BRITISH STANDARD

BS EN
61158-6-7:2008

Industrial communication networks — Fieldbus specifications —

Part 6-7: Application layer protocol specification — Type 7 elements

ICS 25.040.40; 35.100.70

BSI
British Standards

National foreword

This British Standard is the UK implementation of EN 61158-6-7:2008. It is identical with IEC 61158-6-7:2007. Together with all of the other sections of BS EN 61158-6, it supersedes BS EN 61158-6:2004 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee AMT/7, Industrial communications — Process measurement and control, including Fieldbus.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 June 2008

ISBN 978 0 580 61627 3

Amendments/corrigenda issued since publication

Date	Comments

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 61158-6-7

March 2008

ICS 35.100.70; 25.040.40

Partially supersedes EN 61158-6:2004

English version

Industrial communication networks - Fieldbus specifications - Part 6-7: Application layer protocol specification - Type 7 elements

(IEC 61158-6-7:2007)

Réseaux de communication industriels - Spécifications des bus de terrain - Partie 6-7: Spécification des services des couches d'application - Eléments de type 7 (CEI 61158-6-7:2007)

Industrielle Kommunikationsnetze - Feldbusse - Teil 6-7: Protokollspezifikation des Application Layer (Anwendungsschicht) - Typ 7-Elemente (IEC 61158-6-7:2007)

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
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Ref. No. EN 61158-6-7:2008 E

Foreword

The text of document 65C/476/FDIS, future edition 1 of IEC 61158-6-7, 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 was approved by CENELEC as EN 61158-6-7 on 2008-02-01.

This and the other parts of the EN 61158-6 series supersede EN 61158-6:2004.

With respect to EN 61158-6:2004 the following changes were made:

– deletion of Type 6 fieldbus for lack of market relevance;

– addition of new fieldbus types;

– partition into multiple parts numbered 6-2, 6-3, …6-20.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2008-11-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2011-02-01

NOTE Use of some of the associated protocol types is restricted by their intellectual-property-right holders. In all cases, the commitment to limited release of intellectual-property-rights made by the holders of those rights permits a particular data-link layer protocol type to be used with physical layer and application layer protocols in type combinations as specified explicitly in the EN 61784 series. Use of the various protocol types in other combinations may require permission from their respective intellectual-property-right holders.

Annex ZA has been added by CENELEC.

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Endorsement notice

The text of the International Standard IEC 61158-6-7:2007 was approved by CENELEC as a European Standard without any modification.

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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/TR 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 6-7: Application layer protocol specification – Type 7 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 7 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 specifies interactions between remote applications and defines the externally visible behavior provided by the Type 7 fieldbus application layer in terms of

a) the formal abstract syntax defining the application layer protocol data units conveyed between communicating application entities;
b) the transfer syntax defining encoding rules that are applied to the application layer protocol data units;
c) the application context state machine defining the application service behavior visible between communicating application entities;
d) the application relationship state machines defining the communication behavior visible between communicating application entities.

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

- define the wire-representation of the service primitives defined in IEC 61158-5-7, and
- define the externally visible behavior associated with their transfer.

This standard specify the protocol of the Type 7 fieldbus application layer, in conformance with the OSI Basic Reference Model (ISO/IEC 7498) 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 61158-5-7.

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 parts of the IEC 61158-6 series.

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.

There is no conformance of equipment to the application layer service definition standard. Instead, conformance is achieved through implementation of this application layer protocol specification.

2 Normative references

The following referenced documents are indispensable for the application 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.

IEC 60559, *Binary floating-point arithmetic for microprocessor systems*

IEC 61158-3-7, *Industrial communication networks – Fieldbus specifications – Part 3-7: Data-link layer service definition – Type 7 elements*

IEC 61158-4-7, *Industrial communication networks – Fieldbus specifications – Part 4-7: Data-link layer protocol specification – Type 7 elements*

IEC 61158-5-7, *Industrial communication networks – Fieldbus specifications – Part 5-7: Application layer service definition – Type 7 elements*

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

ISO/IEC 8824, *Information technology – Open Systems Interconnection – Specification of Abstract Syntax Notation One (ASN.1)*

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

ISO/IEC 9506-2, *Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

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

3 Terms, definitions, symbols, abbreviations and conventions

For the purposes of this document, the following definitions 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

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

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 Terms and definitions from IEC 61158-5-7

a) application relationship
b) conveyance path
c) client
d) dedicated AR
e) dynamic AR
f) error class
g) error code
h) name
i) numeric identifier
j) peer
k) pre-defined AR endpoint
l) pre-established AR endpoint
m) publisher
n) subscriber

3.3 Additional terms and definitions

3.3.1
allocate
take a resource from a common area and assign that resource for the exclusive use of a specific entity

3.3.2
application
function or data structure for which data is consumed or produced

3.3.3
application objects
multiple object classes that manage and provide a run time exchange of messages across the network and within the network device

3.3.4
attribute
description of an externally visible characteristic or feature of an object

NOTE 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.

3.3.5
behaviour
indication of how an object responds to particular events

3.3.6
called
service user or a service provider that receives an indication primitive or a request APDU

3.3.7
calling
service user or a service provider that initiates a request primitive or a request APDU

3.3.8
class
set of objects, all of which represent the same kind of system component

NOTE A class is a generalisation of an 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.

3.3.9
class attributes
attribute that is shared by all objects within the same class

3.3.10
class code
unique identifier assigned to each object class

3.3.11
class specific service
service defined by a particular object class to perform a required function which is not performed by a common service

NOTE A class specific object is unique to the object class which defines it

3.3.12
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

3.3.13
clock
device providing a measurement of the passage of time since a defined epoch

NOTE There are two types of clocks in IEC 61588, boundary clocks and ordinary clocks.

3.3.14
communication objects
components that manage and provide a run time exchange of messages across the network

EXAMPLES Connection Manager object, Unconnected Message Manager (UCMM) object, Message Router object.

3.3.15
connection
logical binding between application objects that may be within the same or different devices

NOTE Connections may be either point-to-point or multipoint.

3.3.16
connection ID (CID)
identifier assigned to a transmission that is associated with a particular connection between producers and consumers, providing a name for a specific piece of application information

3.3.17
connection point
buffer which is represented as a subinstance of an Assembly object

3.3.18
consume
act of receiving data from a producer

3.3.19
consumer
node or sink that is receiving data from a producer

3.3.20
consuming application
application that consumes data

3.3.21
cyclic
repetitive in a regular manner

3.3.22
device
physical hardware connected to the link

NOTE: A device may contain more than one node.

3.3.23
device profile
collection of device dependent information and functionality providing consistency between similar devices of the same device type

3.3.24
end node
producing or consuming node

3.3.25
end point
one of the communicating entities involved in a connection

3.3.26
error
discrepancy between a computed, observed or measured value or condition and the specified or theoretically correct value or condition

3.3.27
frame
denigrated synonym for DLPDU

3.3.28
instance
the actual physical occurrence of an object within a class, identifying one of many objects within the same object class.

EXAMPLE California is an instance of the object class state.

NOTE The terms object, instance, and object instance are used to refer to a specific instance.

3.3.29
instance attribute
attribute that is unique to an object instance and not shared by the object class

3.3.30
instantiated
object that has been created in a device

3.3.31
interoperability
capability of User Layer entities to perform coordinated and cooperative operations using the services of the FAL

3.3.32
little endian
Describes a model of memory organisation which stores the least significant octet at the lowest address, or for transfer, which transfers the lowest order octet first

3.3.33
management information
network accessible information that supports the management of the Fieldbus environment

3.3.34
member
piece of an attribute that is structured as an element of an array

3.3.35
message router
object within a node that distributes messaging requests to appropriate application objects

3.3.36
multipoint connection

connection from one node to many

NOTE Multipoint connections allow messages from a single producer to be received by many consumer nodes.

3.3.37
network
a set of nodes connected by some type of communication medium, including any intervening repeaters, bridges, routers and lower-layer gateways

3.3.38
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 clearly defined interface and behaviour

3.3.39
object specific service
service unique to the object class which defines it

3.3.40
originator
client responsible for establishing a connection path to the target

3.3.41
point-to-point connection
connection that exists between exactly two application objects

3.3.42
produce
act of sending data to be received by a consumer

3.3.43
producer
node that is responsible for sending data

3.3.44
receiving
service user that receives a confirmed primitive or an unconfirmed primitive, or a service provider that receives a confirmed APDU or an unconfirmed APDU

3.3.45
resource
resource is a processing or information capability of a subsystem

3.3.46
sending
service user that sends a confirmed primitive or an unconfirmed primitive, or a service provider that sends a confirmed APDU or an unconfirmed APDU

3.3.47
service
operation or function than an object and/or object class performs upon request from another object and/or object class

3.4 Abbreviations and symbols

ASCII	American Standard Code for Information Interchange
CID	connection ID
DLL	data-link layer
PDU	protocol data unit
OSI	open systems interconnection (see ISO/IEC 7498)
Rcv	receive
Rx	receive
SDU	service data unit
STD	state transition diagram, used to describe object behaviour
TPDU	transport protocol data unit
Tx	transmit
Xmit	transmit

3.5 Conventions

3.5.1 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. 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.

3.5.2 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.

3.5.3 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.

3.6 Conventions used in state machines

3.6.1 General

This subclause recalls the main definitions associated with the three specification techniques used : 'Evaluation Networks', 'Abstract objects', 'Service Conventions'.

3.6.2 Evaluation networks

To be helpful for the reader some mechanisms are explained by a graphical representation as shown in Figure 1. These representations are based on evaluation network built on an oriented graph with three types of nodes:

– the states, represented by a disk,

– the requests represented by a rectangle,
– the transitions, represented by a horizontal line.

The evaluation network is built according to the following principle:

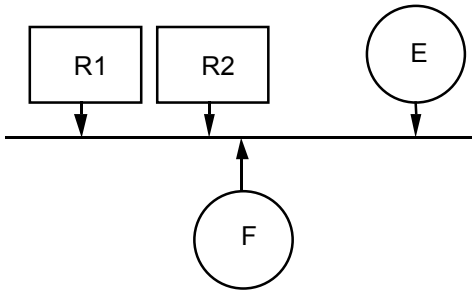


Figure 1 – Example of an evaluation net

When the described system is in state E, the arrival of request R1 or R2 results in a transition which switches it state F.

On the other hand, crossing a transition takes place, by convention, in zero time.

3.6.3 Simple actions

Simple actions can be associated with each transition, corresponding either to the transmission of requests or to the execution of local actions.

They are materially represented by a triangle, labelled with the name of the request or of the description of the executed action.

3.6.4 Conditions

The crossing of a transition can concern a condition. In this case, the oriented graph associated with the representation, shows a condition associated with the arc which precedes the transition.

A corollary of this representation allows defining choices for crossing a transition from the same initial state.

In the same way as for a simple transition, the transmission of an action can be associated with the crossing of a conditional transition.

4 Abstract syntax of data type

4.1 Data abstract syntax specification

This present standard uses the following terms defined in the abstract syntax number 1 (ASN1). Different or added definitions are the following :

4.1.1 Boolean

A Boolean value is encoded on an octet all of whose bits are null for FALSE; any other combination means TRUE.

Example of notation of the type:

Response::= BOOLEAN

Example of value notation and encoding:

Response value::= TRUE

value is encoded, e.g., FFh or 6Dh.

4.1.2 Integer

The INTEGER value is encoded as a sequence of M octets describing a binary number:

- either as a complement of 2 if the values can be positive and negative: the most and least significant bits are respectively bit 8 of the first octet and bit 1 of the last octet. Bit 8 of the first octet represents the integer sign. If the size is the number of bits of the integer (i.e., size=M*8), the value of the integer is between -2**(size-1) and +2**(size-1)-1;

Example of notation of the type:

Signed8::= INTEGER (-128..127)

Example of value notation and encoding:

integer Signed8::= -128

integer is encoded: FFh.

- or as an absolute value if the values are all positive or all negative: the most and least significant bits are respectively bit 8 of the first octet and bit 1 of the last octet. If the size is the number of bits of the integer (i.e., size=M*8), the value of the integer is between -2**(size) and +2**(size)-1.

Example of type notation:

Unsigned8::= INTEGER (0..255)

Example of value notation and encoding:

integer Unsigned8::= 255

integer is encoded: FFh.

4.1.3 Bit string

The value of BIT STRING is encoded on a sequence of M octets; the first bit of the binary string is aligned with bit 8 of the least significant octet of the sequence of octets and its number is zero. The number of unused bits shall be between bit 1 and 7 of the most significant octet of the sequence of octets. The true value of a bit of the bit string takes the binary value 1; unused bits can take the value 0 or 1.

Example of notation of the type:

Bitstring::= BIT STRING SIZE(32)

Example of value notation and encoding:

binaryvalue Bitstring::= '5F291CD0'H

binary value is encoded: 5Fh 29h 1Ch D0h

4.1.4 Octet string

The value of OCTET STRING is encoded on a sequence of M octets; the first octet of the OCTET STRING is aligned with the least significant octet of the sequence of octets.

Example of type notation:

OctetString::= OCTET STRING SIZE(4)

Example value notation and encoding:

octetvalue OctetString::= '5F291CD0'H

octetvalue is encoded: 5Fh 29h 1Ch D0h.

4.1.5 Sequence (sequence or sequence of)

SEQUENCE or SEQUENCE OF encoding is the juxtaposition of the element encoding which comprise it.

Example of type notation:

INFO1::= SEQUENCE {name String, ok BOOLEAN}

String::= OCTET STRING SIZE(5) --string of 5 octets

Example of value notation and encoding:

value INFO1::= {name "SMITH", ok TRUE}

value is encoded as shown in Table 1.

Table 1 – Example of encoding of a SEQUENCE

0006h	53h	4Dh	49h	54h	48h	FFh
SEQUENCE length	"S"	"M"	"I"	"T"	"H"	TRUE

The top line represents the encoding proper and the bottom line describes what is encoded:

Example of type:

INFO2::= SEQUENCE OF date

date::= OCTET STRING SIZE (8) --YYYYMMDD

Example of value notation and encoding:

value INFO2::= { { date "19571111"}, {date "19590717"}}

value is encoded as shown in Table 2.

Table 2 – Example of encoding of a SEQUENCE OF

00h	10h
number	of octets

31h	39h	35h	37h	31h	31h
"1"	"9"	"5"	"7"	"1"	"1"

31h	31h	31h	39h	35h	39h
"1"	"1"	"1"	"9"	"5"	"9"

30h	37h	31h	37h
"0"	"7"	"1"	"7"

In each row pair, the top line represents the encoding proper and the bottom line describes what is encoded. Each table is read from left to right.

4.1.6 Choice

The encoding of CHOICE is the encoding of the possibility selected in this CHOICE.

Example of type notation:

```
INFO::= CHOICE {name [0] String, age [1] Unsigned8}
String::= OCTET STRING SIZE(5) --string of 5 octets
Unsigned8::= INTEGER (0..127) -- unsigned 8 bit integer
Example value notation and encoding:
value INFO::= {name "SMITH"}
```

value is encoded as shown in Table 3.

Table 3 – Example of encoding of a CHOICE

80h	53h	4Dh	49h	54h	48h
identification	"S"	"M"	"I"	"T"	"H"

The top line represents the encoding proper and the bottom line describes what is encoded:

4.1.7 Null

No content encoding is associated with the null element.

Identification encoding is possible if NULL is a possibility of a choice (Cf. section 10.1.2.5.2).

Example of notation of the type:

```
Type-Room::= SEQUENCE {
    number Unsigned8,
    person CHOICE {
        name [0] String,
        default [1] NULL --room not in use
    }
}
Unsigned8::= INTEGER (0..127)
String::= OCTET STRING SIZE(12)
```

Example of value notation and encoding:

```
value-Room Type-Room::= {number 30h, person { default NULL}}
```

value-Room is encoded 0002h 30h 81h

Length encoding is compulsory if NULL is optional (in this case, the length is necessarily equal to zero).

4.1.8 Object identifier

Encoding is comprised of an ordered list of encoding of concatenated sub-identifiers.

Every sub-identifier is represented by a sequence of one or more octets. Every octet is encoded as follows.

- Bit 8 of each octet indicates that it is the last in the sequence.
- Bit 8 of the last octet is on one.
- Bit 8 of each previous octet is on zero.
- Bits 7 to 1 of the octets in the sequence collectively encode the sub-identifier, knowing that:

  Bits 5, 6 and 7 are zero.
- Bits 1 to 4 are used to encode each digit of each sub-identifier. Encoding occurs in the form of an unsigned binary number.

Example: {iso standard 9506 part(2) mms-general-module-version1(2)} is encoded as shown in Table 4.

Table 4 – Example of encoding of an object identifier

81h	80h	09h	05h	00h
"iso"	"standard"	9	5	0

86h	82h	82h
6	part(2)	mms…(2)

In each table, the top line represents the encoding proper and the bottom line describes what is encoded. Each table is read from left to right.

4.1.9 Default

The keyword DEFAULT is ignored.

4.2 FAL PDU abstract syntax

This section illustrates the FER encoding rules specified in the present standard, by showing the representation in octets of an element defined in FIELDBUS ASN.1.

```
PDU::= CHOICE {
   req [0] IMPLICIT PDUreq,
   rep [1] IMPLICIT PDUrep, ....
}

PDUrep::= SEQUENCE {
   invokeID Unsigned32,
   Response }

Response::= CHOICE {
   status                                  [0] IMPLICIT StatusResponse, ...
   getprog                                 [45] IMPLICIT GetProgramInvocationAttributesResponse, ...}

GetProgramInvocationAttributesResponse::= SEQUENCE {
      pi_state                             [0] IMPLICIT PiState,
      listOfDomainId                       [1] IMPLICIT ListOfObjectId,
      mmsdeletable                         [2] IMPLICIT BOOLEAN,
      reusable                             [3] IMPLICIT BOOLEAN,
      monitor                              [4] IMPLICIT BOOLEAN,
      executionargument                    [5] IMPLICIT OCTET STRING OPTIONAL
}

PiState::= Unsigned8

Unsigned8::= INTEGER (0..127) --8 bit unsigned integer

ListOfObjectId::= SEQUENCE OF Identifier

Identifier::= Unsigned16

Unsigned16::= INTEGER (0..32767) --16 bit unsigned integer

Unsigned32::= INTEGER(0..2147483647) --32 bit unsigned integer

The registrated value is:
{ rep {invokeID 1,
   getprog { pi-state 8,
   listOfDomainId { {1024}, {1025}, {1026}, {1027} },
   mmsdeletable TRUE,
   reusable FALSE,
   monitor TRUE,
   executionargument "ARGUMENT"}
}
```

Its representation is as follows: octet encoding is described using the two-line tables below in which the top line represents the encoding proper and the bottom line describes what is encoded. The tables are read from left to right. See Table 5 for details.

Table 5 – Example of encoding of a PDU

81h	00h	00h	00h	01h	ADh
rep	invokeID	(32 b …		…)	getprog

08h	00h	08h	04h	00h	04h	01h
pi-state	number	of octets	1024	(16 b)	1025	(16b)

04h	02h	04h	03h	FFh	00h	FFh	00h
1026	(16b)	1027	(16b)	TRUE	FALSE	TRUE	number

08h	41h	52h	47h	55h	4Dh	45h	4Eh
of octets	"A"	"R"	"G"	"U"	"M"	"E"	"N"

54h
"T"

5 Transfer syntaxes

5.1 Compact encoding

The encoding rules applied to the PDU type values represented by using the ASN1 (ISO 8824) abstract notation syntax, yield the transfer syntax.

In the MPS environment, the values associated with the PDU types, are globally encoded according to the encoding rules of ASN1 (ISO/IEC 8825), with some restrictions.

The encoding rules which yield the MPS transfer syntax associate a set of octets with each of the different PDU types.

This octet sequence comprises three components:

- identification
- size
- contents.

In the general case, the encoding rules permit contents which are recursively structured themselves in Identification, Size, Contents.

NOTE In the case of a CompactValue type PDU, the encoding has only one level.

The organization of an encoding level corresponds to that of the ISO/IEC 8825.

Encoding structure is shown in Figure 2.

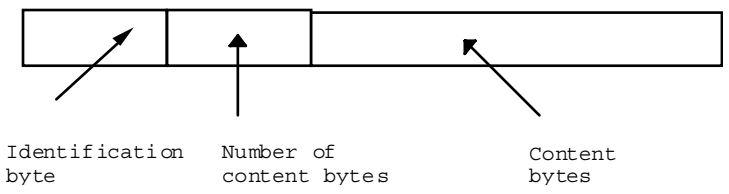


Figure 2 – Encoding of a CompactValue

The following restrictions on the encoding relative to the MPS standard apply:

The Identification is encoded on 1 octet.

The Contents is encoded on a maximum of 126 octets.

5.2 Data type encoding

5.2.1 MPS ASE FAL PDU data types

5.2.1.1 Summary

The specification of the protocol provides a set of communication rules expressed in terms of data interchanges and procedures that shall be supported by the application entities.

AL TYPE 7conformance is based on the compliance to these communication rules which are guidelines for conformance testing in order to achieve interoperability.

This protocol specification consists of:

- the description of the various protocol data units (PDU) interchanged between the communicating entities. This description is affected by use of an abstract syntax.
- encoding rules which transform the abstract syntax into transfer syntax.
- the description of the protocol procedures in terms of interactions between the primitives of each of the application services and the associated data link service primitives.

NOTE In the MPS environment, there is no direct interaction between a producer application entity and a consumer entity during the interchanges associated with a service primitive.

The specification of A_PDUs in the MPS environment is performed with a notation defined independently from the encoding. This notation constitutes the abstract syntax.

The abstract syntax is subsequently transformed by a set of encoding rules which are applied to the various types of A_PDU. These encoding rules yield the transfer syntax.

The conjunction of the abstract syntax and the encoding rules specifies the content of the octets interchanged between application entities by using the data link services.

NOTE The actual representation at the interface between the user and an application entity is out of the scope of this standard and is implementation dependent.

5.2.1.2 Syntax notation

The specification of the different A_PDUs associated with the MPS services is performed with the abstract notation syntax ASN1 defined in the ISO/IEC 8824.

All the ASN1 definitions of this standard are part of the module: " AL TYPE 7 - -MPS-1 ". All the grammar elements which constitute the Part5-3-MPS-1 module correspond to the first version of MPS.

Declaration of the AL TYPE 7 - -MPS-1 module:
AL TYPE 7 - -MPS-1 DEFINITIONS:= BEGIN

NOTE In order to meet the requirements of the ASN1 notation, all the keywords of the language are written in capital letters and the final symbol names begin with a capital letter. Furthermore, all the grammar items existing in this standard which take part in the definition of the AL TYPE 7 - -MPP-1 module are outlined with a double line before and after them.

General quote: The present standard specifies the value of each octet of an encoding by the sentences 'the most significant bit' and 'the least significant bit'. The bits of an octet are numbered from 8 to 1: bit 8 is 'the most significant bit' and bit 1 'the least significant bit'. This encoding is summarized in Figure 3.

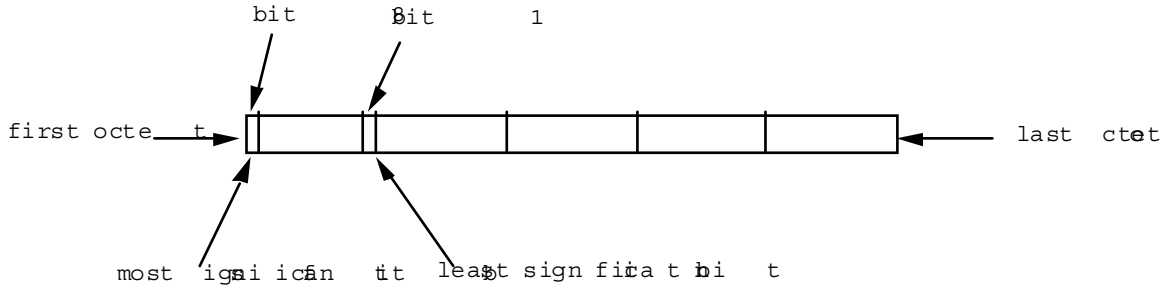


Figure 3 – Organisation of the bits and octets within a PDU

5.2.1.3 Simple predefined types

The PDU specification uses simple predefined types.

Some simple types are predefined by means of a statement that defines limits for these type values.

Unsigned4	::= INTEGER	-- values limited between 0 and 15
Unsigned8	::= INTEGER	-- values limited between 0 and 255
Unsigned16	::= INTEGER	-- values limited between 0 and 65535
Symbol	::= Visible String	-- number of characters limited between 0 and 16

In the MPS environment the variable names, the access names, the type names and the list names are described as a combination of 16 character maximum length.

The characters belong to the set defined for the 'visible string' type of the ASN1 (ISO 8824) syntax notation.

In this set, the following characters are permitted:

Capital letters		(A..Z)
Letters	(a..z)	
Digits	(0..9)	
Underscore		(_)
Currency symbol	($)	

The 'space' character is not permitted.

Strings may not begin with a number.

The 'Unsigned16', 'Unsigned8' and 'Unsigned4' types are used in this standard to describe the limits of the maximum values of the MPS types.

5.2.1.4 PDU Types

5.2.1.4.1 Top Level Definition

The PDUs specified in the MPS environment convey the information associated with *Variable* objects. The PDU type used depends directly on the value of the *Construction* and *A_Name* attributes of the instance of the *Type constructor* associated with the variable and is summarized in Table 6.

Table 6 – MPS PDU types

Construction		PDU type
SIMPLE		CompactValuePDU
ARRAY		CompactValuePDU
STRUCTURE		CompactValuePDU
PREDEFINED	A_Name = K_DVAR	VariableDescriptionPDU
	A_Name = K_DACCESS	AccessDescriptionPDU
	A_Name = K_DTYPE	TypeDescriptionPDU
	A_Name = K_DLIST	ListDescriptionPDU
EXPLICIT		ExplicitPDU

The encoding of values of these different kinds of PDU uses the transfer syntax associated with ASN1 part 2 (ISO 8825). Nevertheless, array compacting and compressing rules can be implemented to optimize the flow on the bus.

NOTE These compacting rules allow the representation of structured type variables by using an octet string.

Specification of PDU type used in MPS:

```
MPS-pdu:: = CHOICE
{
    CompactedVariableValue      [APPLICATION 0]     IMPLICIT CompactValuePDU,
    ExplicitVariableValue       [APPLICATION 1]     IMPLICIT ExplicitPDU,
    VariableDescription         [APPLICATION 2]     IMPLICIT VariableDescriptionPDU,
    AccessDescription           [APPLICATION 3]     IMPLICIT AccessDescriptionPDU
    TypeDescription             [APPLICATION 4]     IMPLICIT TypeDescriptionPDU,
    ListDescription             [APPLICATION 5]     IMPLICIT ListDescriptionPDU,
    extensions                  [APPLICATION 6]     ANY
}
```

NOTE The [APPLICATION 7] to [APPLICATION 15] type PDUs are reserved by this standard for a future definition of other PDU types. The [APPLICATION 16] to [APPLICATION 30] type PDUs are reserved for the use of the Network Management standard. Moreover, the ANY type PDU is used to allow the future definition of additional PDU types in companion standards.

5.2.1.4.2 VariableCompactValue PDU

5.2.1.4.2.1 General

This PDU represents the variable value of SIMPLE, STRUCTURE or ARRAY construction type, and optionally the associated production status. These types are used for variables of NORMAL or SYNCHRONIZATION class.

The PDU of CompactValuePDU type is represented by using the OCTET STRING type:

```
Compact-value-pdu:: = OCTET STRING
-- The total length of the PDU shall not exceed 128 octets.
```

NOTE The fields of this PDU permits encoding of the following attributes in the MPS application layer objects. See Table 7.

Table 7 – Fields of a CompactValuePDU

Field	Class	Attribute
Compact_value_PDU	Variable	Public value Transmitted status value

The ASN1 OCTET STRING type will be then encoded under the ASN1 (ISO 8825 standard) rules as specified in the chapter concerning the transfer syntax.

NOTE The representation of a MPS variable under an ASN1 OCTET STRING type is only possible considering the following restrictions.

- Producers and consumers of the variable have a prior knowledge of the MPS type of the variable, and do not need to transmit the type description with the value of the variable. The knowledge is available by access to the description variable and description type variables.
- The type of the variable has a fixed length and has no conditional or optional fields.

The representation of the public value associated with a variable by using compacting rules is performed from the first content octet of the CompactValuePDU.

The production status are represented on the last octet when this option is selected.

The PDU's length octet value represents the octet count used to encode the variable value and the production status octet when it exists.

The representation of the production status on this octet is performed as follows.

- The refreshment status is encoded on bit 1. This bit is set to '1' when the refreshment status is 'TRUE', and '0' when it is 'FALSE'.
- The punctual refreshment status is encoded on bit 2. This bit is set to '1' when the punctual refreshment status is 'TRUE', and '0' when it is 'FALSE'.
- The bits 3 to 8 are reserved.

The encoding of a given variable is represented with a constant number of octets derived from the type specification of this variable.

5.2.1.4.2.2 BOOLEAN value encoding rule

The boolean encoding is performed on a single octet.

If the value is

FALSE: the octet is $øø_{16}$

TRUE: the octet may take any value different from zero chosen by the producer entity.

5.2.1.4.2.3 INTEGER value encoding rule

The encoding of an integer value is performed on one or several octets. The maximum number of octets is fixed by the maximum size authorized for the INTEGER type, that is, 32 octets.

The number of octets used for encoding an INTEGER type corresponds to E[(e-1)/8] + 1 where E is the integer part, and e the value of the *size* attribute associated with this type.

The content octets shall be a two-complement binary number equal to the integer value and be composed of bits 8 to 1 of the first octet, followed by bits 8 to 1 of the second octet, followed by bits 8 to 1 of each following octet, up to and including the last octet of the contents.

NOTE The value of a twos-complement binary number is derived by numbering the bits of the content octets, starting from bit 1 of the last octet and ending at bit 8 of the first octet. Each bit is assigned a numerical value of 2^{n-1}, where n is the bit position within the numbering sequence. The value of the twos-complement binary number is obtained by adding the numerical values assigned to each of the bits set to '1' (except for bit 8 of the first octet) from which the signed value from bit 8 of the first octet. is derived. The sign is negative when bit 8 of the first octet is set to '1'.

5.2.1.4.2.4 BITSTRING value encoding rule

The encoding of a bitstring value is performed on one or several octets as shown in Figure 4.

The maximum number of octets is fixed by the maximum size authorized for a BITSTRING type, that is, 32 octets.

The number of octets used for encoding a BITSTRING type corresponds to E[(e-1)/8] + 1 where E is the integer part and e the size of this type.

The bits of the bit string, starting from the first bit and ending at the last bit, shall be placed in sequence and in this order:

- in bits 8 to 1 of the first octet for the first 8 bits of the string,
- in bits 8 to 1 of the second octet for the 8 following bits,
- then in bits 8 to 1 of each following octet,
- followed by as many bits of the final octet as necessary always starting with bit 1.

The unused bits of the last octet have a value chosen by the producer entity.

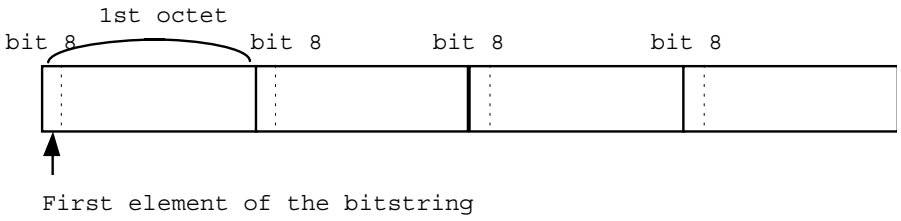


Figure 4 – Encoding of a Bitstring

5.2.1.4.2.5 UNSIGNED value encoding rule

The encoding of an unsigned integer value is performed on one or several octets. The maximum number of octets is fixed by the maximum size permitted for an UNSIGNED type, that is, 32 octets. The number of octets used for encoding a UNSIGNED type corresponds to E[(e-1)/8] + 1 where E is the integer part and e the value of the *size* attribute associated with this type.

The content octets shall be a binary number equivalent to the integer value, composed of bits 8 to 1 of the first octet, followed by bits 8 to 1 of the second octet, followed by bits 8 to 1 of each following octet, up to and including the last octet of the contents.

NOTE The value of a binary number is obtained by numbering the bits of the content octets, starting from bit 1 of the last octet and ending at bit 8 of the first octet. Each bit is assigned a numerical value of 2^{n-1}, where n is the bit position within the numbering sequence.

5.2.1.4.2.6 OCTETSTRING value encoding rule

The encoding of an OCTETSTRING value contains zero, one or several content octets whose value is equal to that of the data value octets, in the same sequence as they are placed in the data value, the most significant bit of a data value being aligned with the most significant bit of a octet of the contents.

The number of octets used for encoding an OCTETSTRING type corresponds directly to the number of terms of this string within the limit of 126 octets.

5.2.1.4.2.7 VISIBLE STRING value encoding rule

The value of a visible string is composed of a string of characters from the set specified in ISO 8824. Each of the characters of this string is encoded in one octet.

The number of octets used for encoding a VISIBLE STRING type corresponds directly to the number of elements of the string within the limit of 126 octets.

5.2.1.4.2.8 GENERALIZED TIME value encoding rule

The encoding of the value is performed in the same manner as a 14 character VISIBLE STRING value.

The generalized time (specified in ISO 8824) is characterized by a specific number of characters encoded on octets.

The generalized time is a juxtaposition of characters in the following sequence:

- 4 digits for the year
- 2 digits for the month
- 2 digits for the day
- 2 digits for the hour
- 2 digits for the minutes
- 2 digits for the seconds.

The first octets are those including the encoding of the year.

The generalized time expresses directly a local time.

5.2.1.4.2.9 FLOATING POINT value encoding rule

The encoding of a floating point value is performed on 4 or 8 octets according to the size attribute corresponding to single or double precision.

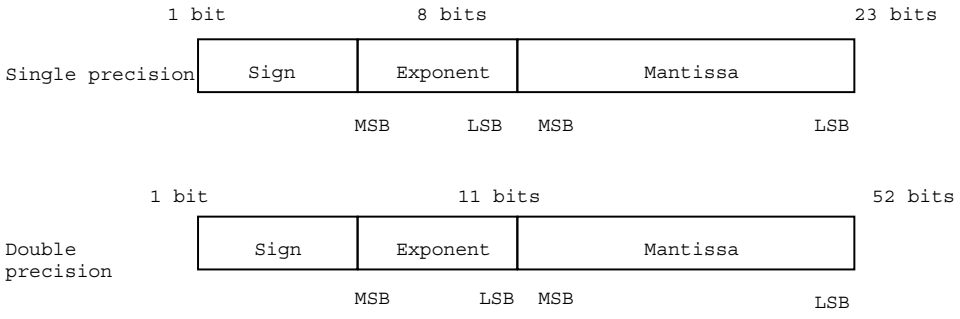


Figure 5 – Encoding of a Floating point value

The presentation formats defined in IEC 60559 are shown in Figure 5.

The content octets contain the sign, the exponent and the mantissa in the previous order starting from the first to the last octet.

In all cases the sign is encoded by using bit 8 of the first octet. It is followed by the the exponent starting from bit 7 of the first octet, and then the mantissa starts from bit 7 of the second octet for the simple precision and from bit 4 of the second octet for the double precision.

The encoding of the mantissa value and the exponent value is described in IEC 60559.

5.2.1.4.2.10 BINARY TIME value encoding rule

The encoding of a binary time value is performed on a number of octets defined by the size, and describes a number of elementary time units. The value of the elementary time unit depends on the selected size.

The content octets contain a binary value equivalent to the binary time value, and composed of bits 8 to 1 of the first octet, followed by bits 8 to 1 of each following octet, up to and including the last octets of the contents.

NOTE The binary value is obtained by numbering the bits of the content octets, starting from bit 1 of the last octet and ending at bit 8 of the first octet. Each bit set to '1' is assigned a numerical value of 2^{n-1}, where n is the bit position within the numbering.

5.2.1.4.2.11 BCD value encoding rule

The BCD encoding is performed on one octet. The binary value associated with the BCD value is encoded on bits 1 to 4 of the octet and obtained by starting from bit 1 up to bit 4. Each bit set to '1' is assigned a numerical value of 2^{n-1}, where n is the position of the bit within the octet.

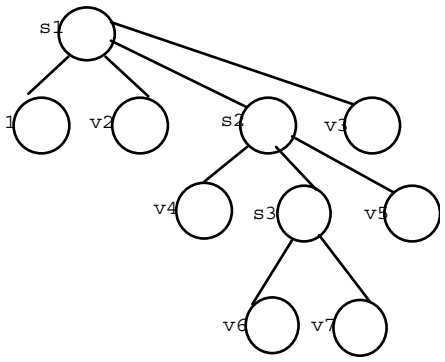
5.2.1.4.2.12 Structure encoding rule

The encoding of a structure type involves the encoding rules of each of the simple types and a concatenation rule of the types composing this structure.

The encoding of the various types composing a structure are juxtaposed in order of appearance within the structure.

The value associated with the first structure field is encoded in the first octets of the content. The value associated with the second field is encoded in the following octets, and so on, up to the last field of the structure.

Consider the following type tree:



Representation within the octets of the contents:

V1	V2	V4	V6	V7	V5	V3

Figure 6 – Encoding of a structure

A structure can comprise several levels of abstraction; in this case, the encoding juxtaposition of the values associated with the various fields is performed by a first in depth traverse over the type tree associated with the structure as shown in Figure 6.

5.2.1.4.2.13 Array encoding

The array encoding involves the encoding rule of a simple type and a concatenation rule of the elements which compose the array.

The encoded values of the array elements are juxtaposed in the statement sequence of the array: these elements may be of simple, structure or array type.

The first array element is contained in the first octet of the content octets.

The array types may be optionally specified with optimisation rules of the associated encoding.

These optimisation rules do not preclude a partial access to an array element and preserve the integrity of the handled data.

5.2.1.4.2.14 Compacted encoding rule for a BOOLEAN array

The normal encoding of a BOOLEAN array type value uses one octet for each element of the array.

The compacted encoding of a BOOLEAN array type value is performed using one octet for a set of eight booleans.

Thus, the content octets used for encoding a compacted BOOLEAN array are organized as shown in Figure 7.

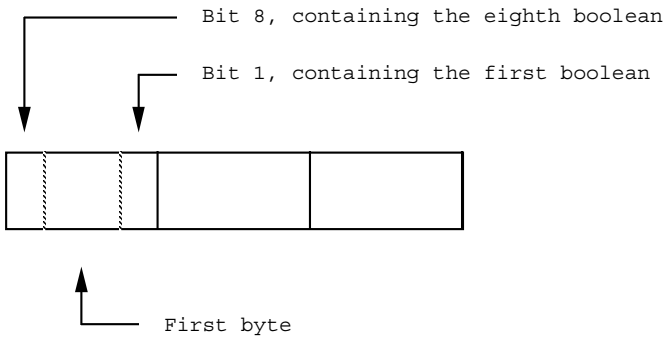


Figure 7 – Encoding of a Boolean array

In the compacted encoding of a boolean array, a boolean value is 'TRUE' when the corresponding bit is set to '1'.

Every compacted boolean array is encoded using a number of octets equal to E[(e-1)/8] + 1 where E is the integer part and e is the number of elements of this boolean array.

5.2.1.4.2.15 Compacted encoding rule for a BCD array

The normal encoding of a BCD array type value uses one octet for each element of the array.

The compact encoding of a BCD array type value is performed by using one octet for a pair of BCDs.

Thus, within the content octets used for encoding a compacted BCD array, bits 8 to 5 of the first octet contain the first BCD of the array, and bits 4 to 1 of the first octet contain the second BCD of the array, and so on up to the last BCD of the array.

The binary value associated with the value of the first BCD of a octet is obtained by starting from bit 5 up to bit 8: each bit is assigned a numerical value of 2^{n-5}, where n is the position of the bit within the octet.

The binary value associated with the value of the second BCD of a octet is obtained by starting from bit 1 up to bit 4: each bit is assigned a numerical value of 2^{n-1}, where n is the position of the bit within the octet.

5.2.1.4.3 ExplicitVariableValue PDU

The Explicit PDU type PDU allows the representation of the values of the variables for which the type construction is EXPLICIT.

