



BSI Standards Publication

Industrial communication networks — Fieldbus specifications

Part 5-10: Application layer service definition — Type 10 elements

National foreword

This British Standard is the UK implementation of EN IEC 61158-5-10:2023. It is identical to IEC 61158-5-10:2023. It supersedes BS EN IEC 61158-5-10:2019, which is withdrawn.

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 committee manager.

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(IEC 61158-5-10:2023)

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(Anwendungsschicht) - Typ 10-Elemente
(IEC 61158-5-10:2023)

This European Standard was approved by CENELEC on 2023-04-28. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

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European foreword

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The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2024-01-28 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2026-04-28 document have to be withdrawn

This document supersedes EN IEC 61158-5-10:2019 and all of its amendments and corrigenda (if any).

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Endorsement notice

The text of the International Standard IEC 61158-5-10:2023 was approved by CENELEC as a European Standard without any modification.

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

IEC/IEEE 60802:— ¹	NOTE Approved as EN IEC 60802:— ² (not modified)
IEC 60870-5-4	NOTE Approved as EN 60870-5-4
IEC 61131-1	NOTE Approved as EN 61131-1
IEC 61375-2-1	NOTE Approved as EN 61375-2-1
IEC 61784-1 (series)	NOTE Approved as EN IEC 61784-1 (series)
IEC 61784-2 (series)	NOTE Approved as EN IEC 61784-2 (series)

¹ Under preparation: Stage at the time of publication: IEC/IEEE CD 60802:2022.

² Under preparation: Stage at the time of publication: prEN IEC 60802:2020.

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.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 61131-3	2013	Programmable controllers - Part 3: Programming languages	EN 61131-3	2013
IEC 61158-1	2023	Industrial communication networks - Fieldbus specifications - Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series	EN IEC 61158-1	2023
IEC 61158-2	2023	Industrial communication networks - Fieldbus specifications - Part 2: Physical layer specification and service definition	EN IEC 61158-2	2023
IEC 61158-5-3	2023	Industrial communication networks - Fieldbus specifications - Part 5-23: Application layer service definition - Type 23 elements	-	-
IEC 61158-6-3	2023	Industrial communication networks - Fieldbus specifications - Part 6-23: Application layer protocol specification - Type 23 elements	-	-
IEC 61158-6-10	2023	Industrial communication networks - Fieldbus specifications - Part 6-10: Application layer protocol specification - Type 10 elements	-	-
IEC 61784-3-3	-	Industrial communication networks - Profiles - Part 3-3: Functional safety fieldbuses - Additional specifications for CPF 3	EN IEC 61784-3-3	-
IEC 61800-7-203	2015	Adjustable speed electrical power drive systems - Part 7-203: Generic interface and use of profiles for power drive systems - Profile type 3 specification	EN 61800-7-203	2016
IEC 62439-2	2021	Industrial communication networks - High availability automation networks - Part 2: Media Redundancy Protocol (MRP)	EN IEC 62439-2	2022
ISO/IEC 646	1991	Information technology - ISO 7-bit coded character set for information interchange	-	-

EN IEC 61158-5-10:2023 (E)

