

INTERNATIONAL STANDARD



Electricity metering data exchange – The DLMS/COSEM suite –
Part 5-3: DLMS/COSEM application layer



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IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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INTERNATIONAL STANDARD



**Electricity metering data exchange – The DLMS/COSEM suite –
Part 5-3: DLMS/COSEM application layer**

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CONTENTS

FOREWORD.....	8
INTRODUCTION.....	2
1 Scope.....	11
2 Normative references	11
3 Terms, definitions and abbreviations	13
3.1 Terms and definitions	13
3.2 Abbreviations	13
4 Overview	15
4.1 DLMS/COSEM application layer structure	15
4.2 DLMS/COSEM application layer services	17
4.2.1 ASO services	17
4.2.2 Services provided for application association establishment and release	17
4.2.3 Services provided for data transfer	18
4.2.4 Layer management services	23
4.2.5 Summary of DLMS/COSEM application layer services	23
4.3 DLMS/COSEM application layer protocols	25
5 Information security in DLMS/COSEM	25
5.1 Definitions	25
5.2 General	25
5.3 Data access security	26
5.3.1 Overview	26
5.3.2 No security (lowest level security) authentication	26
5.3.3 Low Level Security (LLS) authentication	26
5.3.4 High Level Security (HLS) authentication	27
5.4 Data transport security	30
5.4.1 Applying, removing or checking the protection: ciphering and deciphering	30
5.4.2 Security context	31
5.4.3 Security policy	31
5.4.4 Security suite	32
5.4.5 Security material	32
5.4.6 Ciphered xDLMS APDUs	32
5.4.7 Cryptographic keys	36
5.4.8 The Galois/Counter Mode of Operation (GCM)	39
6 DLMS/COSEM application layer service specification	48
6.1 Service primitives and parameters	48
6.2 The COSEM-OPEN service	50
6.3 The COSEM-RELEASE service	55
6.4 COSEM-ABORT service	58
~~6.5 Security parameters~~	~~58~~
6.5 Protection and general block transfer parameters	58
6.6 The GET service	63
6.7 The SET service	66
6.8 The ACTION service	68
6.9 The DataNotification service	72
6.10 The EventNotification service	73

6.11	The TriggerEventNotificationSending service	74
6.12	Variable access specification.....	75
6.13	The Read service	75
6.14	The Write service	79
6.15	The UnconfirmedWrite service	82
6.16	The InformationReport service.....	83
6.17	Client side layer management services: the SetMapperTable.request.....	84
6.18	Summary of services and LN/SN data transfer service mapping	85
7	DLMS/COSEM application layer protocol specification.....	85
7.1	The control function	85
7.1.1	State definitions of the client side control function.....	85
7.1.2	State definitions of the server side control function	87
7.2	The ACSE services and APDUs.....	88
7.2.1	ACSE functional units, services and service parameters	88
7.2.2	Registered COSEM names.....	91
7.2.3	APDU encoding rules	93
7.2.4	Protocol for application association establishment	93
7.2.5	Protocol for application association release	99
7.3	Protocol for the data transfer services	102
7.3.1	Negotiation of services and options – the conformance block	102
7.3.2	Confirmed and unconfirmed service invocations.....	103
7.3.3	Protocol for the GET service	105
7.3.4	Protocol for the SET service.....	108
7.3.5	Protocol for the ACTION service.....	111
7.3.6	Protocol of the DataNotification service	113
7.3.7	Protocol for the EventNotification service.....	113
7.3.8	Protocol for the Read service	113
7.3.9	Protocol for the Write service	117
7.3.10	Protocol for the UnconfirmedWrite service	121
7.3.11	Protocol for the InformationReport service	122
7.3.12	Protocol of general block transfer mechanism	123
8	Abstract syntax of ACSE and COSEM APDUs	134
Annex A (normative)	Using the COSEM application layer in various communications profiles	149
A.1	General.....	149
A.2	Targeted communication environments	149
A.3	The structure of the profile	149
A.4	Identification and addressing schemes	149
A.5	Supporting layer services and service mapping.....	150
A.6	Communication profile specific parameters of the COSEM AL services.....	150
A.7	Specific considerations / constraints using certain services within a given profile	150
A.8	The 3-layer, connection-oriented, HDLC based communication profile	150
A.9	The TCP-UDP/IP based communication profiles (COSEM_on_IP)	150
A.10	The S-FSK PLC profile	150
Annex B (normative)	SMS short wrapper	151
Annex C (informative)	AARQ and AARE encoding examples	152
C.1	General.....	152
C.2	Encoding of the xDLMS InitiateRequest / InitiateResponse APDUs.....	152

C.3	Specification of the AARQ and AARE APDUs	155
C.4	Data for the examples	156
C.5	Encoding of the AARQ APDU	157
C.6	Encoding of the AARE APDU	160
Annex D (informative)	Encoding examples: AARQ and AARE APDUs using a ciphered application context	166
D.1	A-XDR encoding of the xDLMS InitiateRequest APDU, carrying a dedicated key	166
D.2	Authenticated encryption of the xDLMS InitiateRequest APDU	167
D.3	The AARQ APDU	168
D.4	A-XDR encoding of the xDLMS InitiateResponse APDU	169
D.5	Authenticated encryption of the xDLMS InitiateResponse APDU	170
D.6	The AARE APDU	171
D.7	The RLRQ APDU (carrying a ciphered xDLMS InitiateRequest APDU)	172
D.8	The RLRE APDU (carrying a ciphered xDLMS InitiateResponse APDU)	173
Annex E (informative)	Data transfer service examples	174
Annex F (informative)	Overview of cryptography	190
F.1	General	190
F.2	Hash functions	190
F.3	Symmetric key algorithms	191
F.3.1	General	191
F.3.2	Encryption and decryption	191
F.3.3	Advanced Encryption Standard (AES)	192
F.3.4	Encryption Modes of Operation	192
F.3.5	Message Authentication Code	193
F.3.6	Key establishment	194
F.4	Asymmetric key algorithms	194
F.4.1	General	194
F.4.2	Digital signatures	195
F.4.3	Key establishment	195
Annex G (informative)	Significant technical changes with respect to IEC-62056-53 62056-5-3 Ed.1.0:2013	196
Bibliography		200
Index		203
Figure 1	Structure of the COSEM Application layers	16
Figure 2	Summary of DLMS/COSEM AL services	24
Figure 3	LLS and HLS authentication	25
Figure 3	Authentication mechanisms during AA establishment	29
Figure 4	Data transport security in DLMS/COSEM	30
Figure 4	Structure of service specific global ciphering and dedicated ciphering APDUs	34
Figure 5	Ciphered xDLMS APDUs	35
Figure 5	Structure of general global ciphering and dedicated ciphering APDUs	35
Figure 6	Cryptographic protection of xDLMS APDUs using GCM	42
Figure 7	Service primitives	48
Figure 8	Time sequence diagrams	49

Figure 9 – Additional service parameters to control cryptographic protection and general block transfer	60
Figure 10 – Partial state machine for the client side control function	86
Figure 11 – Partial state machine for the server side control function	87
Figure 12 – MSC for successful AA establishment preceded by a successful lower layer connection establishment	95
Figure 13 – Graceful AA release using the A-RELEASE service	100
Figure 14 – Graceful AA release by disconnecting the supporting layer	101
Figure 15 – Aborting an AA following a PH-ABORT indication	102
Figure 16 – MSC of the GET service	105
Figure 17 – MSC of the GET service with block transfer	106
Figure 18 – MSC of the GET service with block transfer, long GET aborted	108
Figure 19 – MSC of the SET service	109
Figure 20 – MSC of the SET service with block transfer	109
Figure 21 – MSC of the ACTION service	111
Figure 22 – MSC of the ACTION service with block transfer	112
Figure 23 – MSC of the Read service used for reading an attribute	116
Figure 24 – MSC of the Read service used for invoking a method	116
Figure 25 – MSC of the Read Service used for reading an attribute, with block transfer	117
Figure 26 – MSC of the Write service used for writing an attribute	120
Figure 27 – MSC of the Write service used for invoking a method	120
Figure 28 – MSC of the Write service used for writing an attribute, with block transfer	121
Figure 29 – MSC of the Unconfirmed Write service used for writing an attribute	122
Figure 30 – Partial service invocations and GBT APDUs	125
Figure 31 – GET service with GBT, switching to streaming	127
Figure 32 – GET service with partial invocations, GBT and streaming, recovery of 4 th block sent in the 2 nd stream	128
Figure 33 – GET service with partial invocations, GBT and streaming, recovery of 4 th and 5 th blocks	129
Figure 34 – GET service with partial invocations, GBT and streaming, recovery of last block	130
Figure 35 – SET service with GBT, with server not supporting streaming, recovery of 3 rd block	131
Figure 36 – ACTION-WITH-LIST service with bi-directional GBT and block recovery	132
Figure 37 – DataNotification service with GBT with partial invocation	133
Figure B.1 – Short wrapper	151
Figure F.1 – Hash function	191
Figure F.2 – Encryption and decryption	192
Figure F.3 – Message Authentication Codes (MACs)	193
Table 1 – Clarification of the meaning of PDU Size for DLMS/COSEM	19
Table 2 – Security suites	32
~~Table 3 – Security control field~~	~~33~~
Table 3 – Ciphered xDLMS APDUs	33
Table 4 – Use of the fields of the ciphered APDUs	36

Table 5 – Cryptographic keys and their management.....	39
Table 6 – Security control byte.....	43
Table 7 – Plaintext and additional authenticated data	43
Table 8 – Example for ciphered APDUs	45
Table 9 – HLS example with GMAC.....	47
Table 10 – Codes for AL service parameters	50
Table 11 – Service parameters of the COSEM-OPEN service primitives.....	51
Table 12 – Service parameters of the COSEM-RELEASE service primitives.....	55
Table 13 – Service parameters of the COSEM-ABORT service primitives.....	58
Table 14 – Additional service parameters	61
Table 15 – Security parameters.....	62
Table 16 – Service parameters of the GET service	63
Table 17 – GET service request and response types	64
Table 18 – Service parameters of the SET service.....	66
Table 19 – SET service request and response types.....	67
Table 20 – Service parameters of the ACTION service	69
Table 21 – ACTION service request and response types.....	70
Table 22 – Service parameters of the DataNotification service primitives	72
Table 23 – Service parameters of the EventNotification service primitives.....	73
Table 24 – Service parameters of the TriggerEventNotificationSending.request service primitive	74
Table 25 – Variable Access Specification.....	75
Table 26 – Service parameters of the Read service.....	76
Table 27 – Use of the Variable_Access_Specification variants and the Read.response choices.....	77
Table 28 – Service parameters of the Write service	80
Table 29 – Use of the Variable_Access_Specification variants and the Write.response choices.....	80
Table 30 – Service parameters of the UnconfirmedWrite service.....	82
Table 31 – Use of the Variable_Access_Specification variants.....	83
Table 32 – Service parameters of the InformationReport service.....	84
Table 33 – Service parameters of the SetMapperTable.request service primitives	84
Table 34 – Summary of ACSE services	85
Table 35 – Summary of xDLMS services for LN referencing	85
Table 36 – Summary of xDLMS services for SN referencing.....	85
Table 37 – ACSE functional units, services and service parameters.....	89
Table 38 – Use of ciphered / unciphered APDUs	92
Table 39 – xDLMS Conformance block.....	103
Table 40 – GET service types and APDUs.....	105
Table 41 – SET service types and APDUs	108
Table 42 – ACTION service types and APDUs.....	111
Table 43 – Mapping between the GET and the Read services	114
Table 44 – Mapping between the ACTION and the Read services	114
Table 45 – Mapping between the SET and the Write services	118

Table 46 – Mapping between the ACTION and the Write service	119
Table 47 – Mapping between the SET and the UnconfirmedWrite services	122
Table 48 – Mapping between the ACTION and the UnconfirmedWrite services	122
Table 49 – Mapping between the EventNotification and InformationReport services	123
Table B.1 – Reserved Application Processes	151
Table C.1 – Conformance block	153
Table C.2 – A-XDR encoding of the xDLMS InitiateRequest APDU	154
Table C.3 – A-XDR encoding of the xDLMS InitiateResponse APDU	155
Table C.4 – BER encoding of the AARQ APDU	158
Table C.5 – Complete AARQ APDU	160
Table C.6 – BER encoding of the AARE APDU	161
Table C.7 – The complete AARE APDU	165
Table D.1 – A-XDR encoding of the xDLMS InitiateRequest APDU	166
Table D.2 – Authenticated encryption of the xDLMS InitiateRequest APDU	167
Table D.3 – BER encoding of the AARQ APDU	168
Table D.4 – A-XDR encoding of the xDLMS InitiateResponse APDU	170
Table D.5 – Authenticated encryption of the xDLMS InitiateResponse APDU	170
Table D.6 – BER encoding of the AARE APDU	171
Table D.7 – BER encoding of the RLRQ APDU	173
Table D.8 – BER encoding of the RLRE APDU	173
Table E.1 – Objects used in the examples	174
Table E.2 – Example: Reading the value of a single attribute without block transfer	175
Table E.3 – Example: Reading the value of a list of attributes without block transfer	176
Table E.4 – Example: Reading the value of a single attribute with block transfer	178
Table E.5 – Example: Reading the value of a list of attributes with block transfer	180
Table E.6 – Example: Writing the value of a single attribute without block transfer	183
Table E.7 – Example: Writing the value of a list of attributes without block transfer	184
Table E.8 – Example: Writing the value of a single attribute with block transfer	185
Table E.9 – Example: Writing the value of a list of attributes with block transfer	187

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING DATA EXCHANGE – THE DLMS/COSEM SUITE –

Part 5-3: DLMS/COSEM application layer

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¹ Device Language Message Specification.

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International Standard IEC 62056-5-3 has been prepared by IEC technical committee 13: Electrical energy measurement and control.

This second edition cancels and replaces the first edition of IEC 62056-5-3 published in 2013. It constitutes a technical revision.

The significant technical changes with respect to the previous edition are listed in Annex G (informative).

The text of this standard is based on the following documents:

FDIS	Report on voting
13/1648/FDIS	13/1657/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62056 series, published under the general title *Electricity metering data exchange– The DLMS/COSEM suite*, can be found on the IEC website.

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

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- withdrawn,
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INTRODUCTION

This second edition of IEC 62056-5-3 has been prepared by IEC TC13 WG14 with a significant contribution of the DLMS User Association, its D-type liaison partner.

This edition is in line with the DLMS UA Green Book Edition 7.0 Amendment 3. The main new features are the DataNotification service, the general protection and the general block transfer mechanisms and the SMS short wrapper.

In 2014, the DLMS UA has published Green Book Edition 8.0 adding several new features regarding functionality, efficiency and security while keeping full backwards compatibility.

The intention of the DLMS UA is to bring also these latest developments to international standardization. Therefore, IEC TC13 WG14 launched a project to bring these new elements also to the IEC 62056 series that will lead to Edition 3.0 of the standard.

Clause 5 and Annex F are based on parts of NIST documents. Reprinted courtesy of the National Institute of Standards and Technology, Technology Administration, U.S. Department of Commerce.