This PDU supports variable values which are not of constant length.

```
ExplicitPDU::= CHOICE
{
   array                          [0] IMPLICIT SEQUENCE OF ExplicitPDU,
   structure                      [1] IMPLICIT SEQUENCE OF ExplicitPDU,
   boolean                            [2] IMPLICIT BOOLEAN,
   bitString                      [3] IMPLICIT BITSTRING,
   integer                        [4] IMPLICIT INTEGER,
   unsigned                       [5] IMPLICIT INTEGER,
   floating                       [6] IMPLICIT OCTET STRING,
   octetString                    [7] IMPLICIT OCTET STRING,
   visibleString                  [8] IMPLICIT OCTET STRING,
   generalizedTime                [9] IMPLICIT OCTET STRING,
   binaryTime                     [10]    IMPLICIT OCTET STRING,
   bcd                            [1] IMPLICIT INTEGER
}
```

The total length of the PDU shall not exceed 128 octets.

5.2.1.4.4 VariableDescription PDU

This PDU represents the value of the variables whose type is K_DVAR. This type is used for the description variables.

```
VariableDescriptionPDU ::= SEQUENCE
{
   FixedDescription               [0] IMPLICIT Description,
                                  -- predefined type specified hereafter
   variableName                   [1] IMPLICIT Symbol,
   resynchronisationReference     [2] IMPLICIT ObjectReference OPTIONAL,
   productionPeriod               [3] IMPLICIT Unsigned16 OPTIONAL,
   synchronisationReference       [4] IMPLICIT ObjectReference OPTIONAL,
   ProductionSlot                 [5] IMPLICIT Unsigned16 OPTIONAL,
   punctualSynchroReference       [6] IMPLICIT ObjectReference OPTIONAL,
   listReference                  [7] IMPLICIT ObjectReference OPTIONAL,
   otherDetails                   [8] IMPLICIT ANY OPTIONAL,
   vendorInformation              [9] IMPLICIT OCTET STRING OPTIONAL
}
```

The total length of the PDU shall not exceed 128 octets. See Table 8.

NOTE The fields of this PDU permits encoding of the following attributes in the MPS application layer objects.

Table 8 – Fields of a VariableDescriptionPDU

Field	Class	Attribute
FixedDescription	Variable	Identifier Network Period Class Consistency Variable Significiant Status Reference Type Constructor
Variable Name	Variable	A_Name
ResynchronizationReference	Resynchronization in Production	Reference (Synchronization) Variable
ProductionPeriod	Refreshment	Production Variable
SynchronizationReference	Refreshment	Reference (Synchronization) Variable
ProductionSlot	Punctual Refreshment	Production Time Slot
PunctualSynchroReference	Punctual Refreshment	Reference (Synchronization) Variable
ListReference	Variable	Reference Variable List

The type description of this PDU uses the Description type which contains the non optional part of constant size of this PDU.

Description:: = OCTET STRING -- Size fixed to 7 octets

Octet semantics:

octets 1 + 2: Described variable identifier

(Most significant bit of the identifier in bit 8 of the first octet and least significant bit in bit 1 of the second octet)

octets 3 + 4: Network period

(Most significant bit of the network period in bit 8 of the first octet, in multiples of 1 millisecond; a 0 value indicates an aperiodic variable)

octet 5: *Bit 8,and 7:* Variable class

00: NORMAL
01: SYNCHRONIZATION
10: DESCRIPTION
All the other combinations are reserved
Bit 6: Sub-class of a synchronization variable
1: Consistency variable
0: Synchronization variable but not consistency variable
Bits 5 and 4: Significant status
00: no significant status
01: significant refreshment
10: significant punctual refreshment
11: significant refreshment and punctual refreshment
Bits 3 to 1 reserved.

octets 6 + 7: Type reference

(encoded on 16 bits by using the description variable identifier of this type. The most significant bit is bit 8 of the octet 6 and the least significant one bit 1 of the octet 7)

The type description of this PDU uses the non terminal grammar element ObjectReference referring to variables, lists and types by means of the identifier of the associated description variable. These identifiers are encoded on two octets: the most significant bit of the identifier is encoded in bit 8 of the first octet and the least significant one in bit 1 of the second octet.

```
ObjectReference::= OCTET STRING          -- Size fixed to 2 octets
```

The ANY types included in the definition of the PDU, as well as the reserved bits within this PDU, used to support, the description complements specified elsewhere.

Moreover, optional octet strings permit, insertion of vendor specific information into this PDU.

5.2.1.4.5 AccessDescription PDU

This PDU supports the variable value whose type is K_DACCESS. This type is used for the access description variables. See Table 9.

```
AccessDescriptionPDU ::= SEQUENCE
{
   accessName                          [0] IMPLICIT Symbol,
   rootReference                       [1] IMPLICIT ObjectReference,
   accessPath                          [2] IMPLICIT SEQUENCE OF CHOICE
   {
      structureFieldName                   [0] IMPLICIT Symbol,
      arrayElementIndex                    [1] IMPLICIT Unsigned8
   } OPTIONAL
   otherDetails                        [3] IMPLICIT ANY OPTIONAL,
   vendorInformation                   [4] IMPLICIT OCTET STRING OPTIONAL
}
```

NOTE The fields of this PDU permits encoding of the following attributes in the MPS application layer objects.

Table 9 – Fields of an AccessDescriptionPDU

Field	Class	Attribute
Access Name	Access	A_Name
Root Reference	Access	Reference Variable
Access Path	Type Constructor	Field Name

The ANY types include description complements specified elsewhere in the definition of the PDU.

Moreover, optional octet strings permit insertion of vendor specific information into this PDU.

5.2.1.4.6 TypeDescription PDU

This PDU supports the variable value whose type is K_DTYPE. This type is used for the type description variables.

```
TypeDescriptionPDU :: = SEQUENCE
{
   typeName                        [0] IMPLICIT Symbol,
   typeDescription                 [1] CHOICE
   {
      array                        [0] IMPLICIT SEQUENCE
      {
         compressed                      [0] IMPLICIT BOOLEAN DEFAULT FALSE,
         dimension                       [1] IMPLICIT Unsigned8,
         elementReference                [2] IMPLICIT ObjectReference
      },
   structure                       [1] IMPLICIT SEQUENCE OF SEQUENCE
      {
      fieldName                        [0] IMPLICIT Symbol OPTIONAL,
      fieldTypeReference               [1] IMPLICIT ObjectReference
      },
   -- simple                          Size                          Type Class
   boolean                            [2] IMPLICIT NULL,            -- BOOLEAN
   binaryString                    [3] IMPLICIT Unsigned8, -- BITSTRING
   integer                         [4] IMPLICIT Unsigned8, -- INTEGER
   unsigned                        [5] IMPLICIT Unsigned8, -- UNSIGNED
   floatingPoint                   [6] IMPLICIT BOOLEAN, -- FLOATING POINT
   octetString                     [7] IMPLICIT Unsigned8,       -- OCTET STRING
   visibleString                   [8] IMPLICIT Unsigned8, -- VISIBLE STRING
   universalTime                   [9] IMPLICIT NULL,            -- UNIVERSAL TIME
   binaryTime                      [10]   IMPLICIT Unsigned4,    -- BINARY TIME
   bcd                             [11]   IMPLICIT NULL,         -- BCD
   predefined                      [12]   IMPLICIT NULL,
   explicit                        [13]   IMPLICIT NULL,
   },
   otherDetails                    [2] IMPLICIT ANY OPTIONAL,
   vendorInformation               [3] IMPLICIT OCTET STRING OPTIONAL
}
```

-- The total length of the PDU shall not exceed 128 octets. See Table 10.

NOTE The fields of this PDU permits encoding of the following attributes in the MPS application layer objects.

Table 10 – Fields of a TypeDescriptionPDU

Field	Class	Attribute
TypeName	TypeConstructor	A_Name
Compressed	TypeConstructor	Compressed
Dimension	TypeConstructor	Dimension
ElementReference	TypeConstructor	TypeConstructor
FieldName	TypeConstructor	FieldName
FieldTypeReference	TypeConstructor	TypeConstructor
BinaryString	TypeConstructor	Size
Integer	TypeConstructor	Size
Unsigned	TypeConstructor	Size
FloatingPoint	TypeConstructor	Size
OctetString	TypeConstructor	Size
VisibleString	TypeConstructor	Size
BinaryTime	TypeConstructor	Size

The ANY types include description complements specified elsewhere in the definition of the PDU.

Moreover, optional octet strings permit insertion of information specific to the vendors into this PDU.

ListDescription PDU

This PDU supports the variable value whose type is K_DLIST. This type is used for the list description variables.

```
ListDescriptionPDU                ::= SEQUENCE
{
   listName                       [0] IMPLICIT Symbol,
   variableReferenceList          [1] IMPLICIT ListComponents,
   inconsistencyDetection         [2] IMPLICIT Unsigned8 OPTIONAL,
                                  -- 0UNDEFINED
                                  -- 1PERMANENT
                                  -- 2PERMANENT
                                  -- The other values are reserved
   synchronizationReference       [3] IMPLICIT ObjectReference OPTIONAL,
   consistencyVariableList        [4] IMPLICIT ListConsistencyVariables OPTIONAL,
   recoveryPeriod                 [5] IMPLICIT Unsigned16 OPTIONAL,
   otherDetails                   [6] IMPLICIT ANY OPTIONAL,
   vendorInformation              [7] IMPLICIT OCTET STRING OPTIONAL
}
```

-- The total length of the PDU shall not exceed 128 octets. See Table 11.

NOTE The fields of this PDU permits encoding of the following attributes in the MPS application layer objects.

Table 11 – Fields of a ListDescriptionPDU

Field	Class	Attribute
ListName	VariableList	A_Name
VariableReferenceList	VariableList	List of Reference ConsumedVariable
InconsistencyDetection	VariableList	InconsistencyDetection
SynchronizationReference	VariableList	Reference (Synchronization)Variable
ConsistencyVariableList	VariableList	List of Reference (Consistency) Variable
RecoveryPeriod	VariableList	RecoveryPeriod

The type description of this PDU uses the non terminal grammar element 'listComponents' which defines the representation format of the references to the variables which compose the described list.

```
ListComponents ::= OCTET STRING          -- The size of this string depends on that of the list.
```

Each variable name which comprise this list is encoded on two octets of this octet string, starting from the first two octets up to the last two octets within the size limits provided by this PDU. The list variable names are represented on two octets in a unique way by means of the identifier of the description variable associated with each variable of this list. The most significant bit of the identifier is encoded in bit 8 of the first octet, and the least significant one in bit 1 of the second octet.

The type description of this PDU uses the non terminal grammar element 'listConsistencyVariables' which defines the representation format of the references to the consistency variables associated with the variable list in the case of the operation of the spatial consistency mechanism.

```
ListConsistencyVariables::= OCTET STRING   -- size relative to the number of application entities involved in the
spatial consistency.
```

Each consistency variable name, which takes part in the elaboration of the spatial consistency of this list, is encoded on two octets of this octet string, starting from the first two octets up to the last two octets within the size limits provided by this PDU. The consistency variable names are represented on two octets in an unique way by means of the identifier of the description variable associated with each consistency variable.

The most significant bit of the identifier is encoded in bit 8 of the first octet, and the least significant one in bit 1 of the second octet.

5.2.1.4.7 PDU Extensions

The ANY types include description complements specified elsewhere in the PDU definition.

For, all the grammar elements participating in the definition of the module being defined, it is necessary to declare the end of this module.

END -- End of the module AL TYPE 7 - -MPS-1

5.2.2 MCS AR ASE AL PDU types

5.2.2.1 Coding rules

All MCS PDUs contain a whole number of octets. The octets of a PDU are numbered from 1 to a maximum of 256 for the longest PDUs. These octets are transmitted via the bus in order from the first octet to the last. Each of the octets of a PDU has bits numbered 1 to 8, where bit 1 is the least significant and bit 8 the first transmitted on the line. Finally, when a number of consecutive octets represents a binary number, the least significant octet contains the most significant value.

In the following figures, the least significant number octets are always on the left when represented horizontally, and at the top when represented vertically. Also, the bits in a octet are always represented with bit 8 on the left and bit 1 on the right.

5.2.2.2 Structure of the PDUs

5.2.2.2.1 Top Level Definition

As a general rule, all MCS PDUs consist, in order, of:

- the header containing:
- the header size,
- the fixed part containing what is mandatory,
- the variable part containing what is optional,
- the data, which are optionally present.

Representation is shown in Figure 8

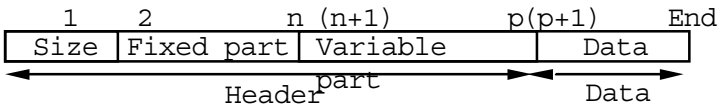


Figure 8 – Representation of a MCS PDU

a) Size:

The size is equal to sum of the numbers of octets of the fixed part and the variable part of the PDU header.

The value of the size is coded in the first octet of the header as a binary number.

The maximum size value is 255, which is coded as 1111 1111.

b) Fixed part

Whatever the PDU type, the fixed part contains its code followed by coding of a list of parameters which are mandatory for the code value.

The values of the PDU codes associated with the different types of PDUs are as shown in Table 12.

Table 12 – Coding of the different MCS PDU types

PDU values	Meaning
1000 0000	association establishment request
1100 0000	association establishment response
1001 0000	association termination request
1101 0000	association termination response
1011 0000	association revocation request
00X0 0XXX	associated transfer
0110 0000	associated transfer acknowledgement
00X1 0XXX	non-associated transfer
0111 0XXX	non-associated transfer acknowledgement

The bits of certain codes marked X have the values indicated in the descriptions of the associated PDU types.

NOTE All other codes are pending in this standard.

c) Variable part

This field is intended to receive optional parameters, which may be present or absent depending on the classes of conformity of the devices and the requirements of the user.

Each service parameter encoded in the variable part is structured as shown in Table 13.

Table 13 – Coding of the variable part of the PDU

Mapping	Meaning
octet 1	Parameter code
octet 2	Parameter length (length = m)
octet 2 + 1	Parameter value start
(to)	(continued)
octet 2 + m	Parameter value end

Each of the parameters has a parameter code which is universal in the MCS environment, and which is therefore covered by this standard (these are defined for each PDU type implementing them).

The length of the parameter is coded in one octet. The value of the parameter is coded in as many octets as is specified in the length and the semantics of the coding is specific to each parameter (the semantics are defined at the level of each type of PDU implementing them).

d) Data

This field is transparent for MCS as it contains data specific to one of the specific application service elements projected onto MCS.

5.2.2.2.2 Association establishment request (AARQ)

AARQ structure is as shown in Table 14.

Table 14 – Structure of association establishment request

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Calling AEI access point
octet 4	ditto
octet 5	ditto
octet 6	Called AEI access point
octet 7	ditto
octet 8	ditto
octet 9	Class of conformity
octet 10	Variable part
to	ditto
octet p	ditto
octet p+1	User data
to	ditto
end octet	ditto

a) Size

The minimum size value is 8 (coded: 0000 1000) when the parameters relating to this PDU are not present, and the maximum size value is reached when all the parameters are present.

(For instance, the maximum size value is 51 octets.)

b) Fixed part

The following fields are present in the fixed part.

- The PDU code takes the value “1000 0000”.

- The calling AEI access point, which corresponds to a link address (of an ADAEI type) is represented by bit I/G as the high order bit in the lowest number octet.

Representation:

octet_3: I / G x x x x x x x
octet_4: x x x x x x x x
octet_5: S / R x x x x x x x

- The called AEI access point which corresponds to a liaison address (of ADAEI type) is represented with the high order bit in the lowest number octet.

Representation:

octet_6 : I / G x x x x x x x
octet_7 : x x x x x x x x
octet_8 : S / R x x x x x x x

NOTE The default value used for this access point when the association establishment initiator does not wish to fill it in is the following value:

octet_6 : 1111 1111
octet_7 : 1111 1111
octet_8 : 1111 1110

It is a link address value which is found in the generalised group address space reserved under the standard.

- The class of conformity

  Representation:

  octet_9: b8 b7 b6 b5 b4 b3 b2 b1

  Where:

  b8 = 1, if PV_RE = 2
  b7 = 1, if PH_AK = 2
  b6 = 1, if PH_RA = 2
  b5 = 1, if PH_SR = 2
  b4 = 1, if PH_CF = 2

  The possible combinations of these bits shall allow for the constraints placed on the classes of conformity

c) Variable part

The following parameters shall be present in the variable part.

- Transfer rate:

  Parameter code: 0000 0000
  Parameter length: 4 octets (0000 0100)
  Parameter value:

xxxx xxxx	:	Calling to Called
xxxx xxxx		
yyyy yyyy	:	Called to Calling
yyyy yyyy		

  The value of these two rates is represented by a binary number equal to the time interval expressed in ms between successive messages.

  The value 0000 0000 0000 0001 corresponds to 1msg/ms and the value 1110 1010 0110 0000 corresponds to 1msg/min.

  The value 0000 0000 0000 0000 conventionally represents a null guaranteed minimum flow in one direction of transfer.

This parameter can only be present if b4 (PH_CF) of the Class of conformity parameter is set to 1.

- Anticipation factor:

  Parameter code: 0000 0001
  Parameter length: 2 octets (0000 0010)
  Parameter value:

xxxx xxxx	:	Calling to Called
yyyy yyyy	:	Called to Calling

  The anticipation factor is represented by a binary number making it possible to discriminate between 255 levels. The anticipation level of “i” means that it is possible to have a maximum of “i” ATAK_SM_RQ current in the association.

  The use of value 0 is illegal.

  This parameter can only be present if the b7(PH_AK) of the Class of conformity parameter is 1 .

- Application context:

  Parameter code: 0000 0010
  Parameter length: 3 octets (0000 0011)
  Parameter value:

xxxx xxxx	:	Specific ASE type
yyyy yyyy	:	Abstract syntax type
zzzz zzzz	:	Transfer syntax type

  The value of these different types is specific to each of the application ASEs. The high order bit of each of these octets indicates whether it is a type defined in a standard (b8=1) or specific to an application (b8=0).

- Calling entity identification:

  Parameter code: 0000 0011
  Parameter length: 6 octets (0000 0110)
  Parameter value:

xxxx xxxx	:	AEI identifier
yyyy yyyy	:	API identifier
zzzz zzzz	:	AE qualifier
uuuu uuuu	:	AP title
uuuu uuuu		
uuuu uuuu		

  The first octet of the value designates the AEI identifier by means of a binary number making it possible to discriminate between 255 AEIs for an API in the context of a given AE. Value 0000 0000 is the default value used to not fill in this parameter.

  The second octet designates the API identifier by means of a binary number making it possible to discriminate between 255 APIs for a given AP. The value 0000 0000 is the default value used to not fill in this parameter.

  The third octet designates the AE qualifier by means of a binary number making it possible to discriminate between 255 AEs for a given AP. The value 0000 0000 is the default value used to not fill in this parameter.

  The last free octets designate the AP title by means of a binary number. These three octets are set to 0000 0000 if this parameter is not adopted.

- Called entity identification:

  Parameter code: 0000 0100
  Parameter length: 6 octets (0000 0110)
  Parameter value:

xxxx xxxx	:	AEI identifier
yyyy yyyy	:	API identifier
zzzz zzzz	:	AE qualifier
uuuu uuuu	:	AP title
uuuu uuuu		
uuuu uuuu		

  The first octet of the value designates the AEI identifier by means of a binary number making it possible to discriminate between 255 AEIs for one API in the context of a given AE. The value 0000 0000 is the default value used to not fill in this parameter.

  The second octet designates the API identifier by means of a binary number making it possible to discriminate between 255 APIs for a given AP. The value 0000 0000 is the default value used to not fill in this parameter.

The third octet designates the AE qualifier by means of a binary number making it possible to discriminate between 255 AEs for a given AP. The value 0000 0000 is the default value used to not fill in this parameter.

The last three octets designate the AP title by means of a binary number. These three octets are set to 0000 0000 if this parameter is not adopted.

- SDU size:

  Parameter code: 0000 0101
  Parameter length: 2 octets (0000 0010)
  Parameter value:
  xxxx xxxx : Calling to Called
  yyyy yyyy : Called to Calling

  SDU size is represented by a binary number providing for a maximum SDU size of 256 DLPDUs, i.e. 64 koctets for a maximum DLPDU size of 256 octets.

  Value 0 of this parameter is illegal.

  This parameter may only be present if b5(PH_SR) of the Class of conformity parameter is set to 1.

- PDU size:

  Parameter code: 0000 0110
  Length: 1 octet (0000 0001)
  Parameter value:
  xxxx xxxx : SDU size

  PDU size is represented by a binary number allowing a maximum PDU size of 256 octets.

  This parameter can be present whatever the value of the class of conformity.

- Number of retries:

  Parameter code: 0000 0111
  Length: 1 octet (0000 0001)
  Parameter value: 0000 xxxx

  The number of retries is represented by a binary number allowing a maximum of 16 retries coded in bits xxxx.

  Value 0 of this parameter is illegal.

  This parameter can only be present if b6(PH_RA) of the Class of conformity parameter is set to 1.

- “Cyclic flow” option:

  Parameter code: 0000 1000
  Length: 0 octet

d) Data

The data carried in this PDU is coded in a manner interpretable in the context of the application.

5.2.2.2.3 Association establishment response (AARP)

AARP structure is shown in Table 15.

Table 15 – Structure of an associated establishment response

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Calling AEI access point
octet 4	ditto
octet 5	ditto
octet 6	Called AEI access point
octet 7	ditto
octet 8	ditto
octet 9	Class of conformity
octet 10	Result
octet 11	Variable part
to	ditto
octet p	ditto
octet p+1	User data
to	ditto
end octet	ditto

a) Size

The minimum size value is 9 octets (coded 0000 1001), when the parameters relating to this PDU are not present and the maximum size value is reached when all the parameters are present.

b) Fixed part

The following fields are present in this part:

- The PDU code takes the value “1100 0000”.

- The calling AEI access point, which corresponds to a link address (of ADAEI type) is represented with bit I/G as the high order bit in the lowest number octet.

  Representation:

  octet_3: I / G x x x x x x x
  octet_4: x x x x x x x x
  octet_5: S / R x x x x x x x

- The called AEI access point which corresponds to a link address (of ADAEI type), is represented with the high order bit in the lowest number octet.

  Representation:

  octet_6: I / G x x x x x x x
  octet_7: x x x x x x x x
  octet_8: S / R x x x x x x x

NOTE The default value used for this access point when the association establishment initiator does not wish to fill it in is the following value:

octet_6: 1111 1111

octet_7: 1111 1111

octet_8: 1111 1110

It is a link address value which is found in the generalised group address space reserved under the standard.

- The class of conformity

  Representation:

  octet_9: b8 b7 b6 b5 b4 b3 b2 b1

  Where:

  b8 = 1, if PV_RE = 2
  b7 = 1, if PH_AK = 1
  b6 = 1, if PH_RA = 2
  b5 = 1, if PH_SR = 2
  b4 = 1, if PH_CF = 2

  The possible combinations of these bits shall allow for the constraints on the classes of conformity.

- The result subsequent to an association establishment request is coded in one octet and indicated if the response is positive or negative, in the latter case providing information on the nature and location of the fault.

  The values of the level 10 octet contain the following values in the following cases:

0000 0000: (+) Positive
0000 0001: (-) MCS provider (general)
0000 0010: (-) Responder user
0000 0011: (-) linked to “Cyclic rate”
0000 0100: (-) linked to “Transfer rate”
0000 0101: (-) linked to “Context name”
0000 0110: (-) linked to “Called entity identification”
0000 0111: (-) linked to “Calling entity identification”
0000 1000: (-) linked to “Service size”
xxxx xxxx: Spare

c) Variable part

The following parameters can be present in the variable part.

- Transfer rate:

  The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request.

- Anticipation factor:

  The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request PDU

- Application context:

  The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request PDU (see 10.2.3.2.2.c).

- Called entity identification:

  The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request PDU

- SDU size:

The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request PDU (see 10.2.3.2.2.c).

- PDU size:

  The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request PDU (see 10.2.3.2.2.c).

- Number of retries:

  The coding and semantics of this parameter are equivalent to those of the parameter of the same name in the association establishment request PDU (see 10.2.3.2.2.c).

d) Data

The data carried in this PDU are coded in a manner interpretable in the context of the application.

5.2.2.2.4 Association termination request (RERQ)

The RERQ structure is shown as in Table 16.

Table 16 – Structure of an association termination request

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	User data
to	ditto
end octet	ditto

a) Length

The size value is 1 octet (coded 0000 0001)

b) Fixed part

The single field containing the fixed part is the PDU code which takes the value “1001 0000”.

c) Variable part

There is no variable part in this PDU.

d) Data

Data carried in this PDU has coding which is interpretable in the context of the application.

5.2.2.2.5 Association termination response (RERP)

The RERP structure is as in Table 17.

Table 17 – Structure of an association termination response

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Result
octet 4	User data
to	ditto
end octet	ditto

a) Size

The size value is 2 octets (coded: 0000 0010).

b) Fixed part

The fixed part of the header contains the following two fields:

- PDU code: “1101 0000”

- The result which is coded in one octet, indicating whether the result is positive or negative, and in the second phase providing information on the fault, to be defined later.

0000 0000: (+) Positive
0000 0001: (-) Negative
xxxx xxxx: Spare (Defaults)

c) Variable part

This PDU has no variable part.

d) Data

The data carried in this PDU has coding which is interpretable in the context of the application.

5.2.2.2.6 Association revocation request (ABRQ)

The ABRQ structure is as in Table 18.

Table 18 – Structure of an association revocation request

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Invocation origin
octet 4	User data
to	ditto
end octet	ditto

a) Size

The size value is 2 octets (coded: 0000 0010).

b) Fixed part

The following two fields make up the fixed part:

- PDU code taking value “1011 0000”.

- Invocation origin, coded in one octet and taking two values:

0000 0000: MCS user
1111 1111: MCS provider
xxxx xxxx: Other codes reserved

c) Variable part

This PDU has no variable part.

d) Data

The data carried in this PDU has coding which is interpretable in the context of the application.

5.2.2.2.7 Associated transfer request (ATRQ)

The ATRQ structure is as in Table 19.

Table 19 – Structure of an associated transfer request

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Sequence number
octet 4	ditto
octet 5	User data
to	ditto
end octet	ditto

a) Size

The size value is 3 octets (coded: 0000 0011).

b) Fixed part

The following two fields constitute the fixed part of the header:

- PDU code, taking values:

  0000 0000: for unacknowledged transfers
  0010 0XXX: for acknowledged transfers

  where XXX is used to code the packet nature in the case of segmentation.

- The packet nature is coded as follows:

  000: NIL (no segmentation)
  100: STT (first packet)
  101: MID (middle packet)
  110: END (last packet)
  111: ALL (first and last packet).

- The sequence number is represented in two octets by means of a binary number. This makes it possible to discriminate between 65536 data transfers. This number is not significant in the case of unacknowledged transfer.

c) Variable part

This PDU has no variable part.

d) Data

The data carried in this PDU have coding which is interpretable in the context of the application specific to the association.

5.2.2.2.8 Associated transfer acknowledgement (AKAT)

The AKAT structure is as in Table 20.

Table 20 – Structure of an associated transfer acknowledgement

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Sequence number
octet 4	ditto

a) Size

The size value is 3 octets (coded: 0000 0011).

b) Fixed part

The following field is contained in the fixed part:

- PDU number, taking the value “0110 0000”.

- Sequence number, attributed by the numbering entity.

c) Variable part

This PDU has no variable part.

d) Data

This PDU has no user data.

5.2.2.2.9 Non-associated transfer request (NTRQ)

The NTRQ structure is as in Table 21.

Table 21 – Structure of a non-associated transfer request

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Invocation identification
octet 4	ditto
octet 5	Variable part
to	ditto
octet p	ditto
octet p+1	User data
to	ditto
end octet	ditto

a) Size

The minimum size value is 3 octets (coded: 0000 0011) when the parameters relating to the PDU parameter are not present, and the maximum value is reached when all the parameters are present.

b) Fixed part

The following fields are present in the fixed part:

- PDU code, taking values:

  0001 0xxx: for unacknowledged transfers
  0011 0xxx: for acknowledged transfers

  where the value of xxx is used to code service priority.

- Service priority, coded in 3 bits making it possible to establish 8 priority levels.

- Invocation identification, represented in 2 octets by a binary number. This makes it possible to discriminate 65536 current simultaneous data transfers.

c) Variable part

The following parameters may be present in the variable part:

- Application context

  The coding and semantics of this parameter are equivalent to those of the parameter with the same name in the association establishment request PDU (see5.2.2.2.2).

- Calling entity identification

  The coding and semantics of this parameter are equivalent to those of the parameter with the same name in the association establishment request PDU (see 5.2.2.2.2).

- Called entity identification

The coding and semantics of this parameter are equivalent to those of the parameter with the same name in the association establishment request PDU (see 5.2.2.2.2).

d) Data

The data carried in this PDU have coding which is interpretable in the context of the application.

5.2.2.2.10 Non-associated transfer acknowledgement (AKNT)

The AKNT structure is as in Table 22.

Table 22 – Structure of a non-associated transfer acknowledgement

Mapping	Meaning
octet 1	Size
octet 2	PDU code
octet 3	Invocation identification
octet 4	ditto

a) Size

The size value is 3 octets (coded: 0000 0011).

b) Fixed part

The following field is contained in the fixed part:

- PDU number, taking the value “0111 0XXX”.

The 3 bits XXX are reserved for coding a fault which can arise at the acceptor.
Fault coding is as follows:
000: AKNT+, no fault
≠000: AKNT-, fault
where:
001: non-specialised fault line
010 to 111: faults, the specialisation of which is reserved under this standard.

NOTE The acknowledgement does not carry the priority of the transfer request which gave rise to the acknowledgement as it is implicit that any requester will reserve the resources to receive the acknowledgement it awaits.

- Invocation identification is represented by 2 octets with a binary number. This makes it possible to discriminate 65536 current simultaneous data transfers.

c) Variable part

This PDU has no variable part.

d) Data

This PDU has no user data.

5.2.3 SUB MMS ASE FAL PDU type

5.2.3.1 SUB-MMS-PDU

5.2.3.1.1 Top Level Definition

This section describes the PDUs used in the SUB-MMS protocol.

```
SUB-MMS-General-module-1 {iso standard 9605
   part-protocol (2)
   sub-mms-general-module-version1 (5) }

DEFINITION:: = BEGIN
EXPORT SUB-MMSpdu;
-- By this affirmation we mean that any production subjected to SUB-MMSpdu is exportable.--
SUB-MMSpdu :: =                    CHOICE{
   confirmed-reqPDU                [0] IMPLICIT ConfirmedReqPDU,
   confirmed-respPDU               [1] IMPLICIT ConfirmedRespPDU,
   confirmed-errorPDU              [2] IMPLICIT ConfirmedErrorPDU,
   unconfirmedPDU                  [3] IMPLICIT UnconfirmedPDU,
   rejectPDU                       [4] IMPLICIT RejectPDU,
   initiate-reqPDU                     [5] IMPLICIT        InitiateReqPDU,
   initiate-respPDU                [6] IMPLICIT InitiateRespPDU,
   initiate-errorPDU               [7] IMPLICIT InitiateErrorPDU,
   conclude-reqPDU                 [8] IMPLICIT ConcludeReqPDU,
   conclude-respPDU                [9] IMPLICIT ConcludeRespPDU,
   conclude-errorPDU               [10]   IMPLICIT        ConcludeErrorPDU
}
```

The SUB-MMSpdu protocol defines 11 types of PDU

The companion Standards can increase this list.

5.2.3.1.2 Definition of confirmed-req-PDU

```
ConfirmedReqPDU:: =                SEQUENCE {
   invoke-ID                       UNSIGNED-32,
   confirmed-service-req           ConfirmedServiceReq}.
```

The confirmed-req-pdu includes two parameters:

a) invoke-ID has the same significance as that given in the ISO/IEC 9506-2.

b) ConfirmedServiceReq is defined below.

5.2.3.1.3 Definition of Unconfirmed-PDU

```
UnconfirmedPDU:: =                 SEQUENCE {
   invoke-ID                       UNSIGNED-32,
   unconfirmed-service             UnconfirmedService}.
```

The unconfirmed-pdu includes two parameters:

a) invoke-ID has the same significance as that given by the ISO/IEC 9506-2.

UnconfirmedService is defined below.

5.2.3.1.4 Definition of confirmed-resp-pdu

```
ConfirmedRespPDU:: =               SEQUENCE {
   invoke-ID       UNSIGNED-32,
   confirmed-service-resp          ConfirmedServiceResp}.
```

The confirmed RespPDU includes two parameters:

The invoke-ID has the same significance as that given by the ISO/IEC 9506-2.

The ConfirmedServiceResp is defined below.

5.2.3.1.5 Definition of confirmed-error-pdu

```
ConfirmedErrorPDU:: =              SEQUENCE {
   invoke-ID       UNSIGNED-32,
   service-error   ErrorType}.
```

The ConfirmedErrorPDU includes two parameters:

a) invoke-ID has the same significance as that given by the ISO/IEC 9506-2.

Error is defined below.

5.2.3.1.6 Definition of "object" and "service"

5.2.3.1.6.1 Definition of a class of objects

A class of objects is a qualifying expression attributed to a type of set of objects to express the fact that the same action applied to these objects always gives the same result. We attribute a name to each class of objects. Consequently a class of objects shall be identified by its name. The CSs can increase this class of objects. See Table 23.

Table 23 – Definitions of object classes

Name of class	Type of object	Creation
vmd	visible part of the server	I/T
dom	domain	I/T/E
pi	executable program	I/T/E
var	variable	I/T
var-list	variables-list	I/T/E
event	event	I/T
association	connection	I/T/E
OD-header	OD-header	I/T
data type	type descriptor	I/T

LEGEND:

I = Implicit creation.

T = Creation following a remote loading.

E = Explicit Creation by Service.

5.2.3.1.6.2 Definition of a service

A type of action applied to an object belonging to a given class is called service. We attach a name to each of the services. Consequently, a service will be identified by its name. The CSs can increase this list of services. See Table 24.

Table 24 – Definition of Sub-MMS Services

Name of service		Object class	Note
1- confirmed services:	Status	vmd	note 1
	Identify	vmd	note 1
	Get Name List	vmd	note 1
	Delete-domain	dom	note 1
	Initiate-download-sequence	dom	note 1
	Download-segment	dom	note 1
	Terminate-download-sequence	dom	note 1
	Initiate-upload-sequence	dom	note 1
	Upload-segment	dom	note 1
	Terminate-upload-sequence	dom	note 1
	Get Domain Attributes	dom	note 1
	Create-program-invocation	pi	note 1
	Delete-program-invocation	pi	note 1
	Start	pi	note 1
	Stop	pi	note 1
	Resume	pi	note 1
	Reset	pi	note 1
	Kill	pi	note 1
	Get Program Invocation Attributes	pi	note 1
	Read	var/var-list	note 1
	Write	var/var-list	note 1
	Get Variable Access Attributes	var	note 1
	Define-variable-list	var-list	note 1
	Delete-variable-list	var-list	note 1
	Get Variable List Attributes	var-list	note 1
	Get-alarm-summary	event	note 1
	Acknowledge-event-notification	event	note 1
	Alter-event-condition-monitoring	event	note 1
	Get Event Condition Attributes	event	note 1
	Initiate	association	note 2
	Conclude	association	note 1
	Generic-Init-Download	OD	note 1
	Generic-Download	OD	note 1
	Generic-terminate-Download	OD	note 1
	Get OD Header/Data Type Attributes	OD	note 1
2-Unconfirmed services:	Unsolicited-Status	Vmd	note 1
	Information-Report	Var	note 1
	Event-Notification	Event	note 1
	Abort	association	note 2
	Reject	PDU	note 3

NOTE 1 service negotiable via the Initiate service.
NOTE 2 service compulsory if the equipment supports the negotiable connection.
NOTE 3 service compulsory for all the equipment supporting the indications of confirmed services (rejection of confirmed services requests).

5.2.3.1.7 Definition of confirmed-service-req

The structure of a service request includes:

1) the service label ([X] = service code),
2) the service parameters (called "req-serv"),
3) the parameter extensions ensured by the CSs (called "req-detail").

For reasons of convenience parameters 2 and 3 are described apart.

NOTE The requests and responses of confirmed services are identified by the same service code. The requests of unconfirmed services are identified by service codes which are distinct from those of the confirmed services.

```
ConfirmedServiceReq:: =                 CHOICE{
--DOMAIN services--
   initiate-download-sequence           [6] IMPLICIT  SEQUENCE{
      req-serv                              [0] IMPLICIT InitiateDownloadSequenceRequest,
      req-detail                            [1] IMPLICIT CSInitiateDownloadSequenceRequest},
   download-segment                     [7] IMPLICIT  SEQUENCE{
      req-serv                              [0] DownloadSegmentRequest,
      req-detail                            [1] IMPLICIT CSDownloadSegmentRequest},
   terminate-download-sequence          [8] IMPLICIT  SEQUENCE{
      req-serv                              [0] IMPLICIT TerminateDownloadSequenceRequest,
      req-detail                            [1] IMPLICIT CSTerminateDownloadSequenceRequest},
   initiate-upload-sequence             [9] IMPLICIT  SEQUENCE{
      req-serv                              [0]  InitiateUploadSequenceRequest,
      req-detail                            [1] IMPLICIT CSInitiateUploadSequenceRequest},
   upload-segment                       [10] IMPLICITSEQUENCE{
      req-serv                              [0]  UploadSegmentRequest,
       req-detail                           [1] IMPLICIT CSUploadSegmentRequest},
    terminate-upload-sequence           [11] IMPLICITSEQUENCE{
      req-serv                              [0]  TerminateUploadSequenceRequest,
      req-detail                            [1] IMPLICIT CSTerminateUploadSequenceRequest},
    delete-domain                       [12] IMPLICITSEQUENCE{
      req-serv                              [0]DeleteDomainRequest,
      req-detail                            [1] IMPLICIT CSDeleteDomainReques},
--VMD services
    status                              [15] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT StatusRequest,
      req-detail                            [1] IMPLICIT CSStatusRequest},
    identify                                [16] IMPLICIT          SEQUENCE{
      req-serv                              [0] IMPLICIT IdentifyRequest,
     req-detail                             [1] IMPLICIT CSIdentifyRequest},
--PROGRAM INVOCATION services--
    create-program-invocation           [20] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT CreateProgramInvocationRequest,
      req-detail                            [1] IMPLICIT CSCreateProgramInvocationRequest},
    delete-program-invocation           [21] IMPLICITSEQUENCE{
      req-serv                              [0]  DeleteProgramInvocationRequest,
      req-detail                            [1] IMPLICIT CSDeleteProgramInvocationRequest},
    start                               [22] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT StartRequest,
      req-detail                            [1] IMPLICIT CSStartRequest},
    stop                                [23] IMPLICITSEQUENCE{
      req-serv                              [0]  StopRequest,
      req-detail                            [1] IMPLICIT CSStopRequest},

    resume                              [24] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT ResumeRequest,
      req-detail                            [1] IMPLICIT CSResumeRequest},
    reset                               [25] IMPLICITSEQUENCE{
      req-serv                              [0]  ResetRequest,
      req-detail                            [1] IMPLICIT CSResetRequest},
    kill                                [26] IMPLICITSEQUENCE{
      req-serv                              [0]  KillRequest,
     req-detail                             [1] IMPLICIT CSKillRequest},
--VARIABLE /VARIABLE-LIST services--
    read                                [30] IMPLICITSEQUENCE{
      req-serv                              [0]  ReadRequest,
      req-detail                            [1] IMPLICIT CSReadRequest},
    write                               [31] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT WriteRequest,
      req-detail                            [1] IMPLICIT CSWriteRequest},
    define-variable-list                [35] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT DefineVariableListRequest,
      req-detail                            [1] IMPLICIT CSDefineVariableListRequest},
    delete-variable-list                [36] IMPLICITSEQUENCE{
      req-serv                              [0]  DeleteVariableListRequest,
     req-detail                             [1] IMPLICIT CSDeleteVariableListRequest},
--EVENT services--
    get-alarm-summary                   [39] IMPLICITSEQUENCE{
      req-serv                              [0]  GetAlarmSummaryRequest,
      req-detail                            [1] IMPLICIT CSGetAlarmSummaryRequest},
    acknowledge event notification      [40] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT AcknowledgeEventNotificationRequest,
      req-detail                            [1] IMPLICIT CSAcknowledgeEventNotificationRequest},
    alter-event-cond-monitor            [41] IMPLICITSEQUENCE{
      req-serv                              [0] IMPLICIT AlterEventConditionMonitoringRequest,
     req-detail                             [1] IMPLICIT CSAlterEventConditionMonitoringRequest},
```

```
--Get Attributes services--
    get-name-list                       [45] IMPLICITSEQUENCE{
        req-serv                            [0] IMPLICIT GetNameListRequest,
        req-detail                          [1] IMPLICIT CSGetNameListRequest},
    get-domain-attributes               [46] IMPLICITSEQUENCE{
        req-serv                            [0]  GetDomainAttributesRequest,
        req-detail                          [1] IMPLICIT CSGetDomainAttributesRequest},
    get-program-invocation-attributes   [47] IMPLICITSEQUENCE{
        req-serv                            [0]  GetProgramInvocationAttributesRequest,
        req-detail                          [1] IMPLICIT CSGetProgramInvocationAttributesRequest},
    get-variable-access-attributes      [48] IMPLICITSEQUENCE{
        req-serv                            [0]  GetVariableAccessAttributesRequest,
        req-detail                          [1] IMPLICIT CSGetVariablesAccessAttributesRequest},
    get-variable-list-attributes        [49] IMPLICITSEQUENCE{
        req-serv                            [0]  GetVariableListAttributesRequest,
        req-detail                          [1] IMPLICIT CSGetVariableListAttributesRequest},
    get-event-condition-attributes      [50] IMPLICITSEQUENCE{
        req-serv                            [0]  GetEventConditionAttributesRequest,
        req-detail                          [1] IMPLICIT CSGetEventConditionAttributesRequest},
--OD services--
    generic-init-download               [55] IMPLICITSEQUENCE{
        req-serv                            [0] IMPLICIT GenericInitDownloadRequest,
        req-detail                          [1] IMPLICIT CSGenericInitDownloadRequest},
    generic-download                    [56] IMPLICITSEQUENCE{
        req-serv                            [0] IMPLICIT GenericDownloadRequest,
        req-detail                          [1] IMPLICIT CSGenericDownloadRequest},
    generic-terminate-download          [57] IMPLICITSEQUENCE{
        req-serv                            [0] IMPLICIT GenericTerminateDownloadRequest,
        req-detail                          [1] IMPLICIT CSGenericTerminateDownloadRequest},
    get-OD-header/datatype-attributes   [58] IMPLICITSEQUENCE{
        req-serv                            [0] IMPLICIT GetODHeaderDataTypeRequest,
        req-detail                          [1] IMPLICIT CSGetODHeaderDataTypeRequest},
}
```

The ConfirmedServiceReq includes:

1) [X] identifies the service,
2) req-serv references the production corresponding to the selected service,
3) req-detail references the production of the Companion Standards (CS) corresponding to the selected service.

