

BS EN 61158-6-9:2014



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Industrial communication networks — Fieldbus specifications

Part 6-9: Application layer protocol specification — Type 9 elements

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National foreword

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Part 6-9: Application layer protocol specification - Type 9
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(IEC 61158-6-9:2014)

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couche application - Éléments de type 9
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Protokollspezifikation des Application Layer
(Anwendungsschicht) - Typ 9-Elemente
(IEC 61158-6-9:2014)

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Foreword

The text of document 65C/764/FDIS, future edition 3 of IEC 61158-6-9, 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 61158-6-9:2014.

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This document supersedes EN 61158-6-9:2012.

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Endorsement notice

The text of the International Standard IEC 61158-6-9:2014 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 standards indicated:

IEC 61784-1	NOTE	Harmonized as EN 61784-1.
IEC 61784-2	NOTE	Harmonized as EN 61784-2.

Annex ZA

(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When 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 61158-1	-	Industrial communication networks - Fieldbus specifications - Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series	EN 61158-1	-
IEC 61158-3-1	-	Industrial communication networks - Fieldbus specifications - Part 3-1: Data-link layer service definition - Type 1 elements	EN 61158-3-1	-
IEC 61158-4-1	-	Industrial communication networks - Fieldbus specifications - Part 4-1: Data-link layer protocol specification - Type 1 elements	EN 61158-4-1	-
IEC 61158-5-5	-	Industrial communication networks - Fieldbus specifications - Part 5-5: Application layer service definition - Type 5 elements	EN 61158-5-5	-
IEC 61158-5-9	-	Industrial communication networks - Fieldbus specifications - Part 5-9: Application layer service definition - Type 9 elements	EN 61158-5-9	-
ISO/IEC 646	-	Information technology - ISO 7-bit coded character set for information interchange	-	-
ISO/IEC 7498-1	-	Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model	-	-
ISO/IEC 8824-1	-	Information technology - Abstract Syntax Notation One (ASN.1): Specification of basic notation	-	-

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
ISO/IEC 8825-1	-	Information technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)	-	-
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	-	-
ISO/IEC/IEEE 60559	-	Information technology - Microprocessor Systems - Floating-Point arithmetic	-	-

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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 protocol provides the application service by making use of the services available from the data-link or other immediately lower layer. The primary aim of this standard is to provide a set of rules for communication expressed in terms of the procedures to be carried out by peer application entities (AEs) at the time of communication. These rules for communication are intended to provide a sound basis for development in order to serve a variety of purposes:

- as a guide for implementors and designers;
- for use in the testing and procurement of equipment;
- as part of an agreement for the admittance of systems into the open systems environment;
- as a refinement to the understanding of time-critical communications within OSI.

This standard is concerned, in particular, with the communication and interworking of sensors, effectors and other automation devices. By using this standard together with other standards positioned within the OSI or fieldbus reference models, otherwise incompatible systems may work together in any combination.

INDUSTRIAL COMMUNICATION NETWORKS – FIELDBUS SPECIFICATIONS –

Part 6-9: Application layer protocol specification – Type 9 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 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 9 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 standard defines in an abstract way the externally visible behavior provided by the Type 9 fieldbus Application Layer in terms of

- a) the abstract syntax defining the application layer protocol data units conveyed between communicating application entities,
- b) the transfer syntax defining the application layer protocol data units conveyed between communicating application entities,
- c) the application context state machine defining the application service behavior visible between communicating application entities; and
- d) the application relationship state machines defining the communication behavior visible between communicating application entities; and.

The purpose of this standard is to define the protocol provided to

- 1) define the wire-representation of the service primitives defined in IEC 61158-5-9, and
- 2) define the externally visible behavior associated with their transfer.

This standard specifies the protocol of the Type 9 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).

1.2 Specifications

The principal objective of this standard is to specify the syntax and behavior of the application layer protocol that conveys the application layer services defined in IEC 61158-5-9.

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 protocols standardized in IEC 61158-6.

1.3 Conformance

This standard does not specify individual implementations or products, nor does it constrain the implementations of application layer entities within industrial automation systems. Conformance is achieved through implementation of this application layer protocol specification.

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.

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

IEC 61158-3-1, *Industrial communication networks – Fieldbus specifications – Part 3-1: Data-link layer service definition – Type 1 elements*

IEC 61158-4-1, *Industrial communication networks – Fieldbus specifications – Part 4-1: Data-link layer protocol specification – Type 1 elements*

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

IEC 61158-5-9, *Industrial communication networks – Fieldbus specifications – Part 5-9: Application layer service definition – Type 9 elements*

ISO/IEC 646, *Information technology – ISO 7-bit coded character set for information interchange*

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

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

ISO/IEC 8825-1, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

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*

ISO/IEC/IEEE 60559, *Information technology – Microprocessor Systems – Floating-Point arithmetic*

3 Terms, definitions, symbols, abbreviations and conventions

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

3.1 Terms and definitions from other ISO/IEC standards

3.1.1 Terms and definitions from ISO/IEC 7498-1

- a) abstract syntax
- b) application entity
- c) application process
- d) application protocol data unit
- e) application service element
- f) application entity invocation
- g) application process invocation
- h) application transaction
- i) presentation context
- j) real open system
- k) transfer syntax