ELECTRICITY METERING DATA EXCHANGE – THE DLMS/COSEM SUITE –

Part 5-3: DLMS/COSEM application layer

1 Scope

This part of IEC 62056 specifies the DLMS/COSEM application layer in terms of structure, services and protocols for COSEM clients and servers, and defines how to use the DLMS/COSEM application layer in various communication profiles.

It defines services for establishing and releasing application associations, and data communication services for accessing the methods and attributes of COSEM interface objects, defined in IEC 62056-6-2²:2016, using either logical name (LN) or short name (SN) referencing.

Annex A (normative) defines how to use the COSEM application layer in various communication profiles. It specifies how various communication profiles can be constructed for exchanging data with metering equipment using the COSEM interface model, and what are the necessary elements to specify in each communication profile. The actual, media-specific communication profiles are specified in separate parts of the IEC 62056 series.

Annex B (normative) specifies the SMS short wrapper.

Annex C, Annex D and Annex E (informative) include encoding examples for APDUs.

Annex F (informative) provides an overview of cryptography.

Annex G (informative) lists the main technical changes in this edition of the standard.

2 Normative references

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

IEC 61334-4-41:1996, *Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 41: Application protocols – Distribution line message specification*

IEC 61334-6:2000, *Distribution automation using distribution line carrier systems – Part 6: A-XDR encoding rule*

IEC TR 62051:1999, *Electricity metering – Glossary of terms*

² ~~To be published simultaneously with this part of IEC 62056.~~

IEC TR 62051-1:2004, *Electricity metering – Data exchange for meter reading, tariff and load control – Glossary of terms – Part 1: Terms related to data exchange with metering equipment using DLMS/COSEM*

IEC 62056-1-0, *Electricity metering data exchange – The DLMS/COSEM suite – Part 1-0: Smart metering standardisation framework*

IEC 62056-6-1:2015, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)*³

IEC 62056-6-2:2016, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes*⁴

IEC 62056-8-3:2013, *Electricity metering data exchange – The DLMS/COSEM suite – Part 8-3: Communication profile for PLC S-FSK neighbourhood networks*⁵

ISO/IEC 8824-1:2008, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC 8825-1:2008, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 15953:1999, *Information technology – Open Systems Interconnection – Service definition for the Application Service Object Association Control Service Element*

NOTE This standard cancels and replaces ISO/IEC 8649-1:1999 and its Amd. 1:1997 and Amd. 2:1998, of which it constitutes a technical revision.

ISO/IEC 15954:1999, *Information technology – Open Systems Interconnection – Connection-mode protocol for the Application Service Object Association Control Service Element*

NOTE This standard cancels and replaces ISO/IEC 8650-1:1999 and its Amd. 1:1997 and Amd. 2:1998, of which it constitutes a technical revision.

~~FIPS PUB 180-1:2002, Secure hash standard~~

FIPS PUB 180-4:2012, *Secure hash standard*

FIPS PUB 197:2001, *Advanced Encryption Standard (AES)*

NIST SP 800-38D:2007, *Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC*

NIST SP 800-57:2006, *Recommendation for Key Management – Part 1: General (Revised)*

The following RFCs are available online from the Internet Engineering Task Force (IETF):
<http://www.ietf.org/rfc/std-index.txt>, <http://www.ietf.org/rfc/>

³ ~~To be published simultaneously with this part of IEC 62056.~~

⁴ ~~To be published simultaneously with this part of IEC 62056.~~

⁵ ~~To be published simultaneously with this part of IEC 62056.~~

RFC 1321:~~1992, Internet Engineering Task Force (IETF), The MD5 Message-Digest Algorithm~~. Edited by R. Rivest (MIT Laboratory for Computer Science and RSA Data Security, Inc.) April 1992 ~~Available from: <http://www.rfc-editor.org/rfc/rfc1321.txt>~~

RFC 3394:~~2002, Internet Engineering Task Force (IETF), Advanced Encryption Standard (AES) Key Wrap Algorithm~~. Edited by J. Schaad (Soaring Hawk Consulting) and R. Housley (RSA Laboratories) September 2002 ~~Available from: <http://www.rfc-editor.org/rfc/rfc3394.txt>~~

RFC 4106:~~2005, The Use of Galois/Counter Mode (GCM) in IPsec Encapsulating Security Payload (ESP)~~

~~NOTE See also the Bibliography.~~

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TR 62051:~~1999~~, in IEC TR 62051-1 and in RFC 4106 apply.

3.2 Abbreviations

AA	Application Association
AAD	Additional Authenticated Data (used with ciphering of APDUs)
AARE	A-Associate Response – an APDU of the ACSE
AARQ	A-Associate Request – an APDU of the ACSE
ACPM	Association Control Protocol Machine
ACSE	Association Control Service Element
AE	Application Entity
AES	Advanced Encryption Standard
AL	Application Layer
AP	Application Process
APDU	Application Layer Protocol Data Unit
API	Application Programming Interface
ASE	Application Service Element
ASO	Application Service Object
A-XDR	Adapted Extended Data Representation
base_name	The short_name corresponding to the first attribute (“logical_name”) of a COSEM object
BER	Basic Encoding Rules
CF	Control Function
CL	Connectionless
Client	A station, asking for services. In the case of the 3-layer, CO HDLC based profile it is the master station
.cnf	.confirm service primitive
CO	Connection-oriented
COSEM	Companion Specification for Energy Metering
COSEM class_id	COSEM interface class identifier
COSEM object	An instance of a COSEM interface class
DCS	Data Collection System

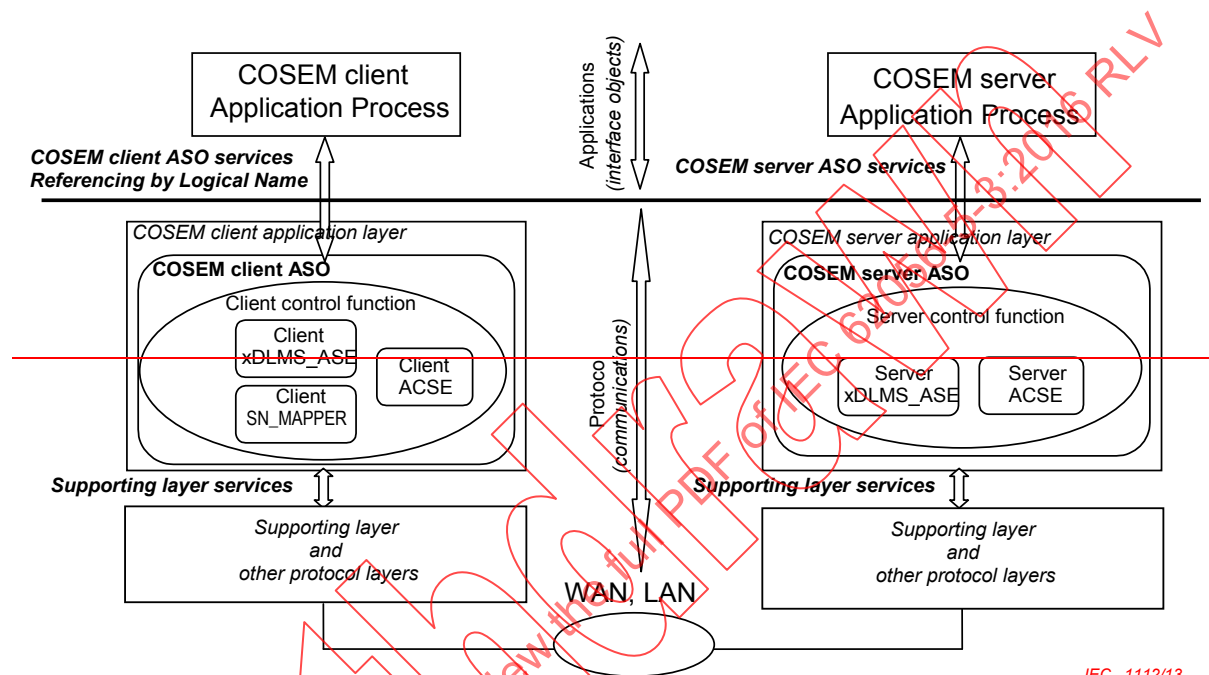
DLMS	Device Language Message Specification
DLMS UA	DLMS User Association
~~FCS~~	~~Frame Check Sequence~~
FIPS	Federal Information Processing Standard
GBT	General Block Transfer
GCM	Galois/Counter Mode, an algorithm for authenticated encryption with associated data
GMAC	A specialization of GCM for generating a message authentication code (MAC) on data that is not encrypted
HDLC	High-level Data Link Control
HLS	High Level Security
HMAC	Keyed-Hash Message Authentication Code
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
.ind	.indication service primitive
IP	Internet Protocol
ISO	International Organization for Standardization
IV	Initialization Vector
LDN	Logical Device Name
LLC	Logical Link Control (Sublayer)
LLS	Low Level Security
LSB	Least Significant Bit
MAC	Medium Access Control (sublayer)
MAC	Message Authentication Code (cryptography)
master	Central station – station which takes the initiative and controls the data flow
MSB	Most Significant Bit
MSC	Message Sequence Chart
NIST	National Institute of Standards and Technology
OBIS	OBject Identification System
OSI	Open System Interconnection
PDU	Protocol Data Unit
PHSDU	PH SDU
PLC	Power line carrier
PPP	Point-to-Point Protocol
.req	.request service primitive
.res	.response service primitive
RLRE	A-Release Response – an APDU of the ACSE
RLRQ	A-Release Request – an APDU of the ACSE
SAP	Service Access Point
Server	A station, delivering services. The tariff device (meter) is normally the server, delivering the requested values or executing the requested tasks.
TCP	Transmission Control Protocol
TDEA	Triple Data Encryption Algorithm

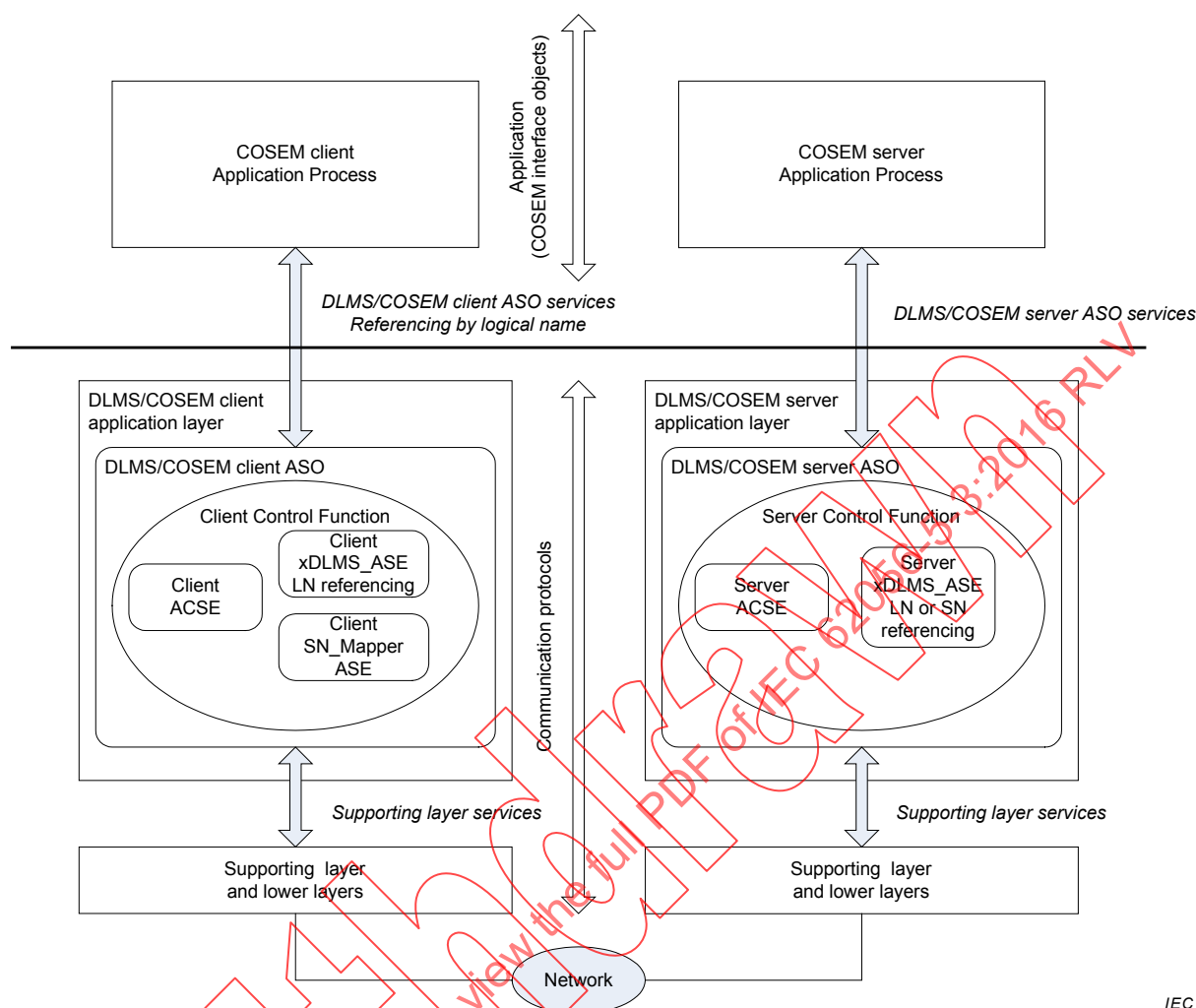
UDP	User Datagram Protocol
VAA	Virtual Application Association
xDLMS_ASE	Extended DLMS Application Service Element

4 Overview

4.1 DLMS/COSEM application layer structure

The structure of the client and server COSEM application layers is shown in Figure 1.





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Figure 1 – Structure of the COSEM Application layers

The main component of the COSEM AL is the COSEM Application Service Object. It provides services to its service user, the COSEM Application Process, and uses services provided by the supporting lower layer. It contains three mandatory components both on the client and on the server side:

- the Association Control Service Element, ACSE;
- the extended DLMS Application Service Element, xDLMS_ASE;
- the Control Function, CF.

On the client side, there is a fourth, optional element, called the **Client SN_MAPPER ASE**.

The task of the ACSE is to establish, maintain, and release application associations. For the purposes of DLMS/COSEM connection oriented (CO) communication profiles, the CO ACSE, specified in ISO/IEC 15953:1999 and ISO/IEC 15954:1999 is used.

The task of the xDLMS_ASE is to provide data transfer services between COSEM APs. It is based on the DLMS standard, IEC 61334-4-41:1996. It has been extended for DLMS/COSEM; see 4.2.3.1. The main objective of DLMS/COSEM is to provide a business domain oriented interface object model for metering devices and systems while keeping backward compatibility with the DLMS standard. To meet these objectives, DLMS/COSEM includes an evolution of DLMS. Remaining fully compliant to the DLMS standard, DLMS/COSEM provides a more metering specific view of the meter through the COSEM interface objects.