5.2.3.1.8 Definition of unconfirmed-service

The unconfirmed services are transmitted spontaneously. The reason for their transmission is not defined by this document (local issue).

The choice of the channel(s) via which a unconfirmed service is transmitted is also a local issue. Consequently, a notification can take place in point to point and/or in multipoint and/or in broadcasting.

The structure of the service includes:

1) the service label ([X] = service code),
2) the parameter services (called "req-serv"),
3) the parameter extensions by the CS (called "req-detail").

For reasons of convenience, parameters 3 and 4 are described separately.

NOTE The requests of unconfirmed services are identified by service codes distinct from those of the confirmed services.

```
UnconfirmedService::= CHOICE{
--VMD service--
    unsolicited-status              [3] IMPLICIT  SEQUENCE{
        req-serv                        [0] IMPLICIT UnsolicitedStatus,
        req-detail                      [1] IMPLICIT CSUnsolicitedStatus},
--EVENT service:
    event-notification              [4] IMPLICIT  SEQUENCE{
        req-serv                        [0] IMPLICIT EventNotification,
        req-detail                      [1] IMPLICIT CSEventNotification}
--VARIABLE service--
    information-report              [5] IMPLICIT  SEQUENCE{
        req-serv                        [0] IMPLICIT InformationReport,
        req-detail                      [1] IMPLICIT CSInformationReport},
}
```

The unconfirmedService includes:

1) [X] identifies the service,
2) req-serv reference of the production corresponding to the selected service,
3) req-detail references the production of the Companion Standards (CS) corresponding to the selected service.

5.2.3.1.9 Definition of confirmed-service-resp

The structure of the service includes:

1) the service label([X] = service code),
2) the service parameters (called "rsp-serv"),
3) the parameter extensions made by the CS (called "rsp-detail").

For reasons of convenience, parameters 2 and 3 are described elsewhere.

NOTE The requests and responses of confirmed services are identified by the same service code. The requests of unconfirmed services are identified by service codes which are distinct from those of the confirmed services.

```
ConfirmedServiceResp::= CHOICE{
--DOMAIN services--
    initiate-download-sequence      [6] IMPLICIT  SEQUENCE{
        rsp-serv                        [0] IMPLICIT InitiateDownloadSequenceResponse,
        rsp-detail                      [1] IMPLICIT CSInitiateDownloadSequenceResponse},
    download-segment                [7] IMPLICIT  SEQUENCE{
        rsp-serv                        [0] IMPLICIT DownloadSegmentResponse,
        rsp-detail                      [1] IMPLICIT CSDownloadSegmentResponse},
    terminate-download-sequence     [8] IMPLICIT  SEQUENCE{
        rsp-serv                        [0] IMPLICIT TerminateDownloadSequenceResponse,
        req-detail                      [1] IMPLICIT CSTerminateDownloadSequenceResponse},
    initiate-upload-sequence        [9] IMPLICIT  SEQUENCE{
        rsp-serv                        [0] IMPLICIT InitiateUploadSequenceResponse,
        rsp-detail                      [1] IMPLICIT CSInitiateUploadSequenceResponse},
    upload-segment                  [10] IMPLICITSEQUENCE{
        rsp-serv                        [0] IMPLICIT UploadSegmentResponse,
        rsp-detail                      [1] IMPLICIT CSUploadSegmentResponse},
    terminate-upload-sequence       [11] IMPLICITSEQUENCE{
        rsp-serv                        [0] IMPLICIT TerminateUploadSequenceResponse,
        rsp-detail                      [1] IMPLICIT CSTerminateUploadSequenceResponse},
    delete-domain                   [12] IMPLICIT         SEQUENCE{
        rsp-serv                        [0] IMPLICIT DeleteDomainResponse,
        rsp-detail                      [1] IMPLICIT CSDeleteDomainRspues},
--VMD services
    status                          [15] IMPLICITSEQUENCE{
        rsp-serv                        [0] IMPLICIT StatusResponse,
        rsp-detail                      [1] IMPLICIT CSStatusResponse},
    identify                        [16] IMPLICIT         SEQUENCE{
        rsp-serv                        [0] IMPLICIT IdentifyResponse,
        rsp-detail                      [1] IMPLICIT CSIdentifyResponse},
--PROGRAM INVOCATION services--
    create-program-invocation       [20] IMPLICITSEQUENCE{
        rsp-serv                        [0] IMPLICIT CreateProgramInvocationResponse,
        rsp-detail                      [1] IMPLICIT CSCreateProgramInvocationResponse},
    delete-program-invocation       [21] IMPLICITSEQUENCE{
        rsp-serv                        [0] IMPLICIT DeleteProgramInvocationResponse,
        rsp-detai                       [1] IMPLICIT CSDeleteProgramInvocationResponse},
```

```
    start                                   [22] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT StartResponse,
        rsp-detail                              [1] IMPLICIT CSStartResponse},
    stop                                    [23] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT StopResponse,
        rsp-detail                              [1] IMPLICIT CSStopResponse},
    resume                                  [24] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT ResumeResponse,
        rsp-detail                              [1] IMPLICIT CSResumeResponse},
    reset                                   [25] IMPLICITSEQUENCE{
         rsp-serv                               [0] IMPLICIT ResetResponse,
         rsp-detail                             [1] IMPLICIT CSResetResponse},
    kill                                    [26] IMPLICITSEQUENCE{
         rsp-serv                               [0] IMPLICIT KillResponse,
         rsp-detail                             [1] IMPLICIT CSKillResponse},
--VARIABLE/VARIABLE-LIST services--
    read                                    [30] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT ReadResponse,
        rsp-detail                              [1] IMPLICIT CSReadResponse},
    write                                   [31] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT WriteResponse,
        rsp-detail                              [1] IMPLICIT CSWriteResponse},
    define-variable-list                    [35] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT DefineVariableListResponse,
        rsp-detail                              [1] IMPLICIT CSDefineVariableListResponse},
    delete-variable-list                    [36] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT DeleteVariableListResponse,
       rsp-detail                               [1] IMPLICIT CSDeleteVariableListResponse},
--EVENT services--
    get-alarm-summary                       [39] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT GetAlarmSummaryResponse,
        rsp-detail                              [1] IMPLICIT CSGetAlarmSummaryResponse}
    acknowledge-event-notification          [40] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT AcknowledgeEventNotificationResponse,
        rsp-detail                              [1] IMPLICIT CSAcknowledgeEventNotificationResponse},
    alter-event-cond-monitor                [41] IMPLICITSEQUENCE{
        rsp-serv                                [0] IMPLICIT AlterEventConditionMonitoringResponse,
       rsp-detail                               [1] IMPLICIT CSAlterEventConditionMonitoringResponse},
--Get Attributes services--
    get-name-list                           [45] IMPLICITSEQUENCE{
        req-serv                                [0]  GetNameListResponse,
        req-detail                              [1] IMPLICIT CSGetNameListResponse},
    get-domain-attributes                   [46] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GetDomainAttributesResponse,
        req-detail                              [1] IMPLICIT CSGetDomainAttributesResponse},
    get-program-invocation-attributes       [47] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICITGetProgramInvocationAttributesResponse,
        req-detail                              [1] IMPLICIT CSGetProgramInvocationAttributesResponse},
    get-variable-access-attributes          [48] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GetVariableAccessAttributesResponse,
        req-detail                              [1] IMPLICIT CSGetVariablesAccessAttributesResponse},
    get-variable-list-attributes            [49] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GetVariableListAttributesResponse,
        req-detail                              [1] IMPLICIT CSGetVariableListAttributesResponse},
    get-event-condition-attributes          [50] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GetEventConditionAttributesResponse,
       req-detail                               [1] IMPLICIT CSGetEventConditionAttributesResponse}
--OD services--
    generic-init-download                   [55] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GenericInitDownloadRequest,
        req-detail                              [1] IMPLICIT CSGenericInitDownloadRequest},
    generic-download                        [56] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GenericDownloadRequest,
        req-detail                              [1] IMPLICIT CSGenericDownloadRequest},
    generic-terminate-download              [57] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GenericTerminateDownloadRequest,
        req-detail                              [1] IMPLICIT CSGenericTerminateDownloadRequest},
    get-OD-header/datatype-attributes       [58] IMPLICITSEQUENCE{
        req-serv                                [0] IMPLICIT GetODHeaderDataTypeRequest,
        req-detail                             [1] IMPLICIT CSGetODHeaderDataTypeRequest},
}
```

ConfirmedServiceResp includes three parameters:

1) [X] identifies the service,

2) rsp-serv references the production corresponding to the selected service,

3) rsp-detail references the production of the CS corresponding to the selected service.

5.2.3.1.10 Definition of error-type

```
ErrorType::= CHOICE{
--Choice of a sub-set of MMS standard errors. The CSs can lengthen the MMS standard error list.--
--MMS standard errors:
     vmd                                    [0] IMPLICIT UNSIGNED-16{
       other                                    (0)},
application-reference                       [1] IMPLICIT UNSIGNED-16{
         other                                      (0),
        application-unreachable                     (1),
-- value (2) reserved for connection lost,
     application-reference-invalid                  (3),
     context-unsupported                            (4)},
     definition                             [2] IMPLICIT UNSIGNED-16 {
     other                                          (0),
    object-undefined                                (1),
--value (2) reserved for invalid-address --
     type-unsupported                               (3),
     type-inconsistent                              (4),
     object exist                                   (5),
     object-attribute-inconsistent                  (6)},
     resource                               [3] IMPLICIT UNSIGNED-16 {
     other                                          (0),
    memory-unavailable                              (1),
--value (2) reserved for processor resource unavailable,--
--value (3) reserved for mass storage unavailable,--
     capability-unavailable                         (4),
     capability-unknown                             (5)},
     service                                  [4] IMPLICIT UNSIGNED-16 {
     other                                          (0),
     primitive-out-of-sequence                      (1),
     object-state-conflict                          (2)+256*valeur "pi-state",
--value (3) reserved for further definition,--
--value (4) reserved for continuation invalid,--
     object-constraint-conflict                     (5)+256*valeur "pi-state"},
     service-preempt                          [5] IMPLICIT UNSIGNED-16 {
     other                                          (0),
     timeout                                        (1),
--value (2) reserved for deadlock,--
--value (3) reserved for concel--},
--choice-value [6] reserved for time resolution,--
     access                                         [7] IMPLICIT UNSIGNED-16 {
     other                                          (0),
     object-access-unsupported                      (1),
     object-non-existent                            (2),
     object-access-denied                           (3),
     object-invalidated                             (4)},
     initiate                                 [8] IMPLICIT UNSIGNED-16 {
     other                                          (0),
--values (1) and (2) are reserved for further definition--
     max serv outstanding calling insufficient          (3),
     max serv outstanding called insufficient       (4),
     service CBB insufficient                       (5),
     parameter CBB insufficient                     (6),
     nesting level insufficient                     (7) }
     conclude                                 [9] IMPLICIT UNSIGNED-16 {
     other                                          (0),
     further-communication-required                 (1)},
--choice value [10] reserved for cancel,--
--choice value [11] reserved for file,--}
     other                                    [12] IMPLICIT UNSIGNED-16 {
--values reserved for local matter--
}
```

In case of failure of the Start, Stop, Resume and Reset services, the Error-Type also contains information on the "class error" and "code error" the value of "pi-state". In case of failure of the other services, the Error-Type should contain information on "class error" and "code error" and the value of the "pi-state" equals (0).

NOTE 1 [x] represents the error class; this is identical to the equivalent MMSs.

NOTE 2 (y) represents the error code; this is identical to the equivalent MMS.

NOTE 3 The authorized values of the "pi-state" are those defined.

5.2.3.1.11 Definitions of the data types

Specifications of the types of data exchanged (data = content of a variable or "ErrorType") allows description of the exact composition of data, indicating the type and length.

```
TypeDataSpecification::= CHOICE{
--The CSs and the Sub-MMS users can increase this list.--
--Each type extension shall be identified by [X] IMPLICIT "Y". The values of "X" varying from 15 to 25 are reserved
for types defined by the Companion Standards. The values of "X" varying from 26 to 127 are reserved for types
defined by the users. "Y" shall be defined using the EN 50170 - Volume 3 ASN.1 notation (see appendix A)--
--DATA-TYPE--
--constructed data type --
   array-type                          [0] IMPLICIT SEQUENCE{
     number-of-elements                    UNSIGNED-8,
     element-type                          TypeDataSpecification
--recommended: nest=1--},
     structure-type                        [1] IMPLICIT SEQUENCE OF{
                                         TypeDataSpecification
--recommended: nest=1--},
--Simple data type--
     Boolean-type                        [2] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; the length is the number of bits used to encode the Boolean value;
authorized length values = 8.
     integer-type                        [3] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of bits used to encode the integer value; authorized
length values = multiple of 8.--
     unsigned-type                           [4] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of bits used to encode the unsigned value; authorized
length values = multiples of 8.--
     bitstring-type                      [5] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of bits used to encode the bitstring value --
     visiblestring-type                  [6] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of octets used to encode the visiblestring value.--
     octetstring-type                    [7] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of octets used to encode the octetstring value.--
     time-difference                         [8] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of octets used to encode the time-difference value;
authorized length value = 4.--
     time-of-day-type                    [9] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of octets used to encode the time of day value;
authorized length value = 6.--
     single-floating-type                [10] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of octets used to encode the single floating value;
authorized length value= 4.--
     double-floating-type                [11] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of octets used to encode the double floating value;
authorized length value = 8 --
     bcd-type                            [12] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of digits--
     Boolean-array-type                  [13] IMPLICIT UNSIGNED-8,
--UNSIGNED-8 represents the length; length is the number of bits used to encode the value of the Boolean array.--
--ERROR-TYPE--
     error-type                          [14] IMPLICIT UNSIGNED-8
--UNSIGNED-8 represents the length; length is the number of octets used to encode the error value; authorized
length value = 3.--
}
```

5.2.3.1.12 Definitions of the data values (without length or type)

– The CSs and the Sub-MMS users can increase this list of Data Values by using the ASN.1 notation.

– The following values, resulting from encoding of the types of ASN.1 data and completed by other types of data judged useful, correspond to data whose type and length are either implicitly known or specified by TypeDataSpecification, or explictly specified in a service. The type and length not included in the encoding, however the value subsists. In the framework of variable management and events, the number of octets used for encoding the value shall correspond with that specified by TypeDataSpecification. These data are used for example in the Read, Write, Information Report services, etc.--

```
DATA VALUE::= CHOICE{
      --Structured data values--
    Array::= OCTETSTRING SIZE (n)
      --OCTETSTRING-SIZE (n) is composed of the juxtaposition of the simple data values composing it--
```

Structure::= OCTETSTRING SIZE (n)
--OCTETSTRING-SIZE (n) is composed of the juxtaposition of the simple data values composing it--
--Simple data values--
BOOLEAN::= BOOLEAN
--the encoding is ensured on 1 octet; binary value OOH signifies "false" and binary value ≠ 00H signifies "true"
UNSIGNED-n:: = Integer(0.. 2**n - 1)
--"n" represents the number of bits used; "n" is a multiple of 8--
--the encoding is done on a series of M octets with M=n/8 the first octet is called "LSB octet", the last octet is called "MSM octet". The binary value is between: 0 and 2**n-1. The MSB of the binary number is aligned with bit 8 of the LSB of the octet string and so on--
INTEGER-n::= Integer(-2**(n - 1)... +2**(n-1)-1)
--"n" represents the number of bits used; "n" is a multiple of 8--
--the value of an integer is encoded on a string of M octets with M = n/8 the first octet is called "LSB octet", the last octet is called "MSM octet". The binary value complement of 2 is between: 0: -2**(n-1) and + 2**(n-1)-1. The sign of the integer is aligned with bit 8 of the LSB octet of the octet string. The MSB is aligned with bit 7 of the first octet and so on--.
BITSTRING-n:: = BITSTRING SIZE(n)
--"n" represents the number of bits used; "n" is a whole number equal to 0, 1,--
--the encoding is done on a series of M octets with M=n/8; the first octet is called "LSB octet," the last bit is called "MSB octet". Bit No. 0 is aligned with bit 8 of the LSB octet of the octet string and so on--.
TimeOfDay::= OCTET STRING SIZE(6)
--the encoding is done on a series of 6 octets. The value contains two items of juxtaposed information, the first indicating the number of days since 1984 encoded in UNSIGNED-16, the second indicating the number of milliseconds since midnight, encoded in UNSIGNED-32; the high order octet of the UNSIGNED-16 is aligned with the low order octet of the string of octets. The high order octet of the UNSIGNED-32 is aligned with the LSB+2 octet of the string of octets--
TimeDifference::= OCTET STRING SIZE(4)
--the encoding is done on a string of 4 octets. The value indicates the number of milliseconds since midnight encoded in UNSIGNED-32; the MSB octet of the UNSIGNED-32 is aligned with the LSB of the string of octets--
BCD-n::= OCTET STRING SIZE(M)
--"n" is the number of bits used; "n" is a whole number equal to 0, 1, 2--
--the encoding is done on a series of M octets with M=n/4. The value represents "n" digits. Each digit is encoded in binary number on a quartet; the first digit(most signficant) is aligned with with the higher order octet of the higher order octet. The unused quartet, if any, shall be the lower order quartet of the higher order octet. The values permitted for a quartet are 0 to 9. The MSB of the quartet is aligned as required with bit 8 or 4.
BooleanArray-n::= BITSTRING SIZE(n)
--"n" is the number of bits used; "n" is a whole number equal to 0, 1, 2--
--The encoding of the Boolean Array is identical to that of the BITSTRING; it differs only by the naming of the bits. The bits are named according to the following rule: bit No. 0 is aligned with bit 2**0 of the 1st octet, bit No. 7 is aligned with bit 2**7 of the 1st octet, bit No. 8 is aligned with bit 2**0 of the 2nd octet, bit No. 15 is aligned with bit 2**7 of the 2nd octet, etc.--
SingleFloating::= OCTET STRING SIZE(4)
--the encoding is done on a series of 4 octets according to the single precision format of IEC 60559 --
DoubleFloating::= OCTET STRING SIZE(8)
--"n" is the number of bits used; "n" is a whole number equal to 0, 1, 2, 3--
--the encoding is done on a series of 8 octets according to the double precision format of IEC 60559--
OCTETSTRING-n::= OCTET STRING SIZE(n)
--"n" is the number of bits used; "n" is a whole number equal to 0, 1, 2--
--the encoding is done on a string of "n" octets.--
VisibleString-n::= OCTET STRING SIZE(n)
--the encoding is identical to that of the OCTETSTRING-n with however the following restriction: each octet represent a visible character to be chosen from the standard MMS characters: "A" to "Z", "a" à "z", "$", "_", "0" to "9"--

5.2.3.1.13 Complementary definitions

```
Identification::= CHOICE {
   index                          UNSIGNED-16 (0 . . 32K-1).
   name                           CHOICE {
   undefined-length-name        [0] IMPLICIT OCTETSTRING SIZE(0 . . 32)
   cs-defined-length-name       [5] IMPLICIT OCTETSTRING SIZE(X)—see note
```

NOTE CS defined-length-name can only be used if the Companion Standards have defined the value X ≤ 32. In this case the length of OCTET STRING SIZE (X) is no longer encoded .

Discard::= OCTET STRING SIZE(0 . . 3)
-- in case of loading of a domain with success, its content is empty, otherwise its content is ErrorType. Discard is used only in "Terminate Download Sequence"--

ListOfAccessResult::= BIT STRING
--each bit fills the result of the access at one variable. A bit at 1 signifies that the access is a success.--

ListOfObjectId::= SEQUENCE OF Identification

ListOfObjectType::= SEQUENCE OF TypeDataSpecification

```
ListOfObjectValue::= OCTET STRING

    --it is the juxtaposition of the values of the variables and/or error types encoded in compliance with "Data
    Value" or Error type

ListOfErrorType::= OCTET STRING
    --contains the juxtaposition of several ErrorType values encoded in compliance with Error Type (See
5.2.3.1.10).
{
ObjectClass::= UNSIGNED-8
   Null          (0),
   Domain        (1),
   PI            (2),
   Variable                    (3),
   Variable-List               (4),
   Event                       (5),
   OD Header                   (6),
   Data Type                   (7).
    }
```

5.2.4 VMD ASE Protocol

5.2.4.1 Environment management protocol

5.2.4.1.1 General

The association management protocol defines the PDUs necessary for execution of the following services:

1) Initiate,
2) Conclude,
3) Abort,
4) Reject.

5.2.4.1.2 Definition of the confirmed initiate service protocol

NOTE Init Detail Request and Init Detail Response are defined in the SUB-MMS-CORE, module,

```
InitiateReqPDU::= SEQUENCE {
    quality-of-service-calling                  QualityOfServiceCalling
    extension-calling                           ExtensionCalling,
    proposed-max-serv-outstanding-calling           INTEGER-16,
    proposed-max-serv-outstanding-called        INTEGER-16,
    proposed-data-structure-nesting             INTEGER-8,
    --recommended nest=1; shall be ≥ 1--
    init-detail-request                 [0] IMPLICIT InitDetailRequest
}
InitiateRespPDU::= SEQUENCE {
    quality-of-service-called                   QualityOfServiceCalled,
    extension-called                            ExtensionCalled,
    negotiated-max-serv-outstanding-calling         INTEGER-16,
    negotiated-max-serv-outstanding-called          INTEGER-16,
    negotiated-data-structure-nesting           INTEGER-8,
    --recommended nest=1; shall be ≥ 1--
    init-detail-response                [0] IMPLICIT InitDetailResponse
    --see 10.2.8--
}
QualityOfServiceCalling ::= BITSTRING-8  {
    quality-of-service                  (0),
    -- quality of service 1 (value of the bit = 1)--
    --quality of service 2 (value of the bit = 0)--
}
ExtensionCalling ::= OCTETSTRING
    -- For quality 1 the content shall be empty--
    -- For quality 2 the content shall be AccessControl--
    -- For service quality extensions, the format of this parameter shall be specified.
```

```
QualityOfServiceCalled ::= BITSTRING-8   {
    quality-of-service                          (0)
    -- quality of service 1 (value of the bit = 1): no information concerning this quality shall be included in
    ExtensionCalling.--
    --quality of service 2 (value of the bit = 0): the information concerning this quality shall be of the AccessControl
    type; this information shall be present in ExtensionCalling and be included in the first row (first two octets of
    OCTETSTRING content)--
}

ExtensionCalled: : = OCTETSTRING
                  }

AccessControl : : = BITSTRING-16 {
    password bit 8                              (0),
    password bit 7                              (1),
    password bit 6                              (2),
    password bit 5                              (3),
    password bit 4                              (4),
    password bit 3                              (5),
    password bit 2                              (6),
    password bit 1                              (7),

    access group 8                              (8),
    access group 7                              (9),
    access group 6                              (10),
    access group 5                              (11),
    access group 4                              (12),
    access group 3                              (13),
    access group 2                              (14),
    access group 1                              (15)    }

InitiateErrorPDU::=                         ErrorType

ParameterCBBSupportOption::= BITSTRING{
    --true value=parameter supported. The CSs can extend this list.--
    --types of data
    arr (array)                             (0),--bit No. 0
    str (structure)                         (1),--bit No. 1
    vlis (variable-list)                    (2),--bit No. 2
    valt (partial access)                   (3),--bit No. 3
}.

ServiceSupport0ption::= BITSTRING {
    --A service is supported when its bit takes the true value (1). The CSs can lengthen this list by adding new
    services.
    a) the sub-set of bits No. 0 to No. 39 indicates the support of the indications of services; this sub-set shall be
    present in the BITSTRING,
    b)the sub-set of bits No. 40 to No. 79 indicates the support of the requests for services and the bits extending
    from No. 40 to No. 81 indicate respectively the support of the name for the indications of services and the
    requests for services; this sub-set is optional for the request and conditional for the response .
    The length of the bitstring can thus take the value 39, or the value 81--

    --Bits No. 0 to 32 are mandatory
    --vmd management services supported
        status.ind                          (0), --bit No. 0
        unsolicited status.ind (unconfirmed)    (1), --bit No. 1
        identify.ind                            (2), --bit No. 2
    -- domain management services supported
        delete domain.ind                   (3), --bit No. 3
        initiate download sequence.ind      (4), --bit No. 4
        download segment.ind                (5), --bit No. 5
        terminate download sequence.ind     (6), --bit No. 6
        initiate upload sequence.ind        (7), --bit No. 7
        upload segment.ind                  (8), --bit No. 8
        terminate upload sequence.ind       (9), --bit No. 9
    -- program invocations management services supported
        create program invocation.ind       (10),--bit No. 10
        delete program invocation.ind       (11),--bit No. 11
        start.ind                           (12),--bit No. 12
        stop.ind                            (13),--bit No. 13
        resume.ind                          (14),--bit No. 14
        reset.ind                           (15),--bit No. 15
        kill.ind                            (16),--bit No. 16
    -- variable management services supported
        read.ind                            (17),--bit No. 17
        write.ind                           (18),--bit No. 18
        information report.ind (unconfirmed)    (19),--bit No. 19
        define variable-list.ind            (20),--bit No. 20
        delete variable-list.ind            (21),--bit No. 21
```

```
    -- event management services supported
        event notification.ind (unconfirmed)    (22),--bit No. 22
        alter event condition monitoring.ind    (23),--bit No. 23
        acknowledge event notification.ind      (24),--bit No. 24
        get alarm summary.ind                   (25),--bit No. 25
    -- context management services supported
        conclude.ind                            (26),--bit No. 26
    -- attributes management services supported
        get name list.ind                       (27),--bit No. 27
        get domain attributes.ind               (28),--bit No. 28
        get program invocation attributes.ind       (29),--bit No. 29
        get variable access attributes.ind      (30),--bit No. 30
        get variable-list attributes.ind        (31),--bit No. 31
        get event condition attributes.ind      (32),--bit No. 32
    -- OD services
        generic-init-download.ind               (33),--bit No. 33
        generic-download.ind                    (34),--bit No. 34
        generic-terminate-download.ind          (35),--bit No. 35
        get OD Header/Data Type.ind             (36),--bit No. 36
    --Bits No. 37 to 39 are reserved for extensions of services
    --The set of bits from 40 to 80 is optional for the request and conditional for the response
    --vmd management services supported
        status.req                              (40), --bit No. 40
        unsolicited status.req (unconfirmed)    (41), --bit No. 41
        identify.req                                (42), --bit No. 42
    -- domain management services supported
        delete domain.req                       (43), --bit No. 43
        initiate download sequence.req          (44), --bit No. 44
        download segment.req                    (45), --bit No. 45
        terminate download sequence.req         (46), --bit No. 46
        initiate upload sequence.req            (47), --bit No. 47
        upload segment.req                      (48), --bit No. 48
        terminate upload sequence.req           (49), --bit No. 49
    -- program invocation management services supported
        create program invocation.req           (50), --bit No. 50
        delete program invocation.req           (51), --bit No. 51
        start.req                               (52), --bit No. 52
        stop.req                                (53), --bit No. 53
        resume.req                              (54), --bit No. 54
        reset.req                               (55), --bit No. 55
        kill.req                                (56), --bit No. 56
    -- variable management services supported
        read.req                                (57), --bit No. 57
        write.req                               (58), --bit No. 58
        information report.req (unconfirmed)        (59), --bit No. 59
        define variable-list.req                (60), --bit No. 60
        delete variable-list.req                (61), --bit No. 61
    -- event management services supported
        event notification.req (unconfirmed)    (62), --bit No. 62
        alter event condition monitoring.req    (63), --bit No. 63
        acknowledge event notification.req      (64), --bit No. 64
        get alarm summary.req                   (65), --bit No. 65
    -- context management service supported
        conclude.req                            (66), --bit No. 66
    -- attributes management services supported
        get name list.req                       (67), --bit No. 67
        get domain attributes.req               (68), --bit No. 68
        get program invocation attributes.req       (69), --bit No. 69
        get variable access attributes.req      (70), --bit No. 70
        get variable-list attributes.req        (71), --bit No. 71
        get event condition attributes.req      (72), --bit No. 72
    -- OD services
        generic-init-download.ind               (73),--bit No. 73
        generic-download.ind                    (74),--bit No. 74
        generic-terminate-download.ind          (75),--bit No. 75
        get OD Header/Data Type.ind             (76),--bit No. 76
    --Bits No. 77 to 79 are reserved for extensions of services
    --Type of identification supported
        name support for service.ind            (80), --bit No. 80
        name support for service.req            (81), --bit No. 81
}
```

5.2.4.1.3 Definition of confirmed conclude service protocol

```
ConcludeReqPDU::= NULL.

ConcludeRespPDU::= NULL

ConcludeErrorPDU::= ErrorType
```

5.2.4.1.4 Definition of the unconfirmed abort service protocol

The Abort service is mapped directly on the A-Abort service of the lower layer ensuring the connections.

5.2.4.1.5 Definition of the unconfirmed reject service protocol

The reject service is described by Reject PDU.

```
RejectPDU::= SEQUENCE{
    original-invocation-Id                  UNSIGNED-32,
    --not significant if the reject concerns Conclude--
    reject-reason                           RejectReason}

RejectReason::= CHOICE                  {
    --The CSs can lengthen the following list --
    confirmed-request-PDU                   [0] IMPLICIT UNSIGNED-8{
        other                                   (0),
        unrecognized-service                    (1),
        invalid invocation Id                   (3),
        invalid-argument                        (4),
        max-serv-outstanding-exceeded           (6),
        max-recursion-exceeded                  (8),
        value-out-of-range                      (9)},
    pdu-error                               [4] IMPLICIT UNSIGNED-8{
      unknown-type-pdu                          (0),
      invalid-pdu                               (1),
      illegal-mapping                           (2)},
    conclude-request-PDU                    [8] IMPLICIT UNSIGNED-8{
        other                                   (0),
        invalid-argument                        (1)},
}
```

5.2.4.2 Protocol concerning the vmd management

5.2.4.2.1 General

This section defines the protocole of the following services:

1) Status,
2) UnsolicitedStatus,
3) Identify,
4) Get Name List.

5.2.4.2.2 Definition of the confirmed status service protocol

– request parameters.

```
StatusRequest::= BOOLEAN --true for extended derivation
```

– response parameters.

```
StatusResponse::= SEQUENCE{
    vmd-logical-status              UNSIGNED-8{
    state-change-allowed                (0),
    no-state-change-allowed             (1),
    others                              (2 to 5),
    --reserved for complementary states. These states shall be explained in the PICS.
    These complementary states allow ensuring the compatibility with MMS, FMS. Values 2 to 3 are reserved to
    ensure compatibility of Sub-MMS with MMS. Value 2 is reserved for the limited service permitted state. Value 3
    is reserved for the support service allowed state. Values 4 to 5 are reserved to ensure the compatibility of Sub-
    MMS with FMS. Value 4 is reserved for the state "loading of objects without consequences for the users". Value
    5 is reserved for the state "loading of objects with consequences for the users".
                                                    (6 to n)
    --reserved for the C.S
  },
    vmd-physical-status             UNSIGNED-8{
    operational                         (0),
    partially-operational               (1),
    inoperable                          (2),
    needs-commissioning                 (3)     },
    local-detail                    BITSTRING SIZE( 0..128)
    --the content of BIT STRING is empty if the local detail is not used --
}
```

1) "State change allowed" (value 0 for UNSIGNED-8):
   all the services of Sub-MMS are authorized.

2) "No state change allowed" (value 1 for UNSIGNED-8):
   the following services are authorized.

Initiate,

Conclude,

Abort,

Status,

Identify.

Read

Get Alarm Summary

Get Name List

Get Domain Attributes

Get Program Invocation Attributes

Get Variable Access Attributes

Get Variable List Attributes

Get Event Condition Attributes

5.2.4.2.3 Definition of the unconfirmed unsolicited status service protocol

– service parameters.

```
UnsolicitedStatus::=                StatusResponse
```

5.2.4.2.4 Definition of the confirmed identify service protocol

– request parameters.

```
IdentifyRequest: :: = NULL
```

– response parameters.

```
IdentifyResponse::= SEQUENCE        {
    vendor's name                       VISIBLESTRING,
    model name                      VISIBLESTRING,
    revision                        VISIBLESTRING
}
```

5.2.4.2.5 Definition of the confirmed get name list service protocol

– request parameters.

```
GetNameListRequest::= SEQUENCE   {
   object class                  OBJECTCLASS        {
      --values authorized
         null                        (0),
         domain                      (1),
         pi                          (2),
         variable                    (3),
         variable-list               (4),
         event                       (5),
         ODHeader                    (6),
         Datatype                    (7).
                                     }
   continue after                identification
}
```

– response parameters.

```
GetNameListResponse:: = CHOICE{
   list-of-ID                    SEQUENCE   {
--selected if the object class value is different from 0
         list-of-identification  ListOfObjectId,
         -- if an object supports the double identification (name and index) only the index will be transmitted--
         more follows            BOOLEAN    },
   list-of-description           SEQUENCE   {
--selected if the value of the object class is equal to 0
   object description            CHOICE   {
      gives the description of the object
      domain-description         GetDomainAttributesResponse
      pi-description             GetProgramInvocationAttributesResponse
      variable-description       GetVariableAccessAttributesResponse
      variable-list-description  GetVariableListAttributesResponse
      event-description          GetEventConditionAttributesResponse
      od-header-description      GetODHeader/DataTypeAttributesResponse
      data-type-description      GetODHeader/DataTypeAttributesResponse
                                    }
   more follows                  BOOLEAN
                                 }
}
```

5.2.5 Domain ASE protocol

5.2.5.1 General

This section defines the protocols of the following services:

1) DeleteDomain,
2) InitiateDownloadSequence,
3) DownloadSegment,
4) TerminateDownloadSequence,
5) InitiateUploadSequence,
6) UploadSegment,
7) TerminateUploadSequence,
8) Get Domain Attributes.

NOTE The status of a Domain can implicitly take the values: "predefined/non-existent", "ready" and "in-use".

– a domain can preexist or can be created by a Sub-MMS service.

– a preexistant domain can either come up with its total data or partial data; the rest of its data can be loaded by the Sub-MMS services.

– the Delete Domain service can be executed locally.

5.2.5.2 Definition of the confirmed delete domain service protocol

– Request parameters.

DeleteDomainRequest: = Identification.

– Response parameters.

DeleteDomainResponse::= NULL

5.2.5.3 Definition of the confirmed initiate download sequence service protocol

– Request parameters.

```
InitDownloadSequenceRequest::= SEQUENCE{
    domain-identification                Identification,
    list-of-capabilities                 SEQUENCE OF OCTETSTRING
-- the content can be blank (caution: the SEQUENCE OF encoding continues)
    sharable                             BOOLEAN--true for sharable
    domain-access-protection             DomainAccessProtection
}
```

NOTE The"domain-access-protection" parameter is assigned to the Domain object created by the service. It characterizes the level of protection of the object with respect to the CLIENTS.

```
DomainAccessProtection::= BITSTRING{
--For a service 1 quality, the content of BITSTRING shall be empty.
For a service 2 quality of the content the BITSTRING shall correspond to the following definition--
--password--
    password-bit 8                       (0),
    password-bit 7                       (1),
    password-bit 6                       (2),
    password-bit 5                       (3),
    password-bit 4                       (4),
    password-bit 3                       (5),
    password-bit 2                       (6),
    password-bit 1                       (7),

    --access group--
    access-group 8                       (8),
    access-group 7                       (9),
    access-group 6                       (10),
    access-group 5                       (11),
    access-group 4                       (12),
    access-group 3                       (13),
    access-group 2                       (14),
    access-group 1                       (15),

    --access object protection--
    --value (16) is reserved--
        Ug                               (17),
    --If the value of the bit = 1 and the client belongs to one of the groups specified in the "access group" attribute,
    then the domain can be attached to a PI by the Create PI service--
        Wg                               (18),
    --If the value of the bit = 1 and the client belongs to one of the groups specified in the "access group" attribute,
    the domain can be downloaded/deleted by the Initiate Download Sequence, Download Segment, Terminate
    Download Sequence and Delete Domain services--
        Rg                               (19),
    --If the value of the bit = 1 and the client belongs to one of the groups specified in the "access group" attribute,
    then the domain can be uploaded by the Initiate Upload Sequence, Upload Segment and Terminate Upload
    Sequence services--
    --value (20) is reserved--
        U                                (21),
    --If the value of the bit = 1 and the client has the required password identical to the attribute "password" then
    the domain can be linked to a PI by the Create PI service--
        W                                (22),
    --If the value of the bit = 1 and the client has given the required password identical to the "password" attribute,
    the domain can be downloaded by the Initiate Download Sequence, Download Segment, Terminate Download
    Sequence and Delete Domain services--
        R                                (23),
    --If the value of the bit = 1 and the client has given the required password identical to the attribute "password",
    the domain can be uploaded by the Initiate Upload Sequence, Upload Segment and Terminate Upload
    Sequence services--
```

```
    --The values (24), (25), (26), (27), (28) are reserved --
        Ua                                  (29),
    --If the value of the bit = 1, all the clients can link the domain to a PI by the Create PI service--
        Wa                                  (30),
    --If the value of the bit = 1, all the clients can download/delete the domain by the Initiate Download Sequence,
    Download Segment, Terminate Download Sequence and Delete Domain services--
        Ra                                  (31)
    --If the value of the bit = 1 all the clients can then upload the domain by the Initiate Upload Sequence, Upload
    Segment and Terminate Upload Sequence services-
}
```

– Response parameters.

```
InitDownloadSequenceResponse::= NULL
 Definition of the confirmed download segment service protocol
```

– Request parameters

```
DownloadSegmentRequest::= Identification.
```

– Response parameters

```
DownloadSegmentResponse::= SEQUENCE{
    load-data                               OCTETSTRING,
    more-follow                                 BOOLEAN
  --If the value is true, this means that there are other segments to be downloaded—
}
```

Definition of the confirmed terminate download sequence service protocol

– Request parameters.

```
TermDownloadSequenceRequest::= SEQUENCE{
    domain-Id                               Identification,
    discard                                     Discard
    --the content of Discard is empty if the loading of the domain is successful, otherwise it contains ErrorType
    (caution: the length encoding continues as long as the content of the Discard is empty) see 5.2.3.1.11.
}
```

– Response parameters.

```
 TermDownloadSequenceResponse::= NULL
```

Definition of the confirmed initiate upload sequence service protocol

– Request parameters

```
  InitUploadSequenceRequest::= Identification.
```

– Response parameters

```
  InitUploadSequenceResponse::= SEQUENCE{
ulsm Index                                  Index,
   --Index is of the UNSIGNED-16 type. if the index is significant (the value of the UNSIGNED-16 is ≤32K-1) the
saving should be continued with the ulsm index; if, on the contrary, the index is non-significant (the value of the
UNSIGNED-16 is 32K) the saving shall continue with the domain identifier(the Name or Index of the domain). The
resolution of the non ambiguity between domain Index and ULSM Index is at the server's charge.—
list-of-capabilities                        SEQUENCE OF OCTETSTRING }
   --the content of the list of capabilities can be empty (caution: the SEQUENCE OF encoding continues)—
```

5.2.5.4 Definition of the confirmed upload segment service protocol

– Request parameters

UploadSegmentRequest ::= Identification

--See the above constraints of the Initiate Upload Sequence service on the significance of the "Identification".

