3-25	2019	Industrial communication networks - Fieldbus specifications - Part 3-25: Data-link layer service definition - Type X elements	EN IEC 61158-3-25	2019
IEC 61158-6-25	2019	Industrial communication networks – Fieldbus specifications - Part 6-25: Application layer protocol specification – Type 25 elements	EN IEC 61158-6-25	2019
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic reference model: The basic model	-	-
ISO/IEC 8822	-	Information technology - Open Systems Interconnection - Presentation service definition	-	-
ISO/IEC 8824-1	-	Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation	-	-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application layer structure	-	-
ISO/IEC 10731	-	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-25: Application layer service definition – Type 25 elements

FOREWORD

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

FDIS	Report on voting
65C/947/FDIS	65C/950/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.

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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.

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INTRODUCTION

This part of IEC 61158 is one of a series produced to facilitate the interconnection of automation system components. It is related to other standards in the set as defined by the “three-layer” fieldbus reference model described in IEC 61158-1.

The application service is provided by the application protocol making use of the services available from the data-link or other immediately lower layer. This document defines the application service characteristics that fieldbus applications and/or system management may exploit.

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 application layer service defined in this document is a conceptual architectural service, independent of administrative and implementation divisions.

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INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-25: Application layer service definition – Type 25 elements

1 Scope

1.1 Overview

The fieldbus Application Layer (FAL) provides user programs with a means to access the fieldbus communication environment. In this respect, the FAL can be viewed as a “window between corresponding application programs.”

This International Standard provides common elements for basic time-critical and non-time-critical messaging communications between application programs in an automation environment and material specific to Type 25 fieldbus. The term “time-critical” is used to represent the presence of a time-window, within which one or more specified actions are required to be completed with some defined level of certainty. Failure to complete specified actions within the time window risks failure of the applications requesting the actions, with attendant risk to equipment, plant and possibly human life.

This document defines in an abstract way the externally visible service provided by the different Types of the fieldbus Application Layer in terms of

a) an abstract model for defining application resources (objects) capable of being manipulated by users via the use of the FAL service,
b) the primitive actions and events of the service;
c) the parameters associated with each primitive action and event, and the form which they take; and
d) the interrelationship between these actions and events, and their valid sequences.

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

a) the FAL user at the boundary between the user and the Application Layer of the Fieldbus Reference Model, and
b) Systems Management at the boundary between the Application Layer and Systems Management of the Fieldbus Reference Model.

This document specifies the structure and services of the IEC fieldbus Application Layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498-1) and the OSI Application Layer Structure (ISO/IEC 9545).

FAL services and protocols are provided by FAL application-entities (AE) contained within the application processes. The FAL AE is composed of a set of object-oriented Application Service Elements (ASEs) and a Layer Management Entity (LME) that manages the AE. The ASEs provide communication services that operate on a set of related application process object (APO) classes. One of the FAL ASEs is a management ASE that provides a common set of services for the management of the instances of FAL classes.

Although these services specify, from the perspective of applications, how request and responses are issued and delivered, they do not include a specification of what the requesting and responding applications are to do with them. That is, the behavioral aspects of the applications are not specified; only a definition of what requests and responses they

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can send/receive is specified. This permits greater flexibility to the FAL users in standardizing such object behavior. In addition to these services, some supporting services are also defined in this document to provide access to the FAL to control certain aspects of its operation.

1.2 Specification

The principal objective of this document is to specify the characteristics of conceptual application layer services suitable for time-critical communications, and thus supplement the OSI Basic Reference Model in guiding the development of application layer protocols for time-critical communications.

A secondary objective is to provide migration paths from previously-existing industrial communications protocols. It is this latter objective which gives rise to the diversity of services standardized as the various Types of IEC 61158, and the corresponding protocols standardized in subparts of IEC 61158-6.

This specification may be used as the basis for formal Application 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 application layer entities within industrial automation systems.

There is no conformance of equipment to this application layer service definition standard. Instead, conformance is achieved through implementation of conforming application layer protocols that fulfill any given Type of application layer services as 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.

IEC 61158-3-25:2019, *Industrial communication networks – Fieldbus specifications – Part 3-25: Data-link layer service definition – Type 25 elements*

IEC 61158-6-25:2019, *Industrial communication networks – Fieldbus specifications – Part 6-25: Application layer protocol specification – Type 25 elements*

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

ISO/IEC 8822, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 9545, *Information technology – Open Systems Interconnection – Application Layer structure*

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ISO/IEC 8824-1, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

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

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 Referenced terms and definitions

3.1.1 ISO/IEC 7498-1 terms

For the purposes of this document, the following terms given in ISO/IEC 7498-1 apply:

a) application entity;
b) application process;
c) application protocol data unit;
d) application service element;
e) application entity invocation;
f) application process invocation;
g) application transaction;
h) real open system;
i) transfer syntax.