IEC 62056-6-2:2016, 4.2 specifies two referencing methods to attributes and methods of COSEM interface objects for use in COSEM servers: LN and SN referencing. When LN referencing is used, the Logical Name of the COSEM objects shall be as specified in IEC 62056-6-1. Therefore, on the server side, two distinct xDLMS service sets are specified: one exclusively for LN referencing and the other exclusively for SN referencing. It can be considered that there are two different xDLMS_ASEs: one providing services for LN referencing and the other for SN referencing. The server AL may include one, the other or both xDLMS_ASEs.

The CF element specifies how the ASO services invoke the appropriate service primitives of the ACSE, the xDLMS_ASE and the services of the supporting layer.

NOTE Both the client and the server COSEM ASO can contain other, optional application protocol components.

The optional **Client** SN_MAPPER ASE is present in the client side AL ASO, when the server uses SN referencing. It provides mapping between services using LN and SN referencing. See also 6.18.

The COSEM AL also performs some functions of the OSI presentation layer:

- encoding the ACSE APDUs in BER (ISO/IEC 8825-1). See also 7.2.3;
- encoding the xDLMS APDUs carrying the data transfer services in A-XDR (IEC 61334-6).

4.2 DLMS/COSEM application layer services

4.2.1 ASO services

The services required by, or provided for the COSEM client and server APs at the logical interfaces with the respective COSEM AL, using CO procedures, fall into three categories:

- application association establishment and release;
- data transfer;
- layer management.

4.2.2 Services provided for application association establishment and release

The services provided for the establishment and release of AAs are the following:

- COSEM-OPEN;
- COSEM-RELEASE;
- COSEM-ABORT.

The COSEM-OPEN service is used to establish AAs. It is based on the ACSE A-ASSOCIATE service. It causes the start of use of an AA by those ASE procedures identified by the value of the Application_Context_Name, Security_Mechanism_Name and xDLMS context parameters. AAs may be established in different ways:

- confirmed AAs are established via a message exchange – using the COSEM-OPEN service – between the client and the server to negotiate the contexts. Confirmed AAs can be established between a single client and a single server;
- unconfirmed AAs are established via a message sent – using the COSEM-OPEN service – from the client to the server, using the parameters of the contexts supposed to be used by the server. Unconfirmed AAs can be established between a client and one or multiple servers;
- pre-established AAs may pre-exist. In this case, the COSEM-OPEN service is not used. A pre-established AA can be confirmed or unconfirmed.

The COSEM-RELEASE service is used to release AAs. If successful, it causes the completion of the use of the AA without loss of information in transit (graceful release). In some

communication profiles – for example in the TCP-UDP/IP based profile – the COSEM-RELEASE service is based on the ACSE A-RELEASE service. In some other communication profiles – for example in the 3-layer, CO, HDLC-based profile – there is a one-to-one relationship between a confirmed AA and the supporting protocol layer connection. Therefore, AAs can be released simply by disconnecting the corresponding supporting layer connection. Pre-established AAs cannot be released.

The COSEM-ABORT service causes the abnormal release of an AA with the possible loss of information in transit. It does not rely on the ACSE A-ABORT service.

The COSEM-OPEN service is specified in 6.2, the COSEM-RELEASE service in 6.3 and the COSEM-ABORT service in 6.4.

4.2.3 Services provided for data transfer

4.2.3.1 The xDLMS application service element

As mentioned in 4.1, xDLMS includes some extensions to the DLMS standard, IEC 61334-4-41:1996. These extensions define added functionality; existing functionality is not modified. They are made in such a way, that there is no conflict with the existing DLMS standard and comprise the following:

- additional services;
- additional data types;
- new DLMS version number;
- new conformance block;
- clarification of the meaning of the PDU Size.

The additional services are:

- the GET, SET services available to access COSEM object attributes and the ACTION ~~and EventNotification~~. They allow to reference attributes and methods of service available to access COSEM ~~interface~~ object methods using LN referencing, see 4.2.3.5 ~~and 4.2.3.6~~;
- the DataNotification service used by the server to push data to the client; see 4.2.3.6.
- the EventNotification service used by the server to notify the client about events that occur in the server, see 4.2.3.6;

The additional data types are specified in Clause 8.

The new DLMS version number, corresponding to the first version of the xDLMS ASE is 6.

The new xDLMS conformance block enables optimised DLMS/COSEM server implementations with extended functionality. It can be distinguished from the DLMS conformance block by its tag "Application 31". See 7.3.1 and Clause 8.

For services using SN referencing, new variants of the Variable_Access_Specification service parameter, the Read.response and the Write.response services have been added to support selective access and block transfer.

To clarify the meaning of the maximum PDU size usable by the client and the server, the modifications shown in Table 1 have been made. The xDLMS-Initiate service uses these names for PDU Sizes.

Table 1 – Clarification of the meaning of PDU Size for DLMS/COSEM

was:	new:
Page 61, Table 3, IEC 61334-4-41:1996	
Proposed Max PDU Size	Client Max Receive PDU Size
Negotiated Max PDU Size	Server Max Receive PDU Size
Page 63, 5th paragraph, IEC 61334-4-41:1996	
The Proposed Max PDU Size parameter, of type Unsigned16, proposes a maximum length expressed in bytes for the exchanged DLMS PDUs. The value proposed in an Initiate request shall be large enough to always permit the Initiate Error PDU transmission.	The Client Max Receive PDU Size parameter, of type Unsigned16, contains the maximum length expressed in bytes for a DLMS PDU that the server may send. The client will discard any received PDUs that are longer than this maximum length. The value shall be large enough to always permit the AARE APDU transmission. Values below 12 are reserved. The value 0 indicates that there is no limit on the PDU size.
Page 63, last paragraph, IEC 61334-4-41:1996	
The Negotiated Max PDU Size parameter, of type Unsigned16, contains a maximum length expressed in bytes for the exchanged DLMS PDUs. A PDU that is longer than this maximum length will be discarded. This maximum length is computed as the minimum of the Proposed Max PDU Size and the maximum PDU size than the VDE-handler may support.	The Server Max Receive PDU Size parameter, of type Unsigned16, contains the maximum length expressed in bytes for a DLMS PDU that the client may send. The server will discard any received PDUs that are longer than this maximum length. Values below 12 are reserved. The value 0 indicates that there is no limit on the PDU size.

4.2.3.2 Client/server and non-client/server type services

xDLMS data transfer services are related to attributes and methods of COSEM interface objects, specified in IEC 62056-6-2:2016 and provide the interface between the COSEM application model and the communication protocols.

When the server uses SN referencing, attributes and methods of COSEM interface objects are mapped to DLMS named variables. The mapping is held by the Association SN interface object(s).

For accessing attributes and methods, client/server type services are used: the client requests services and the server provides them.

There are also unsolicited, ~~non-client/server type, unconfirmed~~ services. ~~This service is requested by the server, upon occurrence of an event.~~ These are requested by the server, on pre-defined conditions, e.g. schedules, triggers or events, to inform the client of the value of one or more attributes, as though they had been requested by the client. ~~It is an unconfirmed service.~~

4.2.3.3 Referencing methods and service mapping

As specified in 4.1, there are two distinct service sets available, one for LN and one for SN referencing.

On the client side, in order to handle the different referencing methods transparently for the AP, the AL provides only one service set, using LN referencing. Using a unique, standardized service set between COSEM client APs and the communication protocol – hiding the particularities of COSEM servers using different referencing methods – allows specifying an Application Programming Interface, API. This is an explicitly specified interface corresponding to this service set for applications running in a given computing environment (for example Windows, UNIX, etc.). Using this – public – API specification, client applications can be developed without knowledge about particularities of a given server.

On the server side, services using LN referencing and/or SN referencing can be provided.

In the case of confirmed AAs, the referencing method and the service set to be used are negotiated during the AA establishment phase via the COSEM application context; see 7.2.2.2, and the conformance block; see 7.3.1. It shall not change during the lifetime of the AA established. Using LN or SN services within a given AA is exclusive.

In the case of unconfirmed and pre-established AAs, the client AL is expected to know the referencing method and the service set supported by the server.

When the server uses LN referencing, the services are the same on both side. When the server does not use LN referencing, a mapping between client side and server side services takes place. As explained in 4.1, if the server uses SN referencing this mapping is performed by the Client SN_MAPPER ASE. See also 6.18.

4.2.3.4 Confirmed and unconfirmed services

Within confirmed AAs, client/server type data transfer services can be invoked in a confirmed or unconfirmed manner. Within unconfirmed AA-s, client/server type data transfer services may be invoked in an unconfirmed manner only. See also 7.3.2.

4.2.3.5 DLMS/COSEM client/server type services

COSEM client/server type data transfer services for LN referencing are the following:

- the GET service, used to read the value of one or more attributes of COSEM interface objects. See 6.6;
- the SET service, used to write the value of one or more attributes of COSEM interface objects. See 6.7;
- the ACTION service, used to invoke one or more methods of COSEM interface objects. Invoking methods may imply sending service parameters and returning data. See 6.8.

COSEM client/server type data transfer services for SN referencing are the following:

- the Read service, used to read the value of one or more attributes or to invoke one or more methods of COSEM interface objects when return parameters are expected. It is a confirmed service. See 6.13;
- the Write service, used to write the value of one or more attributes or to invoke one or more methods of COSEM interface objects when no return parameters are expected. It is a confirmed service. See 6.14;
- the UnconfirmedWrite service, used to write the value of one or more attributes or to invoke one or more methods of COSEM interface objects. It is an unconfirmed service. See 6.15.

4.2.3.6 Services for data and event notification

To support push operation, the DataNotification service is available, see 6.9. It can be used both in application contexts using SN referencing and LN referencing.

NOTE The DataNotification service is used in conjunction with "Push setup" COSEM interface objects see IEC 62056-6-2:2016, 5.3.8.

To support event notification, COSEM also provides non client/server type, unsolicited services:

- with LN referencing the EventNotification service. See 6.10;
- with SN referencing, the InformationReport service. See 6.16.

4.2.3.7 Identifying service invocations: the Invoke_Id parameter

In the client/server model, requests are sent by the client and responses are sent by the server. The client is allowed to send several requests before receiving the response to the previous ones. Therefore – to be able to identify which response corresponds to each request – it is necessary to include a reference in the request.

The Invoke_Id parameter is used for this purpose. The value of this parameter is assigned by the client so that each request carries a different Invoke_Id. The server shall copy the Invoke_Id into the corresponding response.

This feature is available only with LN referencing.

In the DataNotification service – see 6.9 – the Long-Invoke-Id parameter is used instead of the Invoke_Id parameter.

The EventNotification service – being a non-client/server type service – does not contain the Invoke_Id parameter.

4.2.3.8 Priority of service invocations: the Priority parameter

For data transfer services using LN referencing, two priority levels are available: normal (FALSE) and high (TRUE). This feature allows receiving a response to a new request before the response to a previous request is completed.

Normally, the server serves incoming service requests in the order of reception (FIFS, First In, First Served). However, a request with the priority parameter set to HIGH shall be served before the previous requests with priority NORMAL. The response shall carry the same priority flag as that of the corresponding request. Managing priority is a negotiable feature; see 7.3.1.

NOTE 1 As service invocations are identified with an Invoke_Id, services with the same priority can be served in any order.

NOTE 2 If the feature is not supported, requests with HIGH priority are served with NORMAL priority.

This feature is not available with services using SN referencing. The server treats the services on a FIFS basis.

4.2.3.9 Selective access

In the case of some COSEM interface classes, selective access to attributes is available, meaning that either the whole attribute or a selected portion of it can be accessed. For this purpose, access selectors and parameters are specified as part of the specification of the relevant attributes.

To use this possibility, attribute-related services can be invoked with these access selection parameters. In the case of LN referencing, this feature is called Selective access; see 6.6 and 6.7. It is a negotiable feature; see 7.3.1. In the case of SN referencing, this feature is called Parameterized access; see 6.13, 6.14 and 6.15. It is a negotiable feature; see 7.3.1.

4.2.3.10 Multiple references

In a ~~data transfer~~ COSEM object related service invocation, it is possible to reference one or several attributes respectively methods. Using multiple references is a negotiable feature. See 7.3.1.

4.2.3.11 Attribute_0 referencing

With the GET and SET services, a special feature, Attribute_0 referencing, is available. By convention, attributes of COSEM interface objects are numbered from 1 to n, where Attribute_1 is the logical name of the COSEM interface object. Attribute_0 has a special meaning: it references all attributes with positive index (public attributes). The use of Attribute_0 referencing with the GET service is explained in 6.6 and with the SET service in 6.7.

NOTE As specified in IEC 62056-6-2:2016, 4.1 and 4.2, manufacturers can add proprietary methods and/or attributes to any object, using negative numbers.

Attribute_0 referencing is a negotiable feature; see 7.3.1.

4.2.3.12 Transferring long service parameters

~~The data transfer services are carried by the APDUs, exchanged between the peer ALs, in an encoded form. In some cases, the data may be longer than the Client / Server Max Receive PDU Size negotiated. To transfer such 'long' data, two transporting mechanisms are available:~~

- ~~a) long data transfer using the AL block transfer protocol. This mechanism can be used with any confirmed client/server type services. It is a negotiable feature. See 7.3.1;~~
- ~~b) long data transfer in a transparent manner to the AL. This feature can be used when the supporting layer(s) provide(s) segmentation; see Annex A.~~

~~NOTE There is no mechanism within AL block transfer for re-sending or requesting a missing or corrupt block. Such a mechanism can be a feature of long data transfer managed transparently by the supporting layers.~~

The xDLMS service primitives are carried in an encoded form by xDLMS APDUs. This encoded form may be longer than the Client / Server Max Receive PDU Size negotiated. To transfer such 'long' messages, there are two mechanisms available:

- a) service specific block transfer mechanism: in this case, the service primitive invocations contain only one part – one block – of the data (e.g. attribute values), so that the encoded form fits in a single APDU. Using block transfer with the GET / SET / ACTION (LN referencing) and Read / Write (SN referencing) is a negotiable feature, see 7.3.1;

NOTE 1 Block transfer is not available with the unsolicited InformationReport and EventNotification services.

NOTE 2 There is no block-recovery mechanism available with these services.

- b) the general block transfer mechanism specified in 4.2.3.13.

The two mechanisms can co-exist.

An APDU that fits in the Client / Server Max Receive PDU Size negotiated may be too long to fit in a single frame / packet of the supporting layer. Such APDUs may be transported if the supporting layer provide(s) segmentation; see Annex A.

4.2.3.13 General block transfer mechanism

The general block transfer (GBT) mechanism – supporting also streaming of blocks – can be used with any xDLMS service.

NOTE The DataNotification service does not have its own service specific block transfer mechanism. Therefore, to transport long DataNotification APDUs the GBT mechanism is available.

With this mechanism, long application layer level messages are carried by General-Block-Transfer APDUs instead of service specific "with-datablock" APDUs.

The GBT mechanism supports uni-directional and bi-directional block transfer, streaming and lost block recovery:

- uni-directional block transfer means that while one party is sending blocks the other party only confirms the blocks received. If it has blocks to send, it can start sending them when the other party has finished;
- bi-directional block transfer means that while one party is sending blocks, the other party not only confirms the blocks received but if it has blocks to send it can send them as well while it is still receiving blocks;

Bi-directional block transfer is useful when long service parameters need to be transported in both directions.