"Identification" corresponds either to the name or to the domain Index or to the ULSM Index depending on the context.--

– Response parameters

```
UploadSegmentResponse::= SEQUENCE  {
    load-data                          OctetString,
    more-follow                            BOOLEAN
-- true if there are other segments to be saved
}
```

5.2.5.5 Definition of the confirmed terminate upload sequence service protocol

– Request parameters

TerminateUploadSequenceRequest::= Identification

--See the constraints of the Initiate Upload Sequence service on the significance of "Identification".

"Identification" corresponds either to the domain name or Index or to the ULSM Index, depending on the context.--

– Response parameters

TerminateUploadSequenceResponse::= NULL

5.2.5.6 Definition of the confirmed get domain attributes service protocol

– Request parameters

GetDomainAttributesRequest::= Identification

– Response parameters

```
GetDomainAttributesResponse::= SEQUENCE {
    list-of-identification             SEQUENCE OF IDENTIFICATION
    object-class                       ObjectClass
                --Permitted value "Domain"
    list-of-capabilities               SEQUENCE OF OCTETSTRING,
    --the content can be empty (caution the encoding of SEQUENCE OF continues)--
    state                              DomainState,
    predefined                         BOOLEAN, --true if predefined--
    sub-mms-sharable                   BOOLEAN, --true if sharable--
    list-of-pi                         ListOfObjectId
    upload-in-progress                 UNSIGNED-8,
    --number of upload in progress--
    domain-access-protection           DomainAccessProtection
    --if the object is not protected its content shall be empty--
   extension                           OCTETSTRING}

DomainState ::= UNSIGNED-8          {
        non-existent/predefined     (0),
        loading                     (1),
        ready                       (2),
        in-use                      (3),
        complete                    (4),
        incomplete                      (5)
}
```

5.2.6 Program Invocation ASE protocol

5.2.6.1 General

This section defines the protocol concerning the following services:

1) CreateProgramInvocation,
2) DeleteProgramInvocation,
3) Start,
4) Stop,
5) Resume,
6) Reset,
7) Kill,
8) Get program invocation attributes.

NOTE The first 7 services can be executed locally.

5.2.6.2 Definition of the confirmed create program invocation service protocol

– Request_parameters

```
CreateProgramInvocationRequest::= SEQUENCE{
    pi-Identification                   Identification,
    list-of-domains-identification      ListOfObjectID,
    reusable                            BOOLEAN,
    --true for reusable--
    pi-access-protection                PiAccessProtection
    extension                           OCTETSTRING}
```

NOTE The "pi-access-protection" parameter is assigned to the PI object created by the service. It characterizes the level of protection of the object with respect to CLIENTS.

```
PiAccessProtection::= BITSTRING{
    --For a quality of service 1 the content of BITSTRING shall be empty
    For a quality of service 2 the content of BITSTRING shall correspond to the following definition--
    --password--
    password-bit 8                      (0),
    password-bit 7                      (1),
    password-bit 6                      (2),
    password-bit 5                      (3),
    password-bit 4                      (4),
    password-bit 3                      (5),
    password-bit 2                      (6),
    password-bit 1                      (7),
    --access group--
    access-group 8                      (8),
    access-group 7                      (9),
    access-group 6                      (10),
    access-group 5                      (11),
    access-group 4                      (12),
    access-group 3                      (13),
    access-group 2                      (14),
    access-group 1                      (15),
    --access object protection--
    --value (16) is reserved--
        Dg                              (17),
    --If the bit value = 1 and the client belongs to one of the groups specified in the "access groups" attribute then
    he can delete the PI by the Kill, Delete-PI services--
        Hg                              (18),
    --If the value of the bit = 1 and the client belongs to one of the groups specified in the "access groups"
    attribute, then he can stop the execution of the Pi by the Stop service --
        Sg                              (19),
    --If the value of the bit = 1 and the client belongs to one of the groups specified in the "access groups"
    attribute, then he can start execution of the PI by the Start, Resume and Reset services --
    --value (20) is reserved--
        D                               (21),
    --If the value of the bit = 1 and the client has provided a password identical to that of the "password" attribute
    he can delete the PI by the Kill, Delete-PI services--
        H                               (22),
```

```
    --If the value of the bit = 1 and the client has provided a password identical to that of the "password" attribute,
    then he can stop execution of the Pi by the Stop service--
        S                                   (23),
    --If the value of the bit = 1 and the client has provided a password identical to that of the "access group"
    attribute, he can start execution of the PI by the Start, Resume and Reset services--
    --The values (24), (25), (26), (27), (28) are reserved--
        Da                                  (29),
     --If the value of the bit = 1 all the clients can delete the PI by the Kill, Delete-PI services--
        Ha                                  (30),
     --If the value of the bit = 1 all the clients can stop execution of the PI by the Stop service--
        Sa                                  (31)
     --If the value of the bit = 1 all the clients can start execution of the PI by the Start, Resume and Reset
    services--
                                        }
}
```

– Response parameters

```
CreateProgramInvocationResponse::= Index
```

The server can inform the client that he accepts to assign the proposed identifier to the created object by sending back in its response an UNSIGNED_16 type index with a non-significant value (Value = 32K).

The server can signify to the client that it is assigning to the created object an identifier of the index type by sending back in its response an index with a significant value (Value between 0 and 32K-1); this identifier replaces the proposed identifier if it is of the index type, otherwise the created object supports the name and the index as identifier.--

5.2.6.3 Definition of the confirmed delete program invocation service protocol

– Request parameters.

```
DeleteProgInvocRequest::= Identification.
```

– Response parameters.

```
DeleteProgInvocResponse::= NULL
```

5.2.6.4 Definition of the confirmed start service protocol

– Request parameters

```
StartRequest::= SEQUENCE{
    pi-identification               Identification,
    execution-argument              OCTETSTRING }
    --the content of the execution argument can be empty--
```

– Response parameters

```
StartResponse::= NULL
```

5.2.6.5 Definition of the confirmed stop service protocol

– Request parameters

```
StopRequest::= Identification
```

– Response parameters

```
StopResponse::= NULL
```

5.2.6.6 Definition of the confirmed resume service protocol

– Request parameters

```
ResumeRequest::= SEQUENCE{
    pi-identification                Identification,
    execution-argument               OCTETSTRING}
--the content of the execution argument can be empty--
```

– Response parameters

```
Resume Response::= NULL
```

5.2.6.7 Definition of the confirmed reset service protocol

– Request parameters

```
ResetRequest::= Identification
```

– Response parameters

```
ResetResponse::= NULL
```

5.2.6.8 Definition of the confirmed kill service protocol

– Request parameters

```
KillRequest::= Identification
```

– Response parameters

```
KillResponse::= NULL
```

5.2.6.9 definition of the confirmed service protocol get program invocation attributes

– Request parameters

```
GetProgramInvocationAttributesRequest:: =    Identification
```

– Response parameters

```
GetPrograminvocationAttributesResponse::= SEQUENCE          {
  list-of-identification             SEQUENCE OF Identification
  object-class                       ObjectClass --Permitted value "PI"--
  pi-state                           PIState
  list-of-domain-id                  ListOfObjedtid
  sub-mms-deletable                  BOOLEAN, --true if deletable
  reusable                           BOOLEAN, --true if reusable
  execution-argument                 OCTETSTRING,
--the content of OCTETSTRING can be empty, otherwise it should contain the last value supplied by the Start
or Resume service executed with success--
pi-access-protection                 PIAccessProtection
--the content should be empty if the object is not protected
    extension                        OCTETSTRING    }

PISTATE::= UNSIGNED-8 {
    non-existent                     (0)
    unrunnable                       (1)
    idle                             (2)
    running                          (3)
    stopped                          (4)
    starting                         (5),
    stopping                         (6)
    resuming                         (7)
    resetting                        (8)
}
```

5.2.7 Variable ASE protocol

5.2.7.1 Summary

This section defines the following service parameters:

1) Read (a variable-list),
2) Write (a variable-list),
3) InformationReport (a variable-list),
4) DefineVariableList (a variable-list),
5) DeleteVariableList (a variable-list),
6) Get Variable Access Attributes (a variable),
7) Get Variable List Attributes (a variable-list).

5.2.7.2 Common definitions

The following production is used by the Read (without result), Write and Information Report services--

```
VariableDescription::= CHOICE {
    variable_list   [0]                 IMPLICIT Identification,
    list of variables                   [1] IMPLICIT SEQUENCE OF VariableAccessDescription
}
--The following production is used only by the Read service (with result)--

VariableDescriptionWithType::= CHOICE {
    variable_list   [2]                 IMPLICIT Identification,
    list of variables                   [3] IMPLICIT SEQUENCE OF VariableAccessDescription
}
--The following production is used by the Read, Write and Information Report services. It allows global or partial
access to variables identified by their index or their name--

VariableAccessDescription::= CHOICE {
--global-access-choice
   object-index                         UNSIGNED-16 (0..32K-1),
   object-name                          CHOICE {
   undefined-length-name                [0] IMPLICIT OCTETSTRING SIZE (0.32),
   CS-fixed-length-name                 [5] IMPLICIT OCTETSTRING SIZE (X)--  see note 1
                }
--partial access choice
--list-of-comp/elem-selection           [(n≥1) th level nesting]
   object-index/list-of-selection       [1] IMPLICIT SEQUENCE                {
object-index                                UNSIGNED-16 (0..32K-1),
list-of-selection                           [0] IMPLICIT Selections          },

object-name/list-of-selection CHOICE {
    undefined-length-name/list-of-selection [2] IMPLICIT SEQUENCE            {
      undefined-length-name                 OCTETSTRING SIZE (0..32),
      list-of-selection                     [0] IMPLICIT Selections          },

    cs-fixed-length-name/list-of-selection  [6] IMPLICIT SEQUENCE            },
      cs-fixed-length-name                  OCTETSTRING SIZE (X)—see note 1
      list-of-selection                     [0] IMPLICIT Selection           },
                                                  },

    --one-comp/elem-selection               [1 st level nesting]
    object-index/one-selection              [3] IMPLICIT SEQUENCE            {
      object-index                          UNSIGNED-16 (0..32K-1),
      one-selection                         UNSIGNED-16        },

    object-name-one-selection               CHOICE {
    undefined-length-name/one-selection     [4] IMPLICIT SEQUENCE            {
      undefined-length-name                 OCTETSTRING SIZE (0..32),
      one-selection                         UNSIGNED-16        },

    cs-fixed-length-name/one-selection      [7] IMPLICIT SEQUENCE            },
      cs-fixed-length-name                  OCTETSTRING SIZE (X)—see note 1
                                          one-selection
                                          UNSIGNED-16            },
                                            }
                }
```

NOTE 1 CS-fixed-length-name can only be used if the Companion Standards have defined a value at X (X ≤ 32). In this case, the length of OCTETSTRING SIZE (X) is no longer encoded.

```
Selections::= SEQUENCE {
    alternate access                    SEQUENCE OF {--the index number shall be ≥ 0.--
    successive deeper comp/elem index   UNSIGNED-16
    }
    access                                  CHOICE {
      list of comp/elem index           [0] IMPLICIT SEQUENCE OF UNSIGNED-16
      range of elements                 [1] IMPLICIT SEQUENCE {
         start element index          UNSIGNED-16
         number of elements           UNSIGNED-16
      }
    }
}
```

NOTE 2 A table is composed of several elements. Each element can be of the simple, table or structure type. Each element is identified by an index of the UNSIGNED-16 type. The first element is identified by an index with the value 0, the second element having the value 1, etc. The composition of a table is assumed to be known by all the clients.

NOTE 3 A structure is composed of several fields. Each field can be of the simple, table or structure type. Each field is identified by an index of the UNSIGNED-16 type. No rule is imposed on the values to be assigned to the field identifiers. The composition of a structure and the values of the field identifiers are assumed to be known by all the clients.

5.2.7.3 Definition of the confirmed read service protocol

– Request parameters

```
ReadRequest::= CHOICE {
  without result variable access specification   VariableDescription ,
        --This choice indicates a variable-list to be read. It also indicates that the response shall not contain
        descriptors of the types of values read--
  with result variable access specification      VariableDescriptionWithType
        --This choice indicates a variable-list to be read. It also indicates that the response shall contain the
        descriptors of the type of variables--
}
```

– Response parameters.

```
   -- The read procedure for a variable executed with success results in returning the variable value. An
   unsuccessful read procedure for a variable results in returning the ErrorType value--

ReadResponse::= SEQUENCE {
   list-of-access-result                ListOfAccessResult,
        --ListOfAccessResult is of the BITSTRING type. Bit (0) is assigned to the first variable read, bit (1) to
        the second variable read and so on. For each variable read, the bit assigned to it indicates if the
        read operation has been executed successfully or has been unsuccessful. A bit set to 0 indicates
        that the read attempt has been unsuccessful--
   list-of-Type-Data-Specif             ListOfObjectType ,
        --ListOfObjectType does not contain any descriptor if the request does not require their restitution.
        In other cases, it is composed of descriptors of the read variables. If the reading of a variable is
        executed with success, the descriptor should indicate the type of the value read. On the contrary if it
        ends by a failure, the descriptor should indicate the type of the ErrorType value.
        If all the readings of variables are successfully executed, and the values read are of the same type,
        ListOfObjectType can then contain a single descriptor describing the type in question. The
        authorized types are those specified by "TypeDataSpecification" (see section5.2.3.1.11)--
   list-of-Data-value                   ListOfObjectValue
        --The content of ListOfObjectValue is composed of the data of the variables read. These data are
        juxtaposed. If the reading of a variable is executed with success, the data should be of the value
        read. (see "Data Value" section 5.2.3.1.12 for the different possible values). If the reading of a
        variable ends in failure, the data shall be of the ErrorType value. (see section 5.2.3.1.10)--
}
```

5.2.7.4 Definition of the confirmed write service protocol

– Request parameters.

```
WriteRequest::= SEQUENCE{
    variables access specification      VariableDescription,
        --VariableDescription indicates a variable class object identifier list or a variable-list class object
        identifier to be written--
    list-of-Type-Data-Specif. ListOfObjectType,
     --The content of ListOfObjectType could be without any type descriptor.
            If not, it should contain the descriptor of each of the values of the variables to be written.
            If it contains a single descriptor, this signifies that the values of the variables to be written are all of
            the type indicated by the descriptor. The authorized types are those specified by
            "TypeDataSpecification" (see section 5.2.3.1.11)--
    list-of-Data-Value                  ListOfObjectValue}
        --The content of ListOfObjectValue shall correspond to the values of the variables to be written. These
        values are juxtaposed. The permitted values are those specified by "Data Value" (see section5.2.3.1.12)-
        -
```

– Response parameters.

```
WriteResponse::= SEQUENCE {
    list-of-access-result               ListOfAccessResult,
        --ListOfAccessResult is of the BITSTRING type. The bit (0) is assigned to the first written variable, the
        bit (1) is assigned to the second written variable and so on. For each written variable, the bit which is
        assigned to it indicates if the write operation has been successfully executed or that it was unsuccessful.
        A bit set to value 0 indicates that the write operation was unsuccessful--
    list-of-ErrorType                   ListOfErrorType
        --ListOfErrorType contains no value if all the writing operations of the variables have been successfully
        executed. If not, it contains the juxtaposition of ErrorType values of all the writings of variables which
        ended unsuccessfully. The first value should correspond to the first failure, the second to the second
        failure and so on (for the ErrorType value See section 5.2.3.1.10)--
}
```

5.2.7.5 Definition of the unconfirmed information report service protocol

– Request parameters

```
InformationReportRequest::= SEQUENCE{
    local detail                                OCTETSTRING,
     --the content of the OCTETSTRING can be empty--
    variable access specification       VariablesDescription,
        --VariableDescription indicates a list of variable class object identifiers or a variable list class object
        identifier whose values are provided in the ListOfObjectValue parameter--
    list-of-Type-Data-Specif            ListOfObjectType,
     --the content of ListOfObjectType could be empty.
        Otherwise, it is composed of the descriptors of values present in the ListOfObjectValue parameter. If it
        contains only one descriptor this signifies that all the values of the "ListOfObjectValue" parameter are of
        the same type. The authorized types are those specified by "TypeDataSpecification" with the exception
        of error type (see section5.2.3.1.10)--
    list-of-Data-Value                      ListOfObjectValue }

        --The content of ListOfObjectValue is composed of the data of variables identified by the
        "VariablesDescription" parameter. These data are juxtaposed. The authorized values are those specified
        by "Data Value" (see section5.2.3.1.11)--
```

5.2.7.6 Definition of the confirmed define variable list service protocol

– Request parameters

```
DefineVariableListRequest::= SEQUENCE{
    proposed-Var-list-Identification    Identification,
         --the proposed identifier can be either a name or an Index.--
        list-of-var-Identification          SEQUENCE OF Identification
         --Identifiers of the variables (no variable-list) to be linked to the created variable-list--
    variable-list access protection     VariableListAccessProtection,
    extension                               OCTETSTRING
         --allows characterizing the type of user, extension, etc.--
 }
```

Review:

- The "variable-list access protection" parameter is assigned to the created Variable-list object. It characterizes the level of protection of the object with respect to CLIENTS.

```
VarListAccessProtection ::= BITSTRING{
    --for a service quality 1, the content of BITSTRING should be empty.
    For a service quality 2, the content of BITSTRING should correspond to the following definition--
    --password--
    password-bit 8,
    password-bit 7                  (1),
    password-bit 6                  (2),
    password-bit 5                  (3),
    password-bit 4                  (4),
    password-bit 3                  (5),
    password-bit 2                  (6),
    password-bit 1                  (7),

    --access group--
    access-group 8                  (8),
    access-group 7                  (9),
    access-group 6                  (10),
    access-group 5                  (11),
    access-group 4                  (12),
    access-group 3                  (13),
    access-group 2                  (14),
    access-group 1                  (15),

    --access object protection--
    --value (16) is reserved--
    Dg                              (17),
    --if the bit value = 1 and the client has the "access group" rights required, he can delete the Variable-list by the
    Delete Variable-list service--
    Wg                              (18),
    --If the bit value = 1 and the client has the "access group" rights required, he can write in the variables linked to
    the variable -list by the Write service (variable-list) --
    Rg                              (19),
    --If the bit value = 1 and the client has the required "access group" rights, he can read the variables linked to
    the variable-list by the Read service (Variable-list)--
    --value (20) is reserved--
    D                               (21),
    --If the bit value = 1 and the client has the required "password" right, he can delete the variable-list by the
    Delete variable-list service--
    W                               (22),
    --If the bit value = 1 and the client has the required "password" rights, he can write in the variables linked to the
    variable-list by the Write service (Variable-list)--
    R                               (23),
    --If the bit value = 1 and the client has the required "access group" right he can read the variables linked to the
    variable-list by the Read (Variable-list) service--
    --values (24), (25), (26), (27), (28) are reserved--
    Da                              (29),
    --If the bit value = 1 all the clients can delete the variable list object by the Delete variable-list service--
    Wa                              (30),
    --If the bit value = 1, all the clients can write the variables linked to the variable-list by the Write (Variable-list)
    service--
    Ra                              (31)
    --If the bit value = 1 all the clients can read the variables linked to the variable-list by the Read(Variable-list)
    service--
}
```

– Response parameters

```
DefineVariableListResponse::= Index
```

The server can indicate to the client that it accepts to assign the proposed identifier to the created object by returning in its response an index with a non-significant value (Value = 32K).

The server can indicate to the client that it is assigning an identifier of the index type to the created object by returning in its response an index with a significant value (Value between 0 and 32K-1); this identifier replaces the proposed identifier if it is of the index type, otherwise the created object supports both the name and the index as identifier--

5.2.7.7 Definition of the confirmed delete variable list service protocol

– Request parameters.

DeleteVariableListRequest::= Identification.

"Identification" should be the identifier of the created object variable-list. The type of identification borne can be either a Name, or an Index, or a Name and an Index. See the explanations given by the DEFINE VARIABLE-LIST service.--

– Response parameters.

DeleteVariableListResponse::= NULL

5.2.7.8 Definition of the confirmed get variable access attributes service protocol

– Request parameters.

GetVariableAccessAttributesRequest::= Identification.

– Response parameters.

```
GetVariableAccessAttributesResponse::= SEQUENCE                {
    list-of-identification                  SEQUENCE OF IDENTIFICATION
    object-class                                Object-Class
                                          --Permitted value "variable"--
    type data description                    TypeDataSpecification,
    variableaccessprotection                 VariableAccessProtection
    extension  OCTETSTRING                              }

VariableAccessProtection ::= BITSTRING{
     --the content shall be empty if the object is not protected, otherwise, it should contain the information defined
    below--

    --password--
    password-bit 8                          (0),
    password-bit 7                          (1),
    password-bit 6                          (2),
    password-bit 5                          (3),
    password-bit 4                          (4),
    password-bit 3                          (5),
    password-bit 2                          (6),
    password-bit 1                          (7),
    --access group--
    access-group 8                          (8),
    access-group 7                          (9),
    access-group 6                          (10),
    access-group 5                          (11),
    access-group 4                          (12),
    access-group 3                          (13),
    access-group 2                          (14),
    access-group 1                          (15),
    --access object protection--
    --values (16), (17) reserved--
    Wg                                      (18),
    --If the bit value = 1 and the client belongs to one of the groups specified in the "group access" attribute, he
    can write the variable by the Write service (variable) --
    Rg                                      (19),
    --If the bit value = 1 and the client belongs to one of the groups specified in the "access group" attribute, he
    can read the variable by the Read service (Variable)--
    -- values (20), (21) are reserved--
    W                                       (22),
    --If the bit value = 1 and the client has the "password" rights required, he can write the variable by the Write
    service (variable) --
    R                                       (23),
    --If the bit value = 1 and the client has the "group access" rights required, he can read the variable by the Read
    service (Variable) --

    --values (24), (25), (26), (27), (28), (29) are reserved --
    Wa                                      (30),
    --If the bit value = 1 all the clients can write the variable by the Write service (variable) -
```

```
    Ra                                  (31)
    --If the bit value = 1 all the clients can read the variable by the Read service (Variable)--
extension       OCTETSTRING}
```

5.2.7.9 Definition of the confirmed get variable list attributes service protocol

– Request parameters.

GetVariableListAttributesRequest::= Identification.

– Response parameters.

```
GetVariableListAttributesResponse::= SEQUENCE     {
    list-of-identification                  SEQUENCE OF IDENTIFICATION
    object-class                            ObjectClass
    sub-mms-deletable                       BOOLEAN, --true if deletable
    list-of-variable                            ListOfObjectID,
    variable-list-access-protection         VariableListAccessProtection
    --the content should be empty if the object is not protected.--
    extension                               OCTETSTRING }

VariableListAccessProtection ::= BITSTRING{
      --the content shall be empty if the object is not protected, otherwise, it should contain the information defined
    below--
    --password--
    password-bit 8                      (0),
    password-bit 7                      (1),
    password-bit 6                      (2),
    password-bit 5                      (3),
    password-bit 4                      (4),
    password-bit 3                      (5),
    password-bit 2                      (6),
    password-bit 1                      (7),
    --access group--
    access-group 8                      (8),
    access-group 7                      (9),
    access-group 6                      (10),
    access-group 5                      (11),
    access-group 4                      (12),
    access-group 3                      (13),
    access-group 2                      (14),
    access-group 1                      (15),
    --access object protection--
    --value (16) is reserved--
    Dg                                  (17)
    --If the bit value = 1 and the client belongs to one of the groups specified in the "Access Groups" attribute, then
    he can delete the Variable-List object by the Delete Variable-List service--
    Wg                                  (18),
    --If the bit value = 1 and the client belongs to one of the groups specified in the "Access Groups" attribute, then
    he can write the variable by the Write (Variable-List) service--
    Rg                                  (19),
    --If the bit value = 1 and the client belongs to one of the groups specified in the "Access Groups" attribute, then
    he can read the variable by the Read (Variable-List) service--
    -- value (20) is reserved--
    D                                   (21)
    --If the bit value = 1 and the client has given a password identical to that specified in the "Password" attribute,
    he can delete the Variable-List object by the Delete Variable-List service--
    W                                   (22),
    --If the bit value = 1 and the client has given a password identical to that specified in the "Password" attribute,
    he can write the variable by the Write (Variable-List) service.
    R                                   (23),
    --If the bit value = 1 and the client has given a password identical to that specified in the "Password" attribute,
    he can read the variable by the Read (Variable-List) service--

    --values (24), (25), (26), (27), (28) are reserved --
    Da                                  (29)
    --If the value of the bit = 1 all the clients can delete the Variable-List object by the Delete Variable-List service--
    Wa                                  (30),
    --If the bit value = 1 all the clients can write the variable by the Write service (Variable list) -
    Ra                                  (31)
    --If the bit value = 1 all the clients can read the variable by the Read service (Variable list)--
                }
```

5.2.8 Event ASE protocol

5.2.8.1 General

This section defines the protocol for the following services:

1) Event Notification,
2) Acknowledge Event Notification,
3) Alter Event Condition Monitoring,
4) Get Alarm Summary,
5) Get Event Condition Attributes.

5.2.8.2 Definition of the unconfirmed event notification service protocol

– Request parameters.

```
EventNotification::= SEQUENCE {
    common-information                  CommonInformation
    list-of-event-Identification        ListOfObjectId,
    list-of-event-message-description   SEQUENCE OF TypeDataSpecification

        --NOTE

        --The "list-of-event-message-description" parameter gives the list of descriptors of the "EventMessage"
        attributes of the objets listed in the ListOfObjectId parameter. This list could be reduced to ZERO descriptor.
        Each TypeDataSpecification describes the EventMessage type.

        Each "Event Message" is a structure having one or more fields according to the type of the event object.

        According to the type of the object, the description of an "EventMessage" shall be that of a structure having:

        a) either only one field:

        - this field describes Event Data. The authroized types are those defined by TypeDataSpecification with an
        exception of error type.

        b) or two fields:

        - the first field describes Event Occurence ID. The authorized type is OCTETSTRING SIZE(2).

        - the second field describes Event Data. The authorized types are those defined by TypeDataSpecification
        excepting error type.

        c) or three fields:

        - the first field describes Event State. The authorized type is BITSTRING-16.

        - the second field describes Event Occurence ID. The authorized type is OCTETSTRING SIZE(2).

        - the third field describes Event Data. The authorized types are those defined by TypeDataSpecification
        excepting error type.

        If all the "EventMessage" attributes are of the same type, the list could be reduced to a single "Event
        Message" descriptor--

    list-of-event-message-value         OCTETSTRING

        --This parameter contains the juxtaposition of EventMessage values.

        NOTE

        Depending on the type of object, the value of an "EventMessage" comprises:

        a) a single field:

        this field gives the Event Data value. The permitted values are those defined by Data Value (see section
        5.2.3.1.12).

        b) or two fields:

        - the first gives the value of Event Occurence ID. The value authorized is OCTETSTRING-2,

        - The second gives the value of Event Data. The values authorized are those defined by Data Value (see
        section 5.2.3.1.12),

        c) or three fields:

        - the first gives the value of Event State. The value permitted is BITSTRING-16,

        - the second gives the value of Event Occurrence ID. The value authorized is OCTETSTRING-2,
```

- the third gives the value of Event Data. The values permitted are those defined by Data Value (see section 5.2.3.1.12).--

```
CommonInformation::= OCTETSTRING

    --The contents of OCTETSTRING is composed of the ordered juxtaposition of the following information:

    1- the value of the first information is a BITSTRING-16 and represents "Event Type". This information
    mandatory, indicates the type of event objects of which one event is included in the notification.

    2- the value of the second information is an OCTETSTRING-2 and represents
    "EventTransactionOccurenceID".

    3- the value of the third information, optional, is known to the user; it occupies the rest of the octets of the
    OCTETSTRING content.--

EventType ::= BITSTRING-16          {
    common event detection support  (0), --supported if the value is 1.
    acknowledge action support      (1), --supported if the value is 1
    enable action support           (2), --supported if the value is 1
    C.S/User action support         (3 to n) --to be defined by C.S/User
}

EventTransactionOccurenceID ::= OCTETSTRING-2
--the semantic is a local issue; it shall be described in the PICS.--
```

5.2.8.3 Definition of the confirmed acknowledge event notification service protocol

– Request parameters

This service enables acknowledgement of several object events. The acknowledgement of an object is done by forcing the object attribute Ack State to the value: True..The "Ack State" attribute is a component of the "Event State" attribute.--

```
AcknowledgeEventNotificationRequest::= SEQUENCE             {
    list of event identification        ListOfObjectId
    list of event occurence ID type
    description                             SEQUENCE OF TypeDataSpecification
        --The number of TypeDataSpecification can be null when the types are implicitely known. The
        description of each TypeDataSpecification shall be that of OCTETSTRING-2. Since all the type
        descriptors are identical, it is possible to reduce the list to a single descriptor--
    list of event occurence Id value    OCTETSTRING
        --The OCTET STRING content is composed of the ordered justaposition of values "EventOccurrenceID".
        Each of these values is an OCTETSTRING-2--
}
```

– Response parameters

```
AcknowledgeEventNotificationResponse::= SEQUENCE          {
    list-of-access-result               ListOfAccessResult,
        --ListOfAccessResult is of the BITSTRING type. Bit (0) is assigned to the first acknowledged object, bit
        (1) is assigned to the second acknowledged object and so on. For each object acknowledged, the bit
        which is assigned to it indicates if the acknowledgement operation has been successfully carried out or
        has ended in a failure. The bit set to 0 signifies that the acknowledgement is a failure.
    list-of-ErrorType                   ListOfErrorType
        --the content of the ListOfErrorType is empty if all the acknowledgements have been carried out
        successfully, otherwise it contains the juxtaposition of the ErrorType values of all the acknowledgements
        which have ended in a failure. The first value shall correspond to the first failure, the second value shall
        correspond to the second failure and so on. The authorized Error Type values are those defined by the
        section 5.2.3.1.10--
 }
```

5.2.8.4 Definition of the confirmed alter event condition monitoring service protocol

– Request parameters

This service enables modifying the attributes of Enable State or Extension States of several event objects. These attributes are the components of the "Event State" attribute. The C.S or the user can define other actions.

The modification of an "Event State" attribute can entail a new notification of the events of the same object. The present document does not indicate how or when this new notification took place--

```
AlterEventConditionMonitoringRequest::= SEQUENCE            {
    list of event state action ID          SEQUENCE OF EventStatePathAccess
        --This parameter indicates the list of Event State attributes to be modified. For each modification it
        indicates the identification of the object followed by the row of the action. See below the description of
        the EventState with the possible actions--
    list of event state description        SEQUENCE OF TypeDataSpecification
        --The number of TypeDataSpecification can be null when the types are implicitely known. The
        description of each "Event State", made by TypeDataSpecification, shall be that of BITSTRING-16. When
        all the type descriptors are identical it is possible to reduce the list to a single descriptor--
    list of event state value              OCTETSTRING
        --The content of OCTET STRING is composed of the ordered juxtaposition of the "EventState" values.
        Each Event State value is represented by a BITSTRING-16 value with the following constraints: the bits
        which do not belong to the expected action shall be forced to 0. See below the definition of the "Event
        State" actions--
}

EventStatePathAccess::= CHOICE      {
    event-index/action-path-description [3] IMPLICIT SEQUENCE                {
        event-index                         UNSIGNED-16 (0 . . 32K-1),
        action-rank                         ActionRanK          },
    event-name/action-path-description CHOICE   {
        undefined-length-name          [4] IMPLICIT SEQUENCE                {
            event-name                      OCTETSTRING SIZE (0..32),
            action-rank                     ActionRank          },
        cs-defined-length-name         [7] IMPLICITE SEQUENCE               {
            event-name                      OCTETSTRING SIZE (X),
            action-rank                     ActionRank          }
    }
}
```

NOTE CS-defined-length-name can only be used if the Companion Standards have defined the value X ≤ 32. In this case the length of OCTETSTRING SIZE (X), is no longer encoded. (See encoding in appendix 10.A).

```
ActionRank::= UNSIGNED-16           {
    rank 0                              (0), --reserved value
    rank 1                              (1), --validation/invalidation
    rank 2 to n                         (2) to (n), --user action/CS
}

EventState::= BITSTRING-16          {
    acknowledgement                     (0), --true if the object is acknowledged
    validation                          (1), --true if the object is validated
    extension-state                     (2) to (p), --the user or the CS can lengthen the list of actions.
    To this end, we recommend on one hand to break down the bits from 2 to p into n ordered sets, each including
    1 or several bits and, on the other hand, to assign to each set an action of rank 2 to n--
```

– Response parameters

```
AlterEventConditionMonitoringResponse::= SEQUENCE           {
    list-of-access-result               ListOfAccessResult,
        --ListOfAccessResult is of the BITSTRING type. Bit (0) is assigned to the first altered object, Bit (1) is
        assigned to the second altered object and so on. For each altered object,the bit which is assigned to it
        indicates if the alteration operation has been successfully carried out or if it ended in a failure. A bit
        positioned to 0 value signifies that the modification ended in a failure--

    list-of-ErrorType                   ListOfErrorType
        --the content of ListOfErrorType is empty if all the modifications have been successfully executed,
        otherwise it contains the juxtaposition of the ErrorType values of all the modifications which have ended
        in a failure. The first value shall correspond to the first failure, the second value shall correspond to the
        second failure and so on. The authorized values for Error Type are those defined by section 5.2.3.1.10-
}
```

5.2.8.5 Definition of the confirmed get alarm summary service protocol

– Request parameters.

```
GetAlarmSummaryRequest::= CHOICE {
  without result events access          [1] IMPLICIT ListOfObjectID ,
        --This choice indicates a list of event objects whose Event_Message attribute is to be read. It also
        indicates that the response shall not contain descriptors of the read value type--
  with result events access             [3] IMPLICIT ListOfObjectID
        --This choice indicates a list of object events whose Event_Message attribute is to be read. It also
        indicates that the response shall contain the descriptors of the type of values read--
}
```

– Response parameters.

-- The reading procedure for a successfully executed Event_Message attribute causes returning its value. The reading procedure of an unsuccessful Event_Message attribute causes returning of the ErrorType value--

```
GetAlarmSummaryResponse::= SEQUENCE {
    list-of-access-result                   ListOfAccessResult,
        --ListOfAccessResult is of the BITSTRING type. Bit (0) is assigned to the first attribute read, bit (1) is
        assigned to the second attribute read and so on. For each attribute read, the bit which is assigned to it
        indicates if the reading operation has been carried out successfully or has ended in a failure. A bit
        positioned at 0 value signifies that the reading is a failure--
    list-of-event-message-description       SEQUENCE OF TypeDataSpecification  --see note 1--
    list-of-event-message-value             OCTETSTRING                        --see note 2--
}
```

NOTE 1 This parameter contains a list of descriptors. This list could be reduced to ZERO descriptor if the request does not demand the descriptor types. Each TypeDataSpecification describes either an EventMessage type if reading operation was successful, or an Error Type if reading operations were a failure. If all the reading operations were carried out successfully and the descriptors were of the same type, the list could be reduced to only one descriptor of Event Message.

NOTE 2 Depending on the type of the object the "EventMessage" descriptor shall be that of a structure having:

a) either only one field:

- this field describes the Event Data type. The authorized types are those defined by TypeDataSpecification except error type.

b) or two fields:

- the first describes the Event Occurence ID. The authorized type is OCTETSTRING-2,

- the second describes the Event Data Type. The authorized types are those defined by TypeDataSpecification except error type.

c) or three fields:

- the first describes the Event State type. The authorized type is BITSTRING-16,

- the second describes the type of Event Occurence ID. The authorized type is OCTETSTRING-2,

- the third describes the Event Data type. The authorized types are those described by TypeDataSpecification except error type.--

This parameter contains the juxtaposition of Event Message or Error Type values.

Each reading operation carried out successfully restores the Event Message value. Each reading operation ended in a failure retores Error Type value.

NOTE 3 According to the type of the object, the value of an "EventMessage" comprises:

a) either only one field:

- this field gives the Event Data value. The authroized values are those defined by Data Value (see 8.1.10.2).

b) or two fields:

- the first field gives the Event Occurence ID value. The authorized value is OCTETSTRING-2,

- the second gives the Event Data value. The authorized values are those defined by Data Value (see 8.1.10.2),

c) or three fields:

- the first field gives the Event State value. The authorized value is BITSTRING-16.

- the second field gives the Event Occurence ID value. The authorized value is OCTETSTRING-2,

- the third field gives the Event Data value. The authorized values are those defined by Data Value (see 8.1.10.2).--

5.2.8.6 Definition of the confirmed get event condition attribute service protocol

– Request parameters.

```
GetEventConditionAttributesRequest::= Identification
```

– Response parameters.

```
GetEventConditionAttributesResponse::= SEQUENCE {
    list-of-identification              SEQUENCE OF IDENTIFICATION
    object-class                        ObjectClass          --permitted value "Event"--
    event type                          EventType
        --This parameter indicates the type of object. For the definition of Event Type, see the Event Notification
        service (section 8.7.2)--
    event-message-type-description      TypeDataSpecification
        --This parameter gives the descriptor of "Event Message" of an object. The response of the "Get Alarm
        Summary" service (section 8.7.5) explains in detail how to build a description of Event Message--

    Event-access-protection ::= EventAccessProtection
    --The content of this parameter is empty if the object is not protected--
}
EventAccessProtection ::= BITSTRING     {
    --The content is empty if the object is not protected, otherwise it shall correspond to the following description.
    --password--
    password bit 8                              (0),
    password bit 7                              (1),
    password bit 6                              (2),
    password bit 5                              (3),
    password bit 4                              (4),
    password bit 3                              (5),
    password bit 2                              (6),
    password bit 1                              (7),
    --access groups--
    access group 8                              (8),
    access group 7                              (9),
    access group 6                              (10),
    access group 5                              (11),
    access group 4                              (12),
    access group 3                              (13),
    access group 2                              (14),
    access group 1                              (15),
    --bit (16) reserved
    Dg                                          (17),
    --if the value is 1 and if the client has the group access rights required he can validate/invalidate and read the
    object by means of the Alter Event Condition Monitoring and Get Alarm Summary services--
    Wg                                          (18),
    --if the value is 1 and if the client has the group access rights required he can acknowledge and read the object
    by means of Acknowledge Event Notification and Get Alarm Summary services.--
    --bits (19), (20) reserved
    D                                           (21),
    --if the value is 1 and if the client provides a password identical to that specified in the "password" attribute, he
    can validate/invalidate and read the object by means of the Alter Event Condition Monitoring and Get Alarm
    Summary--
    W                                           (22),
    --if the value is 1 and the client has the password rights required he can acknowledge and read the object by
    means of Acknowledge Event Notification and Get Alarm Summary services.--
    --bits (23), (24), (25), (26), (27), (28) reserved
    Da                                          (29),
    --if the value is 1 all the clients can validate/invalidate and read the object by means of Alter Event Condition
    Monitoring and Get Alarm Summary services.--
    Wa                                          (30),
     --if the value is 1 all the clients can acknowledge and read the object by means of Acknowledge Event
    Notification and Get Alarm Summary services.--
    --bit (31) reserved
    extension                                       OCTETSTRING}
```

6 Structure of protocol machines

Interface to FAL services and protocol machines are specified in this clause.