3.1.2 ISO/IEC 8822 terms

For the purposes of this document, the following terms given in ISO/IEC 8822 apply:

a) abstract syntax;
b) presentation context.

3.1.3 ISO/IEC 9545 terms

For the purposes of this document, the following terms given in ISO/IEC 9545 apply:

a) application-association;
b) application-context;
c) application context name;
d) application-entity-invocation;
e) application-entity-type;
f) application-process-invocation;
g) application-process-type;
h) application-service-element;
i) application control service element.

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3.1.4 ISO/IEC 8824-1 terms

For the purposes of this document, the following terms given in ISO/IEC 8824-1 apply:

a) object identifier;

b) type.

3.2 Additional Type 25 terms and definitions

3.2.1
ADP message
message conveyed by an autonomous decentralized system protocol

3.2.2
alive-message
message reporting own node state, periodically transmitted

3.2.3
block
basic unit of data transferred in a cyclic communication, each having a size of 64 bytes

3.2.4
category N_f
category of an autonomous decentralized system protocol in type N with a full specification

3.2.5
category N_l
category of an autonomous decentralized system protocol in type N with a light weight specifications

3.2.6
control communication
acyclic data communication for high time-critical applications in type S network

3.2.7
cyclic communication
periodic data communication for real-time communication

3.2.8
cyclic transfer memory
memory which is allocated to each node in the data field, which each node transmits periodically for the purpose of logical sharing of this memory area

3.2.9
data field
logical place through which specific data passes, corresponding to real networks

3.2.10
domain
administrative set consisting of multiple data fields

3.2.11
duplex LAN
two different network-paths between end nodes

3.2.12
equipment
physical hardware connected to the network

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EXAMPLE Station, device, and server.

3.2.13
information communication
acyclic data communication for low time-critical application in type S network

3.2.14
logical node, node
equipment in data fields where an autonomous decentralized system's function is installed

3.2.15
message mode
identifier that indicates the uses of a message

EXAMPLE Online message or a test message.

3.2.16
multicast group
group of nodes belonging to a data field to determine whether to receive the same data from another node

3.2.17
node list
bit array structure of specifying a node to receive a request data

3.2.18
node mode
identifier that indicates the usage of a node

EXAMPLE Online node or a test node.

3.2.19
primary local area network
local area network (LAN) used in normal state in a duplex LAN system

3.2.20
priority control
transmission order control for the packets arrived from networks, according to the virtual local area network (VLAN)

3.2.21
ring control communication
control for the type S ring network using ring control (RCL) frames

3.2.22
remote control
control for other nodes connected to a network

3.2.23
secondary local area network
local area network (LAN) for backup of a primary LAN in a duplex LAN system

3.2.24
transaction code
information to identify the characteristics of the message within a protocol data unit

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3.3 Symbols and abbreviations

ADP	Autonomous Decentralized Protocol
ADS-net	Autonomous Decentralized System - network
AE	Application Entity
AL	Application Layer
AP	Application Process
APDU	Application Protocol Data Unit
APO	Application Process Object
AR	Application Relationship
AREP	Application Relationship Endpoint
ASCII	American Standard Code for Information Interchange
ASE	Application Service Element
ASN.1	Abstract Syntax Notation 1
CRC	Cyclic Redundancy Check
DF	Data Field
DFN	Data Field Number
DLL	Data-link Layer
DMN	DoMain Number
DMPM	DLL Mapping Protocol Machine
FAL	Fieldbus Application Layer
FSPM	FAL Service Protocol Machine
GMT	Greenwich Mean Time
IP	Internet Protocol
IPv4	Internet Protocol version 4
IPv6	Internet Protocol version 6
LAN	Local area network
LCA	Loop condition alert (type S frame type)
LCC	Loop condition check (type S frame type)
LCN	Loop condition notify (type S frame type)
LLD	Logical link down
LLU	Logical link up
LNA	Loop notify answer (type S frame type)
LNN	Logical Node Number
LSB	Least Significant Bit
MGN	Multicast Group Number
MSB	Most Significant Bit
MTU	Maximum Transmission Unit
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PLD	Physical link down
QoS	Quality-of-service
RCL	Ring control
RHE	Rapid hello (type S frame type)
RT	Real time
SCR	Station condition report (type S frame type)
TCD	Transaction CoDe
TMID	Transfer Memory Identifier

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UDP	User Datagram protocol
VLAN	Virtual local area network

3.4 Conventions

3.4.1 General conventions

Conventions given in IEC 61158-3-25 are also applied in this document.