- streaming means that several blocks may be sent – streamed – by one party without an acknowledgement of each block from the other party;
- lost block recovery means that if the reception of a block is not confirmed, it can be sent again. If streaming is used, lost block recovery takes place at the end of the streaming window.

Using the GBT mechanism is a negotiable feature, see 7.3.1.

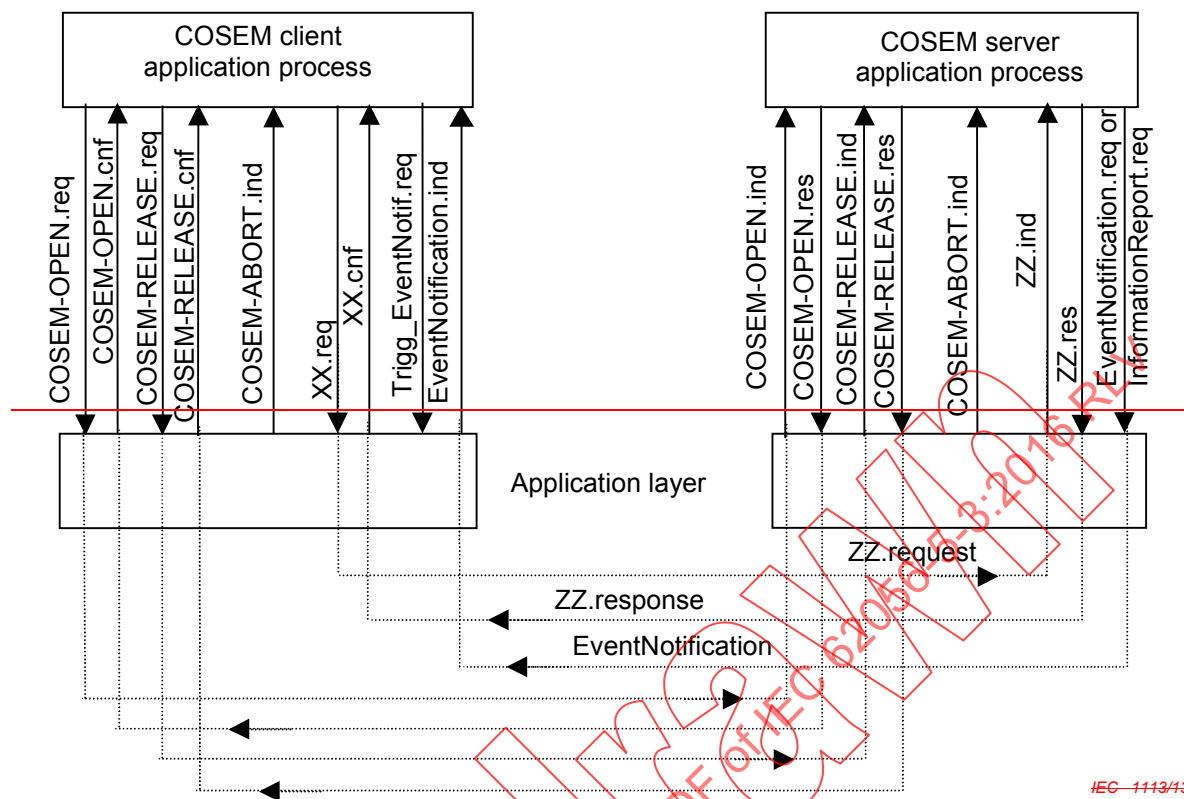
The protocol of the GBT mechanism is specified in 7.3.12.

4.2.4 Layer management services

Layer management services have local importance only. Therefore, specification of these services is not within the scope of this international standard. The specific SetMapperTable service is defined in 6.17.

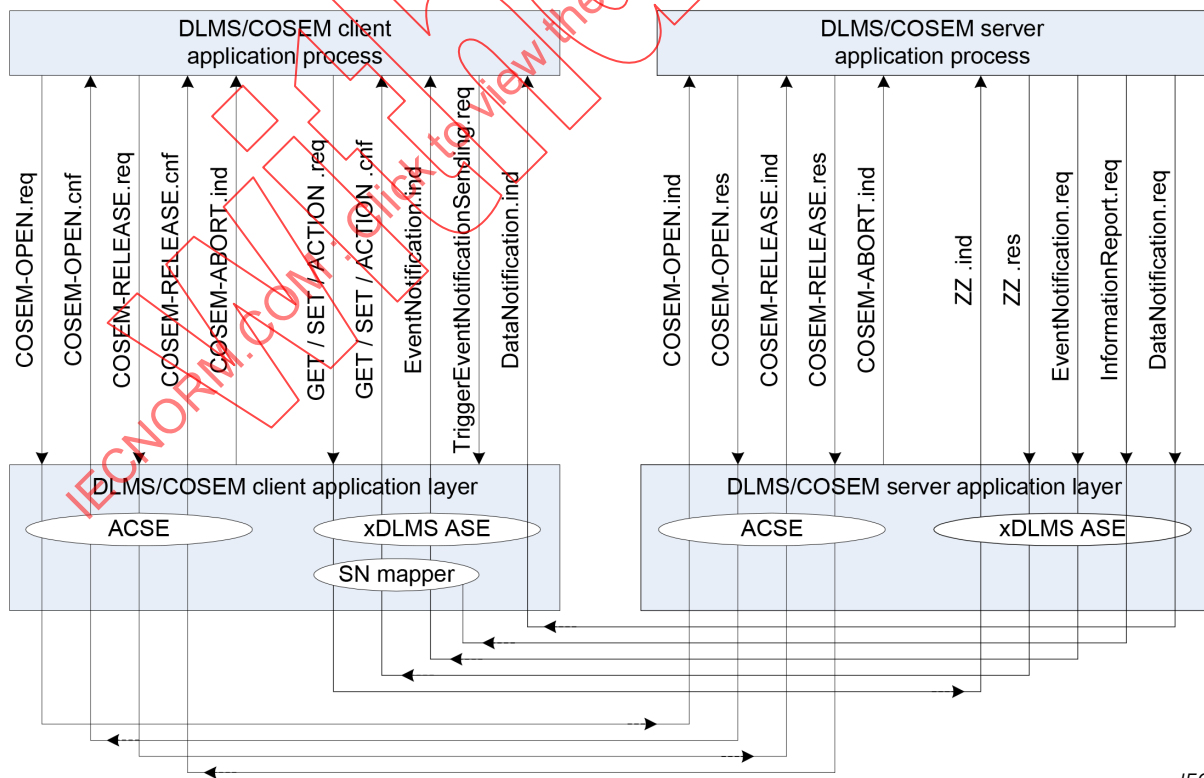
4.2.5 Summary of DLMS/COSEM application layer services

A summary of the services available at the top of the COSEM AL is shown in Figure 2. Layer management services are not shown. Although the service primitives are different on the client and server side, the APDUs are the same. The DLMS/COSEM Application layer services are specified in Clause 6. The DLMS/COSEM Application layer protocol is specified in Clause 7. The abstract syntax of the ACSE and ~~COSEM~~ xDLMS APDUs is specified in Clause 8. Encoding examples are provided in Annex C, Annex D and Annex E.



IEC 1113/13

NOTE XX and ZZ refer to client/server type data transfer services. These services are different on the client side and the server side, if the server does not use LN referencing. See 6.47.



IEC

NOTE The client AP always uses LN referencing. If the server uses SN referencing then a mapping is performed by the SN mapper entity of the client AL. Consequently, the service primitives ZZ.ind and ZZ.res may be LN or SN service primitives. LN/SN service mapping is specified in 6.18.

Figure 2 – Summary of DLMS/COSEM AL services

4.3 DLMS/COSEM application layer protocols

The DLMS/COSEM AL protocols specify the procedures for information transfer for AA control and authentication using connection-oriented ACSE procedures, and for data transfer between DLMS/COSEM clients and servers using xDLMS procedures. Therefore, the AL protocol is based on the ACSE and the DLMS protocols, as specified in ISO/IEC 15954:1999 and in IEC 61334-4-41:1996 – with the extensions for DLMS/COSEM – respectively. The procedures are defined in terms of:

- the interactions between peer ACSE and xDLMS protocol machines through the use of services of the supporting protocol layer;
- the interactions between the ACSE and xDLMS protocol machines and their service user;
- the abstract syntax of the APDUs using ASN.1 as specified in ISO/IEC 8824-1.

The DLMS/COSEM AL protocols are specified in Clause 7.

5 Information security in DLMS/COSEM

~~NOTE Clause 5 is based on parts of NIST documents. Reprinted courtesy of the National Institute of Standards and Technology, Technology Administration, U.S. Department of Commerce. Not copyrightable in the United States.~~

5.1 Definitions

5.1.1 confidentiality

preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information. A loss of confidentiality is the unauthorized disclosure of information

[SOURCE: FIPS PUB 199:2002]

5.1.2 integrity

guarding against improper information modification or destruction, and includes ensuring information non-repudiation and authenticity. A loss of integrity is the unauthorized modification or destruction of information

[SOURCE: FIPS PUB 199:2002]

5.2 General

Confidentiality and integrity are among the key requirements when open systems connect to public media. With the increase of computational power, the requirements for strong cryptographic methods also increase. DLMS/COSEM provides two main information security features for accessing and transporting data:

- *data access security* controls access to the data held by a DLMS/COSEM server. See 5.3;
- *data transport security* allows the sending party to apply cryptographic protection to the xDLMS APDUs sent to ensure confidentiality and integrity. This requires ciphered APDUs. The receiving party can remove or check this protection. See 5.4.

These information security features are provided partly by the COSEM AL, partly by COSEM objects:

- upon AA establishment, ~~two contexts are negotiated: the client and the server negotiate the application context and the authentication context mechanism~~ using the ACSE services. The application context determines whether ciphered APDUs can be used or not. The authentication ~~context mechanism~~ determines the ~~level of data access security~~

protocol to be used by the communication entities to authenticate themselves. The ACSE APDUs are not cryptographically protected;

The user-information field of the ACSE APDUs shall be cryptographically protected as determined by the application-context and the security policy.

- once an AA is successfully established, COSEM services can be used to access attributes and methods of COSEM objects, depending on the access rights valid in the given association. These services are carried by xDLMS APDUs, which may be cryptographically protected: authenticated, encrypted, or both, depending on the security policy in force. The cryptographic protection is applied, removed or checked by the COSEM AL. The COSEM AP of the sending party informs, via service parameters, the COSEM AL about the protection to be applied to the APDU to be sent. The COSEM AL of the receiving party informs the COSEM AP about the protection that has been applied to the APDU received.

The message security methods described in this part of IEC 62056 have been selected from the standards specified by NIST and the IETF.

For an overview of cryptography; see Annex F.

5.3 Data access security

5.3.1 Overview

Data access security concerns role based access to data in a DLMS/COSEM device.

It is managed by the “Association LN” / “Association SN” objects. Each COSEM server i.e. a logical device may support AAs with various clients, each having a different role, and with this, different access rights. Each AA is identified with a pair of lower layer addresses. Each Association object provides a list of objects visible in that particular AA and the access rights to their attributes and methods.

To be able to access data, the client shall be properly authenticated. Upon AA establishment, an authentication ~~context~~ mechanism is negotiated between the client and the server. This specifies the required authentication of the peers, and, where needed, the security algorithm to verify the authentication. Three data access security levels are provided:

- Lowest Level Security (no security);
- Low Level Security (LLS);
- High Level Security (HLS).

5.3.2 No security (lowest level security) authentication

The purpose of No security (lowest level security) authentication is to allow the client to retrieve some basic information from the server. This authentication ~~context~~ mechanism does not require any ~~peer~~ authentication; it allows direct access to the data in the server, within the access rights available in the given AA. The No security authentication mechanism is shown in Figure 3.

5.3.3 Low Level Security (LLS) authentication

The purpose of Low Level Security is to allow the authentication of clients by verifying the password supplied. The server is not authenticated. This authentication ~~context~~ mechanism is typically used when the communication channel offers adequate security to avoid eavesdropping and message (password) replay.

The client has to supply the correct password during the process of AA establishment. If the password is OK, the AA is established and the client can access data within the access rights available in the given AA. Otherwise, the AA is not established.

The LLS authentication process is supported by the COSEM-OPEN service of the COSEM AL – see 6.2 – and it is as follows:

- the client transmits a “secret” (for example a password) to the server, by using the “Calling_Authentication_Value” parameter of the COSEM-OPEN.request service primitive;
- the server checks if the “secret” received corresponds to the client identification;
- if yes, the client is authenticated and the AA can be established. If no, the AA is rejected;
- the result with diagnostic information is sent back by the server using the COSEM-OPEN.response service primitive.

The association objects provide a method/attribute to change the “secret”; see IEC 62056-6-2:2016, 5.3.3 and 5.3.4.

The LLS authentication ~~process with LLS~~ mechanism is shown in Figure 3.

5.3.4 High Level Security (HLS) authentication

The purpose of High Level Security is to allow mutual authentication of the client and the server participating in an association. This authentication ~~context mechanism~~ is typically used when the communication channel offers no intrinsic security and precautions have to be taken against eavesdroppers and against message (password) replay.

HLS requires that both the client and the server mutually authenticate each other. This is a 4-pass process, involving the exchange of challenges during AA establishment, which is followed by exchanging the results of processing these challenges, using cryptographic methods. If the authentication takes place, the client can proceed to access data within the access rights available in the given AA, and it accepts data coming from the server. Otherwise, the AA is not established.

The HLS authentication process is supported by the COSEM-OPEN service – see 6.2 – and by the Association LN / SN objects as follows:

Pass 1: The client transmits a “challenge” CtoS – for example, a random string – to the server;

Pass 2: The server transmits a “challenge” StoC – for example, a random string – to the client.

The length of the challenges shall be 8 octets to 64 octets.

If StoC is the same as CtoS, the client shall reject it.