NOTE The state machines and ARPMs defined in this section only define the valid events for each. It is a local matter to handle these invalid events.

The behavior of the FAL is described by three integrated protocol machines. Specific sets of these protocol machines are defined for different AREP types. The three protocol machines are: FAL Service Protocol Machine (FSPM), the Application Relationship Protocol Machine (ARPM), and the Data Link Layer Mapping Protocol Machine (DMPM). The relationship among these protocol machines as well as primitives exchanged among them are depicted in Figure 9.

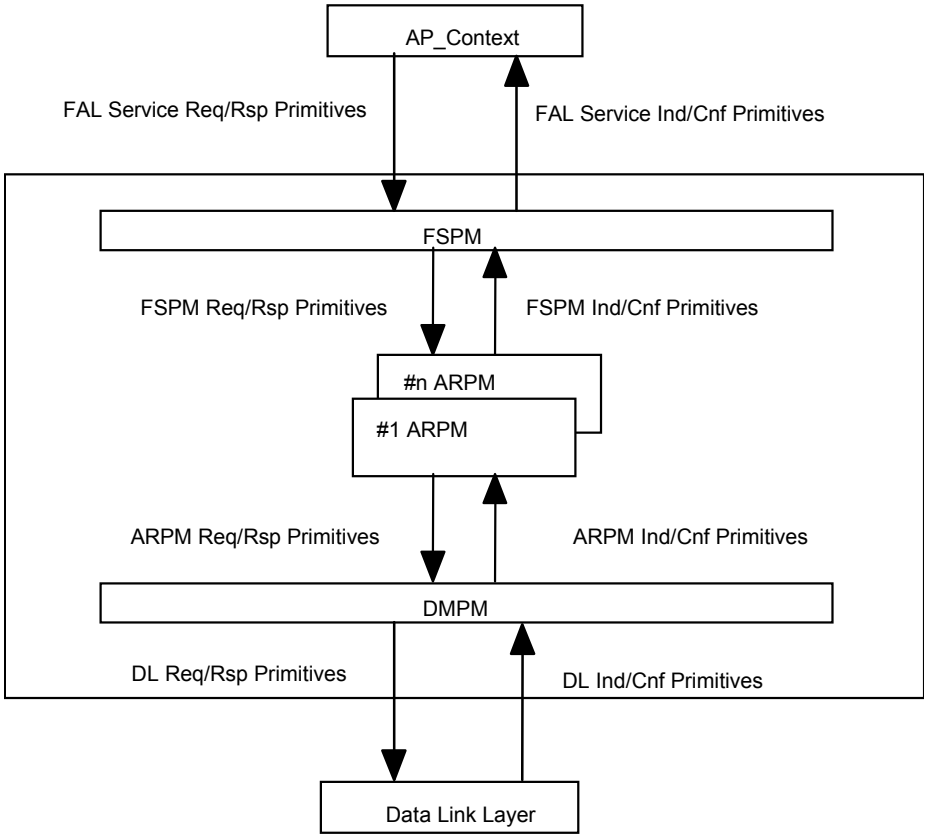


Figure 9 – Relationships among Protocol Machines and Adjacent Layers

The FSPM describes the service interface between the AP-Context and a particular AREP. The FSPM is common to all the AREP classes and does not have any state changes. The FSPM is responsible for the following activities:

a) to accept service primitives from the FAL service user and convert them into FAL internal primitives;

b) to select an appropriate ARPM state machine based on the AREP Identifier parameter supplied by the AP-Context and send FAL internal primitives to the selected ARPM;

c) to accept FAL internal primitives from the ARPM and convert them into service primitives for the AP-Context;

d) to deliver the FAL service primitives to the AP-Context based on the AREP Identifier parameter associated with the primitives.

The ARPM describes the establishment and release of an AR and exchange of FAL-PDUs with a remote ARPM(s). The ARPM is responsible for the following activities:

a) to accept FAL internal primitives from the FSPM and create and send other FAL internal primitives to either the FSPM or the DMPM, based on the AREP and primitive types;

b) to accept FAL internal primitives from the DMPM and send them to the FSPM as a form of FAL internal primitives;

c) if the primitives are for the Establish or Abort service, it shall try to establish or release the specified AR.

The DMPM describes the mapping between the FAL and the DLL. It is common to all the AREP types and does not have any state changes. The DMPM is responsible for the following activities:

a) to accept FAL internal primitives from the ARPM, prepare DLL service primitives, and send them to the DLL;

b) to receive DLL indication or confirmation primitives from the DLL and send them to the ARPM in a form of FAL internal primitives.

For the Type-7 Application Layer protocol: the following restrictions apply.

– AP-Context State machine is not used.

– FAL Service protocol state machines are not used for MPS ASE but are used globally for Sub-MMS (VMD ASE, Domain ASE; Program Invocation ASE, Variable ASE, Event ASE, Directory ASE).

– Application Relationship Protocol Machine (ARPM) and Data Link Layer Mapping Protocol Machine (DMPM) are combined together for both MCS AR ASE and MPS ASE:

– One ARPM-DMPM protocol machine for MPS ASE,

– One ARPM-DMPM protocol machine for MCS AR ASE.

7 AP-context state machine

Feature not used

8 Sub-MMS FAL service protocol machine (FSPM)

8.1 General

For the needs of the fieldbus messaging, this section imposes the MCS lower layer defined in the standard.

8.2 Projection of the SUB-MMS PDUs on the MCS services

SUB-MMSpdu	MCS lower layer service
Confirmed Request PDU	(A-Data or A-Unidata) with/without ack.
Confirmed Response PDU	(A-Data or A-Unidata) with/without ack.
Confirmed Error PDU	(A-Data or A-Unidata) with/without ack.
Unconfirmed Request PDU	(A-Data or A-Unidata) with/without ack.
Reject PDU	(A-Data or A-Unidata) with/without ack.
Initiate Request PDU	A-Associate.Request,
Initiate Response PDU	A-Associate.Response(result +),
Initiate Error PDU	A-Associate.Response(result -),
Conclude Request PDU	A-Release.Request,
Conclude Response PDU	A-Release.Response(result +),
Conclude Error PDU	A-Release.Response(result -).

8.3 Projection of the SUB-MMS abort service on the MCS services

The SUB-MMS Abort service without PDU, shall therefore be directly projected on the MCS A-Abort service; consequently the following actions will be ensured by the supplier of the SUB-MMS service:

a) on receiving an Abort request service (generated by the Sub-MMS user) it shall generate a A-Abort request towards the lower layer,

b) on receiving an A-Abort service indication (generated by the lower layer) it shall generate an Abort indication towards the USER.

8.4 Construction of a SUB-MMS-PDU from a service primitive

On receiving a service primitive (request/response) other than "Abort" the SUB-MMS service supplier shall:

a) construct a PDU in conformity with the SUB-MMS protocol,

b) provide the built PDU to the lower layer via an MCS service in conformity with the Sub-MMS PDU projection requirements of the Sub-MMS PDU for the MCS services.

8.5 Extraction of a valid service primitive from a SUB-MMS-PDU

On receiving an MCS service primitive other than A_Abort the following actions are to be carried out in the order indicated by the SUB-MMS service supplier:

a) check that the "user-data" parameter of the primitive contains a valid PDU (in conformity with the SUB-MMS protocol);

b) if the received PDU is valid, extract a SUB-MMS service primitive and deliver it to the Sub-MMS user;

c) if the received PDU is invalid and the transfer has been performed by means of an association being established (reception with success of "InitiateReqPDU" and no successful transmission of "InitiateRespPDU") then the two following actions can be carried out:

   1) generate an Abort indication and deliver it to the Sub-MMS,

   2) generate an "A-Abort" request to the MCS so that the latter frees the reserved resources. This request will not be transferred to the remote correspondent because the MCS is incapable of it (See MCS ASE);

d) if the PDU is invalid and if the transfer of the PDU has been performed by means of a negotiated association, a predefined association or without association then IEC 61158-5-7, shall be complied with to execute the two following actions:

   1) construct a RejectPDU and deliver to the layer in compliance with the projection requirements of the Sub-MMS PDU for the MCS services,

   2) generate an indication of the Reject service and deliver it to the Sub-MMS user.

8.6 Negotiation of an abstract syntax and a transfer syntax commonly called presentation-context

This paragraph defines the negotiation in the following framework: the lower layer is MCS. It does not show the reductions made by the various intervenants during the negotiation. These reductions are explained in detail in a Sub-MMS Initiate service.

Review: the MCS standard authorises only one abstract syntax and only one transfer syntax per association.

Sequencing of an association opening

1 - Calling user:

The Sub-MMS user wishing to open an association with a remote partner generates a primitive Initiate.Request to the Sub-MMS service supplier.

2 - Sub-MMS service supplier of the calling user:

On receiving the primitive Initiate.Request initiated by the local Sub-MMS user, the Sub-MMS service supplier reserves the necessary resources, constructs an Initiate.Request PDU and generates towards the MCS layer the A_Associate.Request service with the User Data parameter = Initiate.Request PDU.

3 - Sub-MMS service supplier of the called user:

On receiving an A_Associate.Indication service initiated by the MCS layer, the Sub-MMS layer carries out the following actions as required:

a) if it notes that the User Data parameter of A_Associate service does not contain a valid Initiate.RequestPDU or if it is incapable of accepting the opening of an association for various reasons, it generates a primitive A_Associate.Response to the MCS layer with the User Data = Empty and Result = negative parameters because of the user (the user is the Sub-MMS service supplier).

b) if it notes that the User Data parameter of the A_Associate service contains a valid Initiate.Request PDU and accepts the opening of an association, then it reserves the necessary resources and generates the primitive Initiate.Indication to the Sub-MMS user.

4 - Called user:

The Sub-MMS user can either accept or refuse the association.

1) Acceptance of the association:

   Following the reception of the primitive Initiate.Indication the Sub-MMS user generates towards the Sub-MMS service supplier a primitive Initiate.Response(+) and arranges for the future exchange of messages via this communication channel.

2) Refusal of the association:

   Following the reception of the primitive Initiate.Indication the Sub-MMS user generates towards the Sub-MMS service supplier a primitive Initiate.Response(-)and it considers the proposed association inexistant.

5- Sub-MMS service supplier of the called user:

The behaviour of the layer varies according to the Sub-MMS user's response.

1) On receiving a primitive Initiate.Response(+), the Sub-MMS service supplier builds an Initiate.Response PDU and generates towards the MCS layer the A_Associate.Response service with the User Data = Initiate.ResponsePDU and Results = positive parameters and arranges for the future exchanges of messages via this communication channel.

2) On receiving a primitive Initiate.Response(-), the Sub-MMS service supplier frees the reserved resources, builds an Initiate.Error PDU and generates towards the MCS layer the A_Associate.Response service with the User Data = Initiate.ErrorPDU and Result = negative parameters because of the user and it considers the proposed association inexistent.

6- Sub-MMS service supplier of the calling user:

The behaviour of the Sub-MMS service supplier varies according to the response received.

1) On receiving an A_Associate.Confirm(+) primitive, the Sub-MMS service supplier carries out the following actions as required:

   a) if it notes that the User Data parameter of the A_Associate service does not contain a valid Initiate.ResponsePDU, it ignores the service.

b) if it notes that the A_Associate service user data parameter contains a valid Initiate.Response PDU, it generates the Initiate.Confirm(+)primitive towards the Sub-MMS user and makes arrangements for the future message exchanges via this communication channel.

2) On receiving an A_Associate.Confirm(-) primitive, the Sub-MMS service supplier carries out the following actions as required:

a) if it notes that the A_Associate service user data parameter does not contain a valid Initiate.ErrorPDU, it ignores the service.

b) if it notes that the A_Associate service user data parameter contains a valid Initiate.ErrorPDU it generates the Initiate.Confirm(-)primitive towards the Sub-MMS user, frees the reserved resources and considers the proposed association inexistent.

7 - Called user:

The behaviour of the Sub-MMS user varies according to the response received.

1) Positive response:

Following the reception of the Initiate.Confirm(+) primitive the Sub-MMS user takes his dispositions for the future exchanges of messages via this communication channel.

2) Negative response:

Following reception of the Initiate.Confirm(-)primitive the Sub-MMS user considers the proposed association inexistent.

NOTE 1 If is necessary to check the state of a negotiated or predefined association in the absence of traffic the Sub-MMS service supplier can periodically generate an MCS A_Data request service with the parameter User data = empty. The implementation of this mechanism of the client is a local issue.

NOTE 2 If is necessary to check the state of a negotiated or predefined association in the absence of traffic the Sub-MMS service supplier can demand the periodic reception of a Sub-MMS A_Data service request with the parameter User data = empty.

8.7 Identification of the SUB-MMS core abstract syntax

1) The abstract syntax of the CORE-SUB-MMS module is identified by an object-identifier and an object-descriptor. This identification characterises the abstract syntax of the Sub-MMS core.

The present document assigns the following values to them:

FIELDBUS ASN.1 object-identifier value:
{iso standard 9506 part-protocol (2)
SUB-MMS-abstract-syntax-version1 (4) }

FIELDBUS ASN.1 object-descriptor value:
"sub-mms-abstract-syntax-major-version1".

2) The SUB-MMS-General-module-1 is identified by an object identifier and an object-descriptor. This identification characterizes the type of ASE Sub-MMS because it enables generating different abstract syntaxes.

This document assigns to them the following values.

FIELDBUS ASN.1 object-identifier value:
{iso standard 9506 part_protocol (2)
sub-mms-general-module-version1 (5) }
FIELDBUS ASN.1 object-descriptor value:
"sub-mms-general-module-major-version1"

3-The transfer syntax relative to the abstract syntax of the CORE-SUB-MMS and the CS is identified by an oject-identifier and an object-descriptor:

FIELDBUS ASN.1 object-identifier value:

{iso standard 8825 fieldbus-encoding (5) }.
FIELDBUS ASN.1 object-descriptor value:
"fieldbus-encoding-rules",
The major version of this document is 1.
The minor version of this document is 1.

This document permits other transfer syntaxes.

8.8 Identification of the application context name

For the specific use of the application layer, this document proposes the application layer containing "CORE-SUB-MMS" as ASE identified by an object-identifier and an object-descriptor.

This document assigns them the following values.

FIELDBUS ASN.1 object-identifier value:
{iso standard 9506 part-protocol (2)
sub-mms-application-context-version1 (6)}
FIELDBUS ASN.1 object-descriptor value:
"iso sub-mms" .

8.9 Identification of the ASE of the core abstract syntax and the transfer syntax

This subclause defines the following equivalences on behalf of MCS:

1- For the following object-identifier:
FIELDBUS ASN.1 object-identifier value (Sub-MMS general model):
{iso standard 9506 part_protocol (2)
sub-mms-general-module-version1 (5) }

we assign the binary value {0} for the "TYPE of ASE" parameter of the A_Associate service of MCS.

2 - For the following object-identifier (Sub-MMS core):

FIELDBUS ASN.1 object-identifier value:
{iso standard 9506 part-protocol (2)
SUB-MMS-abstract-syntax-version1 (4) }

we assign the binary value {0} for the "ABSTRACT SYNTAX" parameter of the A_Associate service of MCS.

3 - For the following object-identifier (Sub-MMS encoding rule):

FIELDBUS ASN.1 object-identifier value:
{iso standard 8825 fieldbus-encoding (5) }.

we assign the binary value {0} for the "TRANSFERT SYNTAX" parameter of the A_Associate service.

9 Association relationship protocol machine (ARPM)

These machines are defined in this part of standardization with the DLL Mapping Protocol Machine, see next chapter.

10 DLL mapping protocol machine (DMPM)

10.1 MPS ARPM and DMPM

10.1.1 General

The protocol procedures specify:

- the interactions between the MPS application services and link layer services;
- the interaction between the MPS application service elements and the link layer services. The service elements are characterized by application layer internal mechanisms that cannot be locally accessed by the primitives offered to the user.

The mapping between the parameters specifying link faults and the *Type of Error* parameters of the application layer service primitives is not specified .The error types described are simply recommendations.

10.1.2 Service procedures

10.1.2.1 General

The application services protocol procedures describe the interactions with the link services by use of evaluation nets.

Nevertheless the behaviour described by the evaluation nets does not presume the internal implementation of the MPS finite state machines services.

Furthermore, the service procedures describe the mapping on the link services in terms of primitives and parameters.

10.1.2.2 Local read service

10.1.2.2.1 Service description

The local read service only interacts with the link services when reading a non resynchronized variable. When a variable is resynchronized the service performs a read on the *Private Value* and *Private Status* attributes of the *Consumed Variable Local Image* application object, situated at the application layer level.

10.1.2.2.2 Evaluation net

The A_Readloc service evaluation net is shown in Figure 10.

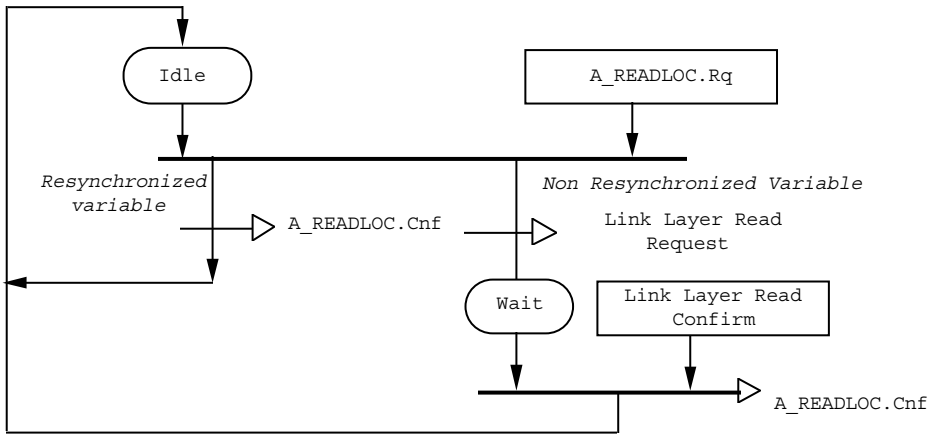


Figure 10 – A_Readloc service evaluation net

The confirmation associated with a A_READLOC.rq read request shall be negative whenever the data link confirmation was itself negative.

10.1.2.2.3 Mapping on link services

The mapping on the link layer services is as follows:

Link Layer Read Request: L_GET.request(IDENTIFIER)

Link Layer Read Confirmation: L_GET.confirm(IDENTIFIER,STATUS, L_DATA)

10.1.2.2.4 Mapping on link parameters

Mapping of MPS objects attributes on link services parameters is performed as follows:

IDENTIFIER: This parameter corresponds to the attribute *Identifier* of the *Consumed Variable Local Image* object.

L_DATA: This parameter corresponds to the transfer syntax PDU resulting from the encoding rules. The components of the PDU contents are available in the *Public value* and in the *Transmitted status value* attributes of the *Consumed Variable Local Image* object.

STATUS: When the confirmation is negative, this parameter specifies the error type.

10.1.2.3 Local write service

10.1.2.3.1 Service description

The local write service only interacts with the link services when writing a non resynchronized variable. When a variable is resynchronized the service writes the value of the *Private Value* attributes of the *Produced Variable Local Image* application object, situated at the application layer level.

10.1.2.3.2 Evaluation net

The A_Writeloc service evaluation net is shown in Figure 11.

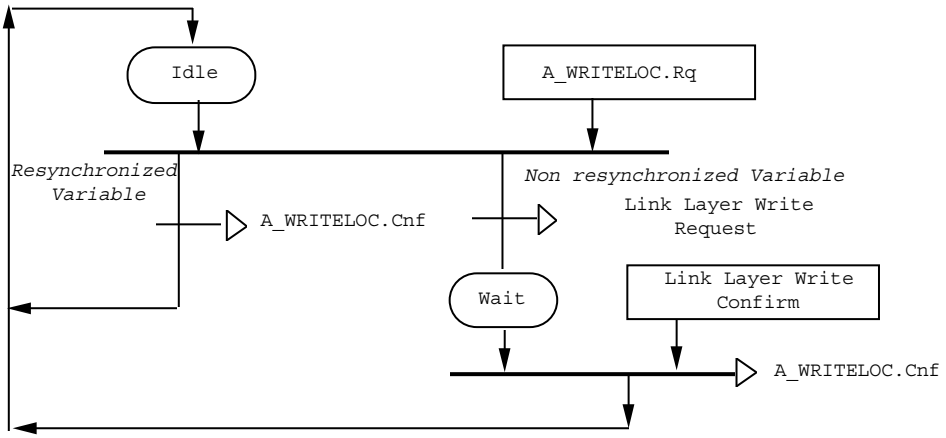


Figure 11 – A_Writeloc service evaluation net

The confirmation associated with a A_WRITELOC.rq write request shall be negative whenever the data link confirmation was itself negative.

10.1.2.3.3 Mapping on the link services

The mapping on the link layer services is as follows:

Link Layer Write Request: L_PUT.request(IDENTIFIER, L_DATA)

Link Layer Write Confirmation: L_PUT.confirm(IDENTIFIER, STATUS)

10.1.2.3.4 Mapping on link parameters

Mapping of MPS objects attributes on link services parameters is performed as follows:

IDENTIFIER: This parameter corresponds to the attribute *Identifier* of the *Produced Variable Local Image* object.

L_DATA: This parameter corresponds to the transfer syntax PDU resulting from the encoding rules. The components of the PDU contents are available in the Public value and the Transmitted status value attributes of the Produced Variable Local Image object.

STATUS: When the confirmation is negative, this parameter specifies the error type.

10.1.2.4 Update service

10.1.2.4.1 Evaluation net

The A_Update service evaluation net is shown in Figure 12.

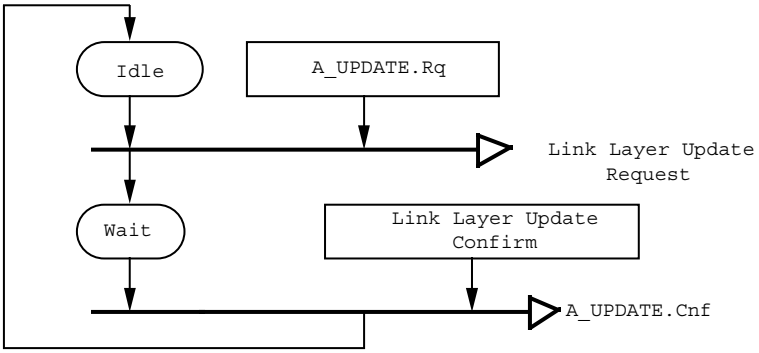


Figure 12 – A_Update service evaluation net

The confirmation associated with a A_UPDATE.rq update request shall be negative whenever the data link confirmation was itself negative.

10.1.2.4.2 Mapping on the link services

The mapping on the data link layer services is performed as follows:

Link Layer Update Request: L_FREE_UPDATE.request(SEQUENCE OF REQUESTED IDENTIFIERS, PRIORITY)

Link Layer Update Confirmation: L_FREE_UPDATE.confirm(STATUS)

10.1.2.4.3 Mapping on Link parameters

Mapping of MPS object attributes on link services parameters is performed as follows:

SEQUENCE OF REQUESTED IDENTIFIERS: This parameter corresponds to the attribute *Identifier* of one of the following objects: *Consumed Variable Local Image, Produced Variable Local Image* or *Third Part Variable Local Image* object. This attribute corresponds to the variable specified in the *Variable Specification* parameter of the A_UPDATE service primitive.

PRIORITY: This parameter corresponds to the *Priority* parameter of the A_UPDATE service primitive.

STATUS: When the confirmation is negative, this parameter specifies the error type.

10.1.2.5 Remote read service

10.1.2.5.1 Service description

When a variable is resynchronized, the remote read service performs only a link update request. The read value being the *Private value* attribute of the *Consumed Variable Local Image* object

When a variable is not resynchronized the remote read service first performs a link update request and, after confirmation of this request, the service performs a local read on the *Public value* attribute of the object *Consumed Variable Local Image.*

10.1.2.5.2 Evaluation net

The A_Readfar service evaluation net is shown in Figure 13.

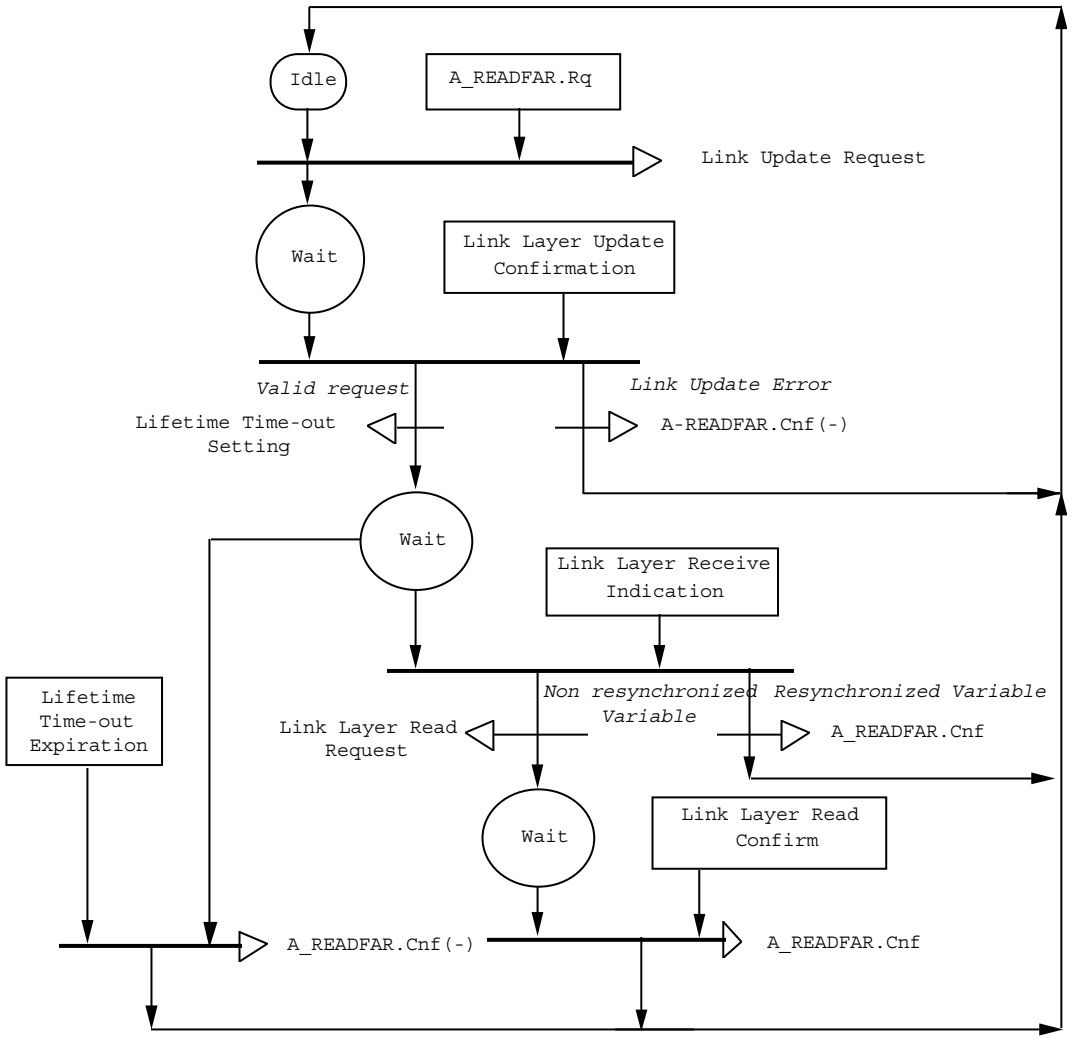


Figure 13 – A_Readfar service evaluation net

10.1.2.5.3 Mapping on the Link services

The mapping on the data Link Layer is made as follows:

Link Layer Read Request:	L_GET.(IDENTIFIER)
Link Layer Read Confirmation:	L_GET.confirm(IDENTIFIER,STATUS, L_DATA)
Link Layer Update Request:	L_FREE_UPDATE.request(SEQUENCE OF REQUESTED IDENTIFIERS, PRIORITY)
Link Layer Update Confirmation:	L_FREE_UPDATE.confirm(STATUS)
Link Layer Receive Indication:	L_RECEIVED.indication(IDENTIFIER)

10.1.2.5.4 Mapping on Link parameters

Mapping of MPS object attributes on link service parameters is performed as follows:

IDENTIFIER: This parameter corresponds to the attribute *Identifier* of the *Consumed Variable Local Image* object.

L_DATA: This parameter corresponds to the transfer syntax PDU resulting from the encoding rules. The components of the PDU contents are available in the *Public value* and in the *Transmitted status value* attributes of the *Consumed Variable Local Image* object.

SEQUENCE OF REQUESTED IDENTIFIERS: This parameter corresponds to the attribute *Identifier* of the *Consumed Variable Local Image* object.

PRIORITY: This parameter corresponds to the *Priority* parameter of the A_READFAR service primitive.

STATUS: When the confirm primitive is negative, this parameter specifies the type of the error.

10.1.2.6 Remote write service

10.1.2.6.1 Service Description

When a variable is resynchronized, the remote write service performs only a link update request, the value of the variable having been already write on the *Private value* attribute of the *Produced Variable Local Image* object

When a variable is not resynchronized the remote write service first performs a local write on the *Public value* attribute of the object *Produced Variable Local Image,* then after confirmation of the local write, the service performs a link update request.

10.1.2.6.2 Evaluation net

The A_writefar service evaluation net is shown in Figure 14.

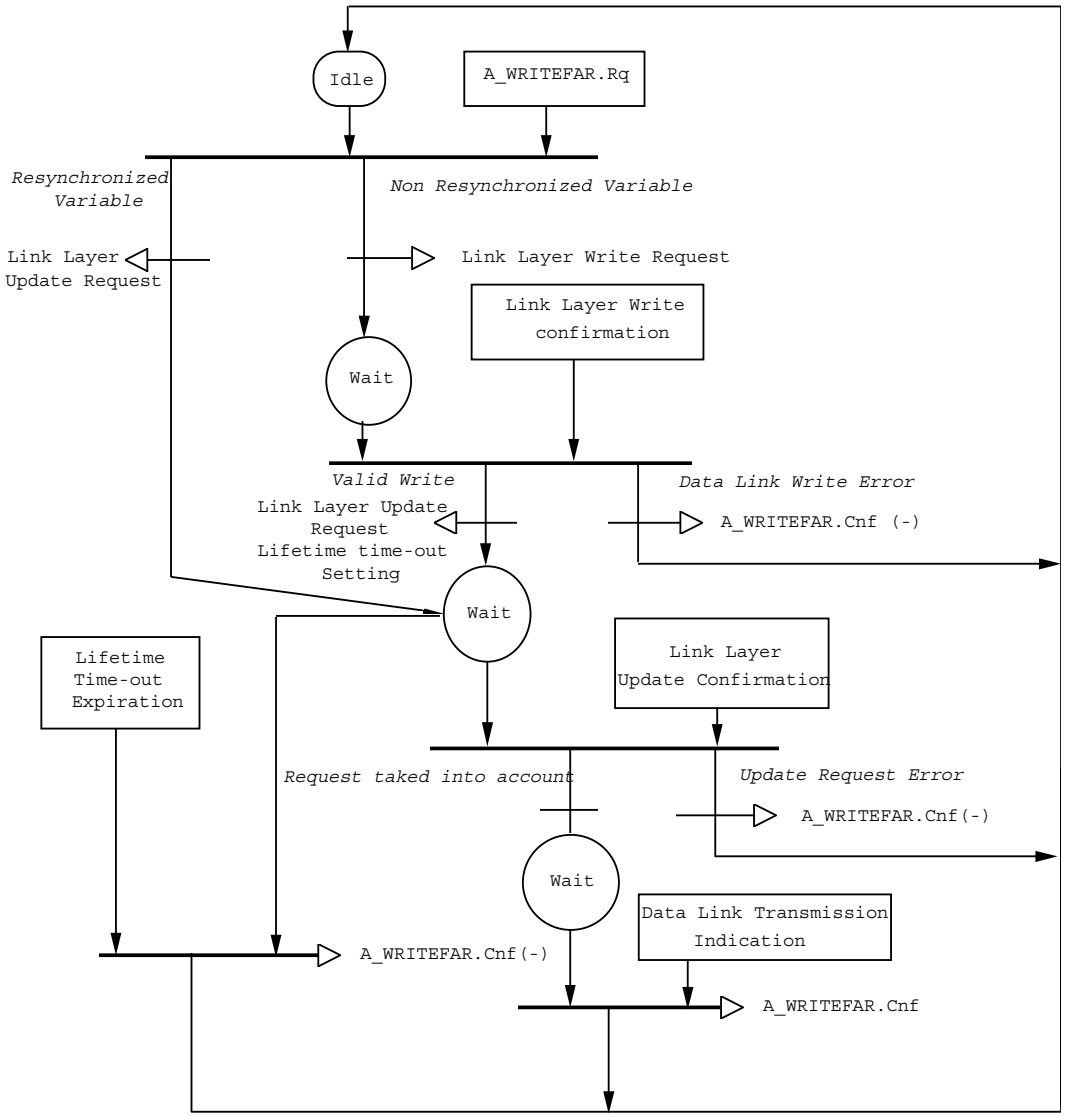


Figure 14 – A_Writefar service evaluation net

10.1.2.6.3 Mapping on the Link services

The mapping on the data Link Layer is performed as follows:

Link Layer Write Request: L_PUT.request(IDENTIFIER, L_DATA)
Link Layer Write Confirmation: L_PUT.confirm(IDENTIFIER, STATUS)
Link Layer Update Request: REQUESTED IDENTIFIERS, PRIORITY)
Link Layer Update Confirmation: L_FREE_UPDATE.confirm(STATUS)
Link Layer Transmission Indication: L_SENT.indication(IDENTIFIER)

10.1.2.6.4 Mapping on the Link parameters

The mapping of MPS object attributes on link services parameters is performed as follows:

IDENTIFIER: This parameter corresponds to the attribute *Identifier* of the *Produced Variable Local Image* object

L_DATA: This parameter corresponds to the transfer syntax PDU resulting from the encoding rules. The components of the PDU contents are available in the *Public value* and in the *Transmitted status value* attributes of the *Produced Variable Local Image* object.

SEQUENCE OF REQUESTED IDENTIFIERS: This parameter corresponds to the attribute *Identifier* of the *Produced Variable Local Image* object.

PRIORITY: This parameter corresponds to the *Priority* parameter of the A_WRITEFAR service primitive.

STATUS: When the confirm primitive is negative, this parameter specifies the type of error.

10.1.2.7 Transmission Indication Service

10.1.2.7.1 Evaluation net

The A_Sent service evaluation net is shown in Figure 15.

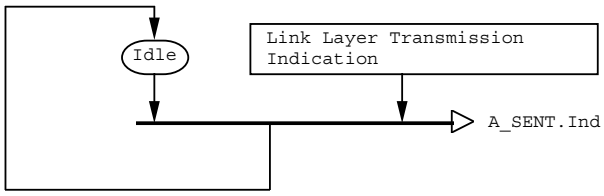


Figure 15 – A_Sent service evaluation net

10.1.2.7.2 Mapping on Link services

The mapping on the Link Layer services is performed as follows:

Link Layer Transmission Indication: L_SENT.indication(IDENTIFIER)

10.1.2.7.3 Mapping on the Link parameters

The mapping of MPS object attributes on link services parameters is performed as follows:

IDENTIFIER: This parameter corresponds to the attribute *Identifier* of the *Produced Variable Local Image* object of the variable which implements the transmission indication service.

10.1.2.8 Reception indication service.

10.1.2.8.1 Evaluation net

The A_Received service evaluation net is shown in Figure 16.

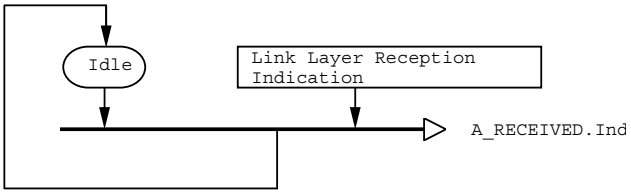


Figure 16 – A_Received service evaluation net

10.1.2.8.2 Mapping on the Link services.

The mapping on the Link Layer services is performed as follows:

Link Layer Reception Indication: L_RECEIVED.indication(IDENTIFIER)

10.1.2.8.3 Mapping on the Link parameters

Mapping of MPS objects attributes on link services parameters is performed as follows:

IDENTIFIER: This parameter corresponds to the attribute *Identifier* of the *Consumed Variable Local Image Object* of the variable which implements the reception indication service.

10.1.3 Service elements procedures

10.1.3.1.1 General

The application services elements are defined by Application Layer internal mechanisms that cannot be accessed by dedicated application primitives.

The protocol procedures associated with service elements describe the interaction with the link services by using evaluation nets; besides, the service procedures describe the mapping of those mechanisms on the link services of the AL TYPE 7environment in terms of primitives and parameters.

10.1.3.2 Mapping of request and actions of the production validity status elaboration mechanisms:

An object *Produced Variable Local Image* has a service element procedure associated with the production validity status either the variable is resynchronized on production, or not resynchronized.

Status updating:

This action is mapped on the service primitive of data link level

L_PUT.request(IDENTIFIER,L_DATA)

The parameter IDENTIFIER, corresponds to the value of the attribute *Identifier* of the *Produced Variable Local Image* object.

The parameter L_DATA corresponds to the values of the attributes *Public Value* and *Transmitted Status Value* of the *Produced Variable Local Image* object.

Synchronization Order:

This request is mapped on a service primitive of data link level

L_RECEIVED.indication(IDENTIFIER) or

L_SENT.indication(IDENTIFIER)

The parameter IDENTIFIER, corresponds to the value of the attribute *Identifier* of the object *Consumed Variable Local Image* (of synchronization) or *Produced Variable Local Image* object (of synchronization) associated with the synchronization variable involved in the production validity status elaboration.

When the two objects *Consumed Variable Local Image* and *Produced Variable Local Image* associated with the synchronization variable are resident in the same application entity, the synchronization order is mapped on the consumed variable reception.

10.1.3.3 Mapping of request, and actions of the transmission validity status elaboration mechanisms:

A *Consumed Variable Local Image* object has a service element procedure associated with the transmission validity status whether the variable is resynchronized or not.

Variable reception:

This request is mapped on the data link level service primitive

L_RECEIVED.indication(IDENTIFIER)

The parameter IDENTIFIER corresponds to the value of the attribute *Identifier* of the *Consumed Variable Local Image* object.

Synchronization order:

This request is mapped on the link layer level services primitives

L_RECEIVED.indication (IDENTIFIER) or

L_SENT.indication(IDENTIFIER)

The parameter IDENTIFIER, corresponds to the value of the attribute *Identifier* of the object *Consumed Variable Local Image* (of synchronization) or *Produced Variable Local Image* object (of synchronization) associated with the synchronization variable involved in the transmission validity status elaboration mechanism.

10.1.3.4 Mapping of request, and actions of the recovery list elaboration mechanisms

The contents of the recovery list is managed by one service element which takes into account firstly, the synchronization order associated with the list, and secondly, the reception of the various variables of the list.

Recovery List Content Management

List Content Initialization:

These actions are mapped on the Data Link level service primitive

L_SPEC_UPDATE.request(SPECIFIED IDENTIFIER, SEQUENCE OF REQUESTED IDENTIFIERS)

The SPECIFIED IDENTIFIER parameter corresponds to the attribute *Recovery List Identifier* of the *List of Variables Local Image* object.

The SEQUENCE OF REQUESTED IDENTIFIERS corresponds to the attribute *Recovery List Content* of the *List of Variables Local Image* object.

List Synchronization Order:

This action is mapped on the data link level service primitive

L_RECEIVED.indication (IDENTIFIER)

The parameter IDENTIFIER corresponds to the attribute *Reference (synchronization) Variable* of the *Variables List Local Image* object.

When the two objects *Consumed Variable Local Image* and *Produced Variable Local Image* are resident in the same application entity, the synchronization order is mapped on the consumed variable reception.

Reception of the Variable List:

This action is mapped on the data link layer service primitive L_RECEIVED.indication (IDENTIFIER)

The parameter IDENTIFIER corresponds to the attribute *Reference Consumed Variable* of the *List of Variables Local Image* object.

NOTE When the attribute *Recovery Nature* of the *List of Variables Local Image* object has the value FRAGMENTED, the RQ_INHIBED link layer indicator shall have the value FALSE. When the attribute has the value INDIVISIBLE the indicator shall have the value TRUE.