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
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) - Part 1: Specification of basic notation	-	-
ISO/IEC 9545	-	Information technology - Open Systems Interconnection - Application layer structure	-	-
ISO/IEC 9834-8	-	Information technology - Procedures for the operation of object identifier registration authorities - Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers	-	-
ISO/IEC 10646	-	Information technology - Universal coded character set (UCS)	-	-
ISO/IEC 10731	-	Information technology - Open Systems Interconnection - Basic Reference Model - Conventions for the definition of OSI services	-	-
ISO/IEC/IEEE 60559	2020	Information technology - Microprocessor Systems - Floating-Point arithmetic	-	-
ISO 8601-1	2019	Date and time - Representations for information interchange - Part 1: Basic rules	-	-
IEEE 802.1AB	2016	IEEE Standard for Local and metropolitan area networks - Station and Media Access Control Connectivity Discovery	-	-
IEEE 802.1AS	2020	IEEE Standard for Local and Metropolitan Area Networks - Timing and Synchronization for Time-Sensitive Applications	-	-
IEEE 802.1CB	2017	IEEE Standard for Local and metropolitan area networks - Frame Replication and Elimination for Reliability	-	-
IEEE Std 802.1Q	2018	IEEE Standard for Local and metropolitan area networks - Media Access Control (MAC) Bridges and Virtual Bridged Local Area Networks	-	-
IEEE 802.3	2018	IEEE Standard for Ethernet	-	-
IETF RFC 768	1980	User Datagram Protocol	-	-
IETF RFC 791	1981	Internet Protocol Darpa Internet Program Protocol Specification	-	-
IETF RFC 792	1981	Internet Control Message Protocol	-	-
IETF RFC 826	1982	Ethernet Address Resolution Protocol: Or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware	-	-
IETF RFC 894	1984	Standard for the Transmission of IP Datagrams over Ethernet Networks	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IETF RFC 1034	1987	Domain names - concepts and facilities	-	-
IETF RFC 1112	1989	Host Extensions for IP multicasting	-	-
IETF RFC 1157	1990	Simple Network Management Protocol (SNMP)	-	-
IETF RFC 1213	1991	Management Information Base for Network Management of TCP/IP-based Internets: MIB-II	-	-
IETF RFC 2131	1997	Dynamic Host Configuration Protocol	-	-
IETF RFC 2132	1997	DHCP Options and BOOTP Vendor Extensions	-	-
IETF RFC 2365	1998	Administratively Scoped IP Multicast	-	-
IETF RFC 2674	1999	Definitions of Managed Objects for Bridges with Traffic Classes, Multicast Filtering and Virtual LAN Extensions	-	-
IETF RFC 2737	1999	Entity MIB (Version 2)	-	-
IETF RFC 2863	2000	The Interfaces Group MIB	-	-
IETF RFC 3418	2002	Management Information Base (MIB) for the Simple Network Management Protocol (SNMP)	-	-
IETF RFC 3490	2003	Internationalizing Domain Names in Applications (IDNA)	-	-
IETF RFC 3621	2003	Power Ethernet MIB	-	-
IETF RFC 4836	2007	Definitions of Managed Objects for IEEE 802.3 Medium Attachment Units (MAUs)	-	-
IETF RFC 5905	2010	Network Time Protocol Version 4: Protocol and Algorithms Specification	-	-
IETF RFC 6020	2010	A Data Modeling Language for the Network Configuration Protocol (NETCONF)	-	-
IETF RFC 6241	2011	Network Configuration Protocol (NETCONF)	-	-
IETF RFC 6890	2013	Special-Purpose IP Address Registries	-	-
The Open Group - Publication C706	-	Technical Standard DCE1.1: Remote Procedure Call	-	-
Metro Ethernet Forum - MEF 10.4	2018	Subscriber Ethernet Service Attributes	-	-

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**INDUSTRIAL COMMUNICATION NETWORKS –
FIELDBUS SPECIFICATIONS –****Part 5-10: Application layer service definition –
Type 10 elements****FOREWORD**

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IEC 61158-5-10 has been prepared by subcommittee 65C: Industrial networks, of IEC technical committee 65: Industrial-process measurement, control and automation. It is an International Standard.

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

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

- a) integration of system redundancy basic functionality;
- b) integration of dynamic reconfiguration basic functionality;
- c) integration of reporting system basic functionality;
- d) integration of asset management basic functionality;

e) integration of media redundancy ring interconnection basic functionality.

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

Draft	Report on voting
65C/1203/FDIS	65C/1244/RVD

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

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

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

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

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

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

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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 can 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.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 5-10: Application layer service definition – Type 10 elements

1 Scope

1.1 General

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 part of IEC 61158 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 10 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 Type 10 fieldbus application layer in terms of:

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

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

- the FAL user at the boundary between the user and the application layer of the fieldbus reference model, and
- 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 Type 10 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 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 Specifications

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 document can 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 the Type 10 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 the IEC 61784-1 series and the IEC 61784-2 series are maintained simultaneously. Cross-references to these documents within the text therefore refer to the editions as dated in this list of normative references.