3.1.2 Terms and definitions from ISO/IEC 9545

- 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

3.1.3 Terms and definitions from ISO/IEC 8824-1

- a) object identifier
- b) type
- c) value
- d) simple type
- e) structured type
- f) component type
- g) tag
- h) Boolean type
- i) true
- j) false
- k) integer type
- l) bitstring type
- m) octetstring type
- n) null type
- o) sequence type
- p) sequence of type
- q) choice type
- r) tagged type
- s) any type
- t) module
- u) production

3.1.4 Terms and definitions from ISO/IEC 8825-1

- a) encoding (of a data value)
- b) data value
- c) identifier octets (the singular form is used in this standard)
- d) length octet(s) (both singular and plural forms are used in this standard)
- e) contents octets

3.2 IEC 61158-1 terms

For the purposes of the present document, the following IEC 61158-1 terms apply.

3.2.1

application

function or data structure for which data is consumed or produced

3.2.2

application layer interoperability

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

3.2.3

application object

object class that manages and provides the run time exchange of messages across the network and within the network device

Note 1 to entry: Multiple types of application object classes may be defined.

3.2.4

application process

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

3.2.5

application process identifier

distinguishes multiple application processes used in a device

3.2.6

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 objects and their corresponding definitions.

3.2.7

application process object class

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

3.2.8

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.

3.2.9

application relationship application service element

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

3.2.10**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.

3.2.11**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 may also affect the behaviour of an object. Attributes are divided into class attributes and instance attributes.

3.2.12**behaviour**

indication of how the object responds to particular events

Note 1 to entry: Its description includes the relationship between attribute values and services.

3.2.13**class**

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

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

3.2.14**class attributes**

attribute that is shared by all objects within the same class

3.2.15**class code**

unique identifier assigned to each object class

3.2.16**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.

3.2.17**client**

(a) object which uses the services of another (server) object to perform a task

(b) initiator of a message to which a server reacts, such as the role of an AR endpoint in which it issues confirmed service request APDUs to a single AR endpoint acting as a server

3.2.18**conveyance path**

unidirectional flow of APDUs across an application relationship

3.2.19**cyclic**

events which repeat in a regular and repetitive manner

3.2.20**dedicated AR**

AR used directly by the FAL User

Note 1 to entry: On Dedicated ARs, only the FAL Header and the user data are transferred

3.2.21**device**

physical hardware connection to the link

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

3.2.22**device profile**

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

3.2.23**dynamic AR**

AR that requires the use of the AR establishment procedures to place it into an established state

3.2.24**endpoint**

one of the communicating entities involved in a connection

3.2.25**error**

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

3.2.26**error class**

general grouping for error definitions

Note 1 to entry: Error codes for specific errors are defined within an error class.

3.2.27**error code**

identification of a specific type of error within an error class

3.2.28**FAL subnet**

networks composed of one or more data link segments

Note 1 to entry: They are permitted to contain bridges, but not routers FAL subnets are identified by a subset of the network address.

3.2.29**logical device**

specifies a certain FAL class that abstracts a software component or a firmware component as an autonomous self-contained facility of an automation device

3.2.30**management information**

network-accessible information 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.

3.2.31**network**

series of nodes connected by some type of communication medium

Note 1 to entry: The connection paths between any pair of nodes can include repeaters, routers and gateways.

3.2.32**peer**

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

3.2.33**pre-defined AR endpoint**

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

Note 1 to entry: Pre-defined ARs that are not pre-established are established before being used.

3.2.34**pre-established AR endpoint**

AR endpoint that is placed in an established state during configuration of the AEs that control its endpoints

3.2.35**publisher**

role of an AR endpoint in which it transmits APDUs onto the fieldbus for consumption by one or more subscribers

Note 1 to entry: The publisher may not be aware of the identity or the number of subscribers and it may publish its APDUs using a dedicated AR. Two types of publishers are defined by this standard, Pull Publishers and Push Publishers, each of which is defined separately.

3.2.36**server**

a) role of an AREP in which it returns a confirmed service response APDU to the client that initiated the request

b) object which provides services to another (client) object

3.2.37**service**

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

Note 1 to entry: A set of common services is defined and provisions for the definition of object-specific services are provided. Object-specific services are those which are defined by a particular object class to perform a required function which is not performed by a common service.

3.2.38**subscriber**

role of an AREP in which it receives APDUs produced by a publisher

Note 1 to entry: Two types of subscribers are defined by this standard, pull subscribers and push subscribers, each of which is defined separately.

3.3 Abbreviations and symbols

AE	Application Entity
AL	Application Layer
ALME	Application Layer Management Entity
ALP	Application Layer Protocol
APO	Application Object

AP	Application Process
APDU	Application Protocol Data Unit
API	Application Process Identifier
AR	Application Relationship
AREP	Application Relationship End Point
ASCII	American Standard Code for Information Interchange
ASE	Application service Element
Cnf	Confirmation
DL-	(as a prefix) data-link-
DLC	Data-link Connection
DLCEP	Data-link Connection End Point
DLL	Data-link layer
DLM	Data-link-management
DLSAP	Data-link service Access Point
DLSDU	DL-service-data-unit
FAL	Fieldbus Application Layer
ID	Identifier
IEC	International Electrotechnical Commission
Ind	Indication
LME	Layer Management Entity
OSI	Open Systems Interconnect
QoS	Quality of service
Req	Request
Rsp	Response
SAP	Service Access Point
SDU	Service Data Unit
SMIB	System Management Information Base
SMK	System Management Kernel
VFD	Virtual Field Device

3.4 Conventions

3.4.1 General concept

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 three parts: its class definitions, its services, and its protocol specification. The first two are contained in IEC 61158-5 subseries. The protocol specification for each of the ASEs is defined in this standard.