10.1.3.5 Mapping of request, and actions of the resynchronization mechanisms.

When a variable is resynchronized, the involved mechanism uses:

- resynchronization order.
- The transfer of the public value into the private value for a consumed resynchronized variable.
- The transfer of the private value into the public value for a produced resynchronized variable.

Resynchronization Order:

This request is mapped on the data link layer level service primitives

L_RECEIVED.indication(IDENTIFIER) or

L_SENT.indication(IDENTIFIER)

The parameter IDENTIFIER, corresponds to the value of the attribute *Identifier* of the object *Consumed Variable Local Image* (of synchronization) or *Produced Variable Local Image* object (of synchronization) associated with the synchronization variable involved in the resynchronization mechanism.

When the two objects *Consumed Variable Local Image* and *Produced Variable Local Image* are resident in the same application entity, the synchronization order is the consumed variable reception.

Private Value into Public Value Transfer:

This action is mapped on the data link level service primitive

L_PUT.request(IDENTIFIER,L_DATA)

immediately after the update of the public context by means of the private context of the resynchronized variable.

The IDENTIFIER parameter corresponds to the attribute *Identifier* of the *Produced Variable Local Image* object.

The L_DATA parameter corresponds to the value of the attributes *Public Value* and *Transmitted Status Value* of the *Produced Variable Local Image* object.

Public Value into Private Value Transfer:

This action is mapped on the data link level service primitive

L_GET.request(IDENTIFIER,L_DATA)

immediately after the update of the private context by means of the public context of the resynchronized variable.

The IDENTIFIER parameter corresponds to the attribute *Identifier* of the *Consumed Variable Local Image* object.

The L_DATA parameter corresponds to the value of the attributes *Public Value* and *Transmitted Status Value* of the *Consumed Variable Local Image* object

10.1.3.6 Mapping of request, and actions of the consistency variable elaboration mechanisms

Each consistency variable value is elaborated in several application entities by using application service elements.

The value elaboration is done from the two following events: reception of the components of the variable list and reception of the synchronization variable of the list.

Consistency Variable Management

Consistency Variable Value Initialization:

These actions are mapped on the data link level service primitives L_SPEC_UPDATE.request (SPECIFIED IDENTIFIER, SEQUENCE OF REQUESTED IDENTIFIERS)

The parameter SPECIFIED IDENTIFIER corresponds to the attribute *Reference Produced Variable (of consistency)* of the object *List of Variable Local Image*.

The parameter SEQUENCE OF REQUESTED IDENTIFIERS corresponds to the attribute *Public Value* of the object *Produced Variable Local Image* which is referenced in the attribute *Reference Produced Variable (of consistency)* of the object *List of variables Local Image*.

Synchronisation List Order:

This action is mapped on the data link service primitive L_RECEIVED.indication(IDENTIFIER) or

L_SENT.indication(IDENTIFIER).

The parameter IDENTIFIER corresponds to the attribute Reference (synchronization) Variable of the object List of variables Local Image.

When the two objects Consumed Variable Local Image and Produced Variable Local Image are resident in the same application entity, the synchronization order is mapped on the consumed variable reception.

Reception of the Variable List:

This action is mapped on the data link level service primitive

L_RECEIVED.indication(IDENTIFIER)

The parameter IDENTIFIER corresponds to the attribute *Reference Consumed Variable* of the *List of Variables Local Image* object.

10.2 MCS ARPM and DMPM

10.2.1 General

The MCS protocols define the procedures which define the interactions between remote application entities and between data link layer entities, for the various services.

List of procedures:

- Association establishment
- Association termination
- Association revocation
- Associated mode data transfer
- Numbering
- Retry/Antiduplication
- Multiple anticipation
- Segmentation/Reassembly
- Non-associated mode data transfer
- Invocation identification

This definition, also features the different types of application data unit types implemented for carrying out the services.

- AARQ: Association establishment request
- AARP: Association establishment response
- RERQ: Association termination request
- RERP: Association termination response
- ABRQ: Association revocation request
- ATRQ: Associated transfer request
- AKAT: Associated transfer acknowledgement
- NTRQ: Non-associated transfer request
- AKNT: Non-associated transfer acknowledgement

NOTE Details of the coding of these application data units is covered in 3.8.6.

It is also important to know that all the protocol procedures consider the L_MSG_XX.rq/cnf/ind generic link primitives, and that it is only in 3.8.7 that an exact projection onto the link layer is to be found.

10.2.2 Association establishment

10.2.2.1 General

The association establishment procedure consists of two parts: the association establishment requesting element and responding element. These two elements of the procedure call upon functions which process the values of parameters and manage the resources of the association.

10.2.2.2 Requester element

a) For the association establishment requester element, the events and conditions accounted for are the following:

- invocation of the A_ASSOCIATE.rq() primitive by the user,
- reception of the AARP-APDU in the data of the L_MSG_XX.ind() primitive. This PDU contains the “Result” parameter which indicates whether establishment is accepted,
- a time-out which monitors the “Establishment duration” designed to limit the requester wait,
- invocation by the data link layer of the L_MSG_XX.cnf(+/-) primitive, indicating whether sending has taken place correctly or not,
- an establishment reinitialisation occurrence which corresponds to switching of the association status from OPEN to NON-EXISTENT.

NOTE This transition can be obtained by invoking the A_ABORT service by the user or the provider element, or any local initiative under network management responsibility.

- the association status value NON-EXISTENT governs acceptance of the A_ASSOCIATE.rq() primitive by the requester element.

b) The actions performed by this requester element are the following:

- invocation of the A_ASSOCIATE.cnf(+/-) primitive,
- transmission of an AARQ-APDU in the L_MSG_XX.rq() primitive data,
- resetting of the timer which monitors the “Establishment duration”, designed to limit the requester’s wait,
- assigns the value OPENING, ESTABLISHED or NON-EXISTENT to the association status.

c) Requester element mechanism:

An instantiation of this mechanism at the level of an application entity which supports the association establishment procedure causes the creation of an association. One or more associations can be in the process of being established simultaneously depending on the capability of the application entity.

The calling entity has invoked this mechanism for a given association.

In this mechanism, all interactions with the user are in the context of an “AE address” pair which identifies the two application entities concerned by the association opening, and all interactions with the data link layer are in the context of the link address (of ADAE type) which is associated with the AE address of the caller to localise the requester mechanism. See Figure 17.

NOTE It is important to understand that not all A_ASSOCIATE.rq() service invocation requests are necessarily followed by an A_ASSOCIATE.cnf(+/-) confirmation. Indeed, in the case of establishment reinitialisation, it is the A_ABORT.ind() primitive which follows the establishment request and thus takes the place of confirmation.

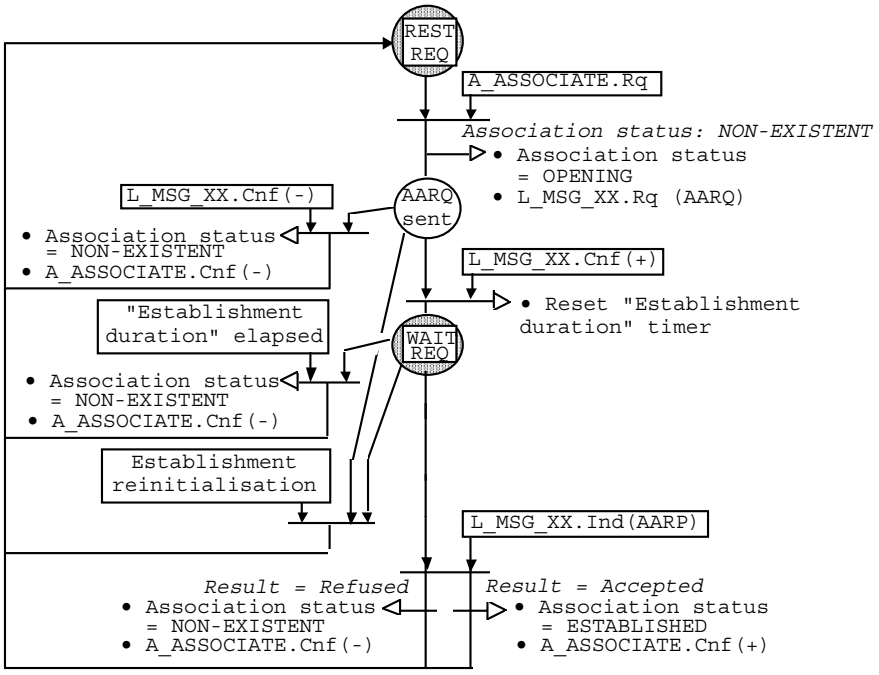


Figure 17 – Association establishment: Requester element state machine

d) Description of this mechanism

As soon as a A_ASSOCIATE.rq establishment request is made at a calling AEI access point for which there is no association (which corresponds to NON-EXISTENT association status), the latter switches to OPENING status and an establishment opening PDU is sent.

Sending consists of invoking the L_MSG_XX.rq() link service which is locally confirmed by L_MSG_XX.cnf() when the message has effectively disappeared from the link queues, subsequent to a successful transmission, or subsequent to a failure.

In the event of a link transmission failure, the requester element is reset to REST REQ status and the association to NON-EXISTENT status.

After sending an establishment request, the mechanism resets the “Establishment duration” timer and awaits an establishment response.

On arrival of the establishment response, the association changes to ESTABLISHED status or NON-EXISTENT status, depending on whether the establishment request has been accepted or refused by the responder to the request.

In addition, awaiting the response will be interrupted and the association set to NON-EXISTENT status if an establishment time-out is reached.

Finally, from the moment when the establishment procedure is started, i.e. when the requester element has “AARQ send” or “WAIT REQ” status, the latter is reinitialised in “REST REQ” status, when the status of the association changes from OPENING to NON-EXISTENT.

NOTE This change in the association status results from invoking the ABORT service by the local or remote user, or the local or remote provider element.

10.2.2.3 Responder element

a) For the establishment responder element, the events and conditions accounted for are the following:

- invoking the A_ASSOCIATE.rp() primitive by the user,
- receiving an AARQ-APDU in the L_MSG_XX.ind() primitive data,
- invoking the L_MSG_XX.cnf(+/-) primitive by the data link layer, indicating whether or not sending has taken place correctly,

- the occurrence of reinitialisation, which corresponds to changing the status of the association from OPENING to NON-EXISTENT,
- the association status value NON-EXISTENT governs acceptance of the receipt of an AARQ by the responder element.

b) The actions carried out by this responder element are the following:

- transmission of an AARP-APDU in the L_MSG_XX.rq() primitive data,
- assigning values OPENING, ESTABLISHED or NON-EXISTENT to the association status.

c) Responder element mechanism:

An instantiation of this mechanism at the level of an application entity which supports the association establishment procedure causes the creation of an association. One or more associations can be in the process of being established simultaneously depending on the capacity of the application entity.

NOTE Consequently, all establishment requests arriving after the maximum number of simultaneous establishment requests is reached are lost and there is no corresponding response. When such a loss occurs, the requesters wait until establishment time-out before repeating their requests.

The called entity is that which invokes the mechanism for a given association.

In this mechanism, all interactions with the user take place in the context of a pair of “AE addresses” which identify the two application identities concerned by the association opening, and all interactions with the data link layer are in the context of a link address (of ADAE type) which is associated with the AE address of the called entity for localising the responder mechanism. See Figure 18.

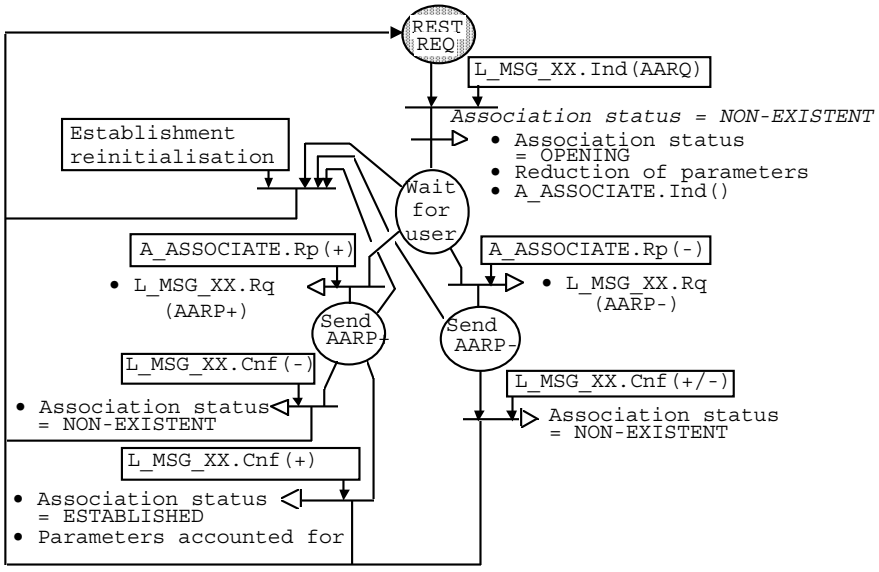


Figure 18 – Association establishment: Responder element state machine

d) Description of mechanism

As soon as the L_MSG_XX.ind() service is invoked with AARQ-APDU for data, when the association was previously NON-EXISTENT, the association is placed in OPENING status, the A_ASSOCIATE.ind() primitive is invoked, and an quality of service parameter reduction may occur.

The mechanism then enters an A_ASSOCIATE.rp() primitive wait state. As soon as the latter occurs, an AARP, which is positive or negative depending on the establishment response, is sent by invoking the L_MSG_XX.rq primitive.

This link service returns a local confirmation when the message has effectively disappeared from the link queues, after a successful transmission or after a failure.

In the event of failure in transmission of an AARP or success in transmission of a negative AARP signifying establishment refusal, the association status returns to NON-EXISTENT and the resources reserved on receiving the request are freed. The association status changes to ESTABLISHED in the event of successfully transmitting and AARP signifying establishment acceptance.

Finally, as soon as the establishment procedure is begun, i.e. the responder element status is other than “REST REQ”, the latter is reinitialised when the association status changes from OPENING to NON-EXISTENT.

10.2.3 Association termination

10.2.3.1 General

This association termination procedure consists of two parts, one relating to the termination requester and the other to the termination responder.

10.2.3.2 Requester element

a) For the termination requester element, the events and conditions accounted for are the following:

- invocation of the A_RELEASE.rq() primitive by the user,
- reception of an RERP-APDU in the data of the L_MSG_XX.ind() primitive. This PDU contains the “Result” parameter which indicates whether the termination is accepted,
- a “Termination duration” time-out, designed to limit the requester’s wait,
- the invoking of the L_MSG_XX.cnf(+/-) primitive by the data link layer, indicating whether or not the sending has occurred correctly,
- the occurrence of reinitialisation of termination which corresponds to the changing of the association status from CLOSING to ESTABLISHED,
- the association status established value governs the acceptance by the requesting element of the A_RELEASE.rq primitive,
- condition CN = LSNS.

b) The actions carried out by this requester element are the following:

- invoking of the A_RELEASE.cnf(+/-) primitive,
- sending of an RERQ-APDU in the data of the L_MSG_XX.rq() primitive,
- setting the time-out which monitors the “Termination duration”, designed to limit the requester’s wait,
- assigning of association status values CLOSING, ESTABLISHED and NON-EXISTENT.

c) Requester element mechanism:

An association in which it is possible to implement the termination procedure supports one single instance of this mechanism at called and calling entity levels. Both ends of the association can request termination.

This mechanism requires not only that all the interactions with the user take place in the context of the association to which the mechanism belongs but also that all interaction with the data link layer take place in the context of the pair of addresses (of ADAEI type) specific to the association. See Figure 19.

NOTE It is important to understand that the A_RELEASE.rq() service invocation request is not necessarily followed by an A_RELEASE.cnf(+/-) confirmation. Indeed, in the case of establishment reinitialisation, it is the A_ABORT.ind() primitive which follows a termination request and thus replaces the confirmation.

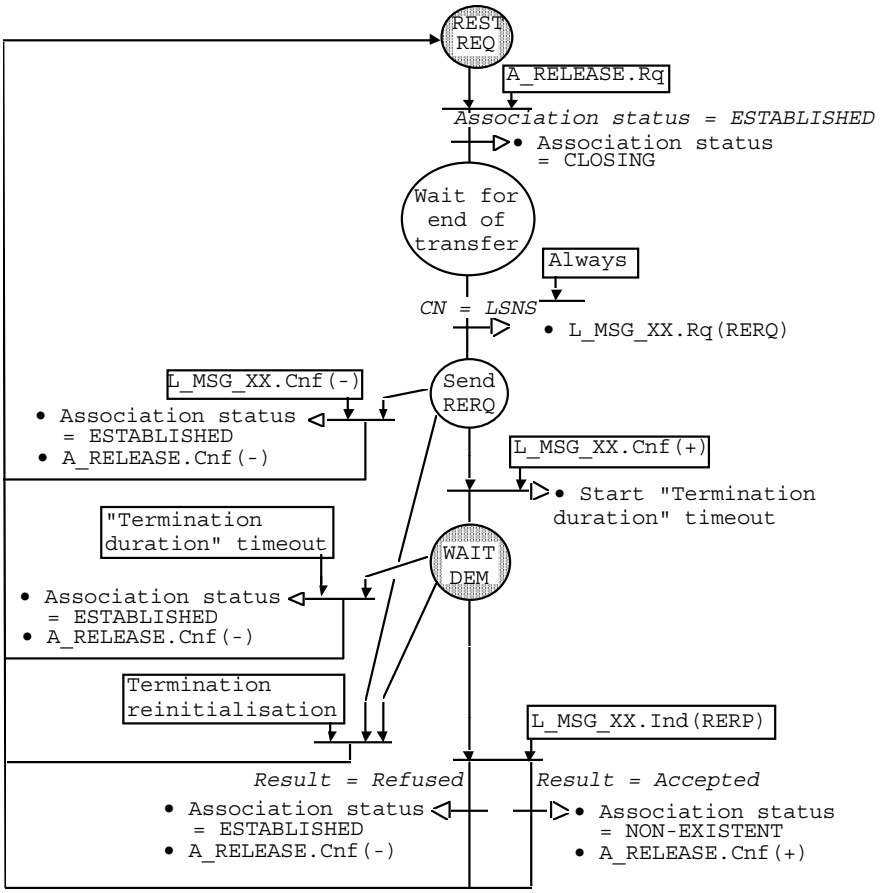


Figure 19 – Association termination: Requester element state machine

d) Description of mechanism:

As soon as the A_RELEASE.rq termination request is carried out in an ESTABLISHED association, its status changes to CLOSING and a PDU is sent requesting termination as soon as all the data transfers in progress in the association are finished (CN=LSNS).

Sending is by invoking the L_MSG_XX.rq() link service which is locally confirmed by L_MSG_XX.cnf() when the message has effectively disappeared from the link queues, subsequent to a successful transmission or subsequent to a failure.

In the case of a link transmission failure, the requester element is reset to quiescent status and the association is set to ESTABLISHED status.

NOTE Termination is a procedure in which priority is given to opening in the event of execution faults.

After transmitting a termination request, the mechanism awaits a termination response, after having started a “Termination duration” time-out.

On the arrival of the termination response, the association status changes to ESTABLISHED or to NON-EXISTENT, depending on whether the termination request was accepted or refused by the responder to this request.

In addition, the wait for a response is interrupted, and the association status becomes ESTABLISHED, if the termination time-out is reached. Finally, as soon as the termination procedure is begun, i.e. the requester element status is “Send RERQ” or “WAIT REQ”, the latter is reinitialised with “REST REQ” status when the association changes from CLOSING to NON-EXISTENT.

NOTE This association state transition results from invocation of the ABORT service by the local or remote user or by the local or remote provider element for simultaneous termination purposes.

10.2.3.3 Responder element

a) For the termination responder element, the events and conditions accounted for are the following:

- invoking the A_RELEASE.rp() primitive by the user,
- receiving a RERQ-APDU in the data of the L_MSG_XX.ind() primitive,
- invoking the L_MSG_XX.cnf(+/-) primitive by the data link layer, indicating whether the transmission has taken place properly or not,
- an occurrence of termination reinitialisation, which corresponds to changing the association from the CLOSING to the ESTABLISHED state,
- the association status value CLOSING governs the acceptance of reception of an RERQ by the responder element.

b) The actions carried out by this responder element are the following:

- sending an RERP-APDU in the data of the L_MSG_XX.rq() primitive,
- assigning association status value CLOSING, ESTABLISHED and NON-EXISTENT,
- a provider ABORT request.

c) Responder element mechanism:

An association in which it is possible to implement the termination procedure supports a single instance of the mechanism at calling and called entity levels. Both ends of the association can respond to a termination.

In addition, if both ends request simultaneously, the termination collision is detected by the responder mechanism, which then proceeds to request a provider ABORT for the association.

The mechanism also requires that all interactions with the user be made in the context of the association to which the mechanism belongs and that all interactions with the data link level are in the context of the pair of addresses (of ADAEI type) specific to the association. See Figure 20.

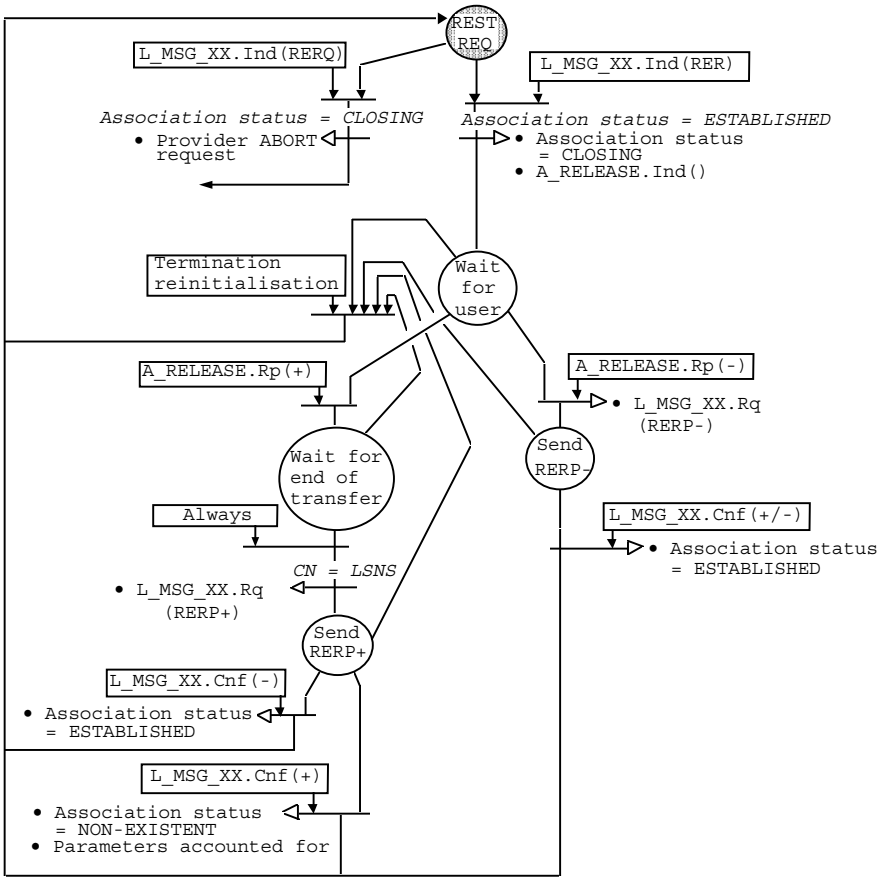


Figure 20 – Association termination: Responder element state machine

d) Description of mechanism:

As soon as the L_MSG_XX.ind() service is invoked with an RERQ-APDU for data, when the association is ESTABLISHED, the association state changes to CLOSING and the A_RELEASE.ind() is invoked.

The mechanism then awaits the A_RELEASE.rp() primitive. As soon as this arises, depending on whether it is negative or positive, an RERP termination response is sent by invoking the L_MSG_XX.rq() primitive immediately or as soon as CN = LSNS.

This link service returns a local confirmation when the message has effectively disappeared from the link queues, subsequent to a successful termination or subsequent to a failure.

In the event of a failure, or of success in transmission of an RERP signifying refusal of termination, the association returns to ESTABLISHED status.

In all other cases, the status of the association changes to NON-EXISTENT.

In the case of receiving a termination request (i.e. invoking the L_MSG_XX.ind(RERQ) service when the association status is already CLOSING, a provider ABORT request is made. Indeed, receiving a termination request in a state corresponding to a termination collision resulting from simultaneous termination requests by the two correspondents of the association.

Finally, as soon as the termination procedure is begun, i.e. the status of the responder element is other than “REST REQ”, the latter is reinitialised when the association status changes from CLOSING to NON-EXISTENT.

10.2.4 Association revocation

10.2.4.1 General

This association revocation procedure consists of two parts: requester and acceptor.

NOTE The difference between the responder and the acceptor is that for the first association revocation is a confirmed service and for the second it is not.

10.2.4.2 Requester element

The requester element is that which causes the sending of an association revocation request to an association.

a) For an association revocation requester element, the events and conditions accounted for are the following:

- invoking the A_ABORT.rq() primitive by the user,
- invoking the L_MSG_XX.cnf(+/-) primitive by the data link layer,
- indicating whether or not sending has taken place correctly,
- the association status values OPENING, ESTABLISHED AND CLOSING govern acceptance of the A_ABORT.rq() primitive by the requester element.

b) The actions which are carried out by this requester element are the following:

- invoking the A_ABORT.ind() primitive,
- sending an ABRQ-APDU in the data of the L_MSG_XX.rq() primitive,
- setting association status value to NON-EXISTENT.

c) Mechanism of requester element:

An association in which it is possible to implement the revocation procedure supports a single instance of this mechanism at called and calling entity level.

This mechanism requires all interaction with the user to take place in the context of the association to which the mechanism belongs and all interaction with the data link level being in the context of the pair of addresses (of ADAEI type) specific to the association. See Figure 21.

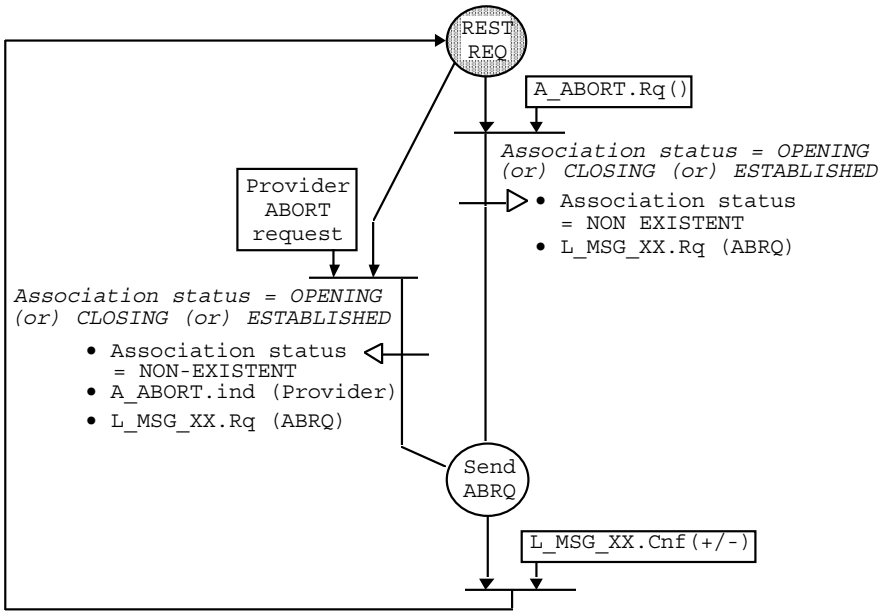


Figure 21 – Association revocation: Requester element state machine

d) Description of mechanism:

As soon as a revocation request from user A_ABORT.rq or the provider is made on an association which is ESTABLISHED, OPENING or CLOSING, the status of the latter changes to NON-EXISTENT and a revocation request PDU is sent. In addition, in the event of a provider attempt, the A_ABORT.ind primitive is invoked to warn the local user.

Whatever the results of sending, all the resources locally reserved for the association are freed.

10.2.4.3 Acceptor element

The acceptor element is that which receives an association revocation request and which processes it regardless of its origin.

a) For the revocation acceptor element, the events and conditions accounted for are the following:

- receiving an ABRQ-APDU in the data of the L_MSG_XX.ind() primitive,
- the OPENING, CLOSING or ESTABLISHED status of the association governs the acceptance by the acceptor element of the receipt of an ABRQ.

b) The actions carried out by this acceptor element are the following:

- invoking the A_ABORT.ind() primitive,
- setting the status of the association to NON-EXISTENT.

c) Acceptor element mechanism:

An association in which it is possible to implement the revocation process, supports a single instance of the mechanism at called and calling entity level.

This mechanism requires all interaction with the user to take place in the context of the association to which the mechanism belongs and for all interaction with the data link layer to be in the context of the pair of addresses (of ADAEI type) specific to the association. See Figure 22.

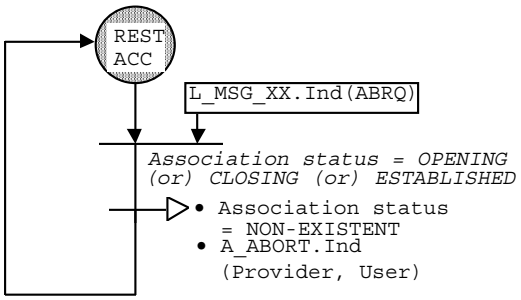


Figure 22 – Association revocation: Acceptor element state machine

NOTE Invocation of the A_ABORT.ind() service of which the origin is the “User” are necessarily from the correspondent, whereas one of “Provider” origin may be local or remote.

d) Description of mechanism:

As soon as the L_MSG_XX() service is invoked with an ABRQ-APDU for data, with the association ESTABLISHED, OPENING or CLOSING, the association status becomes NON-EXISTENT and the A_ABORT.ind() primitive is invoked.

10.2.5 Associated mode data transfer

10.2.5.1 General

In the associated mode, the complexity of the data transfer protocol procedure varies with the supported mechanisms adopted for the association.

The overall procedure is thus composed of a number of state machines respectively associated with the various mechanisms which can be implemented in association, interacting via calls and responses or via global variables.

The various state machines defined for the mechanisms which can be implemented in an association at data transfer requester or acceptor level are the following:

- TS_SM_RQ, TS_SM_ACC:

  Transfer service machine for requester and acceptor.

- AT_SM_RQ, AT_SM_ACC:

  Non-acknowledged transfer machine for the requester and the acceptor.

- ATAK_SM_RQ, ATAK_SM_ACC:

  Acknowledged transfer machine for the requester and the acceptor.

- NB_SM:

  Numbering machine at requester level.

- RC_SM:

  Retry machine at requester level.

- DU_SM:

  Antiduplication machine at acceptor level.

- MA_SM:

  Anticipation machine at requester level.

- SG_SM:

  Segmentation machine at requester level.

- RS_SM:

  Reassembly machine at acceptor level.

NOTE The term “acceptor” is used for the receiver of a data transfer, as it is an unconfirmed service. For a confirmed service, the term “responder” would be used.

All state machines interact both:

- between themselves in the context of an association. These interactions take place by MCS local identification of calls/responses between machines,
- with other application service elements participating at the same association. These take place by local identification between ASEs,
- with the data link layer in the case of a pair of link addresses of the ADAEI type, which localises the ends of the association.

Figure 23 shows interaction between the various state machines.

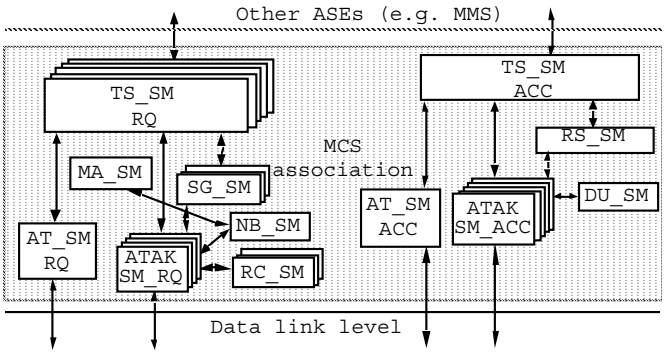


Figure 23 – Interactions between state machine in an associated mode data transfer

This breakdown of the associated mode data transfer procedure uses modularity associated with the classes of conformity. It is thus that the only necessary machine is that of the transfer service which, in conjunction with the acknowledged or unacknowledged transfer machine, constitutes the simplest classes of conformity for transfer of data in the associated mode.

10.2.5.2 Definitions

10.2.5.2.1 Variables

The various state machines implemented in the context of an association for the transfer of data in the associated mode are co-ordinated by variables. There are two types of variables:

- local variables, which are specific to one status machine and which have a value which exists and may vary in the context of each of the invocations of the machine,
- global variables, which makes it possible to manage interaction between the different mechanisms and which have a value which exists and possibly varies in the context of each association.

The local variables are described at the level of each of the mechanisms to which they belong, and the global variables are described below.

SA (Service Access): Access to the service used to specify whether a new transfer service can be invoked in the association. (TS_SM_RQ), in order to avoid interlacing of the data transfers associated with a number of service invocations. This variable is shared by TS_SM_RQ and SEG_SM machines.

The value varies dynamically between:

- FREE if another invocation is possible,
- BUSY is it is temporarily impossible to invoke another transfer service.

Typically, the status of the variable changes from FREE to BUSY when the transfer service machine, on the requester side, activates a segmentation machine.

This it remains in the BUSY state for the time interval during which the segmentation machine divides the messages into packets and instantiates as many ATAK_SM_RQ acknowledged transfer protocol machines as there are packets. The status of the SA variable changes from BUSY to FREE in two cases:

- when all the packets subsequent to the message have been invoked by an ATAK_SM_RQ machine or
- if the service is interrupted after negative confirmation of a packet (other than the last one) originating from the ATAK_SM_RQ machine invoked for the packet. Indeed, in this case the message is considered to have been corrupted and the current transfer is interrupted, whereafter another transfer can be envisaged.

AC (Anticipation Credit): The anticipation credit is utilised to specify that another acknowledged transfer (ATAK_SM_RQ) can be invoked in the association.

Another transfer can only be invoked within the quantitative limits set by the anticipation factor provided that the difference between the sequence number of the earliest invocation and the current number is less than the value of the anticipation factor.

The value varies dynamically between:

- FREE if a new invocation is possible,
- BUSY if it is temporarily impossible to invoke another acknowledged transfer.

On opening an association, the variable is initialised at FREE.

The mechanism controlling variation of the value of this variable is MA_SM.

CN (Current Number): The sequence number to be allocated to the next acknowledged data transfer.

This variable is shared by the machines NB_SM, MA_SM, SEG_SM and ATAK_SM_RQ.

The value varies under the control of the numbering mechanism (NB_SM).

This variable is initialised at “0” on opening the association.

LSNS (Lowest Sequence Number Send): The lowest sequence number attributed to an acknowledge transfer being exchanges and known at transfer initiator level.

The sequence numbers (SN) identify the invocations of transfer in the associated mode. Each of the PDUs sent contains a sequence number, which is necessary for numerous mechanisms.

This variable is initialised at “0” on opening the association.

S (Size): Size of service expressed in terms of the number of packets of maximum size.

a (Anticipation factor): This is the anticipation factor adopted for the association. The minimum value of a is 1.

RC: Specifies whether retry (RC_SM) is adopted in the association. The value of this variable is static throughout the life of an association and is governed by the fact that the two devices participating in it belong to a class of conformity which supports it.

The values are the following:

- USED: mechanism adopted, necessarily being supported by the devices,
- UNUSED: mechanism not adopted as not supported, or not supported by any one of the devices.

DU: Specifies whether antiduplication (DU_SM) is adopted in the association. The value of this variable is static throughout the life of an association and is governed by the fact that the two devices participating in it belong to a class of conformity which supports it.

The values are the following:

- USED: mechanism adopted, necessarily being supported by the devices,

- UNUSED: mechanism not adopted as not supported, or not supported by any one of the devices.

SG: Specifies whether segmentation (SG_SM) is adopted in the association. The value of this variable is static throughout the life of an association and is governed by the fact that the two devices participating in it belong to a class of conformity which supports it.

The values are the following:

- USED: mechanism adopted, necessarily being supported by the devices,
- UNUSED: mechanism not adopted as not supported, or not supported by any one of the devices.

RS: Specifies whether reassembly (RS_SM) is adopted in the association. The value of this variable is static throughout the life of an association and is governed by the fact that the two devices participating in it belong to a class of conformity which supports it.

The values are the following:

- USED: mechanism adopted, necessarily being supported by the devices,
- UNUSED: mechanism not adopted as not supported, or not supported by any one of the devices.

10.2.5.2.2 Operators

The different state machines have conditional transitions which are expressed with arithmetic in 2exp16 modulo numbers. Indeed, all MCS-APDU identification is carried out with 16-bit binary-coded numbers which vary between 0 and 2exp16-1= Max.

Consequently, to facilitate expression of conditions, operators have been defined:

– **"successor"**

When y=success(x); y=x+1, if x<Max; and y=0, if x=Max

– **"distance"**

When y=dist(a,b); y=a-b, if a≥b; and y=a+max+1-b, if a<b

– **"between"**

When (x)between(a,b)=y;

y=TRUE, if b>a and x≥a and x<b,

if a>b and x≥a,

if a>b and x<b

y=FALSE, in all other cases.

NOTE In the special case where a is equal to b, y takes the value FALSE.

10.2.5.3 Transfer service (TS_SM)

10.2.5.3.1 General

The transfer service machine consists of two parts, one relating to the requester and the other to the acceptor.

10.2.5.3.2 Requester element (TS_SM_RQ)

The requester element is that which causes the transmission of a data transfer request on an association. See Figure 24.

a) For the transfer service request element, the following events and conditions are accounted for:

A_DATA.rq(Request_ack), where Request_ack = TRUE (or) FALSE

dt_noack_cnf(+/-) (see 10.2.5.4.2)

dt_ack_cnf(+/-) (see 10.2.5.5)

- segment_cnf(+/-) (see 10.2.5.9)
- Association status = ESTABLISHED
- AC = FREE
- SA = FREE
- SG = USED or UNUSED.

b) The actions carried out by the requester element are the following:

A_DATA.cnf(+/-)

- dt_noack_rq() ,
- dt_ack_rq(Packet nature), where Packet nature = NIL (see 10.2.5.2.1),
- segment_rq() (see 10.2.5.9).

c) Mechanism of requester element:

An association necessarily has a transfer service mechanism and can support one or more instances at called and calling entity level. The multiplicity of instances is limited by the maximum anticipation value specified in an association. Indeed, the number of instances possible is equal to the maximum anticipation value if there is no segmentation, and less than or equal to it otherwise.

NOTE If the segmentation mechanism is adopted, the number of instances of the mechanism possible in an association is equal, on average, to maximum anticipation “a” divided by the average number of packets necessary for the exchange of a service.

Machine: TS_SM_RQ

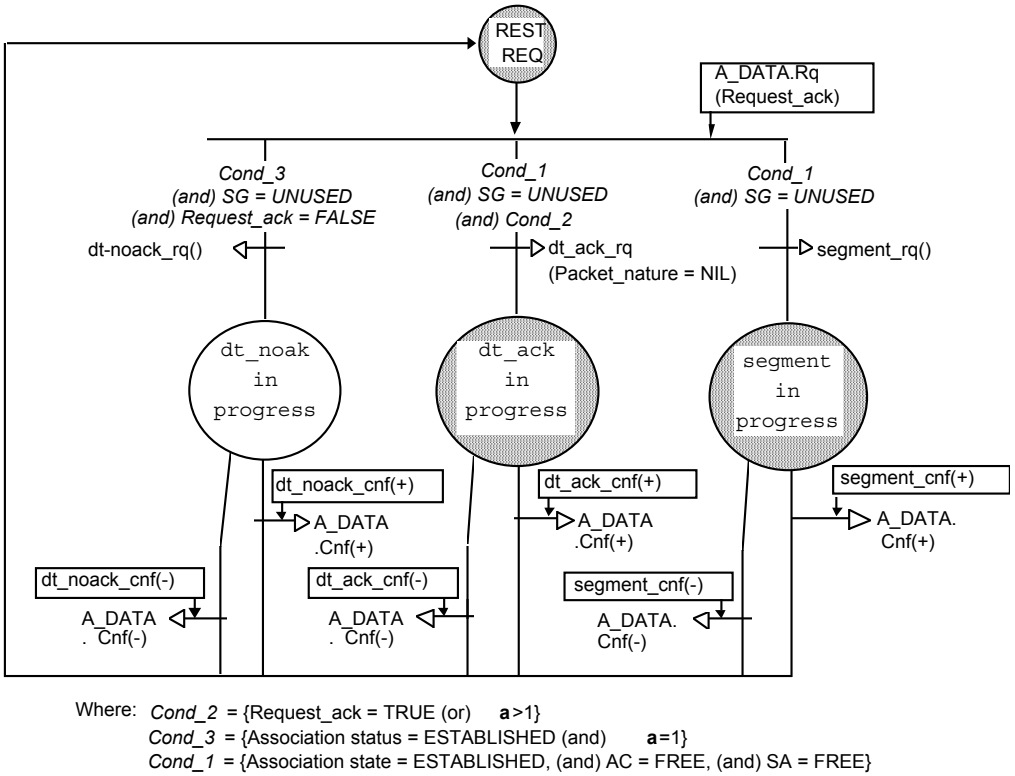


Figure 24 – Transfer service: Requester element state machine

d) Description of mechanism:

As soon as a A_DATA.rq(Request_ack) data transfer request is made by the user, a call to another mechanism is made depending on the value of the global variables of the association and the “Request_ack” parameter transferred in the request.