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IEC 61158-1:2023, *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61158-2:2023, *Industrial communication networks – Fieldbus specifications – Part 2: Physical layer specification and service definition*

IEC 61158-5-3:2023, *Industrial communication networks – Fieldbus specifications – Part 5-3: Application layer service definition – Type 3 elements*

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ISO/IEC 9834-8, *Information technology – Procedures for the operation of object identifier registration authorities – Part 8: Generation of universally unique identifiers (UUIDs) and their use in object identifiers*

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IEEE Std 802.1AB-2016, *IEEE Standard for Local and metropolitan area networks: Station and Media Access Control Connectivity Discovery*

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IEEE Std 802.1CB-2017, *IEEE Standard for Local and metropolitan area networks – Frame Replication and Elimination for Reliability*

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3 Terms, definitions, abbreviated terms, symbols and conventions

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

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

- IEC Electropedia: available at <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 as defined 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 as defined 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 as defined 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

3.1.4 ISO/IEC 8824-1 terms

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

- a) object identifier
- b) type

3.2 Additional Type 10 terms and definitions

3.2.1

alarm

activation of an event that shows a critical state

3.2.2

alarm ack

acknowledgment of an event that shows a critical state

3.2.3

alarm data object

object(s) which represent(s) critical states referenced by device/API/slot/subslot/alarm type

3.2.4

allocate

take a resource from a common area and assign that resource for the exclusive use of a specific entity

3.2.5

application

function or data structure for which data is consumed or produced

3.2.6

application layer interoperability

capability of application entities to perform coordinated and cooperative operations using the services of the FAL

3.2.7

application objects

multiple object classes that manage and provide a runtime exchange of Protocol Data Units (PDUs) across the network and within the network device

3.2.8

application process

part of a distributed application on a network, which is located on one device and unambiguously addressed

3.2.9

application process identifier

attribute that identifies an application process used in a device

3.2.10

application process object

component of an application process that is identifiable and accessible through an FAL application relationship

Note 1 to entry: Application process object definitions are composed of a set of values for the attributes of their class (see the definition for Application Process Object Class Definition). Application process object definitions may be accessed remotely using the services of the FAL Object Management ASE. FAL Object Management services can be used to load or update object definitions, to read object definitions, and to dynamically create and delete application process objects and their corresponding definitions.

3.2.11

application process object class

class of application process objects defined in terms of the set of their network-accessible attributes and services

3.2.12

application relationship

cooperative association between two or more application-entity-invocations for the purpose of exchange of information and coordination of their joint operation

Note 1 to entry: This relationship is activated either by the exchange of application-protocol-data-units or as a result of preconfiguration activities

3.2.13

application relationship application service element

application-service-element that provides the exclusive means for establishing and terminating all application relationships

3.2.14

application relationship endpoint

context and behavior of an application relationship as seen and maintained by one of the application processes involved in the application relationship

Note 1 to entry: Each application process involved in the application relationship maintains its own application relationship endpoint.

3.2.15**attribute**

description of an externally visible characteristic or feature of an object

Note 1 to entry: The attributes of an object contain information about variable portions of an object. Typically, they provide status information or govern the operation of an object. Attributes can also affect the behavior of an object. Attributes are divided into class attributes and instance attributes.

3.2.16**backup**

status of the Input Output Application Relationship (IO AR) which indicates that it is in the backup state

Note 1 to entry: An IO AR needs to be established to enter backup state.

3.2.17**behavior**

indication of how an object responds to particular events

3.2.18**channel**

representation of a single physical or logical link of an input or output application object of a server to the process in order to support addressing of diagnosis information

Note 1 to entry: The channel typically represents a single connector or clamp as a physical interface of a module or submodule. This reference is used to identify points of failure within diagnosis PDUs.

3.2.19**channel diagnosis**

information concerning a specific element of an input or output application object, provided for maintenance purposes

EXAMPLE Wire break

3.2.20**class**

set of objects, all of which represent the same kind of system component

Note 1 to entry: A class is a generalization of an object; a template for defining variables and methods. All objects in a class are identical in form and behavior, but usually contain different data in their attributes.

3.2.21**class attributes**

attribute that is shared by all objects within the same class

3.2.22**class code**

unique identifier assigned to each object class

3.2.23**class specific service**

service defined by a particular object class to perform a required function which is not performed by a common service

Note 1 to entry: A class specific object is unique to the object class which defines it.