The class definitions define the attributes of the classes supported by each ASE. The attributes are accessible from instances of the class using the Management ASE services specified in IEC 61158-5 standard. The service specification defines the services that are provided by the ASE.

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

3.4.2 Conventions for class definitions

The data-link layer mapping definitions are described using templates. Each template consists of a list of attributes for the class. The general form of the template is defined in IEC 61158-5-5.

3.4.3 Abstract syntax conventions

When the "optionalParametersMap" parameter is used, a bit number which corresponds to each OPTIONAL or DEFAULT production is given as a comment.

3.5 Conventions used in state machines

The state machines are described in Table 1:

Table 1 – Conventions used for state machines

#	Current state	Event / condition => action	Next state
Name of this transition.	The current state to which this state transition applies.	Events or conditions that trigger this state transaction. => The actions that are taken when the above events or conditions are met. The actions are always indented below events or conditions.	The next state after the actions in this transition is taken.

The conventions used in the state machines are as follows:

:= Value of an item on the left is replaced by value of an item on the right. If an item on the right is a parameter, it comes from the primitive shown as an input event.

xxx A parameter name.

Example:

Identifier := reason

means value of a 'reason' parameter is assigned to a parameter called 'Identifier.'

"xxx" Indicates fixed value.

Example:

Identifier := "abc"

means value "abc" is assigned to a parameter named 'Identifier.'

= 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 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.

<> A logical condition to indicate an item on the left is not equal to an item on the right.

&& Logical "AND"

|| Logical "OR"

This construct allows the execution of a sequence of actions in a loop within one transition. The loop is executed for all values from start_value to end_value.

Example:

for (Identifier := start_value to end_value)

actions

endfor

This construct allows the execution of alternative actions depending on some condition (which might be the value of some identifier or the outcome of a previous action) within one transition.

```
Example:
  If (condition)
    actions
  else
    actions
  endif
```

Readers are strongly recommended to refer to the subclauses for the AREP attribute definitions, the local functions, and the FAL-PDU definitions to understand protocol machines. It is assumed that readers have sufficient knowledge of these definitions, and they are used without further explanations.

4 Abstract syntax

4.1 FAL-AR PDU abstract syntax

4.1.1 Top level definition

The productions defined here shall be used with the rules for APDU encoding (see 5.1.2).

```
APDU ::= CHOICE {
  [PRIVATE 0] ConfirmedSend-RequestPDU,
  [PRIVATE 1] ConfirmedSend-ResponsePDU,
  [PRIVATE 2] UnconfirmedSend-PDU,
  [PRIVATE 3] UnconfirmedAcknowledgedSend-CommandPDU,
  [PRIVATE 4] Establish-RequestPDU,
  [PRIVATE 5] Establish-ResponsePDU,
  [PRIVATE 6] Establish-ErrorPDU,
  [PRIVATE 7] Abort-PDU,
  [PRIVATE 8] DataSendAcknowledge-PDU
}
```

4.1.2 Confirmed send service

```
ConfirmedSend-RequestPDU ::= SEQUENCE {
  [APPLICATION 0] AddressAREP,
  InvokeID,
  ConfirmedServiceRequest
}

ConfirmedSend-ResponsePDU ::= SEQUENCE {
  [APPLICATION 1] AddressAREP,
  InvokeID,
  pduBody CHOICE {
    ConfirmedServiceResponse,
    ConfirmedServiceError
  }
}
```

4.1.3 Unconfirmed send service

```
UnconfirmedSend-PDU ::= SEQUENCE {
  [APPLICATION 2] AddressAREP,
  InvokeID,
  pduBody CHOICE {
    UnconfirmedServiceRequest,
    UnconfirmedSendPD-PDU
  }
}
```

4.1.4 Unconfirmed acknowledge send service

```
UnconfirmedAcknowledgedSend-CommandPDU ::= SEQUENCE {
  [APPLICATION 3] AddressAREP,
  InvokeID,
  UnconfirmedServiceRequest
}
```

4.1.5 InvokeID

InvokeID ::= Unsigned8

4.1.6 Establish service

MaxOSCC ::= Unsigned8

MaxOSCS ::= Unsigned8

MaxUCSC ::= Unsigned8

MaxUCSS ::= Unsigned8

CIU ::= Unsigned32

Establish-RequestPDU ::= SEQUENCE {
 [APPLICATION 4] AddressAREP,
 ConType,
 MaxOSCC,
 MaxOSCS,
 MAXUCSC,
 MAXUCSS,
 CIU,
 InvokeID,
 initiateRequest
 } [PRIVATE 0] IMPLICIT Initiate-RequestPDU