Pass 3: The client processes a “challenge” StoC according to the rules of the HLS authentication mechanism negotiated:

- in the case of HLS authentication_mechanism_id(2), the method of processing the challenge is secret – for example encrypting with a secret key – which is the HLS secret known by both the client and the server;
- in the case of HLS authentication_mechanism_id(3), the client ~~right concatenates StoC received during Pass2 with the HLS secret, known by both the client and the server, and generates a digest using the MD5 algorithm as specified in RFC 1321~~ processes StoC concatenating StoC and the shared HLS secret and calculating a digest using the MD5 algorithm (RFC 1321)

$$f(\text{StoC}) = \text{MD5}(\text{StoC} \parallel \text{HLS secret})$$

- in the case of HLS authentication_mechanism_id(4), the process is the same, but the client generates a digest using the SHA-1 algorithm. FIPS PUB ~~180-1~~ 180-4 applies in this respect;

- in the case of HLS authentication_mechanism_id(5), ~~an authentication tag is calculated using GMAC~~ the client processes StoC calculating a hash value T using the GMAC algorithm

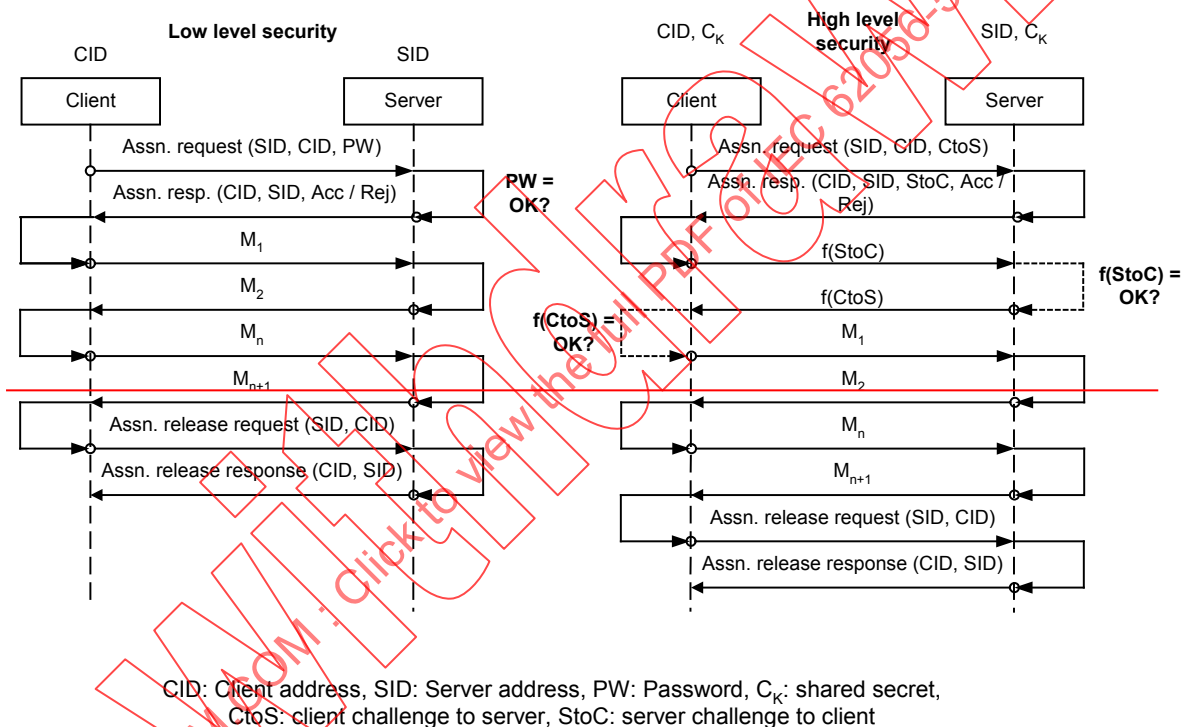
$$f(\text{StoC}) = \text{SC} \parallel \text{FC} \parallel T = \text{SC} \parallel \text{FC} \parallel \text{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{StoC})$$

See also 5.4.8.4.

The result – $f(\text{StoC})$ – is sent back to the server. The server checks if $f(\text{StoC})$ is the result of correct processing and – if so – it accepts the authentication of the client.

Pass 4: If the client is authenticated, the server processes the “challenge” CtoS in the same way as described in Pass3. The result – $f(\text{CtoS})$ – is sent back to the client. The client checks if $f(\text{CtoS})$ is the result of correct processing and – if so – it accepts the authentication of the server.

The HLS authentication ~~process with HLS~~ mechanism is shown in Figure 3.



IEC-1114/13

Figure 3 — LLS and HLS authentication

It is important to note that the security of the message exchange phase is independent of the security of the authentication mechanism. Even in the case where the parties are not authenticated the security of message exchanged can be ensured using cryptographically protected APDUs.

Pass 1 is supported by the COSEM-OPEN.request service primitive of the client AL. The parameter "Security_Mechanism_Name" carries the identifier of the HLS mechanism, and the parameter "Calling_Authentication_Value" carries the challenge CtoS.

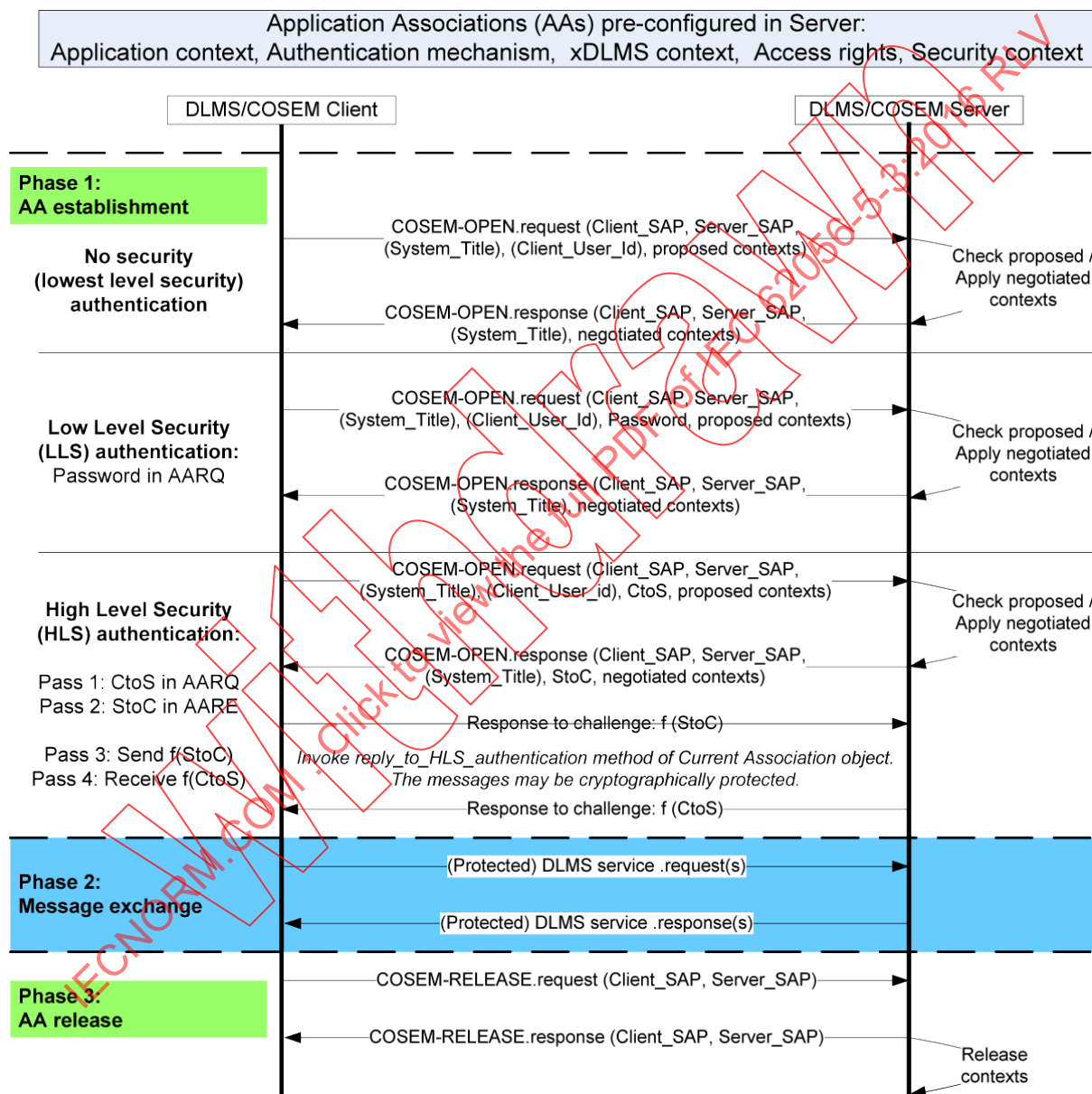
Pass 2 is supported by the COSEM-OPEN.response service primitive of the server AL. The parameter "Security_Mechanism_Name" carries the identifier of the HLS mechanism, and the parameter "Responding_Authentication_Value" carries the challenge StoC.

After Pass 2 ~~the AA is formally established, but the access of the client is restricted to the~~ – provided that the proposed application context and xDLMS context are acceptable – the

server grants access to the method `reply_to_HLS_authentication` of the current "Association SN / LN" object using the application context negotiated.

Pass 3 and Pass 4 are supported by the method `reply_to_HLS_authentication` of the ~~association object(s); see IEC 62056-6-2:—, 5.3.1 and 5.3.2~~ "Association SN / LN" object(s). If both passes 3 and 4 are successfully executed, then ~~full access is granted according to the current AA~~ the AA is established with the application context and xDLMS context negotiated. ~~Otherwise, either the client or the server aborts the AA.~~

NOTE The dedicated-key, if transferred, can be used from this moment.



IEC

NOTE 1 The elements `System_Title` and `Client user` (shown in brackets) are optional.

NOTE 2 In pre-established AAs no authentication takes place.

Figure 3 – Authentication mechanisms during AA establishment

In addition, the Association SN / LN object provides the method to change the HLS "secret": `change_HLS_secret`.

REMARK After the client has issued the `change_HLS_secret()` – or `change_LLS_secret()` – method, it expects a response from the server acknowledging that the secret has been changed. It is possible that the server transmits the acknowledgement, but due to communication problems, the acknowledgement is not received at the client side. Therefore, the client does not know if the secret has been changed or not. For simplicity reasons, the server does not offer any special support for this case; i.e. it is left to the client to cope with this situation.

5.4 Data transport security

5.4.1 Applying, removing or checking the protection: ciphering and deciphering

~~For data transport security, cryptographic protection can be applied before sending an xDLMS APDU as determined by the security policy; see 5.4.3 then removed or checked after the reception of an APDU.~~

~~NOTE Cryptographic protection of data in storage is out of the scope of this companion specification.~~

~~Applying the protection is achieved by ciphering. Deciphering removes or checks the protection, restoring the original xDLMS APDU. Ciphering and deciphering is performed by the COSEM AL as shown in Figure 4.~~

~~When a COSEM service request or response primitive is invoked by the client or the server AP respectively, the service parameters include the Security_Options parameter. This parameter informs the AL on the requested security to be applied on the xDLMS APDU carrying the service primitive, and it may identify elements of the security material to be used.~~

~~Similarly, a COSEM indication or confirm service primitive includes a Security_Status parameter. This parameter informs the AP on the security that was applied on the xDLMS APDU carrying the service primitive, and it may include information on the elements of the security materials used. The authentication tag – if any – is also passed.~~

~~For COSEM service specifications, see Clause 6.~~

xDLMS APDUs – the messages – transported between the client and the server can be protected using cryptographic methods.

NOTE This also applies to the xDLMS Initiate APDUs carried by the AARQ / AARE APDUs.

When a COSEM object attribute or method related xDLMS service primitive is invoked by the AP, the service parameters include the Security_Options parameter. This parameter informs the AL on the kind of ciphered APDU to be used, on the protection to be applied, and includes the necessary security material. The AL builds first the APDU corresponding to the service primitive then it builds the ciphered APDU.

When the AL receives a ciphered APDU, it decipheres it, verifying and removing the protection, restoring the original, unciphered APDU. When this is successfully done, it invokes the appropriate service primitive. The service parameters include the Security_Status parameter, that informs the AP about the kind of ciphered APDU used, on the protection that has been verified and removed, and may include security material. They also include the Protection_Element parameter.

The Security_Options, Security_Status and Protection_Element parameters are specified in 6.5.

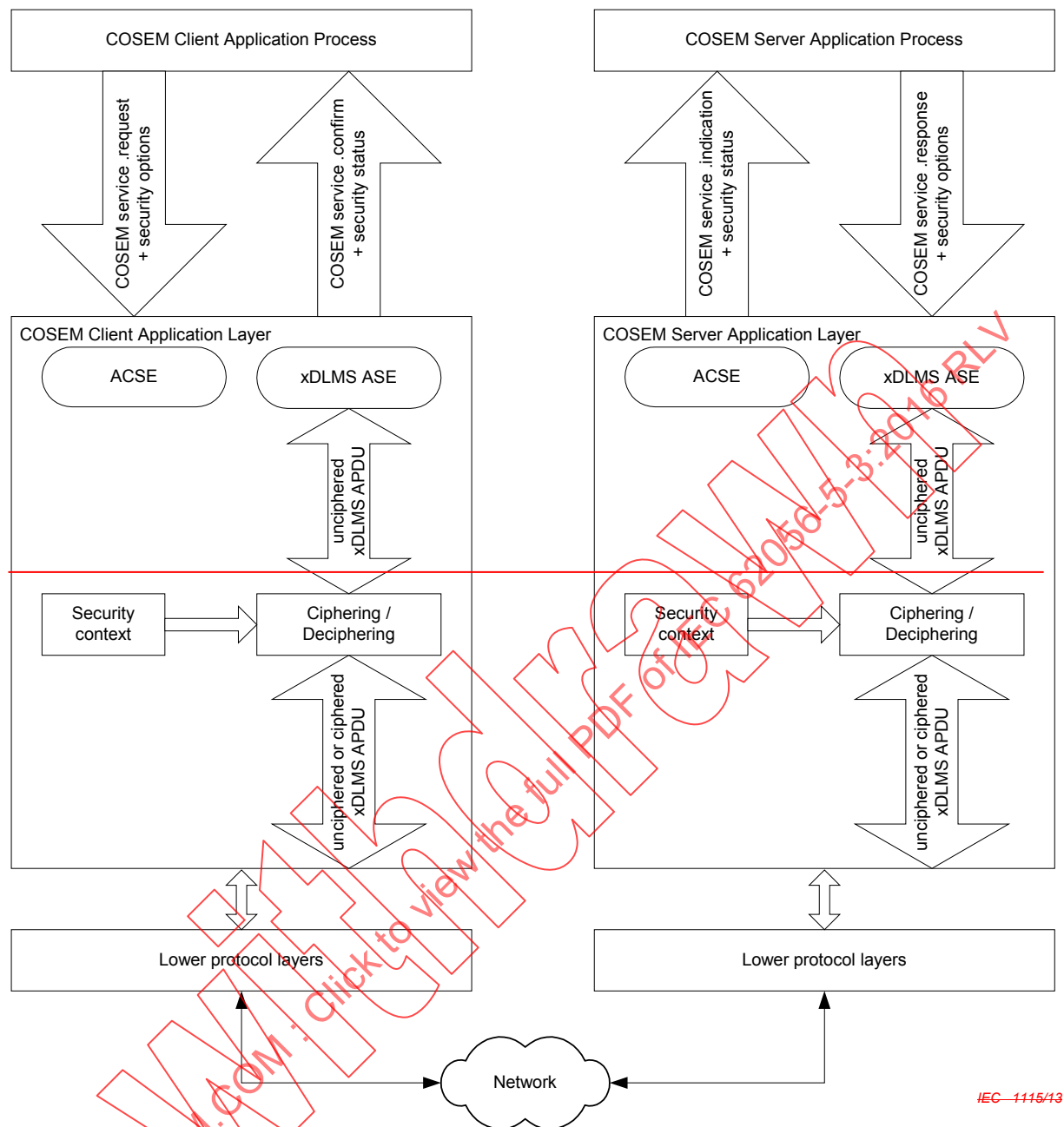


Figure 4 — Data transport security in DLMS/COSEM

5.4.2 Security context

The security context defines security attributes relevant for the ciphering / deciphering process:

- the security policy in force, determining the kind of protection to be applied. See 5.4.3;
- the security suite, specifying the security algorithm(s). See 5.4.4;
- the security material relevant for the given security suite, including elements like block cipher keys, authentication keys, initialization vectors etc. See 5.4.5.