3.2.24**clear**

status of the IO controller which indicates that the control algorithm is currently not running

3.2.25

client

<client server> initiator of a PDU to which a server reacts

3.2.26

common profile

collection of device independent information and functionality providing consistency between all devices

3.2.27

communication data object

object(s) which is(are) parameter(s) of communication relationships and referenced by device/ slot/ subslot/ index

3.2.28

configuration check

comparison of the expected IO-Data object structuring of the client with the real IO-Data object structuring to the server in the start-up phase

3.2.29

configuration fault

unacceptable difference between the expected IO-Data object structuring and the real IO-Data object structuring, as detected by the server

3.2.30

configuration identifier

representation of a portion of IO Data of a single input- and/or output-module of a server

3.2.31

consume

act of receiving data from a provider

3.2.32

consumer

node or sink receiving data from a provider

3.2.33

context management

network-accessible information (communication objects) that supports managing the operation of the fieldbus system, including the application layer

Note 1 to entry: Managing includes functions such as controlling, monitoring and diagnosing.

3.2.34

conveyance path

unidirectional flow of Application Protocol Data Units (APDUs) in an application relationship

3.2.35

credential

Information that an entity (a person or device) possesses that allow it to make a verifiable claim of identity, i.e., to be authenticated.

Note 1 to entry: In this document, IDevIDs and LDevIDs are credentials.

3.2.36

cyclic

repetitive in a regular manner

3.2.37**data consistency**

means for coherent transmission and access of the input- or output-data object between and within client and server

3.2.38**device**

physical hardware connected to the link

Note 1 to entry: A device can contain more than one node.

3.2.39**device ID**

vendor assigned device type identification

3.2.40**device profile**

collection of device dependent information and functionality providing consistency between similar devices of the same device type

3.2.41**diagnosis data object**

object(s) which contain(s) diagnosis information referenced by device /API/ slot/ subslot/ index

3.2.42**diagnosis information**

all data available at the server for maintenance purposes

3.2.43**dynamic reconfiguration**

change of IO data objects without interruption of an established application relationship and continuous updating of non-changed IO data objects

3.2.44**endpoint**

one of the communicating entities involved in a connection

3.2.45**engineering**

abstract term that characterizes the client application or device responsible for configuring an automation system

3.2.46**error**

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

3.2.47**error class**

general grouping of related error definitions and corresponding error codes

3.2.48**error code**

identification of a specific type of error within an error class

3.2.49**event**

instance of a change of conditions

3.2.50

extended channel diagnosis

information concerning a specific element of a specific application object, provided for maintenance purposes

EXAMPLE Link Fail

3.2.51

fast startup

accelerated procedure to setup an IO device after a power cycle

3.2.52

frame

unit of data transmission on an IEEE Std 802 Local Area Network (LAN) that conveys a Media Access Control (MAC) Protocol Data Unit (MPDU)

3.2.53

identification data object

object(s) that contain(s) information about device, module and submodule manufacturer and type referenced by device/ API/ slot/ subslot/ index

3.2.54

implicit AR endpoint

AR endpoint that is defined locally within a device without use of the Create service

3.2.55

index

address of a record data object within an application process

3.2.56

instance

actual physical occurrence of an object within a class that identifies one of many objects within the same object class

3.2.57

instance attributes

attribute that is unique to an object instance and not shared by the object class

3.2.58

instantiated

object instance that has been created in a device

3.2.59

invocation

act of using a service or other resource of an application process

Note 1 to entry: Each invocation represents a separate thread of control that can be described by its context. Once the service completes, or use of the resource is released, the invocation ceases to exist. For service invocations, a service that has been initiated but not yet completed is referred to as an outstanding service invocation. Also for service invocations, an Invoke ID can be used to unambiguously identify the service invocation and differentiate it from other outstanding service invocations.

3.2.60

IO controller

controlling device, which acts as client for several IO devices (field devices)

Note 1 to entry: This is usually a programmable controller or a distributed control system.

3.2.61**IO data object**

object designated to be transferred cyclically for the purpose of processing and referenced by device/API/slot/subslot

3.2.62**IO device**

field device which acts as server for IO operation

3.2.63**IO parameter server**

server for application parameters of IO devices (client)

Note 1 to entry: This is usually a device to backup parameter data and to log online changes of device parameters.

3.2.64**IO subsystem**

subsystem composed of one IO controller and all its associated IO devices

3.2.65**IO supervisor**

engineering device which manages commissioning and diagnosis of an IO system

3.2.66**IO system**

system composed of all its IO subsystems

Note 1 to entry: As an example, a PLC with more than one IO controller (network interface) controls one IO system composed of an IO subsystem for each IO controller.