Establish-ResponsePDU ::= SEQUENCE {
 [APPLICATION 5] AddressAREP,
 InvokeID,
 initiateResponse
 } [PRIVATE 0] IMPLICIT Initiate-ResponsePDU

Establish-ErrorPDU ::= SEQUENCE {
 [APPLICATION 6] AddressAREP,
 InvokeID,
 initiateError
 } [PRIVATE 0] IMPLICIT Initiate-ErrorPDU

4.1.7 ConType

ConType ::= ENUMERATED {
 mmaz (0)
 }

4.1.8 Data send acknowledge service

DataSendAcknowledge-PDU ::= SEQUENCE {
 Protocol-Code, [APPLICATION 8], Address2ARP, --- Protocol-Code in the higher nibble of the
 octet!!!
 Block-Number,
 Block-Length,
 Protocol-Data,
 }

4.1.9 Protocol-code

Protocol-Code ::= ENUMERATED {
 TCP/IP (1) --- TCP/IP protocol
 }

4.1.10 Block-number

Block-Number ::= Unsigned8
 --- 0 no blocking
 ---- 1...254 block number
 ---- 255 last block

4.1.11 Block-length

Block-Length ::= Unsigned

4.1.12 Protocol-data

Protocol-Data ::= Any --- transparent protocol transfer

4.1.13 Address2 ARP

```
Address2ARP ::= SEQUENCE {
    Destination-Address,
    Source-Address,
    Destination-Node,
    Destination-Subnode,
    Source-Node,
    Source-Subnode
}
```

4.1.14 Destination-address

```
Destination-Address ::= OctetString --- 3 Octets
```

4.1.15 Source-address

```
Source-Address ::= OctetString --- 3 Octets
```

4.1.16 Destination-node

```
Destination-Node ::= Unsigned8
```

4.1.17 Source-node

```
Source-Node ::= Unsigned8
```

4.1.18 Destination-subnode

```
Destination-Subnode ::= Unsigned8
```

4.1.19 Source-subnode

```
Source-Subnode ::= Unsigned8
```

4.2 Abstract syntax of PDUBody**4.2.1 Abort service**

```
Abort-PDU ::= SEQUENCE {
    [APPLICATION 7] AddressAREP,
    Identifier,
    ReasonCode,
    AdditionalDetail
}
```

4.2.2 ConfirmedServiceRequest

```
ConfirmedServiceRequest ::= CHOICE {
    read-Request          [0] IMPLICIT Read-RequestPDU,
    write-Request         [3] IMPLICIT Write-RequestPDU,
    start-Request         [6] IMPLICIT Start-RequestPDU,
    stop-Request          [9] IMPLICIT Stop-RequestPDU,
    status-Request        [15] IMPLICIT Status-RequestPDU,
    identify-Request      [18] IMPLICIT Identify-RequestPDU,
    getAttributes1-Request [21] IMPLICIT GetAttributes-RequestPDU, -- short form
    getAttributes2-Request [35] IMPLICIT GetAttributes-RequestPDU, -- long form
    reset-Request         [36] IMPLICIT Reset-RequestPDU,
    resume-Request        [39] IMPLICIT Resume-RequestPDU
}
```

4.2.3 ConfirmedServiceResponse

```
ConfirmedServiceResponse ::= CHOICE {
    read-Response           [1] IMPLICIT Read-ResponsePDU,
    write-Response          [4] IMPLICIT Write-ResponsePDU,
    start-Response          [7] IMPLICIT Start-ResponsePDU,
    stop-Response           [10] IMPLICIT Stop-ResponsePDU,
    status-Response         [16] IMPLICIT Status-ResponsePDU,
    identify-Response       [19] IMPLICIT Identify-ResponsePDU,
    getAttributes-Response  [22] IMPLICIT GetAttributes-ResponsePDU,
    reset-Response          [37] IMPLICIT Reset-ResponsePDU,
    resume-Response         [40] IMPLICIT Resume-ResponsePDU
}
```

4.2.4 ConfirmedServiceError

```
ConfirmedServiceError ::= CHOICE {
    read-Error              [2] IMPLICIT ErrorType,
    write-Error             [5] IMPLICIT ErrorType,
    start-Error             [8] IMPLICIT ErrorFiType,
    stop-Error              [11] IMPLICIT ErrorFiType,
    status-Error            [17] IMPLICIT ErrorType,
    identify-Error          [20] IMPLICIT ErrorType,
    getAttributes-Error     [23] IMPLICIT ErrorType,
    reset-Error             [38] IMPLICIT ErrorFiType,
    resume-Error            [41] IMPLICIT ErrorFiType
}
```

4.2.5 Error type

Error type as specified in 4.1.4.6.

4.2.6 Error Fi type

```
ErrorFiType ::= SEQUENCE {
    errorClass              [0] IMPLICIT ErrorClass,
    additionalCode          [1] IMPLICIT Integer16 OPTIONAL,
    fiState                 [3] IMPLICIT Integer8
}
```

4.2.7 Error class

Error Class as specified in 4.1.4.7.