5.4.3 Security policy

The following security policies are specified:

- security is not imposed;
- all messages are authenticated;

- all messages are encrypted;
- all messages are authenticated and encrypted.

The security policy is held by the security_policy attribute of the “Security setup” object; see IEC 62056-6-2:2016, 5.3.7.

Authenticated access may be required selectively: certain attributes and methods may be accessible only by using authenticated messages. This is indicated by the access mode to each attribute and method; see IEC 62056-6-2:2016, 5.3.3 and 5.3.4 respectively. Therefore, authenticated xDLMS APDUs may be used – within a ciphered application context – even when the security policy in effect does not require that all messages be authenticated.

Note that if authenticated access is required, but the application context is not a ciphered one, the attributes and methods requiring authentication cannot be accessed. If the client attempts to send a ciphered APDU in an unciphered application context, then the server application layer shall reject it. In the case of SN referencing, the response shall be ConfirmedServiceError APDU, carrying the tag of the rejected APDU. In the case of LN referencing, the response shall be an ExceptionResponse APDU.

On the other hand, encryption applies generally for all messages within a given AA: if the security policy requires that all messages shall be encrypted, then all APDUs shall be encrypted – and additionally they may be authenticated.

When the security policy requires that all messages shall be authenticated and encrypted, then only APDUs that are both encrypted and authenticated can be used.

Messages protected by higher security than what the security policy requires are always allowed (provided that the application context negotiated allows them).

5.4.4 Security suite

A security suite determines the cryptographic algorithm(s) used for message security. A security suite is identified with a Security Suite ID; see Table 2. Currently, one security suite is specified, the Galois/Counter Mode (GCM) with AES-128. In this security suite, global keys – see 5.4.7.3.3 – are protected during transportation using the AES-128 key wrap algorithm.

Table 2 – Security suites

Security Suite ID	Authentication algorithm	Encryption algorithm	Key transport method
0	AES-GCM-128	AES-GCM-128	Key wrapping using AES-128 key wrap
All other reserved	–	–	–

5.4.5 Security material

The elements of the security material are the following:

- a block cipher key, denoted *EK*;
- an authentication key, denoted *AK*;
- an initialization vector, denoted *IV*.

The elements depend on the security suite. For AES-GCM-128, they are defined in 5.4.8.

5.4.6 Ciphered xDLMS APDUs

~~Ciphered xDLMS APDUs can be used in a ciphered COSEM application context only. A ciphered APDU is always an octet string.~~

~~In a ciphered COSEM application context, unciphered APDUs may also be used.~~

~~The structure of the ciphered APDU depends on the kind of ciphering applied; see Figure 5:~~

- ~~• if the APDU is authenticated only, it contains the APDU tag, the length field, the security header field, the original APDU and the authentication tag;~~
- ~~• if the APDU is encrypted only, it contains the APDU tag, the length field, the security header field, and the encrypted DLMS APDU;~~
- ~~• if the APDU is both authenticated and encrypted, it contains the APDU tag, the length field, the security header field, the encrypted APDU and the authentication tag.~~

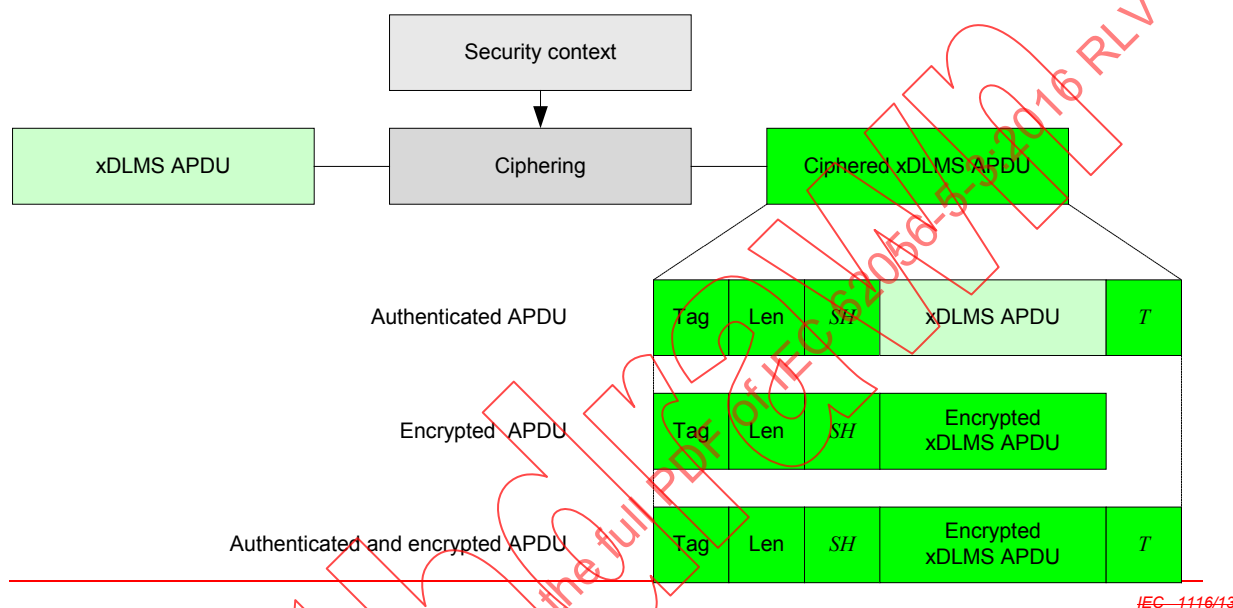


Figure 5 – Ciphered xDLMS APDUs

~~The APDU tag identifies the type of the APDU; see Clause 8.~~

~~The length field specifies the length of the octet-string (including the security header, the unencrypted or encrypted xDLMS APDU and the authentication tag).~~

~~The Security Header, SH, includes the Security Control field, SC right concatenated with the Frame Counter, FC.~~

~~The Security Control field is shown in Table 3, where:~~

- ~~• Bit 3...0: Security_Suite_Id; see 5.4.4;~~
- ~~• Bit 4: “A” subfield: indicates that the APDU is authenticated;~~
- ~~• Bit 5: “E” subfield: indicates that the APDU is encrypted;~~
- ~~• Bit 6: Key_set subfield 0 = Unicast;~~
~~1 = Broadcast; see 5.4.7.2;~~
- ~~• Bit 7: Reserved, shall be set to 0.~~

Table 3 – Security control field

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3...0
Reserved, set to 0	Key_set	E	A	Security_Suite_Id

~~The Frame Counter is an internal counter maintained by the sending and receiving parties.~~

~~Finally, T is the authentication tag, calculated by the authentication algorithm.~~

Ciphered xDLMS APDUs can be used in a ciphered application context only. In a ciphered application context, unciphered APDUs may also be used.

The different kind of ciphered APDUs are shown in Table 3. Their structure is shown in Figure 4 and Figure 5.

Table 3 – Ciphered xDLMS APDUs

APDU type	Parties	Type of crypto	Security services	Key used
Service specific global / dedicated ciphering	Client – Server	Symmetric	Authentication Encryption	Shared global / dedicated key
general-glo-ciphering				
general-ded-ciphering				

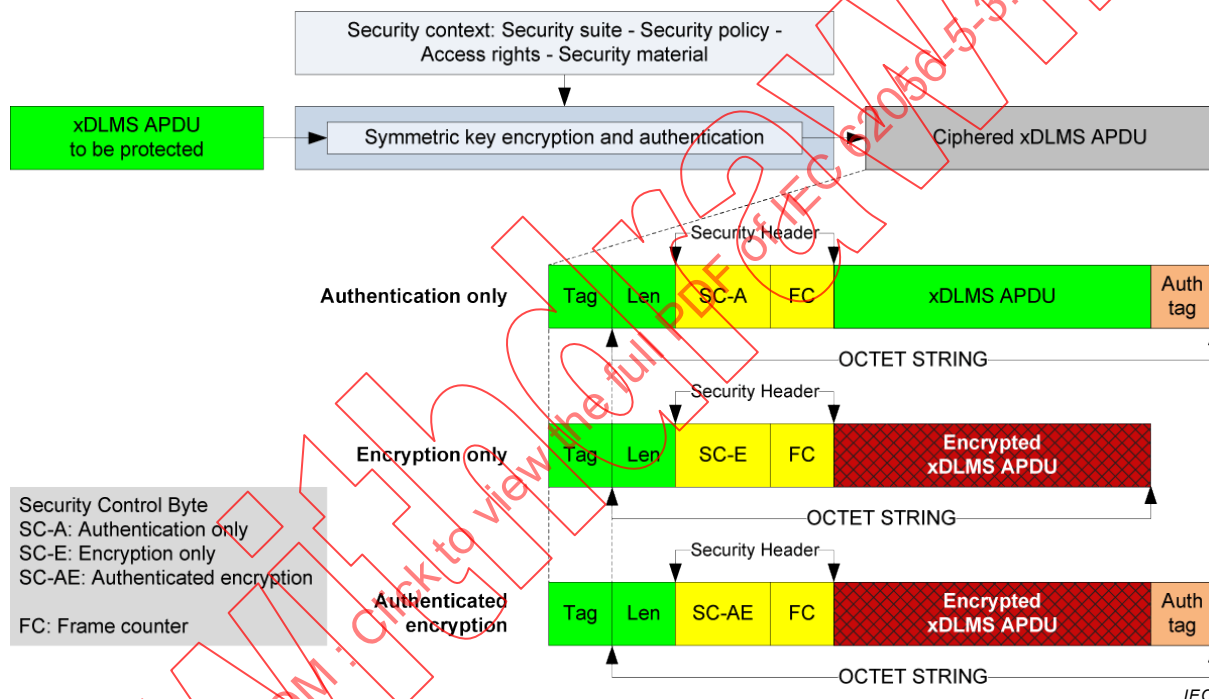
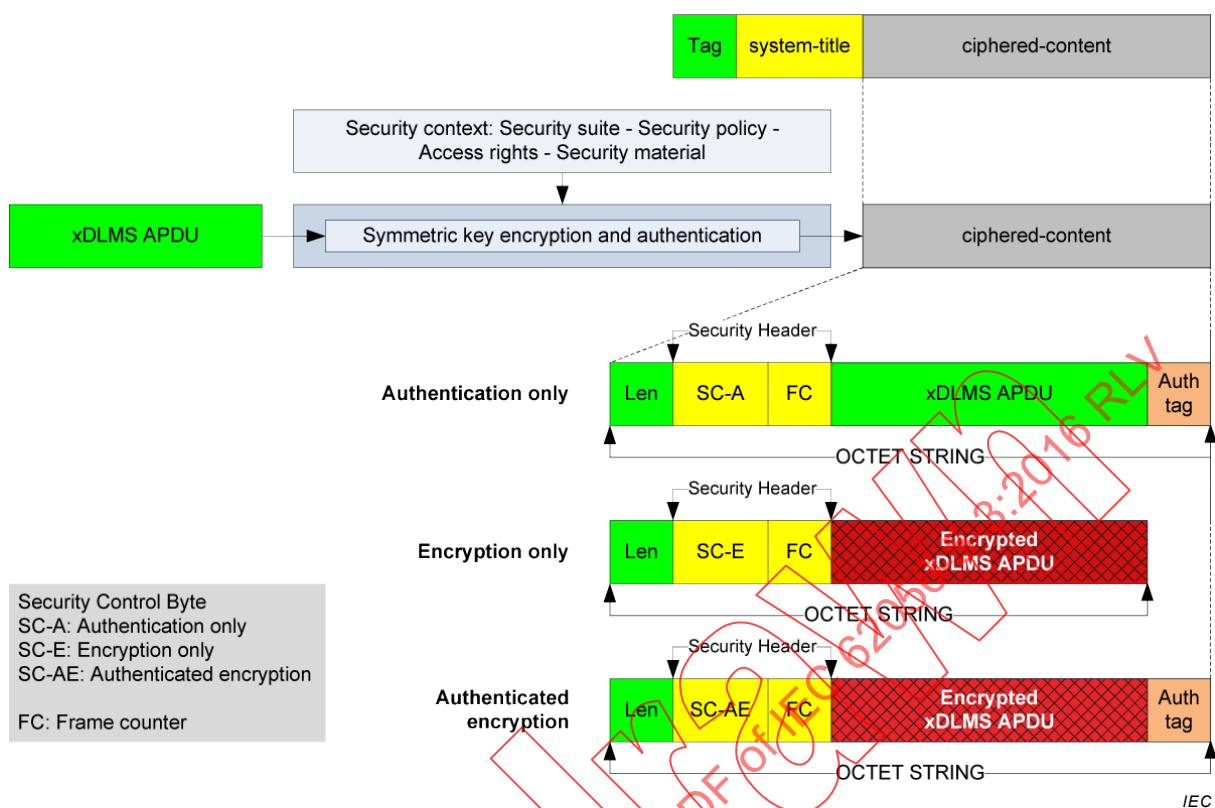


Figure 4 – Structure of service specific global ciphering and dedicated ciphering APDUs



NOTE The purpose to include system-title of the sender is to allow the other party to build the initialization vector where the system-title has not been exchanged in another way; see 5.4.8.3.4.6.

Figure 5 – Structure of general global ciphering and dedicated ciphering APDUs

The use of the fields of the ciphered APDUs is summarized in Table 4.

Table 4 – Use of the fields of the ciphered APDUs

APDU field	Service specific global / dedicated ciphering	general-glo-/ general-ded-ciphering	Meaning
tag	Service specific	[219] [220]	The tag of the ciphered APDU; see Clause 8.
system-title	–	0	System title of the sender. NOTE It is octet-string, which may be of length zero when transmitting the system-title is not required.
length	+	+	Length of the octet-string that contains the ciphered xDLMS APDU / ciphered-content.
security control byte	+	+	Provides information on the protection applied, the key-set and the security suite used. See Table 6.
Frame counter	+	+	The invocation field of the initialization vector. It is an integer counter which increments upon each invocation of the authenticated encryption function using the same key. When a new key is established the related frame counter shall be reset to 0.
unprotected xDLMS APDU	(+)	(+)	The APDU that is protected.
encrypted xDLMS APDU	(+)	(+)	The encrypted APDU i.e. the ciphertext.
authentication tag	(+)	(+)	Calculated by the AES-GCM algorithm, see 5.4.8.

5.4.7 Cryptographic keys

5.4.7.1 General

A cryptographic key is a parameter used in conjunction with a cryptographic algorithm that determines its operation in such a way that an entity with knowledge of the key can reproduce or reverse the operation, while an entity without knowledge of the key cannot. For the purposes of DLMS/COSEM, examples of operations include:

- the transformation of plaintext data into ciphertext data;
- the transformation of ciphertext data into plaintext data;
- the computation of an authentication code from data;
- the verification of an authentication code from data and a received authentication code.

5.4.7.2 Key types

Various key types are defined. They are identified according to their classification, their cryptographic function, their use and their scope.