3.2.67**Isochronous mode**

IO system operating tightly synchronized with a jitter of less than 1 μ s

3.2.68**member**

piece of an attribute that is structured as an element of an array

3.2.69**method**

synonym for an operational service which is provided by the server ASE and invoked by a client

3.2.70**module**

hardware or logical component of a physical device

3.2.71**network**

set of nodes connected by some type of communication medium, including any intervening repeaters, bridges, routers and lower-layer gateways

3.2.72**object**

abstract representation of a particular component within a device, usually a collection of related data (in the form of variables) and methods (procedures) for operating on that data that have a clearly defined interface and behavior

3.2.73

object specific service

service unique to the object class which defines it

3.2.74

operate

status of the IO controller that indicates that the control algorithm is currently running

3.2.75

peer

role of an AR endpoint in which it is capable of acting as both client and server

3.2.76

physical device

automation or other network device

3.2.77

point-to-point connection

connection that exists between exactly two application objects

3.2.78

primary

status of the IO AR that indicates that it is in the operating state

Note 1 to entry: Besides a primary IO AR a backup IO AR may exist. For example used for redundancy and dynamic reconfiguration of IO data.

3.2.79

provider

node or source sending data to one or many consumer

3.2.80

PTCP domain

certain number of PTCP subdomains in one IP subnet

3.2.81

PTCP subdomain

certain amount of DTEs with synchronized clocks

3.2.82

record data object

object(s) which are already pre-processed and transferred acyclically for the purpose of information or further processing and referenced by device/API/slot/subslot/index

3.2.83

resource

processing or information capability

3.2.84

run

status of the IO controller which indicates that the control algorithm is currently operating

3.2.85

server

<client server> object which provides services to another (client) object

3.2.86**service**

operation or function that an object and/or object class performs upon a request from another object and/or object class

3.2.87**slot**

address of a structural unit within an IO device

Note 1 to entry: Within a modular device, a slot typically addresses a physical module. Within compact devices, a slot typically addresses a logical function or virtual module.

3.2.88**stop**

status of the IO controller which indicates that the control algorithm is currently not running

3.2.89**submodule**

hardware or logical component of a module

3.2.90**subslot**

address of a structural unit within a slot

Note 1 to entry: A subslot can address a physical interface for submodules within a module. Generally, a subslot is a second level to structure data within a device.

3.2.91**vendor ID**

central administrative number used as manufacturer identification

3.3 Additional Type 10 terms and definitions for media redundancy**3.3.1****failure**

termination of the ability of an item to perform a required function

Note 1 to entry: After failure the item has a fault.

Note 2 to entry: “Failure” is an event, as distinguished from “fault”, which is a state.

Note 3 to entry: This concept as defined does not apply to items considering of software only.

3.3.2**fault**

state of an item characterized by its inability to perform a required function, excluding the inability during preventive maintenance or other planned actions, or due to lack of external resources

Note 1 to entry: A fault is often the result of a failure of the item itself, but can exist without prior failure.

3.3.3**recovery**

event when the item regains the ability to perform a required function, after a fault

3.3.4**recovery time**

time period required for recovery

3.3.5

redundancy

existence in an item of two or more means of performing a required function

Note 1 to entry: In this context, the existence of more than one path (consisting of links and switches) between end nodes.

3.3.6

ring

network where each node is connected in series to two other nodes

Note 1 to entry: Nodes are connected to one another in the logical shape of a circle.

Note 2 to entry: Frames are passed sequentially between active nodes, each able to examine or modify the frame before forwarding it.

3.3.7

ringport

port of a switch to which a ring link is attached

3.3.8

ring link

link that connects two switches of a ring

3.3.9

switch node

MAC bridge as defined in IEEE Std 802.1Q

Note 1 to entry: It is called “switch” in this context.