4.2.8 Unconfirmed PDUs

```
UnconfirmedServiceRequest ::= CHOICE {
    informationReport-Request [12] IMPLICIT InformationReport-RequestPDU,
    reject-Request           [34] IMPLICIT Reject-RequestPDU
}
```

UnconfirmedSendPD-PDU ::= BIT STRING

4.2.9 Management ASE

4.2.9.1 Get attributes service

```
GetAttributes-Request-PDU ::= SEQUENCE {
    listOfAttributes          [PRIVATE 0] IMPLICIT Mn_SelectedAttributes,
    accessSpecification CHOICE {
        index                 [1] IMPLICIT Gn_NumericID,
        variableName          [2] IMPLICIT Gn_Name,
        fiName                [5] IMPLICIT Gn_Name,
        startIndex            [7] IMPLICIT Gn_NumericID
    }
}

GetAttributes-ResponsePDU ::= SEQUENCE {
    more                     [PRIVATE 0] IMPLICIT Gn_MoreFollows,
    listOfObjectDefinition  [PRIVATE 1] IMPLICIT SEQUENCE OF Gn_ObjectDefinition
}
```

4.2.10 Application process ASE

4.2.10.1 Get status service

Status-RequestPDU ::= NULL

```
Status-ResponsePDU ::= SEQUENCE {
    logicalStatus          [PRIVATE 0] IMPLICIT ENUMERATED {
        ready-for-communication (0),
        limited-services-permitted (2),
    },
    physicalStatus         [PRIVATE 1] IMPLICIT ENUMERATED {
        operational (0),
        partially-operational (1),
        inoperable (2),
        needs-commissioning (3),
    },
    localDetail             [PRIVATE 2] IMPLICIT BitString OPTIONAL
}
```

4.2.10.2 Identify service

Identify-RequestPDU ::= NULL

```
Identify-ResponsePDU ::= SEQUENCE {
    vendorName             [PRIVATE 0] IMPLICIT VisibleString,
    modelIdentifier        [PRIVATE 1] IMPLICIT VisibleString,
    vendorRevision         [PRIVATE 2] IMPLICIT VisibleString
}
```

4.2.10.3 Initiate service

```
Initiate-RequestPDU ::= SEQUENCE {
    versionObjectDefinitionsCalling [PRIVATE 0] IMPLICIT Integer16,
    apDescriptorCalling             [PRIVATE 1] IMPLICIT OctetString,
    accessProtectionSupportedCalling [PRIVATE 2] IMPLICIT Ap_AccessProtectionSupported,
    passwordAndAccessGroupsCalling [PRIVATE 3] IMPLICIT Ap_AccessControl,
    configuredMaxPduSizeSending     [PRIVATE 4] IMPLICIT Unsigned8,
    configuredMaxPduSizeReceiving   [PRIVATE 5] IMPLICIT Unsigned8,
    listOfSupportedServicesCalling   [PRIVATE 6] IMPLICIT Mn_PduSupportedMap
}
```

```
Initiate-ResponsePDU ::= SEQUENCE {
    versionObjectDefinitionsCalled [PRIVATE 0] IMPLICIT Integer16,
    apDescriptorCalled             [PRIVATE 1] IMPLICIT OctetString,
    accessPrivilegeSupportedCalled [PRIVATE 2] IMPLICIT Ap_AccessProtectionSupported,
    passwordAndAccessGroupsCalled [PRIVATE 3] IMPLICIT Ap_AccessControl
}
```

```
Initiate-ErrorPDU ::= SEQUENCE {
    errorCode [PRIVATE 0] IMPLICIT ENUMERATED {
        other (0),
        max-fal-pdu-size-insufficient (1),
        service-not-supported (2),
        version-obj-def-incompatible (3),
        user-initiate-denied (4),
        password-error (5),
        profile-number-incompatible (6),
    },
    maxPduLengthSendingCalled [PRIVATE 1] IMPLICIT Unsigned8,
    maxPduLengthReceivingCalled [PRIVATE 2] IMPLICIT Unsigned8,
    listOfSupportedServicesCalled [PRIVATE 3] IMPLICIT Mn_PduSupportedMap
}
```

4.2.10.4 Reject service

```
Reject-RequestPDU ::= SEQUENCE {
    original-invokeID [PRIVATE 0] IMPLICIT Integer8,
    reject-code        [PRIVATE 1] IMPLICIT ENUMERATED {
        pdu-size (5)
    }
}
```

4.2.11 Function invocation ASE

4.2.11.1 Reset service

```
Reset-RequestPDU ::= SEQUENCE {
    keyAttribute          Gn_KeyAttribute
}
```

```
Reset-ResponsePDU ::= NULL
```

4.2.11.2 Resume service

```
Resume-RequestPDU ::= SEQUENCE {
    keyAttribute          Gn_KeyAttribute
}
```

```
Resume-ResponsePDU ::= NULL
```

4.2.11.3 Start service

```
Start-RequestPDU ::= SEQUENCE {
    keyAttribute          Gn_KeyAttribute
}
```

```
Start-ResponsePDU ::= NULL
```

4.2.11.4 Stop service

```
Stop-RequestPDU ::= SEQUENCE {
    keyAttribute          Gn_KeyAttribute
}
```

```
Stop-ResponsePDU ::= NULL
```