3.4.2 Conventions for class definitions

Class definitions are defined using templates. Each template consists of a list of attributes and services for the class. The general form of the template is shown below:

FAL ASE:			**ASE Name**
CLASS:			**Class Name**
CLASS ID:			**#**
PARENT CLASS:			**Parent Class Name**
ATTRIBUTES:			
1	(o)	Key Attribute:	numeric identifier
2	(o)	Key Attribute:	name
3	(m)	Attribute:	attribute name (values)
4	(m)	Attribute:	attribute name (values)
4.1	(s)	Attribute:	attribute name (values)
4.2	(s)	Attribute:	attribute name (values)
4.3	(s)	Attribute:	attribute name (values)
5	(c)	Constraint:	constraint expression
5.1	(m)	Attribute:	attribute name (values)
5.2	(o)	Attribute:	attribute name (values)
6	(m)	Attribute:	attribute name (values)
6.1	(s)	Attribute:	attribute name (values)
6.2	(s)	Attribute:	attribute name (values)
SERVICES:			
1	(o)	OpsService:	service name
2	(c)	Constraint:	constraint expression
2.1	(o)	OpsService:	service name
3	(m)	MgtService:	service name

a) The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.

b) The "CLASS:" entry is the name of the class being specified. All objects defined using this template will be an instance of this class. The class may be specified by this document, or by a user of this document.

c) The "CLASS ID:" entry is a number that identifies the class being specified. This number is unique within the FAL ASE that will provide the services for this class. When qualified by the identity of its FAL ASE, it unambiguously identifies the class within the scope of the FAL. The value "NULL" indicates that the class cannot be instantiated. Class IDs between 1 and 255 are reserved by this document to identify standardized classes. They have been assigned to maintain compatibility with existing national standards. CLASS IDs between 256 and 2048 are allocated for identifying user defined classes.

d) The "PARENT CLASS:" entry is the name of the parent class for the class being

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specified. All attributes defined for the parent class and inherited by it are inherited for the class being defined, and therefore do not have to be redefined in the template for this class.

NOTE The parent-class "TOP" indicates that the class being defined is an initial class definition. The parent class TOP is used as a starting point from which all other classes are defined. The use of TOP is reserved for classes defined by this document.

e) The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.

   1) Each of the attribute entries contains a line number in column 1, a mandatory (m) / optional (o) / conditional (c) / selector (s) indicator in column 2, an attribute type label in column 3, a name or a conditional expression in column 4, and optionally a list of enumerated values in column 5. In the column following the list of values, the default value for the attribute may be specified.

   2) Objects are normally identified by a numeric identifier or by an object name, or by both. In the class templates, these key attributes are defined under the key attribute.

   3) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by a period. Nesting is used to specify

      i) fields of a structured attribute (4.1, 4.2, 4.3),

      ii) attributes conditional on a constraint statement (5). Attributes may be mandatory (5.1) or optional (5.2) if the constraint is true. Not all optional attributes require constraint statements as does the attribute defined in (5.2),

      iii) the selection fields of a choice type attribute (6.1 and 6.2).

f) The "SERVICES" label indicates that the following entries are services defined for the class.

   1) An (m) in column 2 indicates that the service is mandatory for the class, while an (o) indicates that it is optional. A (c) in this column indicates that the service is conditional. When all services defined for a class are defined as optional, at least one has to be selected when an instance of the class is defined.

   2) The label "OpsService" designates an operational service (1).

   3) The label "MgtService" designates a management service (2).

   4) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by a period. Nesting within the list of services is used to specify services conditional on a constraint statement.

Subclause 3.4.3 represents additions in the context of their respective IEC document standards.

3.4.3 Conventions for service definitions

3.4.3.1 General

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

3.4.3.2 Service parameters

Service primitives are used to represent service user/service provider interactions (see ISO/IEC 10731). They convey parameters which indicate information available in the user/provider interaction. In any particular interface, not all parameters need be stated explicitly.

The service specifications of this document use a tabular format to describe the component parameters of the ASE service primitives. The parameters which apply to each group of service primitives are set out in tables. Each table consists of up to five columns for the

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a) parameter name,

b) request primitive, (transmitted from the sender),

c) indication primitive, (transmitted to the receiver),

d) response primitive, (transmitted from the receiver), and

e) confirm primitive (transmitted to the sender).

One parameter or component 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 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 dynamic usage of the service 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 service user.

— (blank) parameter is never present.

S parameter is a selected item.

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

1) 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;

2) 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.

3.4.3.3 Service procedure

The procedures are defined in terms of:

- the interactions between application entities through the exchange of fieldbus Application Protocol Data Units, and
- the interactions between an application layer service provider and an application layer service user in the same system through the invocation of application layer service primitives.

These procedures are applicable to instances of communication between systems which support time-constrained communications services within the fieldbus application layer.

4 Concept

The basic concept of application layer services follows Clause 9 of IEC 61158-1.