3.4 Abbreviations and symbols

3.4.1 General

AE	Application Entity
AL	Application Layer
ALME	Application Layer Management Entity
ALP	Application Layer Protocol
AP	Application Process
APDU	Application Protocol Data Unit
API	Application Process Identifier
APMR	Acyclic Protocol Machine Receiver
APMS	Acyclic Protocol Machine Sender
APO	Application Process Object
AR	Application Relationship
AREP	Application Relationship End Point

ARL	Application Relationship List
ASE	Application Service Element
BMA	Best Master Algorithm
BMP	Basic Multilingual Page
CID	Connection ID
CIM	Communication Interface Management
CIP	Control and Information Protocol
CNC	Centralized Network Configuration
CR	Communication Relationship
CRC	Cyclic Redundancy Check
CREP	Communication Relationship End Point
CTL SM	Controller state machine
DEV SM	Device state machine
DIAG_DIAG	Diagnosis entry state machine
DIAG_MD	Maintenance demanded entry state machine
DIAG_MR	Maintenance required entry state machine
DIAG_QUALIFIED	Qualified entry state machine
DL-	(as a prefix) Data Link-
DLC	Data Link Connection
DLL	Data Link Layer
DLSAP	Data Link Service Access Point
DNS	Domain Name System
DP	Decentralized Peripherals
FAL	Fieldbus Application Layer
FIFO	First In First Out
FODIAG	Fiber Optic Diagnosis

FOMD	Fiber Optic Maintenance Demanded
FOMR	Fiber Optic Maintenance Required
Gbps	Gigabits per second
HMI	Human Machine Interface
ID	Identifier
IEC	International Electrotechnical Commission
IP	Internet Protocol
ISO	International Organization for Standardization
LLC	Logical Link Control
LME	Layer Management Entity
LOC_LNK	Local Link
MAU	Medium Attachment Unit
Mbps	Megabits per second
MIB	Management Information Base
MRA	Media Redundancy Manager (auto negotiation)
MRC	Media Redundancy Client
MRM	Media Redundancy Manager
MRP	Media Redundancy Protocol
MRPD	Media Redundancy with Planned Duplication of frames
ns	Nano second
OSI	Open Systems Interconnect
OWNSM	Ownership Submodule
PDev	Physical Device
PDU	Protocol Data Unit
PL	Physical Layer
PLUGSM	Plug State Machine

PULLSM	Pull State Machine
ps	Pico second
REM_CHK	Remote check (neighborhood check)
REP	Route Endpoint
RSMSM	Real Submodule State Machine
SAP	Service Access Point
SCL	Security Level
SDU	Service Data Unit
SEM	State Event Matrix
SMIB	System Management Information Base
SMK	System Management Kernel
SNMP	Simple Network Management Protocol
STD	State Transition Diagram, used to describe object behavior
S-VFD	Simple Virtual Field Device
SYNC_DIAG	Synchronization Diagnosis
TSN	Time Sensitive Network
UTC	Universal Time Coordinated

3.4.2 Additional Type 10 abbreviations and symbols

ACD	Access Control Decision
ACK	Acknowledged
ALPMI	Alarm Protocol Machine Initiator
ALPMR	Alarm Protocol Machine Responder
ARP	Address Resolution Protocol
BBUU	Buffer Buffer Unconfirmed Unidirectional
BBUU-OM	Buffer Buffer Unconfirmed Unidirectional – One to Many
BMC	Best Master Clock

BNME	Best Network Management Engine
CL-RPC	Connectionless Remote Procedure Call
CM	Context Management
CMDEV	Context Management Protocol Machine Device
CMDEV_DA	Context Management Device Access Protocol Machine Device
CMCTL	Context Management Protocol Machine Controller
CMCTL_DA	Context Management Device Access Protocol Machine Controller
COC	Combined object container
CPM	Cyclic Consumer Protocol Machine
CRV	Credential Vault
DCE	OSF Distributed Computing Environment
DCP	Discovery and basic Configuration Protocol
DHCP	Dynamic Host Configuration Protocol
DLPDU	Data Link-Protocol Data Unit
DTE	Data Terminal Equipment
GSDML	General Station Description Markup Language
I&M	Identification and Maintenance Profile
IANA	Internet Assigned Numbers Authority
ICMP	Internet Control Message Protocol
IDNA	Internationalizing Domain Names in Applications
IOCR	Input Output Communication Relation
IOCS	Input Output Object Consumer Status
IOPS	Input Output Object Provider Status
IR	Isochronous Relay
IRT	Isochronous Real Time Protocol
ISO	International Organization for Standardization