4.2.12 Variable ASE

4.2.12.1 Information report service

```
InformationReport-RequestPDU ::= SEQUENCE {
    index                Gn_NumericID,
    subIndex              [PRIVATE 0] IMPLICIT Gn_SubIndex OPTIONAL,
    value                 [PRIVATE 1] IMPLICIT ANY
}
```

4.2.12.2 Read service

```
Read-RequestPDU ::= SEQUENCE {
    index                Gn_NumericID,
    subIndex              [PRIVATE 0] IMPLICIT Gn_SubIndex OPTIONAL
}
```

```
Read-ResponsePDU ::= SEQUENCE {
    value                 [PRIVATE 0] IMPLICIT ANY
}
```

4.2.12.3 Write service

```
Write-RequestPDU ::= SEQUENCE {
    index                Gn_NumericID,
    subIndex              Gn_SubIndex OPTIONAL,
    value                 [PRIVATE 0] IMPLICIT ANY
}
```

```
Write-ResponsePDU ::= NULL
```

4.3 Type definitions for ASEs

4.3.1 AP ASE types

4.3.1.1 Ap_AccessProtectionSupported

```
Ap_AccessProtectionSupported ::= Boolean
-- True means Access Protection is supported.
-- False means Access Protection is not supported.
```

4.3.1.2 Ap_AccessControl

```

Ap_AccessControl ::= BitString {
    password_Bit1          (8),
    password_Bit2          (7),
    password_Bit3          (6),
    password_Bit4          (5),
    password_Bit5          (4),
    password_Bit6          (3),
    password_Bit7          (2),
    password_Bit8          (1),
    access_Groups-1        (16),
    access_Groups-2        (15),
    access_Groups-3        (14),
    access_Groups-4        (13),
    access_Groups-5        (12),
    access_Groups-6        (11),
    access_Groups-7        (10),
    access_Groups-8        (9)
}

```

-- The Password (Unsigned8) is encoded as a bit string.

4.3.2 AR ASE types

4.3.2.1 Reason code and additional detail

4.3.2.1.1 Reason code

ReasonCode ::= Unsigned8

4.3.2.1.2 Additional detail

AdditionalDetaill ::= OctetString

4.3.2.2 AREP

AddressAREP ::= Unsigned8 -- Least significant octet of DLCEP address

4.3.2.3 Abort type identifier

```

Identifier ::= ENUMERATED {
    fal-user              (0),
    fal-APO-ASE           (1),
    fal-AR-ASE            (2),
    dll                   (3)
}

```

4.3.3 Function Invocation ASE types

4.3.3.1 Fi_AccessPrivilege

```

Fi_AccessPrivilege ::= BitString {
    rightToStartPassword   (24),
    rightToStopPassword    (23),
    rightToDeletePassword  (22),
    rightToStartAccessGroup (20),
    rightToStopAccessGroup  (19),
    rightToDeleteAccessGroup (18),
    rightToStartAllPartner  (32),
    rightToStopAllPartner   (31),
    rightToDeleteAllPartner (30),
    password_Bit1          (8),
    password_Bit2          (7),
    password_Bit3          (6),
    password_Bit4          (5),
    password_Bit5          (4),
    password_Bit6          (3),
    password_Bit7          (2),
    password_Bit8          (1),
    access_Groups-1        (16),
    access_Groups-2        (15),
    access_Groups-3        (14),
    access_Groups-4        (13),
    access_Groups-5        (12),
    access_Groups-6        (11),
    access_Groups-7        (10),
    access_Groups-8        (9)
}

```

-- The Password (Unsigned8) is encoded as a bit string.

}

4.3.3.2 Fi_State

```

Fi_State ::= Unsigned8 {
    unrunnable           (1),
    idle                 (2),
    running              (3),
    stopped              (4),
    starting             (5),
    stopping             (6),
    resuming             (7),
    resetting            (8)
}

```

4.3.4 Management ASE types**4.3.4.1 Mn_PduSupportedMap**

```

Mn_PduSupportedMap ::= BIT STRING {
    getAttributes-RequestPDU      (1),    -- Requester
    start-RequestPDU              (8),
    stop-RequestPDU               (9),
    resume-RequestPDU             (9),
    reset-RequestPDU              (9),
    read-RequestPDU               (11),
    write-RequestPDU              (12),
    informationReport-RequestPDU  (17),
    getAttributes-ResponsePDU     (25),    -- Responder
    start-ResponsePDU             (33),
    stop-ResponsePDU              (33),
    resume-ResponsePDU            (33),
    reset-ResponsePDU             (33),
    read-ResponsePDU              (35),
    write-ResponsePDU             (36),
    informationReport-ResponsePDU (41)
}

```

4.3.5 Variable ASE types**4.3.5.1 Vr_AccessPrivilege**

```

Vr_AccessPrivilege ::= BitString {
    rightToReadPassword           (24),
    rightToWritePassword          (23),
    rightToDeletePassword         (22),
    rightToReadAccessGroup        (20),
    rightToWriteAccessGroup        (19),
    rightToDeleteAccessGroup       (18),
    rightToReadAllPartners         (32),
    rightToWriteAllPartners        (31),
    rightToDeleteAllPartners       (30),
    password_Bit1                 (8),    -- The Password (Unsigned8) is encoded as a bit string.
    password_Bit2                 (7),
    password_Bit3                 (6),
    password_Bit4                 (5),
    password_Bit5                 (4),
    password_Bit6                 (3),
    password_Bit7                 (2),
    password_Bit8                 (1),
    access_Groups-1               (16),
    access_Groups-2               (15),
    access_Groups-3               (14),
    access_Groups-4               (13),
    access_Groups-5               (12),
    access_Groups-6               (11),
    access_Groups-7               (10),
    access_Groups-8               (9)
}

```

4.3.6 General types**4.3.6.1 Gn_Deletable**

```

Gn_Deletable ::= Boolean
-- True means deletable.
-- False means not deletable.