The FAL defined herein has two primary deployment models. Type S network has characteristics of simple communication protocols, rapid cyclic communication. Type N network has characteristics of high scalability, expandability, and availability from the small network to the large-scale network. Type N network supports large capacity of the cyclic communication. Both types support a distributed memory model as well as client/server models.

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5 Data type ASE

5.1 Overview

The overview of the data type ASE follows IEC 61158-1, Clause 10. The template is used to define the data type for the FAL.

5.2 Fixed length types

5.2.1 Numeric types

5.2.1.1 Integer types

5.2.1.1.1 Integer8

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	2
2	Data type name	=	Integer8
3	Format	=	Fixed length
4.1	Octet length	=	1

This integer type is a two's complement binary number with a length of one octet.

5.2.1.1.2 Integer16

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	3
2	Data type name	=	Integer16
3	Format	=	Fixed length
4.1	Octet length	=	2

This integer type is a two's complement binary number with a length of two octets.

5.2.1.1.3 Integer32

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	4
2	Data type name	=	Integer32
3	Format	=	Fixed length
4.1	Octet length	=	4

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This integer type is a two's complement binary number with a length of four octets.

5.2.1.2 Unsigned types

5.2.1.2.1 Unsigned8

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	5
2	Data type name	=	Unsigned8
3	Format	=	Fixed length
4.1	Octet length	=	1

This type is a binary number with a length of one octet. No sign bit is included. The most significant bit of the most significant octet is always used as the most significant bit of the binary number.

5.2.1.2.2 Unsigned16

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	6
2	Data type name	=	Unsigned16
3	Format	=	Fixed length
4.1	Octet length	=	2

This type is a binary number with a length of two octets. No sign bit is included. The most significant bit of the most significant octet is always used as the most significant bit of the binary number.

5.2.1.2.3 Unsigned32

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	7
2	Data type name	=	Unsigned32
3	Format	=	Fixed length
4.1	Octet length	=	4

This type is a binary number with a length of four octets. No sign bit is included. The most significant bit of the most significant octet is always used as the most significant bit of the binary number.

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5.3 String types

5.3.1 OctetString

FAL ASE:			**Data type ASE**
CLASS:			**Data type**
CLASS ID:			**5**
PARENT CLASS:			**Top**
ATTRIBUTES:			
1	Data type numeric identifier	=	10
2	Data type name	=	OctetString
3	Format	=	string
4.1	Octet length	=	1 to n

This type is with a length of one to n octets. Octet 1 is referred to as the first octet.

6 Communication model specification

6.1 Communication model

6.1.1 General

Two types of communication models are used in FAL Type 25: The cyclic communication model (n:n cyclic model) and the acyclic communication model (client server and push model).

6.1.2 Cyclic communication model

The cyclic communication model is shown in Figure 1 and uses an unconfirmed push model performed periodically.

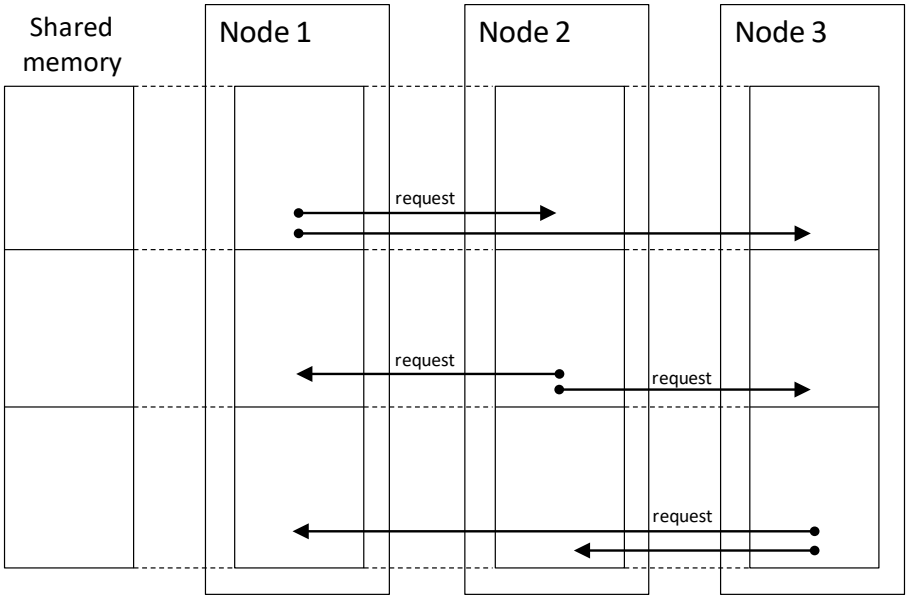

Figure 1 – Cyclic communication model (n:n communication with shared memory)

6.1.3 Acyclic communication model

The acyclic communication model is the client server model shown in Figure 2 and the push model shown in Figure 3.

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