Thus, an acknowledged transfer, or an unacknowledged transfer or a segmentation are begun.

In the case of an association which implements segmentation, the “Request_ack” parameter can only have the value TRUE.

10.2.5.3.3 Acceptor element (TS_SM_ACK)

The acceptor element is that which receives a data transfer in an association.

a) For the transfer service acceptor element, the following events and conditions are accounted for:

- dt_noack_ind() (see 10.2.5.4.3)
- dt_ack_ind() (see 10.2.5.5.3)
- reassemb_ind() (see 10.2.5.10)
- Association status = ESTABLISHED (or) CLOSING
- RS = USED (or) UNUSED

b) The actions carried out by this acceptor element are the following:

- A_DATA.ind(Request_ack), where Request_ack = TRUE, (or) FALSE

NOTE This parameter necessarily has the value TRUE if reassembly takes place.

c)

Acceptor element mechanism (see Figure 25):

An association necessarily has a transfer service mechanism and may support a number of instances of the machine for local anticipation purposes at device level.

Machine: TS_SM_ACC

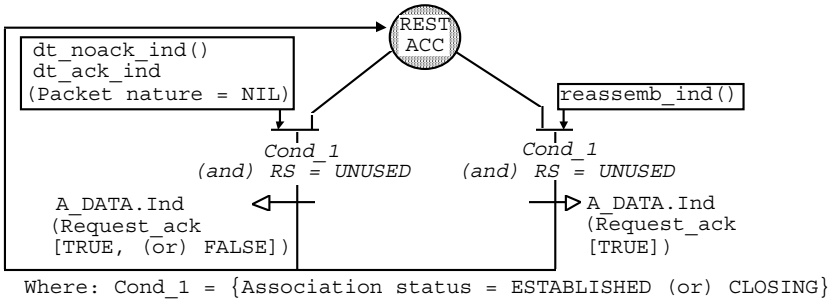


Figure 25 – Transfer service: Acceptor element state machine

d) Description of mechanism:

As soon as another RS_SM or AT_SM_ACC, or ATAK_SM_ACC machine signals receiving the data transfer, this indication is accounted for depending on the value of the global variables of the association.

Its accounting for involves returning an A_DATA.ind(Request_ack) data transfer indication to the user. In the case where an association implements reassembly, the parameter "Request_ack" can only take the value TRUE.

10.2.5.4 Unacknowledged transfer (AT_SM)

10.2.5.4.1 General

In unacknowledged associated mode data transfer, the machine consists of two parts, one relating to the requester and the other to the acceptor.

10.2.5.4.2 Requester element (AT_SM_RQ)

The requester element is that which causes sending of a data transfer request in an association.

a) For the unacknowledged transfer requester element, the following events and conditions are accounted for:

- dt_noack_rq(),
- L_MSG_XX.cnf(+/-) (see IEC 61158-3-7, Type 7).

b) The actions carried out by this requester element are the following:

- L_MSG_XX.rq(ATRQ[noack]) (see IEC 61158-3-7, Type 7),
- dt_noack_cnf(+/-).

c) Requester element mechanism (see Figure 26):

An association in which it is possible to implement the non-acknowledged data transfer machine may support a number of instances of this machine for local anticipation purposes at device level.

Machine: AT_SM_RQ

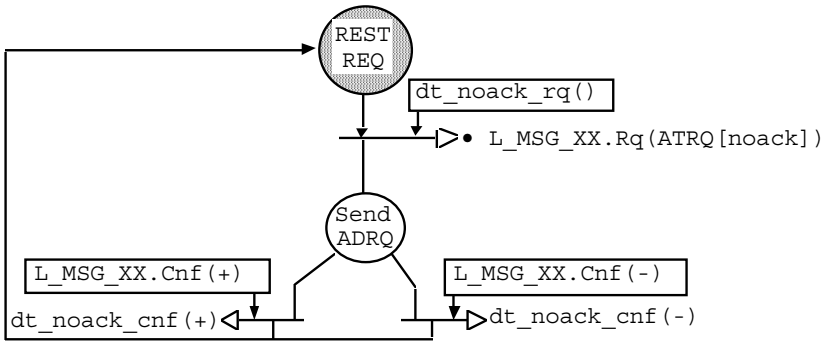


Figure 26 – Unacknowledged transfer: Requester element state machine

d) Description of mechanism:

As soon as a call is made to this machine with dt_noack_rq, an ATRQ data transfer which does not contain an acknowledgement request is sent.

Whatever the results of sending, the mechanism returns to its initial status.

NOTE Sending errors may be accounted for by equipment fault management.

10.2.5.4.3 Acceptor element (AT_SM_ACC)

The acceptor element is that which receives a data transfer with no reception acknowledgement requests and which transfers it to the user.

a) For this element, the following events and conditions are accounted for:

L_MSG_XX.ind(ATRQ[noack]) (see IEC 61158-3-7, Type 7).

b) The following actions are carried out by this acceptor element:

- dt_noack_ind()

c) Acceptor element mechanism (see Figure 27):

An association in which it is possible to implement the non-acknowledged data transfer procedure may support a number of instances of this machine for local anticipation purposes at device level.

Machine: AT_SM_ACC

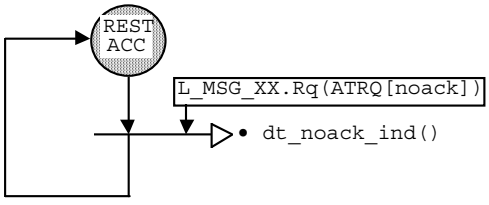


Figure 27 – Unacknowledged transfer: Acceptor element state machine

d) Description of mechanism:

As soon as an L_MSG_XX.ind() link service is invoked, the data of which correspond to an ATRQ without an acknowledgement request, a dt_noack_ind signal is given.

10.2.5.5 Acknowledged transfer (ATAK_SM)

10.2.5.5.1 General

The acknowledged associated mode data transfer machine consists of two parts, one relating to the requester and the other to the acceptor.

10.2.5.5.2 Requester element (ATAK_SM_RQ)

The requester element is that which causes transmission of a data transfer request and receives the corresponding acknowledgement in an association. See Figure 28.

a) For this requester element, the events and conditions accounted for are the following:

- dt_ack_rq(Packet nature), where Packet nature = STT, (or) MID, (or) END, (or) ALL, (or) NIL.

  Packet nature NIL is used when this requester element is invoked outside segmentation.

- L_MSG_XX.cnf(+/-) (see IEC 61158-3-7, Type 7)
- L_MSG.XX.ind(ATAK[Packet_num])
- acknowledgement time-out
- retry_cnf(+/-) (see 10.2.5.6)
- revocation AT_SM_RQ
- RC = USED (or) UNUSED
- SN = Packet_num
- (SN) between (FSN,LSN) = TRUE

b) The following actions are carried out by this requester element:

- SN = Take number (see 10.2.5.5.4)
- L_MSG_XX.rq(ATRQ[ack]) (see IEC 61158-3-7, Type 7)
- resetting of acknowledgement time-out
- retry_rq() (see10.2.5.6)
- dt_ack_cnf(+/-
- free(SN)
- retry revocation

c) Request element mechanism:

For an association in which it is possible to implement the data transfer mechanism with acknowledgement, the number of instances of the machine which can be implemented simultaneously both at calling entity and called entity level is linked to the value of the anticipation factor and the value of the anticipation credit. The anticipation can be implemented simultaneously both at calling entity and called entity level is linked to the value of the anticipation factor and the value of the anticipation credit. The anticipation factor determines the greatest possible number and the credit establishes the greatest instantaneous number on the basis of constraints associated with the retry and antiduplication mechanism designed to increase transmission reliability.

Machine: ATAK_SM_RQ

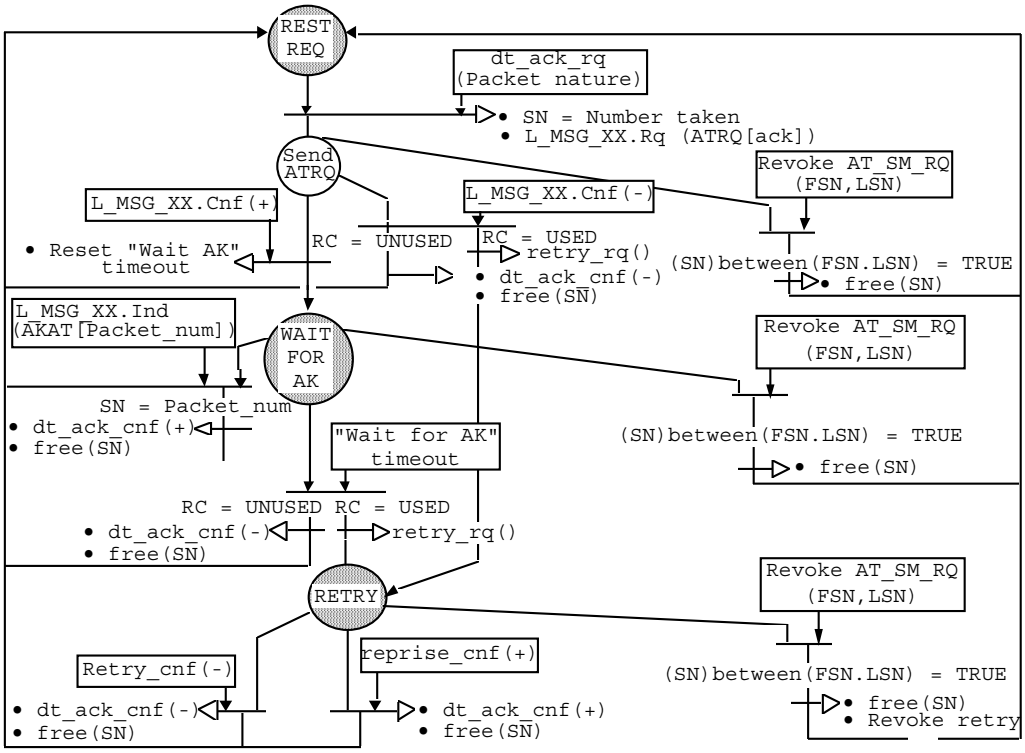


Figure 28 – Acknowledged transfer: Requester element state machine

d) Description of mechanism:

As soon as the unacknowledged data transfer request is made, an ATRQ containing an acknowledgement request is sent.

The “Packet nature” parameter contains values STT, MID, END and ALL if filled in by the segmentation machine and NIL otherwise. This parameter is coded in the ATRQ.

If the result of sending return by the data link layer is positive, an acknowledgement time-out is begun. The state is one of waiting for acknowledgement, which either arrives, in which case the mechanism returns to its initial state, or the acknowledgement time-out expires and a retry may take place before returning to the same initial status.

Furthermore, if after a transfer request, the data link level returns a negative result, a retry is immediately requested if the latter is utilised.

Any invoking of this machine involves taking a sequence number from the global numbering machine of the association. This is stored in the “SN” variable throughout its lifetime. Finally, any event leading to the revocation of an invocation, whether completed normally or abnormally, results in freeing of the sequence number to manage the value of the lowest sequence number (LSNS) still current in the association.

Finally, as soon as an instantiation of this mechanism is in another state than “REST-REQ”, it can be reinitialised at a “Revocation AT_SM_RQ” request from the segmentation mechanism.

10.2.5.5.3 Acceptor element (ATAK_SM_ACC)

The acceptor element is that which receives the data transfer and the acknowledgement in an association. See Figure 29.

a) For this acceptor element, the following events and conditions are taken into account:

- L_MSG_XX.ind(ATRQ[ack]) (see IEC 61158-3-7, Type 7)

antiduplication_cnf(Message), where Message = REPETITION, (or) NEW

- L_MSG_XX.cnf(+/-) (see IEC 61158-3-7, Type 7)
- DU = USED, (or) UNUSED

b) The actions carried out by this acceptor element are the following:

- antiduplication_rq(Sequence number), Sequence number has the value derived from ATRQ[ack]
- L_MSG_XX.rq(AKAT) (see IEC 61158-3-7, Type 7)
- dt_ack_ind(Sequence number; Packet nature) where Packet nature has the value derived from the ATRQ received and Packet nature = STT, (or) MID, (or) END, (or) ALL, (or) NIL (see 10.2.5.5.2).

c) Acceptor element mechanism:

An association in which it is possible to implement the data transfer procedure may support a number of instances of this machine for local anticipation purposes at device level.

Machine: ATAK_SM_ACC

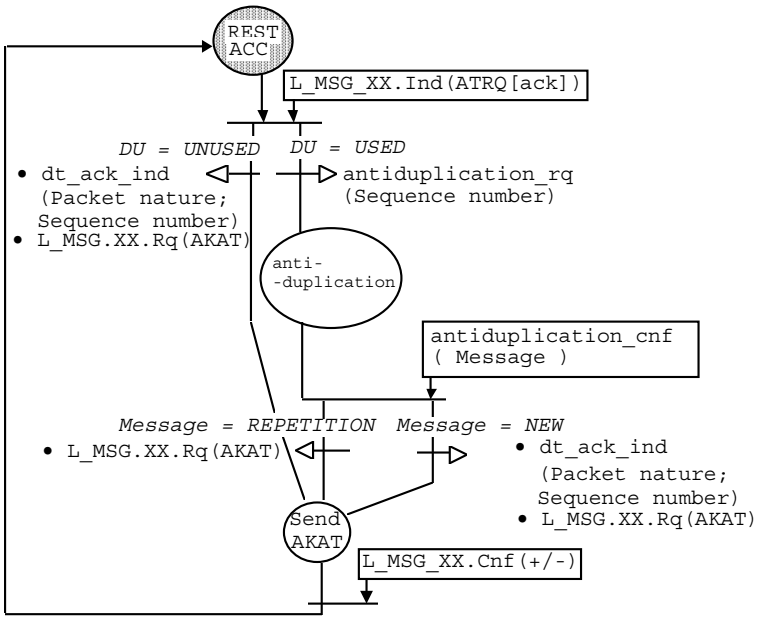


Figure 29 – Acknowledged transfer: Acceptor element state machine

d) Description of mechanism:

As soon as the L_MSG_XX.ind primitive is invoked, with data which corresponds to an ATRQ with acknowledgement request, a condition is evaluated before proceeding with sending an acknowledgement, and return of the message. This condition concerns the fact that antiduplication is implemented in the association.

If this is adopted, depending on whether it considers the message as NEW or as a REPETITION, it is or is not returned.

In all cases, an acknowledgement is returned to the data transfer sender, containing a sequence number which is equal to that of the data transfer acknowledged.

Finally, whether or not sending of the transmission fails at link level, the mechanism returns to its initial state.

10.2.5.5.4 Numbering (NB_SM)

On using the data transfer service with acknowledgement in an association, the numbering element is implemented to manage allocation of sequence numbers (SN). The values of this number are transited together with the data in the transfers using the ATRQ type PDU, and

which are also found in the respectively associated acknowledgements, of which the PDU is of the AKAT type. See Figure 30.

In addition, the state machines implemented at requester and acceptor levels, for acknowledged data transfers, retain this number during their lifetime to make them identifiable by the protocol in the context of the association.

Furthermore, this machine manages freeing of the sequence numbers. Freeing takes place each time a data transfer with acknowledgement terminates normally or abnormally. This management system makes it possible to update the value of the LSNS variable.

a) This mechanism accounts for the following events and conditions:

- "Take number"
- A_ASSOCIATE.rp(+), (or) A_ASSOCIATE. cnf(+)
- A_RELEASE.rp(+), or A_RELEASE.cnf(+), or A_ABORT.ind()
- free(SN).

b) The actions triggered by this mechanism are the following:

- CN = success(CN)
- LSNS management
- ma_rq()
- LSNS = CN = 0
- LACT[i] = Not received, when 0≤i≤Max.

c) Mechanism:

There is a single instance of this mechanism per association at calling entity level and at called entity level. This mechanism shall necessarily exist at the level of one association if the latter supports data transfer with acknowledgement.

Machine: NB_SM

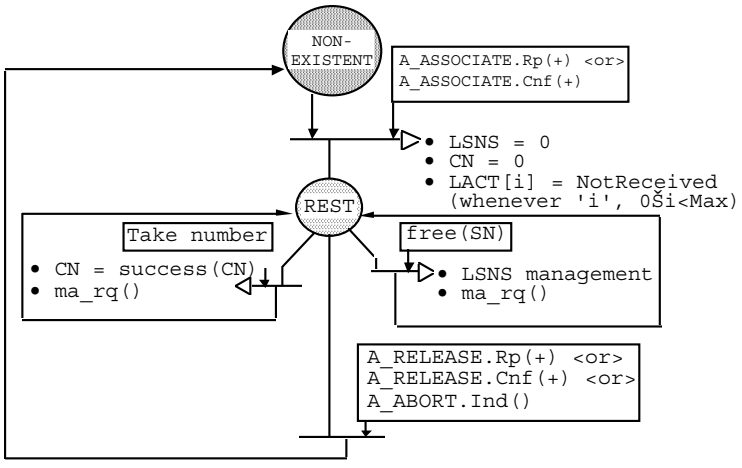


Figure 30 – Numbering mechanism state machine

d)

Description of mechanism:

A numbering entity (NB_SM) is instantiated and utilised on opening an association. Whenever the "Take number" function is invoked by another mechanism causing reading of the value followed by incrementation. The value taken is used to identify an

acknowledged data transfer. In addition, this value circulates in the acknowledged data transfer PDUs but also in the associated acknowledgement.

Whenever the free function (SN) is invoked by another mechanism management of the LSNS variable takes place. Management of the LSNS is based on a list LACT[i] containing "Max" elements (see 10.2.5.2.2) and proceeds to the following operations:

– if SN≠LSNS, then account for the reception by setting LACT[SN]=Received,

– if SN=LSNS, then repeat LSNS=success(LSNS) and LACT[SN]=Not received until LACT[LSNS]≠Not received.

10.2.5.6 Retry (RC_SM)

On using the data transfer service with acknowledgement in an association, the retry element can be implemented if adopted in the association. See Figure 31.

This element can only be implemented conjointly with that of antiduplication (10.2.5.7).

This element makes it possible to reiterate, a number of times, a data transfer with acknowledgement in the event of absence of receiving an acknowledgement after a specified time limit has elapsed.

a) The following events and conditions are accounted for by this mechanism:

- retry_rq()
- Acknowledgement time-out
- Counter: retry counter
- Rpmax: maximum value of retry counter adopted for the association
- L_MSG_XX.cnf(+/-) (see IEC 61158-3-7, Type 7)
- L_MSG_XX.ind(AKAT) (see IEC 61158-3-7, Type 7)
- Retry revocation.

b) The following actions are triggered by this mechanism:

- retry.cnf(+/-)
- L_MSG_XX.rq(ATRQ) (see IEC 61158-3-7, Type 7)
- Incrementation of counter
- Starting of "Wait for AK" time-out.

c) Mechanism:

There is one instance of this mechanism per request for data transfer with acknowledgement being retried. Each of these mechanisms has its own current counter value (Counter). As for the maximum value of the retry counter (Rpmax), it is that which is specific to the association in which it is implemented.

Machine: RC_SM

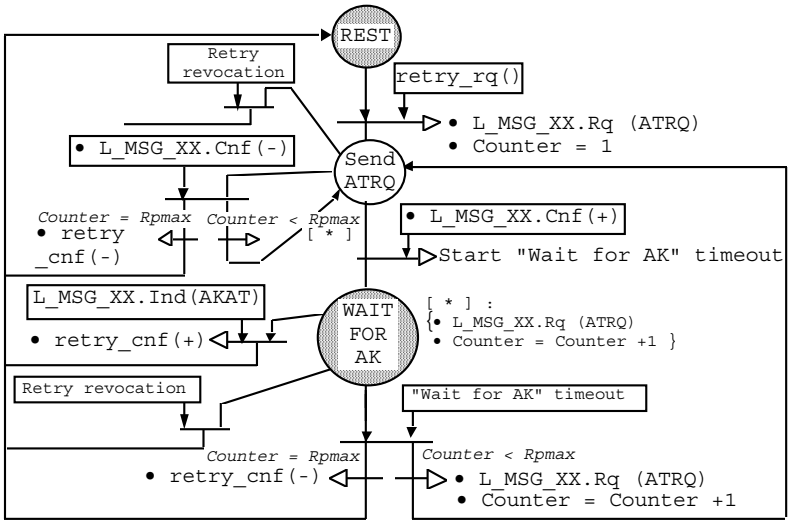


Figure 31 – Retry machanism state machine

d) Description of mechanism:

This mechanism simply proceeds with resending a data transfer within the limit of the maximum number set per association, knowing that a first transmission has already taken place.

Resending takes place in the event of negative confirmation by the data link layer or in the event of positive confirmation if the acknowledgement arrives after the time interval during which it is expected.

10.2.5.7 Antiduplication (DU_SM)

During data transfers with acknowledgement in an association, the antiduplication element is implemented if adopted in the association. It is used conjointly with the retry element (see 10.2.5.6).

This element makes it possible to detect, at acceptor level, an ATRQ which has already been the subject of a data transfer with acknowledgement, as a number of repetitions of the same ATRQ can occur after a transmission fault.

a) The following events are accounted for by this mechanism:

– antiduplication_rq(Sequence number)

NOTE The acknowledged data transfer acceptor mechanism which invokes this mechanism transits the sequence number available to the ATRQ for which it wants to make an antiduplication check.

b) The following actions are triggered by this mechanism:

– antiduplication_cnf(Message), where Message = REPETITION or NEW.

c) Mechanism:

There is a single instance of this mechanism per association at calling entity and called entity level.

This antiduplication mechanism is purely transformational and there is therefore no state machine but simply a description of the data and processing associated with it.

- Data description:

The processing is based on an “antiduplication list” containing information concerning the latest data transfers with acknowledgement which have taken place.

This antiduplication list is an LAD[i] structure table in which the number of elements is equal to the anticipation factor adopted for the association, and of which each structure features a sequence number and reception status associated with the transfer LAD[i] = (sn[i], Etr[i]).

At any given moment, the first element in the table has a sequence number that was the greatest (HSNA) of those received in the ATRQs for which the antiduplication mechanism was invoked. Consequently, this first element necessarily has reception status value YES.

The other elements contain successively smaller sequence numbers and a reception status with a value of YES or NO depending on whether the antiduplication mechanism has been invoked or not.

NOTE It is important to understand that the value of the sequence number allocated by the numbering element increases as modulo 2exp(n) where n=16, in view of 16-bit representation of the sequence number in the PDUs. See Table 25.

Table 25 – Structure of the antiduplication list

Sequence number	Reception status
sn(1)	YES
sn(2) where, dist(sn(1),sn(2))=1	YES/NO
sn(3) where, dist(sn(1),sn(3))=2	YES/NO
sn(a) where, dist(sn(1),sn(a))=a-1	YES/NO

- Processing description:

When the mechanism is invoked with antiduplication_rq(Sequence number), the value of the parameter SN sequence number governs the processing:

- When sn belongs to the antiduplication list, the nature of the processing in accordance with the value of the reception status associated with it in the list is as follows:
- if reception status is NO, it is set to YES and the message is considered as NEW,
- if reception status is YES, it stays at YES and the message is considered as a REPETITION.
- When it does not belong to the antiduplication list, it is considered to be new and the processing consists in offsetting the elements in the antiduplication list so that the value of sn(1) corresponds to the received SN sequence number.

  The processing consists of three stages, after assessment of the distance N = dist(SN,sn(1)).

- if N<a, then for the elements in the LAD[i] list, where i decreases from a to N+1, make LAD[i] = LAD[i-N]. This constitutes shifting the elements of the structure by N cells.
- when i increases from 2 to Min(N,a), make sn[i] = M so that dist(SN,M) = i-1 and Etr[i] = NO. It is a question of setting to not received the reception status associated with the sequence numbers contained exclusively within the values of sn(1) and SN.
- make sn(1) = SN, and Etr(1) = YES. It is a question of setting the first element of the list to received.

10.2.5.8 Anticipation (MA_SM)

10.2.5.8.1 General

During transfer of data with acknowledgement in an association, the anticipation element is implemented if adopted in the association.

This element monitors the traffic in the association.

10.2.5.8.2 Requirements

Anticipation relates to transfers of data with acknowledgement in an association. It makes it possible to envisage commitment of a new acknowledged transfer when the acknowledgement of other current transfers has not yet arrived. This makes it possible to optimise the pass-band by multiplexing the data transfers and acknowledgements on the bus.

The anticipation possibilities offered by an association are linked both to the anticipation factor which characterises the association and to the anticipation credit which may temporarily reduce them.

10.2.5.8.3 Anticipation factor

Anticipation factor “a” corresponds to the maximum number of transfers which can be awaiting acknowledgement.

The anticipation factor “a” specific to each direction of transmission in an association establishes both:

– the maximum number of acceptor and requester elements for data transfer with acknowledgement which can be invoked simultaneously,
– and the size of the antiduplication list necessary at the acceptor in the event of implementation of retry and antiduplication.

10.2.5.8.4 Anticipation credit

The anticipation credit which is specific to each end of the association, establishes its capacity whether or not to allow invocation of new requester elements of data transfer with acknowledgement within the limits of the anticipation factor. See Figure 32.

The anticipation credit (AC) is characterised by two values:

– FREE, if it is possible to invoke an acknowledged data transfer requester element,
– BUSY, if it is temporarily impossible to invoke a requester element.

Anticipation credit changes between states depending on the following events:

– ma_rq()

Anticipation credit changes make allowance for two other variables:

– LSNS: the lowest sequence number attributed to an ATRQ sent and awaiting acknowledgement (Lowest Sequence Number Send),
– CN: the current value of the numbering entity for transfer of data with acknowledgement.

Machine: MA_SM

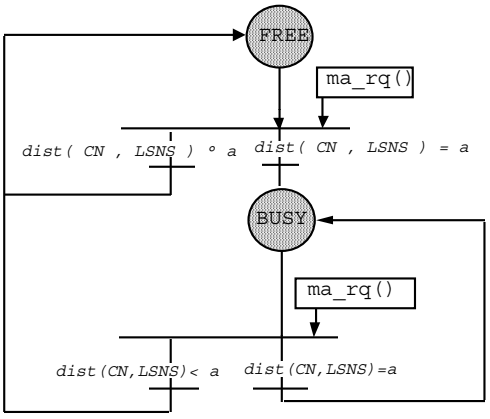


Figure 32 – Anticipation mechanism state machine

10.2.5.8.5 Optimum performance

For the anticipation factor adopted for a given association to constitute the optimum as regards the traffic adopted for it, it shall allow for the following factors:

– ensuring best use of the traffic adopted for the association.

NOTE 1 If it is too large, the maximum number of instances will never be reached, and if it is too low the pass-band will be wasted.

– ensure that the time necessary for chaining the maximum number of retries will be close to that necessary for passing the anticipation traffic.

NOTE 2 This ensures that the data transfer requester user will not be unable to access the association due to using up the anticipation credit by the current repetitions.

As for the user of the acknowledged data transfer service, it will choose an anticipation factor and a traffic which corresponds to these requirements in terms of:

– the capacity to relay a number of data transfer requests (A_DATA) in a given time.

NOTE 3 In the MMS environment, this capacity integrates both the “Outstanding” services and the time taken for execution of the services by the VMD.

– data transfer size, which in the case of segmentation implements a number of MCS transfers for different packets.

10.2.5.9 Segmentation (SG_SM)

A segmentation element can be implemented on an association. This element makes it possible to divide the data unit (SDU) associated with a data transfer service into one or more packets depending on its size, and to manage the acknowledged exchange of the different packets. The implementation of this element at data transfer initiator level is only possible conjointly with that of reassembly at receptor level. See Figure 33.

Global variables utilised by this mechanism:

– AC (Anticipation Credit), global for all association mechanisms,

– SA (Service Access) global for all association mechanisms,

– LSNS (Last Smallest Sequence Number), the smaller sequence number attributed to a transfer currently exchanged.

Local variables of the mechanism:

– PN (Packet Number), the number of packets of an SDU remaining to be sent,

– LSN (Last Sequence Number), the sequence number of the next lowest value, in the modulo sense, to that attributed to the latest packet.

– FSN (First Sequence Number), the sequence number attributed to the first packet arising from segmentation,

– Count_ack, the received acknowledgement counter, relating to transfer of packets of a service.

a) This mechanism accounts for the following events and conditions:

  – segment_rq(),
  – “End of division (n)”, resulting from the division operation, where parameter (n) is the number of packets obtained,
  – Always, permanent event to indicate that the transition is receptive at all times,
  – dt_ack_cnf(+/-),
  – AC = FREE, to account for the end of sending of packets belonging to the same SDU, or otherwise to indicate whether the packet is the last or not,
  – PN > 1; PN = 1; PN = 0; to test for the end of sending of packages belonging to the same SDU, or otherwise to indicate whether the packet is the last or not,
  – Count_ack = n, to verify that all the acknowledgements associated with the packets of a service have been received.

b) The following actions are triggered by this mechanism:

  – Setting SA to BUSY or FREE,
  – “SDU division request”,
  – PN = n; initialisation of PN at value n of the number of packets resulting from division of the SDU,
  – Packet nature = STT; for the first packet of a segmentation, or ALL if the number of packets arising from subdivision is 1,
  – FSN=CN and LSN=x so that dist(x,CN)=n; initialisation of the variables FSN and LSN,
  – Count_ack = 0, initialisation at zero of the acknowledgement counter,
  – Count_ack = Count_ack+1, incrementation of the acknowledgement counter,
  – dt_ack_rq(Packet nature), where Packet nature = MID, END,
  – PN=PN-1; decrementation of the number of packets remained to be sent,
  – Packet number = MID or END, depending on whether it is the last packet or not,
  – segment_cnf(+/-),
  – AT_SM_RQ revocation; revocation of all ATAK_SM_RQ machines of which the associated sequence number is between LSN (value excluded) and FSN (value included). It being impossible to transmit one of these packets, the operation becomes globally impossible and results in interruption of transmission of the packets not yet sent. Thus, the lowest sequence number during transmission (LSNS), will necessarily change to a value equal or greater than LSN.

NOTE 1 Revocation of the ATAK_SM_RQ is atomic with regard to the lifetime of all the machines of the association.

c) Mechanism:

  For an association in which it is possible to implement segmentation, the number of instances is bounded by the maximum anticipation value specified in the association. Indeed, the number of possible instances is equal to the maximum anticipation if the SDUs exchanged only call a single packet, and otherwise less.

NOTE 2 The average number of instances of this mechanism in an association is equal to the maximum anticipation (a) divided by the average number of packets necessary for exchange of a service.

Machine: SG_SM

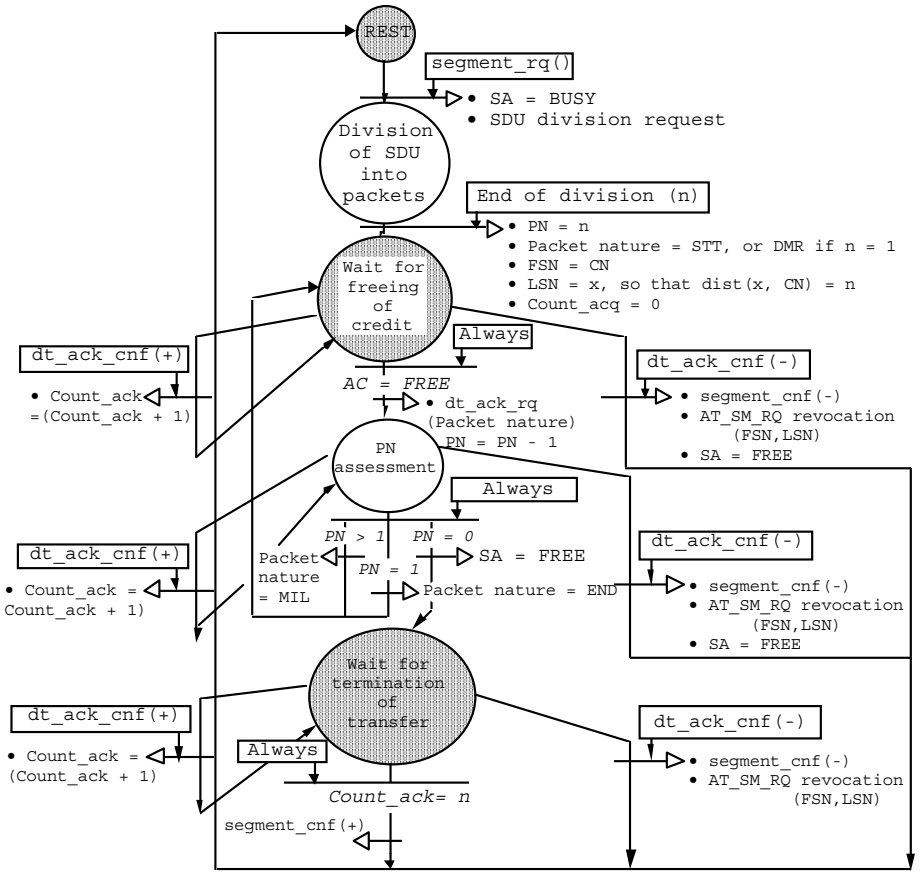


Figure 33 – Segmentation mechanism state machine

NOTE 3 The various mechanisms which can be implemented in an association can, in some cases, operate in parallel. It is therefore necessary to specify that after crossing of a transition, a mechanism retains the new target status until all the actions induced by the transition are terminated. Thus the SG_SM machine retains "PN assessment" status as long as dt_ack_rq(), then number taking, then ma_rq() have not been accounted for by machines ATAK_SM_RQ, NB_SM and MA_SM respectively.

d) Description of mechanism:

As soon as a data transfer service segmentation request is made, service access (SA) is inhibited until all the packets are assigned to an acknowledged data transfer machine. Service access is then freed, allowing new segmentation requests to be accounted for, even if transfer of the packets of the preceding request is not terminated.

Segmentation request processing always begins with division of the MCS-SDU into n packets, starting at the beginning. The different packets are the subject of individual acknowledged transfer. The first packet resulting from division is attributed packet nature STT (or ALL if the MCS-SDU is contained in a single packet) and an FSN sequence number. The following packets have a packet nature of MID, except for the last which has a packet nature of END.

During transmission of the different packets associated with the segmentation of the service, the segmentation machine passes the packets one by one as the acknowledged transfer machine invocations are freed. The availability of acknowledged data transfer machines can be monitored using anticipation credit value FREE.

In addition, if a transmission failure is detected by an acknowledged transfer machine, sending of the remaining packets to be sent is suspended and revocation of the acknowledged transfer machine is effected for each packet in the process of being transferred. This suspension makes it possible to immediately free transfer machines which become available for other SDU exchanges. The acknowledged transfer positive confirmation primitives are counted to detect determination of the transfer of all the packets, and in order to obtain positive confirmation of the segmentation request.

10.2.5.10 Reassembly (RS_SM)

A reassembly element can be implemented in an association. This element makes it possible to reconstitute the data associated with a data transfer service which has been received in a number of packets. Implementation of this element at data transfer receiver level can only be carried out conjointly with that of segmentation at initiator level.

This reassembly element is both reactive and transformational, it is consequently necessary to provide a state machine and describe the associated processing. See Figure 34.

a) Description of variables specific to the mechanism:

The data specific to this mechanism can be represented by a reassembly list as shown in Table 26. This reassembly list is an LR[i] structure table, in which the number of elements is equal to (a+s), where “a” is the association anticipation factor and “s” is the maximum number of MCS-PDUs for an MCS-SDU, in the context of an association. All structures of the table include a sequence number, the packet reassembly status associated with the sequence number as well as the packet nature LR[i] = (sn[i], Etrs[i] and NatP[i]).

Reassembly status can be either:

– UNAVAILABLE, if the packet has not been received and therefore not restored to the user,
– AVAILABLE, if the packet has been received.

The packet nature is either:

– STT, first packet of SDU,
– MID, for intermediate packets of the SDU,
– END, for the last packet of the SDU,

At any given time, the sequence number of the first element of the table is the largest of all those received and has a reassembly status value which is necessarily other than available.

Each of the other elements in the table has a sequence number which decreases by one modulo increment relative to that preceding it, and one of the two possible reassembly status values.

– ALL, for a packet containing the entire SDU.

NOTE The packet nature cannot have the value NIL in the reassembly machine case.

Table 26 – Structure of the reassembly list

Sequence number	Reassembly status	Packet nature
sn(1)	AVAILABLE	STT/MID/END/ALL
sn(2) such that dist(sn(1), sn(2)) = 1	AVAIL/UNAVAIL	STT/MID/END/ALL
……	……	……
sn(a) such that dist(sn(1), sn(a)) = a-1	AVAIL/UNAVAIL	STT/MID/END/ALL
sn(a+1) such that dist(sn(1), sn(a+1)) = a	AVAIL/UNAVAIL	STT/MID/END/ALL
……	……	……
sn(a+s) such that dist(sn(1), sn(a+s)) = a+s-1	AVAIL/UNAVAIL	STT/MID/END/ALL

b) The following events and conditions are accounted for by the mechanism:

– dt_ack_ind(Packet nature, NS).
– “End of update”, “End of shift”, “End of operation”, corresponding to termination of the operations.

- Packet nature ≠ NIL (and) SN do not belong to “Reassembly list”, so as to be able to ascertain that the packet does in fact originate from a segmentation machine and that the sequence number belongs to the antiduplication window.
- Packet nature ≠ NIL (and) SN do not belong to “Reassembly list”, so as to consider a sequence number greater than those received to date.
- Packet nature = END (or) ALL, possibility of detecting an entire message.
- Packet nature = STT (or) MID, impossible to detect an entire message.
- SDU = COMPLETE or INCOMPLETE, reception of all or not all of the packets of a transfer.

c) The following actions are triggered by the mechanism:

- Updating of “reassembly list”, “reassembly list” shift, “reassembly list” scanning, initiation of associated processing,
- reassemb_ind.

d) Mechanism:

For an association in which it is possible to implement reassembly, a single instance of this machine is necessary.

Machine: RS_SM

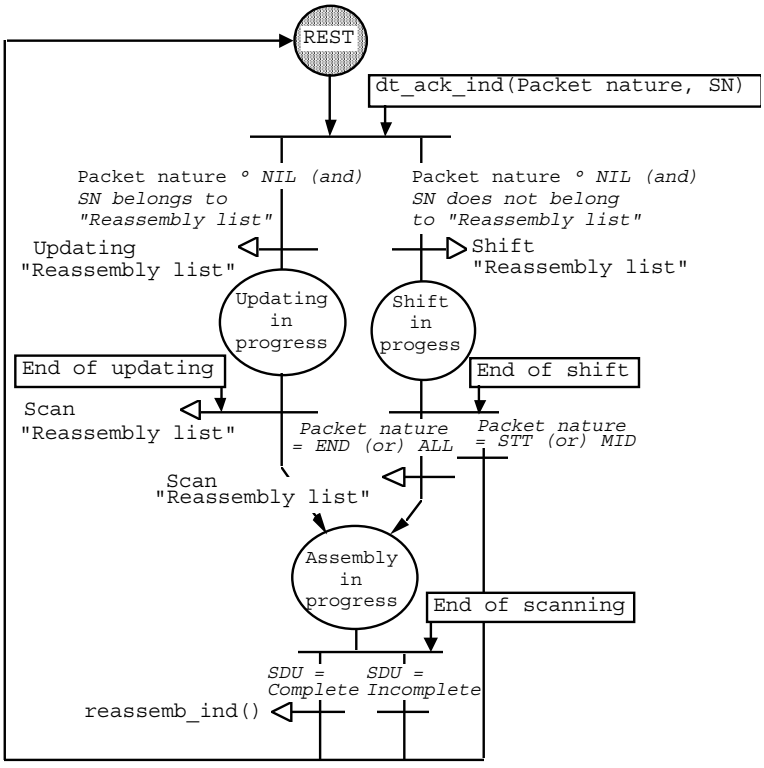


Figure 34 – Reassembly mechanism state machine

e) Description of mechanism:

When a packet is received, depending on whether or not its sequence number belongs to the reassembly list, “Update” or “Shift” processing is carried out on the reassembly list.