```

4.3.6.2 Gn_KeyAttribute

```
Gn_KeyAttribute ::= CHOICE {
-- When this type is specified, only the key attributes of the class referenced are valid.
    numericID          [0] IMPLICIT Gn_NumericID,
    name               [1] IMPLICIT Gn_Name,
    listName           [2] IMPLICIT Gn_Name,
    numericAddress     [4] IMPLICIT Gn_NumericAddress,
    symbolicAddress    [5] IMPLICIT Gn_SymbolicAddress
}
```

4.3.6.3 Gn_Length

Gn_Length ::= Unsigned8

4.3.6.4 Gn_MoreFollows

Gn_MoreFollows ::= Boolean

4.3.6.5 Gn_NumericID

Gn_NumericID ::= Unsigned16 -- The values of this parameter are unique within an AP.

4.3.6.6 Gn_Name

Gn_Name ::= OctetString

4.3.6.7 Gn_ObjectClass

```
Gn_ObjectClass ::= ENUMERATED {
    functionInvocation      (3),
    fixedLengthStringDataType (5),
    structuredDataType      (6),
    fixedLengthStringVariable (7),
    arrayVariable           (8),
    dataStructureVariable   (9),
}
```

4.3.6.8 Gn_ObjectDefinition

Gn_ObjectDefinition ::= OctetString -- The semantics of this parameter are application specific.

4.3.6.9 Gn_Reusable

Gn_Reusable ::= Boolean -- True means reusable.
-- False means not reusable.

4.3.6.10 Gn_SubIndex

Gn_SubIndex ::= Unsigned8

4.3.6.11 Gn_TypeDescription

```
Gn_TypeDescription ::= CHOICE {
    boolean          [1] Gn_Length,
    integer8         [2] Gn_Length,
    integer16        [3] Gn_Length,
    integer32        [4] Gn_Length,
    unsigned8        [5] Gn_Length,
    unsigned16       [6] Gn_Length,
    unsigned32       [7] Gn_Length,
    float            [8] Gn_Length,
    visiblestring    [9] Gn_Length,
    octetstring      [10] Gn_Length,
    binaryDate       [11] Gn_Length,
    timeOfDay        [12] Gn_Length,
    timeDifference    [13] Gn_Length,
    bitstring        [14] Gn_Length
}
```

4.3.7 Object definitions

4.3.7.1 Top Level Definition

```
Object-Definition ::= CHOICE {
    [PRIVATE 0] ListHeader,
    [PRIVATE 1] DataTypeList,
    [PRIVATE 2] StaticList,
    [PRIVATE 3] FunctionInvocationDefinition
}
```

4.3.7.2 ListHeader

```
ListHeader ::= SEQUENCE {
    numericId [PRIVATE 0] IMPLICIT Unsigned16,
    romRamFlag [PRIVATE 1] IMPLICIT Boolean,
    maxNameLength [PRIVATE 2] IMPLICIT Unsigned8,
    accessProtectionSupported [PRIVATE 3] IMPLICIT Boolean,
    versionOfObjectDefinition [PRIVATE 4] IMPLICIT Integer16,
    localReferenceOfListHeader [PRIVATE 5] IMPLICIT Unsigned32 OPTIONAL,
    numberOfEntriesInDataTypeList [PRIVATE 6] IMPLICIT Unsigned16,
    localReferenceOfDataTypeList [PRIVATE 7] IMPLICIT Unsigned32 OPTIONAL,
    firstNumericIdOfStaticList [PRIVATE 8] IMPLICIT Unsigned16,
    numberOfEntriesInStaticList [PRIVATE 9] IMPLICIT Unsigned16,
    localReferenceOfStaticList [PRIVATE 10] IMPLICIT Unsigned32 OPTIONAL,
    firstNumericIdOfVariableListDefinition [PRIVATE 11] IMPLICIT Unsigned16,
    numberOfEntriesInVariableListDefinition [PRIVATE 12] IMPLICIT Unsigned16,
    localReferenceOfVariableListDefinition [PRIVATE 13] IMPLICIT Unsigned32 OPTIONAL,
    firstNumericIdOfFunctionInvocationDefinition [PRIVATE 14] IMPLICIT Unsigned16,
    numberOfEntriesInFunctionInvocationDefinition [PRIVATE 15] IMPLICIT Unsigned16,
    localReferenceOfFunctionInvocationDefinition [PRIVATE 16] IMPLICIT Unsigned32 OPTIONAL
}
```