IsoM	Isochronous Mode
ISOM_IN	Isochronous Mode Input Data state machine
ISOM_OUT	Isochronous Mode Output Data state machine
ISOM_SYNC	Isochronous Mode Sync state machine
LED	Light Emitting Diode
LLDP	Link Layer Discovery Protocol
LME	Layer Management Entity
lsb	Least Significant Bit
LT	Length/Type
MAC	Medium Access Control
MCR	Multicast Communication Relation
msb	Most Significant Bit
NCA	Network Computing Architecture
NCE	Network Configuration Engine
NME	Network Management Engine
NUE	Network Update Engine
PCE	Path Compute Engine
PL	Physical Layer
PPM	Cyclic Provider Protocol Machine
PRO	Protection
PTCP	Precision Transparent Clock Protocol
QQCB-CL	Queue Queue Confirmed Bi-directional – Connectionless
QQCB-CO	Queue Queue Confirmed Bi-directional – Connection-Oriented
RAZ	Role Authorization
RPC	Remote Procedure Call
RT	Real Time

RTA	Real Time Protocol Acyclic
RTC	Real Time Protocol Cyclic
RTC3PSM	Realtime Class 3 Port State Machine
SAM	Security Association Management
SAV	Security Association Vault
SCM	Site Credential Management
TCI	VLAN Tag Control Information
TDE	Topology Discovery Engine
TLV	Type Length Value (coding rule)
UDP	User Datagram Protocol
UUID	Universally Unique Identifier
VLAN	Virtual Local Area Network
VLAN ID	Virtual Local Area Network Identifier (see also IEEE Std 802.1Q VID)

3.4.3 Abbreviations and symbols for services

cnf	Confirmation
ind	Indication
req	Request
rsp	Response

3.4.4 Void

Intentionally left blank.

3.5 Conventions

3.5.1 Overview

The FAL is defined as a set of object-oriented ASEs. Each ASE is specified in a separate subclause. Each ASE specification is composed of two parts, its class specification, and its service specification.

The class specification defines the attributes of the class. The attributes are accessible from instances of the class using the Object Management ASE services specified in Clause 5 of this document. The service specification defines the services that are provided by the ASE.

3.5.2 General conventions

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

3.5.3 Conventions for class definitions

Class definitions are described using templates. Each template consists of a list of attributes 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

- 1) The "FAL ASE:" entry is the name of the FAL ASE that provides the services for the class being specified.
- 2) 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.
- 3) 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 2 048 are allocated for identifying user defined classes.
- 4) The "PARENT CLASS:" entry is the name of the parent class for the class being 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.

- 5) The "ATTRIBUTES" label indicate that the following entries are attributes defined for the class.
 - a) 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.
 - b) 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.
 - c) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by 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).
- 6) The "SERVICES" label indicates that the following entries are services defined for the class.
 - a) 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 shall be selected when an instance of the class is defined.
 - b) The label "OpsService" designates an operational service (1).
 - c) The label "MgtService" designates a management service (2).
 - d) The line number defines the sequence and the level of nesting of the line. Each nesting level is identified by period. Nesting within the list of services is used to specify services conditional on a constraint statement.

Attributes and services are addressed with the following syntax:

- ASE:class:attribute
- ASE::attribute (if ASE contains only one class with same name)
- ASE:class:service():parameter
- ASE::service():parameter (if ASE contains only one class with same name)

Among other things, this is used for relation definitions.

3.5.4 Conventions for service definitions

3.5.4.1 General

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

3.5.4.2 Service parameters

Service primitives are used to represent service user/service provider interactions (see ISO/IEC 10731). These services convey parameters which indicate information available in the user/provider interaction. Not all parameters need be explicitly stated for an interface.

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

- a) parameter name,
- b) request primitive,

- c) indication primitive,
- d) response primitive, and
- e) confirm primitive.

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 can be provided or not depending on dynamic usage of the service user. This does not imply that the support of the parameter is optional. 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.

3.5.4.3 Service procedures

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 services get a “local” prefix in this document.

These procedures are applicable to instances of communication between systems which support time-constrained communications services within the Fieldbus Application Layer.

Interactions between the ASEs in the same layer are not shown here.

3.5.5 Conventions used in state machines

The same conventions apply as defined in IEC 61158-6-10, Clause 3 “Conventions used in state machines”.

4 Concepts

IEC 61158-1, Clause 9 describes the concepts of the application layer service descriptions and the templates used in this document.