By their classification, a distinction is made between:

- *symmetric* keys. A symmetric key is a single cryptographic key that is used with a secret (symmetric) key algorithm. For an overview of symmetric key algorithms; see Clause F.3;
- *public* and *private* keys, used with public key cryptographic algorithms. For an overview of asymmetric key algorithms; see Clause F.4.

For symmetric keys, a distinction is made between:

- *Symmetric authentication keys*, used with symmetric key algorithms to provide assurance of the integrity and source of messages;
- *Symmetric data encryption keys*, used with symmetric key algorithms to apply confidentiality protection to information; and
- *Symmetric key wrapping keys*, used to encrypt other keys using symmetric key algorithms. Key wrapping keys are also known as key encrypting keys (KEK).

By their use, a distinction is made between:

- *unicast keys*, used to secure unicast communication between two peers;
- *broadcast keys*, used to secure broadcast communication between a DLMS/COSEM client and several DLMS/COSEM servers. In DLMS/COSEM, broadcast can be initiated by the client only.

By their scope, a distinction is made between *dedicated keys* and *global keys*. These terms are DLMS/COSEM specific:

- a *dedicated key* is a ciphering key that may be used to cipher xDLMS APDUs from the establishment of an AA between a client and a server until the AA is released. Therefore, its lifetime is the same as the lifetime of the AA. It is delivered during AA establishment and used in subsequent transmissions within the same AA.

When the AA is released, the dedicated key should be destroyed by the server as well as by the client.

- a *global key* is a ciphering key that may be (re-)used to cipher xDLMS APDUs, exchanged between the same client and server, in more than one instance of the AA.

The following (symmetric) encryption keys may be available: global unicast key, global broadcast key, dedicated unicast key.

A (symmetric) authentication key is always a global key that can be used in unicast and broadcast messages.

In addition, security suite specific rules may apply. See also Table 5.

5.4.7.3 Key management

5.4.7.3.1 System architectures

NOTE Subclause 5.4.7.3 provides general guidelines for secure implementation. The management of the security system, including the security keys is the responsibility of the system operator.

For the purposes of 5.4.7.3, two general system architectures are considered:

- the ~~COSEM~~ client is the central DCS, exchanging data directly with ~~COSEM~~ servers;
- the ~~COSEM~~ client is a concentrator, exchanging data on the one hand with ~~COSEM~~ servers, and on the other hand with the central DCS. In this case, the concentrator may or may not be a ~~COSEM~~ server at the same time. The central DCS may or may not be a ~~COSEM~~ client.

For generation and distribution of symmetric keys, NIST SP 800-57:2006, 8.1.5.2 applies.

5.4.7.3.2 Master key

A master key shall be present in each ~~COSEM~~ server logical device configured in the system. This key is used for wrapping global keys; see 5.4.7.3.3.

NOTE 1 The way of generating and installing the master key is out of the scope of this international standard.

A secure mechanism shall be in place to ensure that the central data DCS knows the master key of each ~~COSEM~~ server logical device participating in the system.

NOTE 2 The specification of such a mechanism is out of the scope of this international standard.

The concentrators, if they are present in the system, shall not know the master keys.

For security reasons, the lifetime of the master key should be limited. The way to replace the master keys is out of the scope of this standard. For guidance, see NIST SP 800-57:2006, 8.2.3, Key change function.

5.4.7.3.3 Global keys

Before ciphering can be used, global keys have to be generated and delivered to the COSEM logical devices participating in the system.

Global keys shall be generated by the central DCS.

The way to generate the global keys is outside the scope of this international standard. For security reasons, their lifetime should be limited.

For delivery, global keys shall be wrapped using the AES-128 key wrap algorithm as specified in RFC 3394, and using the master key as the Key Encryption Key (KEK).

When the system works without (a) concentrator(s), the global keys shall be delivered by the central DCS invoking the `global_key_transfer` method of the "Security setup" interface object in the ~~COSEM~~ server with the wrapped global key as a parameter; see IEC 62056-6-2:2016, 5.3.7.

When the system works with (a) concentrator(s), the global keys shall be delivered – wrapped by the master key – to the concentrator. The `global_key_transfer` method of the "Security setup" interface object in the ~~COSEM~~ server shall be invoked then by the concentrator with the wrapped global key as a parameter. For details, see IEC 62056-6-2:2016, 5.3.7.

In any case, the global key is wrapped by the master key.

The concentrator should not know the master keys, therefore it should not be able to wrap / unwrap global keys.

The global keys shall also be made available by the central DCS to the concentrator(s), if present, in a secure way.

NOTE The specification of such a process is out of the scope of this part of IEC 62056.

5.4.7.3.4 Dedicated keys

When the system works without (a) concentrator(s), dedicated keys shall be generated by the central DCS. When the system works with (a) concentrator(s), dedicated keys shall be generated by the concentrators.

For delivery, they shall be included in the dedicated-key field of the xDLMS InitiateRequest APDU, carried by the user-information field of the AARQ APDU. The xDLMS InitiateRequest APDU shall be authenticated and encrypted using the AES-GCM-128 algorithm, the global unicast encryption key and – if in use, see 5.4.8.3.4.4 – the authentication key. Likewise, the xDLMS InitiateResponse APDU, carried by the user-information field of the AARE APDU shall be also encrypted and authenticated the same way. See also 5.2.

5.4.7.3.5 Summary

The various cryptographic key types, together with their use and their management are summarized in Table 5.

Table 5 – Cryptographic keys and their management

Key type	Use	Generation	Delivery	Location
Symmetric keys				
Master key	Key Encryption Key (KEK) for global keys	Not specified	Not specified	Central DCS and DLMS /COSEM server
Global unicast encryption key	Global ciphering of unicast xDLMS APDUs	Central DCS	Wrapped with master key, invocation of <code>global_key_transfer</code> method by the central DCS or the concentrator	Central DCS (and Concentrator) and COSEM server
Global broadcast encryption key	Global ciphering of broadcast xDLMS APDUs	Central DCS	Wrapped with master key, invocation of <code>global_key_transfer</code> method by the central DCS or the concentrator	Central DCS (and Concentrator) and DLMS /COSEM server
Authentication key (Global)	Authentication of xDLMS APDUs	Central DCS	Wrapped with master key, invocation of <code>global_key_transfer</code> method by the central DCS or the concentrator	Central DCS (and Concentrator) and DLMS /COSEM server
Dedicated (unicast) encryption key	Dedicated ciphering of unicast xDLMS APDUs	Central DCS or Concentrator	Transported as part of the xDLMS <code>InitiateRequest</code> APDU, which is encrypted and authenticated using the AES-GCM-128 algorithm, the global unicast encryption key and the authentication key	Central DCS (or Concentrator) and DLMS /COSEM server (during the lifetime of the AA)
NOTE If alternatives are given, the first alternative is valid for systems not using concentrators and the second alternative for systems using concentrators.				

5.4.8 The Galois/Counter Mode of Operation (GCM)

5.4.8.1 General

NOTE The following text is taken from NIST SP 800-38D:2007, Clause 3.

Galois/Counter Mode (GCM) is an algorithm for authenticated encryption with associated data. GCM is constructed from an approved symmetric key block cipher with a block size of 128 bits, such as the Advanced Encryption Standard (AES) algorithm; see FIPS PUB 197. Thus, GCM is a mode of operation of the AES algorithm.

GCM provides assurance of the confidentiality of data using a variation of the Counter mode of operation for encryption.

GCM provides assurance of the authenticity of the confidential data (up to about 64 gigabytes per invocation) using a universal hash function that is defined over a binary Galois (i.e., finite) field. GCM can also provide authentication assurance for additional data (of practically unlimited length per invocation) that is not encrypted.

If the GCM input is restricted to data that is not to be encrypted, the resulting specialization of GCM, called GMAC, is simply an authentication mode on the input data.

GCM provides stronger authentication assurance than a (non-cryptographic) checksum or error detecting code; in particular, GCM can detect both accidental modifications of the data and intentional, unauthorized modifications.

In DLMS/COSEM, it is also possible to use GCM to provide confidentiality only: in this case, the authentication tags are simply not computed and checked.

For more information, see NIST SP 800-38D:2007.

5.4.8.2 Definitions, abbreviations, symbols and notation relevant for the Galois/Counter mode

Term / Abbreviation	Symbol	Meaning
Additional authenticated data (AAD)	A	Input data to the authenticated encryption function that is authenticated but not encrypted. It is also known as Associated Data.
Authenticated decryption		Function of GCM in which the ciphertext is decrypted into the plaintext, and the authenticity of the ciphertext and the AAD are verified.
Authenticated encryption		Function of GCM in which the plaintext is encrypted into the ciphertext, and an authentication tag is generated on the AAD and the ciphertext.
Authentication key	AK	Part of the AAD
Block cipher		Parameterized family of permutations on bit strings of a fixed length; the parameter that determines the permutation is a bit string called the key.
Ciphertext	C	Encrypted form of the plaintext
	EK	Block cipher key
Fixed field		In the deterministic construction of IVs, field that identifies the device or context for the instance of the authenticated encryption function.
	FC	Frame counter
Fresh		For a newly generated key, property of being unequal to any previously used key.
GCM		Galois/Counter Mode
Initialization vector	IV	Nonce that is associated with an invocation of authenticated encryption on a particular plaintext and AAD.
Invocation field		In the deterministic construction of IVs, field that identifies the sets of inputs to the authenticated encryption function in a particular device or context. For the purposes of this international standard, the invocation field is the frame counter.
Key		Parameter of the block cipher that determines the selection of the forward cipher function from the family of permutations.
	KEK	Key encryption key
	$len(X)$	Bit length of the bit string X
	$LEN(X)$	Octet length of the octet string X
Nonce		Value that is used only once within a specified context.
Plaintext	P	Input data to the authenticated encryption function that is both authenticated and encrypted.
	SC	Security control byte
	SH	Security header; concatenation of the security control byte SC and the frame counter FC : $SH = SC \parallel FC$.
System title	$Sys-T$	A unique identifier of the system.
Authentication tag	T	Cryptographic checksum on data that is designed to reveal both the accidental errors and the intentional modification of the data.
	t	Bit length of the authentication tag NOTE This is the same as $len(T)$.
	$X \parallel Y$	Concatenation of two strings, X and Y .

5.4.8.3 Elements of GCM

5.4.8.3.1 Block cipher and keys

For the purposes of this international standard, the AES encryption standard has been selected. GCM uses the forward cipher function; it does not employ the inverse cipher function.

GCM uses a single key, the block cipher key (the key, for short). Its size shall be 128 bits. In DLMS/COSEM, for additional security, an authentication key is also specified. It is part of the additional authenticated data, AAD. The block cipher key is denoted *EK* and the authentication key is denoted *AK*.

5.4.8.3.2 GCM functions

5.4.8.3.2.1 General

NOTE The following is based on NIST SP 800-38D:2007, 5.2.

The two functions that comprise GCM are called authenticated encryption and authenticated decryption. The authenticated encryption function encrypts the confidential data and computes an authentication tag on both the confidential data and any additional, non-confidential data. The authenticated decryption function decrypts the confidential data, contingent on the verification of the tag.

When the input is restricted to non-confidential data, the resulting variant of GCM is called GMAC. For GMAC, the authenticated encryption and decryption functions become the functions for generating and verifying an authentication tag on the non-confidential data.

Finally, if authentication is not required, the authenticated encryption function encrypts the confidential data, but the authentication tag is not computed. The authenticated decryption function decrypts the confidential data, but no authentication tag is computed and verified.

5.4.8.3.2.2 Authenticated encryption – input and output data

NOTE The following text is based on NIST SP 800-38D:2007, 5.2.1.1 and RFC 4106:2005, 2.1.

The authenticated encryption operation has four inputs, each of which shall be an octet string:

- a plaintext, denoted *P*;
- additional authenticated data (AAD), denoted *A*. It shall include – together with other elements – the authentication key, denoted *AK*.
- a secret block cipher key denoted *EK*;
- an initialization vector denoted *IV*.

The plaintext and the AAD are the two categories of data that GCM protects. GCM protects the authenticity of the plaintext and the AAD; GCM also protects the confidentiality of the plaintext, while the AAD is left in the clear.

The IV is essentially a nonce, i.e. a value that is unique within the specified (security) context, which determines an invocation of the authenticated encryption function on the input data to be protected. See 5.4.8.3.4.5.

There are two outputs:

- a ciphertext, denoted *C* whose length is exactly that of the plaintext *P*;
- an authentication tag, denoted *T*.

5.4.8.3.2.3 Authenticated decryption – input and output data

The authenticated encryption and authenticated decryption functions, their inputs and outputs, as well as the structure of the ciphered xDLMS APDU / ciphered-content are shown in Figure 6 below. The authenticated decryption operation has five inputs:

- the secret block cipher key, denoted EK ;
- the initialization vector, denoted IV ;
- the ciphertext, denoted C ;
- the additional authenticated data (AAD), denoted A ;
- the authentication tag, denoted T .

The output is one of the following:

- the plaintext P that corresponds to the ciphertext C , or
- a special error code, denoted $FAIL$ in this standard.

The output P indicates that T is the correct authentication tag for IV , A , and C ; otherwise, the output is $FAIL$.