In the case where the assembly list shall be shifted whereas the packet nature is STT or MID, no further action is required. In all other cases, the list is scanned for complete SDUs, any found being restored to the user by a reassembly indication.

Description of the processing used by the machine:

- “Update”: Updating of the reassembly list consists of updating the “reassembly status” and “packet nature” fields of that element with the same sequence number as that received.

  This updating consists of setting the packet nature to STT, MID, END or ALL depending on the value received, and reassembly status to AVAILABLE.

NOTE 1 The reassembly machine cannot receive the same packet twice as prior filtering is carried out by the antiduplication machine.

- “Shift”: This processing consists of shifting the elements in the reassembly list so that the value of sn(1) corresponds to the SN sequence number received.

  This processing involves the following operations, after evaluation of distance N = dist(SN,sn(1)).

- if N<a+s, then for all the elements of all the LR[i] list, where i decreases from a+s to N+1, set LR[i] = LR[i-N]. This shifts the elements of the structure by N cells.
- where i increases from 2 to Min(N,a+s) set sn[i] = M so that dist(SN,M) = i-1 and Etrs[i] = UNAVAILABLE. This is a question of setting to UNAVAILABLE the reception status associated with the sequence numbers contained exclusively within the values of sn(1) and SN.
- set sn(1) = SN, and Etrs(1) = AVAILABLE, and NatP(1) = Packet nature. It is a question of setting the first element of the list to AVAILABLE while retaining its packet nature.
- “Scan”: Scanning consists of determining whether the packet received contains an ALL packet nature or scanning the reassembly list on either side of the packet received to find any series of consecutive numbers, marked available, bounded by two packets of packet natures END and STT respectively.
- This processing involves the following operations, after having identified m, such that sn(m) = SN:
- if NatP(m) m = ALL, reconstitute the SDU.
- if NatP(m) ≠ ALL, set j = m and Finexp = FALSE, then perform the following operations until Finexp ≠ FALSE or j = 0:
- if Etrs(j) = UNAVAILABLE, set Finexp = TRUE,
- if Etrs(j) = AVAILABLE and NatP(j) = END, then set Finexp = CONTINUE,
- j = j + 1.
- if Finexp = CONTINUE, set k = m, then perform the following operations until Finexp ≠ CONTINUE or k = a+s:
- k = k+1,
- if Etrs(k) = UNAVAILABLE, set Finexp = TRUE,
- if Etrs(k) = AVAILABLE and NatP(k) = STT, then set Finexp = TRUE, reconstitute the SDU.

NOTE 2 The numbers of the first and last packet of the SDU are k and j+1 respectively.

10.2.6 Non-associated mode data transfer

10.2.6.1 General

Two protocol procedures can be implemented in the context of non-associated mode data transfer, depending on whether or not acknowledgement is requested. See Figure 35.

NOTE Non-associated mode data transfer mechanisms do not feature retry and antiduplication or segmentation and reassembly.

The following state machines are defined:

– NT_SM_RQ, NT_SM_ACC:

  Non-associated mode unacknowledged transfer machine for requester and acceptor.

– NTAK_SM_RQ, NTAK_SM_ACC:

  Non-associated mode acknowledged transfer machine for requester and acceptor.

In the non-associated mode, the state machines concerned with these transfers interact with both:

– the other application service elements available to the application entity. These are carried out by local identification,
– and the data link layer in the case where an ADAE type link address pair localises the pair of application entities communicating.

The following diagram shows all the state machines implemented by the non-associated transfers at the level of an application entity, and situates them relative to associated transfers of the same entity.

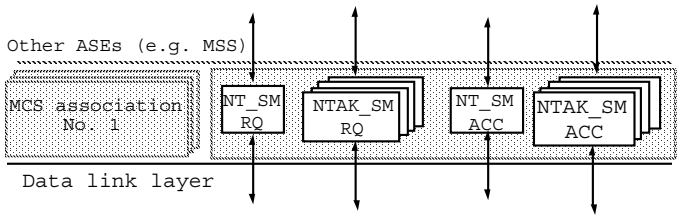


Figure 35 – Interaction of state machine in a non associated data transfer

This shows that an application entity can have a number of associations possessing their own machines, as well as a set of machines delegated to non-associated transfers which are shared by all the corresponding entities.

10.2.6.2 Unacknowledged transfer (NT_SM)

10.2.6.2.1 General

The unacknowledged non-associated mode data transfer procedure consists of two parts, relating to the requester and the acceptor respectively.

10.2.6.2.2 Requester element (NT_SM_RQ)

The requester element is that which causes the sending of a data transfer request from an application entity to a destination in another application entity. See Figure 36.

a) The following events and conditions are accounted for:

   – A_UNIDATA.rq (Request_ack), Request_ack = FALSE.
   – L_MSG_XX.cnf(+/-) (See IEC 61158-3-7, Type-7)

b) The following actions are performed:

   – L_MSG_XX.rq(NTRQ[noack]) (See IEC 61158-3-7, Type-7)
   – A_UNIDATA.cnf(+/-).

c) Mechanism:

   An application entity in which it is possible to implement the unacknowledged data transfer procedure supports one or possibly a number of instances of the mechanism for local anticipation purposes at device level.

   Machine: NT_SM_RQ

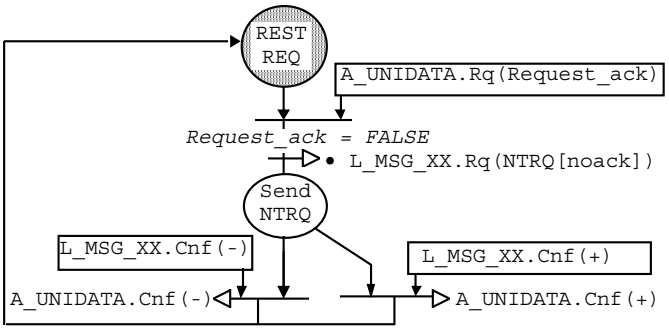


Figure 36 – Unacknowledged transfer: Requester element state machine

d) Description of mechanism:

As soon as an A_UNIDATA.rq(Request_ack) unacknowledged data transfer request is made where (Request_ack = FALSE) with a target application entity, a data transfer (NTRQ) is sent.

Whatever the results of the send, the mechanism returns to its initial state.

10.2.6.2.3 Acceptor element (NT_SM_ACC)

The acceptor element is that which receives a data transfer for which acknowledgement is not requested and transfers it to the user. See Figure 37.

a) The following events and conditions are accounted for:

– L_MSG_XX.ind(NTRQ[noack]) (See IEC 61158-3-7, Type-7)

b) The following actions are carried out by the acceptor element:

– A_UNIDATA.ind (Request_ack = FALSE)

c) Acceptor element mechanism:

An application entity in which it is possible to implement the unacknowledged data transfer procedure supports one or possibly a number of instances of the mechanism for local anticipation purposes.

Machine: NT_SM_ACC

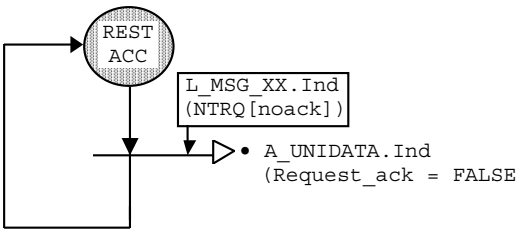


Figure 37 – Unacknowledged transfer: Acceptor element state machine

d) Description of mechanism:

On receiving an L_MSG_XX.ind() primitive whose data correspond to an NTRQ for which acknowledgement is not requested, when the application entity has the resources necessary for instantiation of the mechanism, the primitive A_UNIDATA.ind(Request_ack = FALSE) is invoked.

NOTE The resources associated with a mechanism are, indeed, shared between all the correspondents of the application entity.

10.2.6.3 Acknowledged transfer (NTAK_SM)

10.2.6.3.1 General

The acknowledged non-associated mode data transfer procedure consists of two parts, relating respectively to the requester and the acceptor.

10.2.6.3.2 Requester element (NTAK_SM_RQ)

The requester element is that which causes the sending of a data transfer request from one application entity to a destination in another application entity and which receives the corresponding acknowledgement. See Figure 38.

a) The following events and conditions are accounted for:

- A_UNIDATA.rq (Request_ack = TRUE),
- L_MSG_XX.cnf(+/-) (See IEC 61158-3-7, Type-7),
- reception of an AKNT in the data of the L_MSG_XX.ind primitive containing an acknowledgement request,
- acknowledgement time-out.

b) The following actions are carried out by the requester element:

- calling of the “Identification” function to assign an invocation identification to each transfer,
- L_MSG_XX.rq(NTRQ[ack]) (See IEC 61158-3-7, Type-7),
- starting of acknowledgement time-out,
- A_UNIDATA.cnf(+/-).

c) Requester element mechanism:

For an application entity in which it is possible to implement the acknowledged data transfer procedure, a number of instances of the mechanism can exist simultaneously with one or more per destination application entity.

Machine: NTAK_SM_RQ

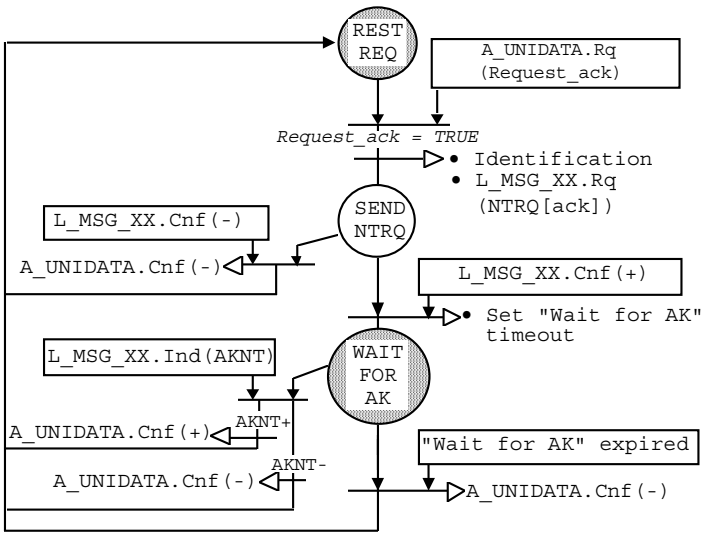


Figure 38 – Acknowledged transfer: Requester element state machine

d) Description of mechanism:

As soon as an acknowledged data transfer is requested, an NTRQ is sent.

When the result of the send returned by the data link layer is positive, an acknowledgement time-out is started. Either the expected acknowledgement arises and the mechanism returns to its initial state after returning a confirmation to the user which can be positive or negative depending on whether or not the acknowledgement received is positive, or the acknowledgement time-out expires and a negative confirmation is sent to the user.

10.2.6.3.3 Acceptor element (NTAK_SM_ACC)

The acceptor element is that which receives the data transfer and which sends the corresponding acknowledgement, and relays the data to the user. See Figure 39.

a) The following events and conditions are accounted for:

- L_MSG_XX.ind(NTRQ[ack]) (See IEC 61158-3-7, Type-7)
- L_MSG_XX.cnf(+/-) (See IEC 61158-3-7, Type-7)

b) The following actions are carried out by the requester element:

- L_MSG_XX.rq(AKNT[+/-]) (See IEC 61158-3-7, Type-7)
- A_UNIDATA.ind(Request_ack = TRUE)

c) Acceptor element mechanism:

For an entity in which it is possible to implement the acknowledged data transfer procedure, a number of instances of the machine can exist simultaneously with one or more per source entity.

Machine: NTAK_SM_ACC

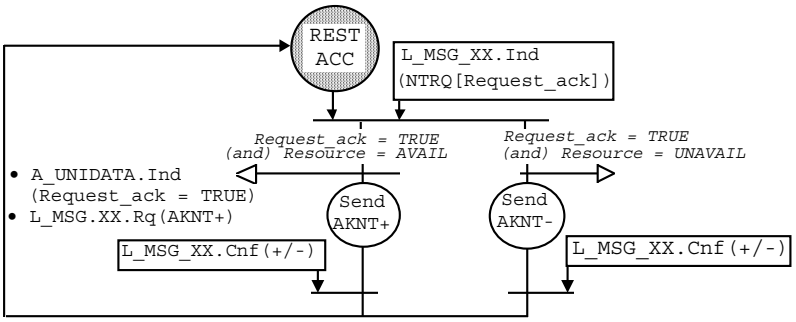


Figure 39 – Acknowledged transfer: Acceptor element state machine

d) Description of mechanism:

As soon as the L_MSG_XX.ind primitive, the data of which corresponds to an NTRQ with an acknowledgement request, the data transfer sender is returned an acknowledgement containing a sequence number equal to that of the acknowledged data transfer.

Depending on whether or not the message can be supplied to the user, the acknowledgement return is positive or negative. The various reasons preventing an application entity from returning data to the user are modelled by the resources not being available.

Finally, whether or not there is a failure during sending of the acknowledgement at link level, the mechanism returns to its initial state.

10.2.6.4 Invocation identification

When using the acknowledged data transfer service with a pair of application entities, the identification function supplies an invocation identification which transits with the data in the transfers using the NTRQ type PDU, and is also found in the corresponding acknowledgements of which the PDU is of the AKNT type.

There is a single instance of this mechanism per application entity. The value of the invocation identification is random, provided it makes it possible to discriminate between the different transfers pending acknowledgement in the same pair of application entities.

NOTE There is no special initial value or rules for changing the value of the invocation identification.

10.2.6.5 Anticipation

Multiple anticipation is authorised in the case of acknowledged data transfers, provided the resources are available at the requester and the acceptor.

11 Protocol options

11.1 Conformances classes

11.1.1 General

Conformance classes in AL define various levels of quality of service. These levels are qualified in terms of the services provided by a device and in terms of the supported mechanisms. Three series of parameters are use to define the conformance class. These characterize the horizontal, vertical and type conformance.

11.1.2 Vertical conformance

11.1.2.1 General

Vertical conformance describes the application level services supported by a device.

To define the device vertical conformance there are three independent parameters on which some constraints apply. A set of values of those parameters defines a vertical conformance block. Each parameter is representative of a functionality or group of functionalities provided by the application level services, and it has a set of values featuring the ability of the device to support these functionalities.

The values of those parameters are set in upward compatibility. So, a device supporting the services characterized by the parameter value **n** will also support all the functionalities provided by services characterized by values inferior to **n** of this same parameter.

For the AL TYPE 7application layer, the parameters are:

11.1.2.2 Read / write parameter: PV_R/W

This parameter defines the various read / write possibilities supported by the device depending on of the provided services. See Table 27. It can take the following values.

PV_R/W[1] Local write Service (Primitive A_WRITELOC)

PV_R/W[2] is equal to PV_R/W[1] plus local read Service (Primitive A_READLOC)

PV_R/W[3] is equal to PV_R/W[2] plus update Service (Primitive A_UPDATE)

PV_R/W[4] is equal to PV_R/W[3] plus remote read and write Services (Primitives A_READFAR plus A_WRITEFAR)

PV_R/W[5] is equal to PV_R/W[4] plus universal read and write Services (Primitives A_READ and A_WRITE).

Table 27 – PV_R/W parameter values

Parameter PV_R/W	1	2	3	4	5
A_WRITELOC	X	X	X	X	X
A_READLOC		X	X	X	X
A_UPDATE			X	X	X
A_WRITEFAR				X	X
A_READFAR				X	X
A_WRITE					X
A_READ					X

11.1.2.3 Indication parameter: PV_IND

This parameter defines the various possibilities of the indication services supported by the application layer. See Table 28. It can take the following values:

PV_IND[0] No indication service supported

PV_IND[1] Reception and transmission indication services (Primitives A_SENT and A_RECEIVED)

Table 28 – PV_IND parameter values

Parameter PV_IND	0	1
A_SENT		X
A_RECEIVED		X

11.1.2.4 List service parameter: PV_LIS

This parameter defines the access services to variable lists supported by the application layer. See Table 29.

PV_LIS[0] No list access services.

PV_LIS[1] Read variable list service (Primitive A_READLIST)

Table 29 – PV_LIS parameter values

Parameter PV_LIS	0	1
A_READLIST		X

11.1.2.5 Constraints on parameters

11.1.2.5.1 General

For each parameter, a table specifies the constraints by giving the minimum value of the other parameters to which this parameter is linked.

11.1.2.5.2 Parameter PV_R/W

No constraint.

11.1.2.5.3 Parameter PV_IND

No constraint.

11.1.2.5.4 Parameter PV_LIS

See Table 30 for the definitions.

Table 30 – Constraints on PV_LIS parameter

Constraints on PV_LIS	0	1
PV_R/W		PV_R/W[2]

11.1.2.5.5 Vertical Conformance parameters for Sub-MMS ASEs

The vertical parameters make it possible to specify the subset of primitives of services offered.

a) See Table 31 for the definitions of the associated mode data transfer parameter.

Table 31 – PV_AT parameter values

PV_AT	1	2	3	
A_ASSOCIATE			X	
A_ABORT			X	
A_DATA		X	X	

b) See Table 32 for the definitions of the association termination parameter.

Table 32 – PV_RE parameter values

PV_RE	1	2		
A_RELEASE		X		

c) See Table 33 for the definitions of the non-association mode data transfer parameter.

Table 33 – PV_UT parameter values

PV_UT	1	2		
A_UNIDATA		X		

See Table 34 for the expression of the constraints which remain between the various vertical parameters.

Table 34 – Constraints on PV_RE parameter

Constraints on PV_RE	1	2		
PV_AT		[3]		

11.1.3 Horizontal conformance

11.1.3.1 Asynchronous refreshment parameter: PH_R_A

This parameter, as shown in Table 35, describes the asynchronous refreshment status elaboration mechanisms that are supported by an information producer. It can take the following values:

PH_R_A[0] No asynchronous refreshment status is elaborated.

PH_R_A[1] A mechanism to elaborate the asynchronous refreshment status is implemented.

Table 35 – PH_R_A parameter values

Parameter PH_R_A	0	1
Asynchronous refreshment		X

11.1.3.2 Synchronous refreshment parameter: PH_R_S

This parameter, as shown in Table 36, describes the synchronous refreshment status elaboration mechanisms that are supported by an information producer. It can take the following values:

PH_R_S[0] No synchronous refreshment status is elaborated.

PH_R_S[1] A mechanism to elaborate the synchronous refreshment status is implemented.

Table 36 – PH_R_S parameter values

Parameter PH_R_S	0	1
Synchronous refreshment		X

11.1.3.3 Punctual refreshment parameter: PH_R_P

This parameter, as shown in Table 37, describes the punctual refreshment status elaboration mechanisms, supported by the application layer of an information producer. It can take the following values:

PH_R_P[0] No punctual refreshment status is elaborated.

PH_R_P[1] A mechanism to elaborate the punctual refreshment status is implemented.

Table 37 – PH_R_P parameter values

Parameter PH_R_P	0	1
Punctual refreshment		X

11.1.3.4 Asynchronous promptness parameter: PH_P_A

This parameter, as shown in Table 38, describes the asynchronous promptness status elaboration mechanisms that are supported by an information producer. It can take the following values:

PH_P_A[0] No asynchronous promptness status is elaborated.

PH_P_A[1] A mechanism to elaborate the asynchronous promptness status is implemented.

Table 38 – PH_P_A parameter values

Parameter PH_P_A	0	1
Asynchronous promptness		X

11.1.3.5 Synchronous promptness parameter: PH_P_S

This parameter, as shown in Table 39, describes the synchronous promptness status elaboration mechanisms that are supported by an information producer. It can take the following values:

PH_P_S[0] No synchronous promptness status is elaborated.

PH_P_S[1] A mechanism to elaborate the synchronous promptness status is implemented.

Table 39 – PH_P_S parameter values

Parameter PH_P_S	0	1
Synchronous promptness		X

11.1.3.6 Punctual promptness parameter: PH_P_P

This parameter, as shown in Table 40, describes the variable punctual promptness status elaboration mechanisms supported by the application layer of an information consumer. It can take the following values:

PH_P_P[0] No punctual promptness status is elaborated.

PH_P_P[1] A mechanism to elaborate the punctual promptness status is implemented.

Table 40 – PH_P_P parameter values

Parameter PH_P_P	0	1
Punctual promptness		X

11.1.3.7 Variables list consistency parameter: PH_COH

This parameter, as shown in Table 41, describes the various production or transmission status elaboration mechanisms associated with a variable list at the level of a consumer entity. It can take the following values:

PH_COH[0] No consistency mechanism is supported

PH_COH[1] Consistency status elaboration mechanisms implemented

Table 41 – PH_COH parameter values

Parameter PH_COH	0	1
Consistency		X

11.1.3.8 List reliability parameter: PH_FIA

This parameter, as shown in Table 42, describes the various mechanisms supported to make the variable transmission reliable at the consuming application entity level.

PH_FIA[0] No reliability mechanism is supported

PH_FIA[1] List recovery mechanism implemented

Table 42 – PH_FIA parameter values

Parameter PH_FIA	0	1
Recovery		X

11.1.3.9 Transitory spatial consistency status: PH_SPF

This parameter, as shown in Table 43, describes the elaboration mechanism of the contents of the produced consistency variable. This variable is used in the elaboration of the transitory spatial consistency status of the lists of variables at the consumer application entity level.

PH_SPF[0] No transitory spatial consistency mechanism is supported

PH_SPF[1] A mechanism of transitory spatial consistency on lists is implemented

Table 43 – PH_SPF parameter values

Parameter PH_SPF	0	1
Transistory spatial consist.		X

11.1.3.10 Permanent spatial consistency parameter: PH_SPM

This parameter, as shown in Table 44, describes the contents elaboration of the produced consistency variable mechanism. This variable is used in the elaboration of the permanent spatial consistency status of the lists of variables at the consumer application entity level.

PH_SPM[0] No permanent spatial consistency mechanism is supported

PH_SPM[1] A mechanism of permanent spatial consistency on lists is implemented

Table 44 – PH_SPM parameter values

Parameter PH_SPM	0	1
Permanent spatial consist.		X

11.1.3.11 Access parameter: PH_ACC

This parameter, as shown in Table 45, describes the various variable access modes. It can take the following values:

PH_ACC[0] Application variable global access

PH_ACC[1] is equal to PH_ACC[0] plus variable partial access

PH_ACC[2] is equal to PH_ACC[1] plus variable renamed access

Table 45 – PH_ACC parameter values

Parameter PH_ACC	0	1	2
Partial access		X	X
Renamed access			X

11.1.3.12 Resynchronization parameter: PH_RES

This parameter, as shown in Table 46, defines whether or not the resynchronization mechanism is supported by the application layer. It can take the following values:

PH_RES[0] The resynchronization mechanism is not supported

PH_RES[1] The resynchronization mechanism is supported

Table 46 – PH_RES parameter values

Parameter PH_RES	0	1
Resynchronization		X

11.1.3.13 Horizontal conformance parameters for Sub-MMS ASEs

The horizontal parameters make it possible to specify the various procedures supported.

a) Acknowledgement parameter: See Table 47.

Table 47 – PH_AK parameter values

PH_AK	1	2		
AT_SM		C		
NT_SM		C		
NB_SM		C		
MA_SM		C		

As soon as PV_AT and PV_UT have value 2, if PH_AK has the value 2, they shall offer the acknowledged transfer.

b) Retry/antiduplication parameter: See Table 48.

Table 48 – PH_RA parameter values

PH_RA	1	2		
RC_SM		X		
DU_SM		X		

c) Segmentation/reassembly parameter: See Table 49.

Table 49 – PH_SR parameter values

PH_SR	1	2		
SG_SM		X		
RS_SM		X		

d) Flow control parameter: See Table 50.

Table 50 – PH_CF parameter values

PH_CF	1	2		
Flow control		X		

Expression of the constraints which remain between the various horizontal parameters. See Table 51 and Table 52.

Table 51 – Constraints on PH_RA parameter

Constraints on PH_RA	1	2		
PH_AK		[2]		

Table 52 – Constraints on PH_SR parameter

Constraints on PH_SR	1	2		
PH_AK		[2]		

11.1.4 Type conformance

11.1.4.1 General

The set of types available for the AL TYPE 7application variables is issued from all the possible instances of the Type Constructor object. Within this set are defined a certain number of subsets related to the various categories of variables handled by a device. The conformance type blocks define the supported types subsets on a device.

11.1.4.2 Primitive type parameters

11.1.4.2.1 Octet string parameter PT_OCT

This parameter specifies whether or not the device supports the octet string type. See Table 53.

PT_OCT[0] Octet string type not supported

PT_OCT[1] Octet string type supported

Table 53 – PT_OCT parameter values

Parameter PT_OCT	0	1
Octet string		X

11.1.4.2.2 Binary string parameter PT_BIN

This parameter specifies whether or not the device supports the binary string type. See Table 54.

PT_BIN[0] Binary string type not supported

PT_BIN[1] Binary string type supported

Table 54 – PT_BIN parameter values

Parameter PT_BIN	0	1
Bit string		X

11.1.4.2.3 Visible string parameter PT_VIS

This parameter specifies whether or not the device supports the visible string type. See Table 55.

PT_VIS[0] Visible string type not supported

PT_VIS[1] Visible string type supported

Table 55 – PT_VIS parameter values

Parameter PT_VIS	0	1
Visible string		X

11.1.4.2.4 Boolean parameter PT_BOO

This parameter specifies whether or not the device supports the boolean type. See Table 56.

PT_BOO[0] Boolean type not supported

PT_BOO[1] Boolean type supported

Table 56 – PT_BOO parameter values

Parameter PT_BOO	0	1
Boolean		X

11.1.4.2.5 BCD parameter PT_BCD

This parameter specifies whether or not the device supports the BCD type. See Table 57.

PT_BCD[0] BCD type not supported

PT_BCD[1] BCD type supported

Table 57 – PT_BCD parameter values

Parameter PT_BCD	0	1
BCD		X

11.1.4.2.6 Binary time parameter PT_BTM

This parameter specifies whether or not the device supports the binary time type. See Table 58.

PT_BTM[0] Binary time type not supported

PT_BTM[1] Binary time type supported

Table 58 – PT_BTM parameter values

Parameter PT_BTM	0	1
Binary time		X

11.1.4.2.7 Integer parameter PT_INT

This parameter specifies whether or not the device supports the integer type. See Table 59.

PT_INT[0] Integer type not supported

PT_INT[1] Integer type supported

Table 59 – PT_INT parameter values

Parameter PT_INT	0	1
Integer		X

11.1.4.2.8 Unsigned parameter PT_UNS

This parameter specifies whether or not the device supports the unsigned type. See Table 60.

PT_UNS[0] Unsigned type not supported

PT_UNS[1] Unsigned type supported

Table 60 – PT_UNS parameter values

Parameter PT_UNS	0	1
Unsigned		X

11.1.4.2.9 Floating point parameter PT_FPT

This parameter specifies whether or not the device supports the floating point type. See Table 61.

PT_FPT[0] Floating point type not supported

PT_FPT[1] Floating point type supported

Table 61 – PT_FPT parameter values

Parameter PT_FPT	0	1
Floating point		X

11.1.4.2.10 Generalized time PT_GTM

This parameter specifies whether or not the device supports the generalized time type. See Table 62.

PT_GTM[0] Generalized time type not supported

PT_GTM[1] Generalized time type supported

Table 62 – PT_GTM parameter values

Parameter PT_GTM	0	1
Generalised time		X

11.1.4.3 Array type parameter PT_TAB

This parameter describes the various possibilities for a device to implement the array type. See Table 63. It can take the following values:

PT_TAB[0] Array type not supported

PT_TAB[1] Array composed of primitive types

PT_TAB[2] is equal to PT_TAB[1] plus complex structured type arrays (array, structures)

Table 63 – PT_TAB parameter values

Parameter PT_TAB	0	1	2
Primitive type array		X	X
Structured type array			X

11.1.4.4 Structure type parameter PT_STR

This parameter describes the several possibilities for a device to implement the structure type. See Table 64. It can take the following values:

PT_STR[0] Structure type not supported

PT_STR[1] Structure composed of primitive types

PT_STR[2] is equal to PT_STR[1] plus complex structured type structures (array, structures)

Table 64 – PT_STR parameter values

Parameter PT_STR	0	1	2
Primitive type structure		X	X
Complex type structure			X

11.1.4.5 Constraints on parameters

11.1.4.5.1 General

For each parameter, a table specifies the constraints by giving the minimum value of the other parameters to which it is linked.

11.1.4.5.2 Parameter PT_TAB

See Table 65.

Table 65 – Constraints on PT_TAB parameter

Constraints on PT_TAB	0	1	2
PT_TAB			PT_TAB[1]

11.1.4.5.3 Parameter PT_STR

See Table 66.

Table 66 – Constraints on PT_STR parameter

Constraints on PT_STR	0	1	2
PT_STR			PT_STR[1]

There are no particular constraints on the other parameters specifying type conformity.

11.1.5 Protocol Implementation Conformance statement

11.1.5.1 General

This part of the document describes the "Protocol Implementation Conformance Statement Proforma (PICS). Each implementation should fill all the PICS.

1- Part 1 of the PICS shall indicate the information relative to the implementation and to the system.

2- Part 2 of the PICS shall indicate the CBB services implemented

3- Part 3 of the PICS shall indicate the CBB services and the values implemented.

4- Part 4 of the PICS shall indicate the "local implementations values".

11.1.5.2 PICS Part 1 :

PICS Serial Number : Date:

Vendor's Name,

Model Name,

Revision Identifier,

Machine Name(s) and Version Number(s),

Operating System(s),

Sub-mms Abstract syntax,

Version Number of the Sub-MMS Abstract Syntax Supported (minor number),

CS Sub-mms abstract syntax,

Version Number of the CS Sub-MMS Abstract Syntax Supported (minor number),

Calling (yes or no),

Called (yes or no),

List of standardized names.

11.1.5.3 PICS part 2 :

PICS Serial Number : Date issued :

Initiate, (server,client or both)

Conclude,

Unsolicited Status,

Identify
Status,
Get name list,
Delete domain,
Initiate download sequence,
Download segment,
Terminate download sequence,
Initiate upload sequence,
Upload segment,
Terminate upload sequence,
Get domain attributes,
Create program nvocation,
Delete program invocation,
Start,
Stop,
Resume,
Reset,
Kill,
Get program invocation attributes,
Read,
Write,
Get variable access attributes,
Information report,
Define variable list,
Delete variable list,
Get variable list attributes,
Event notification,
Get alarm summary,
Alter event condition monitoring,
Acknowledge event notification,
Get event condition attributes.
Generic Init Download
Generic Download
Generic Terminate Download
Get OD Header/Data Type Request

11.1.5.4 PICS part 3 :

PICS Serial number : Date :
Object identification by name
Object identification by index
Recursivity of variable data
variable-list
Partial access

11.1.5.5 PICS part 4 :

PICS Serial number : Date :

List of Data Types supported with limit values

Max time-out value in seconds,

Time with system-clock,

Granularity of time in milliseconds,

Uninterruptible-access to variables,

Local detail & execution argument for all services,

Max outstanding calling,

Max outstanding called,

Load data format for Download segment,

Max number of simultaneous upload.

Max number of variables read in one service invocation (1 to n)

Max number of variables written in one service invocation (1 to n)

Max number of variables notified in one service invocation (1 to n)

Max number of events notified in one service invocation (0 to n)

Max number of events read in one service invocation (1 to n)

Maximum number of acknowledged event objects (1 to n)

Maximum number of modified event objects (1 to n)

Object Access Protection (supported or not)

11.1.5.6 Minimum conformance classes

The following conformance classes concern only the SERVER devices.

The minimum conformance classes are listed by management types.

The types of management are:

a) association management,
b) VMD management,
c) domain management,
d) program invocation management,
e) variable management,
f) event management.

There are 5 conformance classes for each type of management. Each of these conformance classes defines the services, the data types, the complex variable objects and the obligatorily supported mechanismes.

The conformance class of a device is composed of 6 values. Each value corresponds to the conformance class of one type of management. These 6 values can be different from one another.

It is not forbidden to have a device belonging to one conformance class services, data types, complex variable objects and mechanismes not obligatory for its class.

1- Conformance classes for environment management: See Table 67.

Table 67 – Conformance classes for environment management

Services	Class 1	Class 2	Class 3	Class 4	Class 5
initiate				M	M
conclude					M
abort				M	M
status					
unsolicited status					
identify					
get name list					
initate download sequence					
download segment					
terminate download sequence					
initiate upload sequence					
upload segment					
terminate upload sequence					
delete domain					
get domain attributes					
create program invocation					
delete program invocation					
start					
stop					
resume					
reset					
kill					
get program invocation attributes					
read					
write					
information report					
define variable list					
delete variable list					
get variable access attributes					
get variable list attributes					
event notification					
acknowledge event notification					
alter event condition monitoring					
get alarm summary					
get event condition attributes					
Variable Data Type					
simple data					
structured data (arr/str)					
Complex Variable Objects					
Variable-list					
Mechanisms					
partial access to the variables					
controlled access by protections					
association(predef/negotiated)		M	M	M	M
without association	M		M	M	M

2- Conformance classes for VMD management: See Table 68.

Table 68 – Conformance classes for VMD management

Services	Class 1	Class 2	Class 3	Class 4	Class 5
initiate					
conclude					
abort					
status		M	M	M	M
unsolicited status				M	M
identify			M	M	M
get name list					M
initate download sequence					
download segment					
terminate download sequence					
initiate upload sequence					
upload segment					
terminate upload sequence					
delete domain					
get domain attributes					
create program invocation					
delete program invocation					
start					
stop					
resume					
reset					
kill					
get program invocation attributes					
read					
write					
information report					
define variable list					
delete variable list					
get variable access attributes					
get variable list attributes					
event notification					
acknowledge event notification					
alter event condition monitoring					
get alarm summary					
get event condition attributes					
Variable Data Type					
simple data					
structured data (arr/str)					
Complex Variable Objects					
Variable-list					
Mechanisms					
partial access to the variables					
controlled access by protections					
association(predef/negotiated)					
without association					

3- Conformance classes for domain management: See Table 69.

Table 69 – Conformance classes for PI managment

Services	Class 1	Class 2	Class 3	Class 4	Class 5
initiate					
conclude					
abort					
status					
unsolicited status					
identify					
get name list					
initate download sequence		M	M	M	M
download segment		M	M	M	M
terminate download sequence		M	M	M	M
initiate upload sequence			M	M	M
upload segment			M	M	M
terminate upload sequence			M	M	M
delete domain				M	M
get domain attributes					M
create program invocation					
delete program invocation					
start					
stop					
resume					
reset					
kill					
get program invocation attributes					
read					
write					
information report					
define variable list					
delete variable list					
get variable access attributes					
get variable list attributes					
event notification					
acknowledge event notification					
alter event condition monitoring					
get alarm summary					
get event condition attributes					
Variable Data Type					
simple data					
structured data (arr/str)					
Complex Variable Objects					
Variable-list					
Mechanisms					
partial access to the variables					
controlled access by protections					M
association(predef/negotiated)					
without association					

4- Conformance classes for PI management: See Table 70.

Table 70 – Conformance classes for domain management

Services	Class 1	Class 2	Class 3	Class 4	Class 5
initiate					
conclude					
abort					
status					
unsolicited status					
identify					
get name list					
initate download sequence					
download segment					
terminate download sequence					
initiate upload sequence					
upload segment					
terminate upload sequence					
delete domain					
get domain attributes					
create program invocation				M	M
delete program invocation				M	M
start		M	M	M	M
stop		M	M	M	M
resume		M	M	M	M
reset			M	M	M
kill				M	M
get program invocation attributes					M
read					
write					
information report					
define variable list					
delete variable list					
get variable access attributes					
get variable list attributes					
event notification					
acknowledge event notification					
alter event condition monitoring					
get alarm summary					
get event condition attributes					
Variable Data Type					
simple data					
structured data (arr/str)					
Complex Variable Objects					
Variable-list					
Type of access					
partial access to the variables					
controlled access by protections					M
association(predef/negotiated)					
without association					

5- Conformance classes for the variable/variable-list management: See Table 71.

Table 71 – Conformance classes for variable/variable list management

Services	Class 1	Class 2	Class 3	Class 4	Class 5
initiate					
conclude					
abort					
status					
unsolicited status					
identify					
get name list					
initate download sequence					
download segment					
terminate download sequence					
initiate upload sequence					
upload segment					
terminate upload sequence					
delete domain					
get domain attributes					
create program invocation					
delete program invocation					
start					
stop					
resume					
reset					
kill					
get program invocation attributes					
read	M	M	M	M	M
write	M	M	M	M	M
information report	M	M	M	M	M
define variable list				M	M
delete variable list				M	M
get variable access attributes					M
get variable list attributes					M
event notification					
acknowledge event notification					
alter event condition monitoring					
get alarm summary					
get event condition attributes					
Variable Data Type					
simple data	M	M	M	M	M
structured data (arr/str)		M	M	M	M
Complex Variable Objects					
Variable-list				M	M
Type of access					
partial access to the variables			M	M	M
controlled access by protections					M
association(predef/negotiated)					
without association					

6- Conformance classes for event management: See Table 72.

Table 72 – Conformance classes for event management

Services	Class 1	Class 2	Class 3	Class 4	Class 5
initiate					
conclude					
abort					
status					
unsolicited status					
identify					
get name list					
initate download sequence					
download segment					
terminate download sequence					
initiate upload sequence					
upload segment					
terminate upload sequence					
delete domain					
get domain attributes					
create program invocation					
delete program invocation					
start					
stop					
resume					
reset					
kill					
get program invocation attributes					
read					
write					
information report					
define variable list					
delete variable list					
get variable access attributes					
get variable list attributes					
event notification		M	M	M	M
acknowledge event notification			M	M	M
alter event condition monitoring				M	M
get alarm summary					M
get event condition attributes					M
Variable Data Type					
simple data					
structured data (arr/str)					
Complex Variable Objects					
Variable-list					
Mechanisms					
partial access to the variables					
controlled access by protections					M
association(predef/negotiated)					
without association					

Bibliography

IEC/TR 61158-1 (Ed.2.0), *Industrial communication networks – Fieldbus specifications – Part 1: Overview and guidance for the IEC 61158 and IEC 61784 series*

IEC 61784-1 (Ed.2.0), *Industrial communication networks – Profiles – Part 1: Fieldbus profiles*
NOTE Harmonized as EN 61784-1:2008 (not modified).

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

ISO 8649, *Information technology – Open Systems Interconnection – Service definition for the Association Control Service Element*

ISO/IEC 8650 (all parts), *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification*

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

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Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following referenced documents are indispensable for the application 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 When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60559	- [1)]	Binary floating-point arithmetic for microprocessor systems	HD 592 S1	1991 [2)]
IEC 61158-3-7	- [1)]	Industrial communication networks - Fieldbus specifications - Part 3-7: Data-link layer service definition - Type 7 elements	EN 61158-3-7	2008 [2)]
IEC 61158-4-7	- [1)]	Industrial communication networks - Fieldbus specifications - Part 4-7: Data-link layer protocol specification - Type 7 elements	EN 61158-4-7	2008 [2)]
IEC 61158-5-7	- [1)]	Industrial communication networks - Fieldbus specifications - Part 5-7: Application layer service definition - Type 7 elements	EN 61158-5-7	2008 [2)]
ISO/IEC 7498-1	- [1)]	Information technology - Open Systems Interconnection - Basic Reference Model: The Basic Model	EN ISO/IEC 7498-1	1995 [2)]
ISO/IEC 8824-2	- [1)]	Information technology - Abstract Syntax Notation One (ASN.1): Information object specification	-	-
ISO/IEC 8825-1	- [1)]	Information technology - ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)	-	-
ISO/IEC 9506-2	- [1)]	Industrial automation systems - Manufacturing message specification - Part 2: Protocol specification	EN 29506-2	1990 [2)]
ISO/IEC 9545	- [1)]	Information technology - Open Systems Interconnection - Application Layer structure	-	-

[1)] Undated reference.

[2)] Valid edition at date of issue.

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