4.3.7.3 DataTypeList

```
DataTypeList ::= CHOICE {
    [PRIVATE 0] DataTypeDefinition,
    [PRIVATE 1] StructuredDataTypeDefinition
}

DataTypeDefinition ::= SEQUENCE {
    numericId Gn_NumericID,
    objectClass Gn_ObjectClass,
    dataTypeNameLength Gn_Length,
    dataTypeName [PRIVATE 0] IMPLICIT VisibleString OPTIONAL
}

StructuredDataTypeDefinition ::= SEQUENCE {
    numericId Gn_NumericID,
    objectClass Gn_ObjectClass,
    numberOfElements [PRIVATE 0] IMPLICIT Integer8,
    recordList SEQUENCE OF SEQUENCE {
        numericIdOfDataTypeDefinition Gn_NumericID,
        dataLength Gn_Length
    }
}
```

4.3.7.4 StaticList

```
StaticList ::= CHOICE {
    [PRIVATE 0] VariableDefinition,
    [PRIVATE 1] ArrayDefinition,
    [PRIVATE 2] StructureDefinition
}

VariableDefinition ::= SEQUENCE {
    numericId Gn_NumericID,
    objectClass Gn_ObjectClass,
    numericIdOfDataTypeDefinition Gn_NumericID,
    dataLength Gn_Length,
    accessPrivilege Vr_AccessPrivilege OPTIONAL,
    localReferenceOfVariable [PRIVATE 0] IMPLICIT Unsigned32 OPTIONAL,
    variableName [PRIVATE 1] IMPLICIT VisibleString OPTIONAL,
    extension [PRIVATE 2] IMPLICIT OctetString OPTIONAL
}
```

```

ArrayDefinition ::= SEQUENCE {
    numericId          Gn_NumericID,
    objectClass        Gn_ObjectClass,
    numericIdOfDataTypeDefinition Gn_NumericID,
    dataLength         Gn_Length,
    numberOfElements   [PRIVATE 0] IMPLICIT Unsigned8,
    accessPrivilege    Vr_AccessPrivilege OPTIONAL,
    localReferenceOfArray [PRIVATE 1] IMPLICIT Unsigned32 OPTIONAL,
    arrayName          [PRIVATE 2] IMPLICIT VisibleString OPTIONAL,
    extension          [PRIVATE 3] IMPLICIT OctetString OPTIONAL
}

StructureDefinition ::= SEQUENCE {
    numericId          Gn_NumericID,
    objectClass        Gn_ObjectClass,
    numericIdOfDataTypeDefinition Gn_NumericID,
    accessPrivilege    Vr_AccessPrivilege OPTIONAL,
    structureName      [PRIVATE 0] IMPLICIT VisibleString OPTIONAL,
    extension          [PRIVATE 1] IMPLICIT OctetString OPTIONAL,
    localReferenceOfElement [PRIVATE 2] IMPLICIT SEQUENCE OF Unsigned32 OPTIONAL
}

```

4.3.7.5 FunctionInvocationDefinition

```

FunctionInvocationDefinition ::= SEQUENCE {
    numericId          Gn_NumericID,
    objectClass        Gn_ObjectClass,
    numberOfRelatedObjects [PRIVATE 0] IMPLICIT Unsigned8,
    accessPrivilege    Fi_AccessPrivilege OPTIONAL,
    deletable          Gn_Deletable,
    reusable           Gn_Reusable,
    functionInvocationState FI_State,
    numericIdOfLoadRegion SEQUENCE OF Gn_NumericID,
    functionInvocationName [PRIVATE 1] IMPLICIT VisibleString OPTIONAL,
    extension          [PRIVATE 2] IMPLICIT OctetString OPTIONAL
}

```

4.4 Abstract syntax of data types

4.4.1 Referenced data types

4.4.2 Notation for the Boolean type

```

Boolean ::= BOOLEAN
-- TRUE if the value is non-zero.
-- FALSE if the value is zero.

```

4.4.3 Notation for the Integer types

```

Integer ::= INTEGER -- any integer
Integer8 ::= INTEGER (-128..+127) -- range  $-2^7 \leq i \leq 2^7-1$ 
Integer16 ::= INTEGER (-32768..+32767) -- range  $-2^{15} \leq i \leq 2^{15}-1$ 
Integer32 ::= INTEGER -- range  $-2^{31} \leq i \leq 2^{31}-1$ 

```

4.4.4 Notation for the Unsigned types

```

Unsigned ::= INTEGER -- any non-negative integer
Unsigned8 ::= INTEGER (0..255) -- range  $0 \leq i \leq 2^8-1$ 
Unsigned16 ::= INTEGER (0..65535) -- range  $0 \leq i \leq 2^{16}-1$ 
Unsigned32 ::= INTEGER -- range  $0 \leq i \leq 2^{32}-1$ 

```

4.4.5 Notation for the Floating Point type

```

Floating32 ::= BIT STRING SIZE (4) -- ISO/IEC/IEEE 60559 Single precision

```

4.4.6 Notation for the BitString type

```

BitString ::= BIT STRING -- For generic use
BitString8 ::= BIT STRING SIZE (8) -- Fixed eight bits bitstring
BitString16 ::= BIT STRING SIZE (16) -- Fixed 16 bits bitstring
BitString32 ::= BIT STRING SIZE (32) -- Fixed 32 two bits bitstring

```