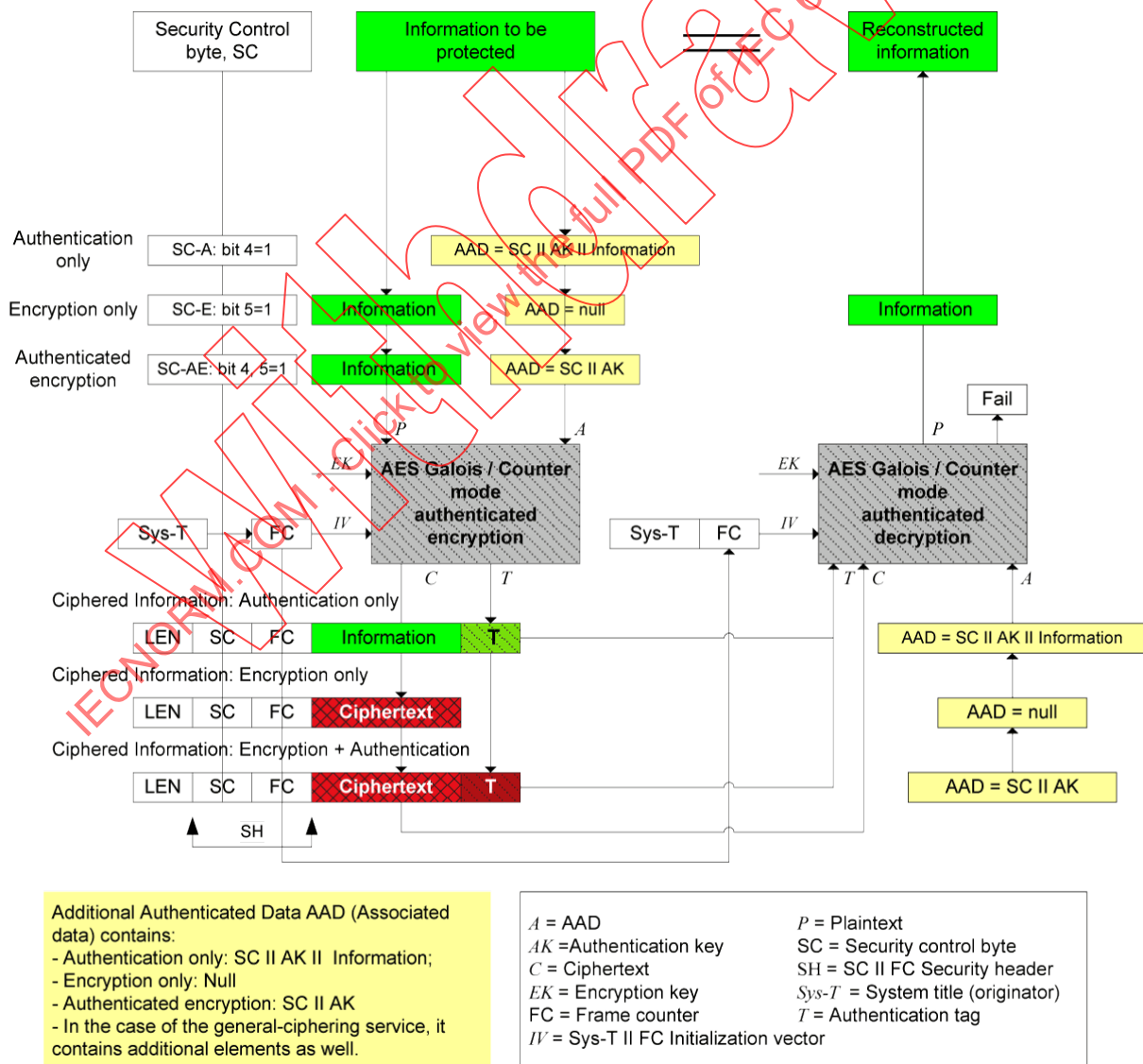


Figure 6 – Cryptographic protection of xDLMS APDUs using GCM

5.4.8.3.3 Security header with GCM

The security header ~~shall be as specified in 5.4.6, with security_suite_id = 0 and with the appropriate values of the Key_set, E and A sub-fields~~ SH includes the security control byte concatenated with the invocation counter: SH = SC || FC. The security control byte is shown in Table 6, where:

- Bit 3...0: Security_Suite_Id, see 5.4.4;
- Bit 4: “A” subfield: indicates that authentication is applied;
- Bit 5: “E” subfield: indicates that encryption is applied;
- Bit 6: Key_Set subfield 0 = Unicast;
1 = Broadcast
- Bit 7: Reserved, shall be set to 0.

Table 6 – Security control byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3..0
Reserved	Key_Set	E	A	Security_Suite_Id

The Frame Counter is an internal counter maintained by the sending and receiving parties.

5.4.8.3.4 GCM parameters and data elements

5.4.8.3.4.1 Length of the authentication tag

The bit length of the authentication tag, denoted t , is a security parameter. Its value shall be 96 bits.

5.4.8.3.4.2 Plaintext and additional authenticated data

The plaintext, denoted P and the additional authenticated data, denoted A depend on the kind of protection. They are shown in Table 7, where SC is the security control byte, AK is the authentication key and M is the message, i.e. the xDLMS APDU to be protected.

The bit lengths of P and A shall meet the following requirements:

- $\text{len}(P) < 2^{39}-256$;
- $\text{len}(A) < 2^{64}-1$;
- the bit lengths of P and A shall all be multiples of 8, so that these values are octet strings.

Table 7 – Plaintext and additional authenticated data

Security control, SC		Security	P	A
E field	A field			
0	0	None	–	–
0	1	Authenticated only	–	$SC AK M$
1	0	Encrypted only	M	–
1	1	Encrypted and authenticated	M	$SC AK$

5.4.8.3.4.3 Block cipher key, EK

The size of the block cipher key, denoted EK shall be 128 bits (16 octets): $\text{len}(EK) = 128$.

The key shall be generated uniformly at random or close to uniformly at random i.e., so that each possible key is (nearly) equally likely to be generated. Consequently, the key will be

fresh, i.e., unequal to any previous key, with high probability. The key shall be secret and shall be used exclusively for GCM with the chosen block cipher AES. Additional requirements on the establishment and management of keys are discussed in NIST SP 800-38D:2007, 8.1.

5.4.8.3.4.4 Authentication key, *AK*

Although not required by GCM, an authentication key denoted *AK* is specified for additional security in DLMS/COSEM. For its length and its generation, the same rules apply as for the encryption key. The authentication key shall be part of the additional authenticated data AAD. If an authentication key has been transferred, it shall be used, until a null authentication key is transferred.

5.4.8.3.4.5 Initialization vector, *IV*

For the construction of the initialization vector, *IV*, deterministic construction as specified in NIST SP 800-38D:2007, 8.2.1 shall be used.

In the deterministic construction, the *IV* is the concatenation of two fields, called the fixed field and the invocation field. The fixed field shall identify the physical device, or, more generally, the (security) context for the instance of the authenticated encryption function. The invocation field shall identify the sets of inputs to the authenticated encryption function in that particular device.

For any given key, two distinct physical devices shall not share the same fixed field, and two distinct sets of inputs to any single device shall not share the same invocation field.

The length of the *IV* shall be 96 bits (12 octets): $len(IV) = 96$. Within this:

- the leading (i.e. the leftmost) 64 bits (8 octets) shall hold the fixed field. It shall contain the system title; see 5.4.8.3.4.6;
- the trailing (i.e. the rightmost) 32 bits shall hold the invocation field; see 5.4.8.3.4.7.

The bit length of the fixed field limits the number of distinct physical devices that can implement the authenticated encryption function for the given key to 2^{64} . The bit length of the invocation field limits the number of invocations of the authenticated encryption function to 2^{32} with any given input sets without violating the uniqueness requirement.

5.4.8.3.4.6 System title

Each physical device in the system, including the meters, the concentrators when used, and the DCS shall be uniquely identified with its system title. The system title denoted as *Sys-T* shall be constructed as follows:

- its length shall be 8 octets;
- the leading (i.e., the 3 leftmost) octets shall hold the three-letter manufacturer ID⁶. This is the same as used in the leading octets of the Logical Device Name of server logical devices;

The three-letter manufacturer ID shall be used to identify all client and server systems.

NOTE 1 It can be obtained from the DLMS UA.

- the trailing (i.e. the 5 rightmost) octets, together with the manufacturer ID, shall ensure the uniqueness of the system title.

NOTE 2 These 5 octets can be derived for example from the last twelve digits of the manufacturing number, up to 999 999 999 999. This value converts to 0xE8D4A50FFF. Values above this, up to 0xFFFFFFFF

⁶ Administered by the DLMS UA acting as a registration authority; the same as the one used in the LDN.

(decimal value 1 099 511 627 775) can also be used, but these values cannot be mapped to the last 12 digits of the manufacturing number.

Project specific companion specifications may specify a different structure for the system title, but in any case, the system title shall be 8 octets long – if necessary, right padded to 8 octets – and shall be unique. The details shall be specified by the naming authority designated as such for the project.

Before the message security algorithms can be used – this requires a ciphered application context – the peers have to exchange system titles. The following possibilities are available:

- when the S-FSK PLC profile is used, system titles are exchanged during the registration process using the CIASE protocol. See IEC 62056-8-3;
- in all communication profiles, system titles are exchanged during AA establishment with a ciphered context using the COSEM-OPEN service – see 6.2 – carried the AARQ / AARE APDUs;

If the system titles sent / received during AA establishment are not the same as the ones exchanged during the CIASE registration process, the AA shall be rejected.

- by writing the client_system_title attribute and by reading the server_system_title attribute of “Security setup” objects; see IEC 62056-6-2:2016, 5.3.7.

NOTE 3 For broadcast communication, only the COSEM client sends it to the COSEM server.

5.4.8.3.4.7 Invocation field

The invocation field shall be an integer counter (frame counter).

5.4.8.3.5 Example

The following example – see Table 8 – illustrates the process of creating ciphered xDLMS APDUs when applying authentication only, encryption only and authenticated encryption.

Table 8 – Example for ciphered APDUs

	<i>X</i>	Contents			<i>LEN</i> (<i>X</i>) bytes	<i>Len</i> (<i>X</i>) bits
Security material						
Security suite		GCM-AES-128				
System Title	<i>Sys-T</i>	4D4D4D0000BC614E (here, the five last octets contain the manufacturing number in hexadecimal form)			8	64
Frame Counter	<i>FC</i>	01234567			4	32
Initialization Vector	<i>IV</i>	<i>Sys-T</i> <i>FC</i>			12	96
		4D4D4D0000BC614E01234567				
Block cipher key (global)	<i>EK</i>	000102030405060708090A0B0C0D0E0F			16	128
Authentication Key	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF			16	128
Security applied		Authentication	Encryption	Authenticated encryption		
Security control byte (with unicast key)	<i>SC</i>	<i>SC-A</i>	<i>SC-E</i>	<i>SC-AE</i>	1	8
		10	20	30		
Security header	<i>SH</i>	<i>SH</i> = <i>SC-A</i> <i>FC</i>	<i>SH</i> = <i>SC-E</i> <i>FC</i>	<i>SH</i> = <i>SC-AE</i> <i>FC</i>		
		1001234567	2001234567	3001234567	5	40
Inputs		Authentication	Encryption	Authenticated encryption		

	<i>X</i>	Contents			<i>LEN</i> (<i>X</i>) bytes	<i>Len</i> (<i>X</i>) bits
xDLMS APDU to be protected	<i>APDU</i>	C0010000080000010000FF0200 (Get-request, attribute 2 of the Clock object)			13	104
Plaintext	<i>P</i>	Null	C0010000080000010000FF0200	C0010000080000010000FF0200	13	104
Associated data	<i>A</i>	SC II AK II APDU	–	SC II AK		
Associated Data – Authentication	<i>A-A</i>	10D0D1D2D3D4D5D 6D7D8D9DADBDCDD DEDFC0010000080 000010000FF0200	–	–	30	240
Associated Data – Encryption	<i>A-E</i>	–	–	–	0	0
Associated Data – Authenticated encryption	<i>A-AE</i>	–	–	30D0D1D2D3D4D5D 6D7D8D9DADBDCDD DEF	17	136
Outputs		Authentication	Encryption	Authenticated encryption		
Ciphertext	<i>C</i>	NULL	411312FF935A475 66827C467BC	411312FF935A475 66827C467BC	13	104
Authentication tag	<i>T</i>	06725D910F9221D 263877516	–	7D825C3BE4A77C3 FCC056B6B	12	96
The complete Ciphertext APDU		TAG II LEN II SH II APDU II T	TAG II LEN II SH II C	TAG II LEN II SH II C II T	–	–
Authenticated APDU		C81E1001234567C 001000008000001 0000FF020006725 D910F9221D26387 7516	–	–	32	256
Encrypted APDU		–	C81E220012345674 11312FF935A4756 6827C467BC	–	20	160
Authenticated and encrypted APDU		–	–	C81E30012345674 11312FF935A4756 6827C467BC7D825 C3BE4A77C3FCC05 6B6B	32	256

NOTE In this example the value of the invocation field is 01234567. In real life, the value shall be incremented with each invocation of the GCM algorithm.

5.4.8.4 High Level Security peer authentication with GMAC (authentication_mechanism_id(5))

NOTE See also 5.3.4.

In the case of authentication_mechanism_id(5), the process is the following:

- Pass 1 and Pass 2 shall be the same as described in 5.3.4;
- in Pass 3 and 4, instead of the HLS secret (held by the “Association LN” / “Association SN” objects), the global unicast encryption key, and the authentication key (if in use) are used. These are transferred to the server using the global_key_transfer method of the “Security setup” interface class. See IEC 62056-6-2:2016, 5.3.7;
- in Pass 3, the client processes the challenge StoC calculating a hash value T using the GMAC algorithm: The authentication tag T is calculated using GMAC on SC II AK II StoC.

$$f(\text{StoC}) = \text{SC II FC II T} = \text{SC II FC II GMAC}(\text{SC II AK II StoC})$$

The result $f(\text{StoC}) = \text{SC} \parallel \text{FC} \parallel T$ is sent back to the server. The server checks if $f(\text{StoC})$ is the result of the correct processing and – if correct – accepts the authentication of the client.

- in Pass 4: ~~if the client is authenticated, the server processes CtoS in the same way as described in Pass 3, the server processes CtoS calculating a hash value T using the GMAC algorithm: The authentication tag T is calculated using GMAC on SC || AK || CtoS.~~

$$f(\text{CtoS}) = \text{SC} \parallel \text{FC} \parallel T = \text{SC} \parallel \text{FC} \parallel \text{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{CtoS})$$

The result $f(\text{CtoS}) = \text{SC} \parallel \text{FC} \parallel T$ is sent back to the ~~server~~ client. The client checks if $f(\text{CtoS})$ is the result of the correct processing and – if correct – accepts the authentication of the server.

To exchange $f(\text{StoC})$ and $f(\text{CtoS})$, the client invokes the *reply_to_HLS_authentication* method of Current Association object. The messages may be cryptographically protected.

An example is shown in Table 9 below.

Table 9 – HLS example with GMAC

Security material	X	Contents	LEN(X) bytes	len(X) bits
Security suite		GCM-AES-128		
System Title	Sys-T	Client		
		4D4D4D0000000001		
		Server 4D4D4D0000BC614E (here, the five last octets contain the manufacturing number in hexa)	8	64
Frame Counter	FC	00000001	4	32
Initialization Vector	IV	Sys-T FC		
		Client		
		Server 4D4D4D0000BC614E 01234567	12	96
Block cipher key (global)	EK	000102030405060708090A0B0C0D0E0F	16	128
Authentication Key	AK	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Security control	SC	10	1	8
Pass 1: Client sends challenge to server				
CtoS		4B35366956616759 "K56iVagY"	8	64
Pass 2: Server sends challenge to client				
StoC		503677524A323146 "P6wRJ21F"	8	64
Pass 3: Client processes StoC				
SC AK StoC		10D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF503677524A323146		
T = GMAC (SC AK StoC)		1A52FE7DD3E72748973C1E28	12	96
f(StoC) = SC FC T		10000000011A52FE7DD3E72748973C1E28	17	136
Pass 4: Server processes CtoS				
SC AK CtoS		10D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF4B35366956616759		
T = GMAC (SC AK CtoS)		FE1466AFB3DBCD4F9389E2B7	12	96

Security material	X	Contents	LEN(X) bytes	len(X) bits
f(CtoS) = SC FC T		1001234567FE1466AFB3DBCD4F9389E2B7	17	136
NOTE In this example the value of the invocation field is 01234567. In real life, the value shall be incremented with each invocation of the GCM algorithm.				

6 DLMS/COSEM application layer service specification

6.1 Service primitives and parameters

In general, the services of a layer (or sublayer) are the capabilities it offers to a user in the next higher layer (or sublayer). In order to provide its service, a layer builds its functions on the services it requires from the next lower layer. Figure 7 illustrates this notion of service hierarchy and shows the relationship of the two correspondent N-users and their associated N-layer peer protocol entities.

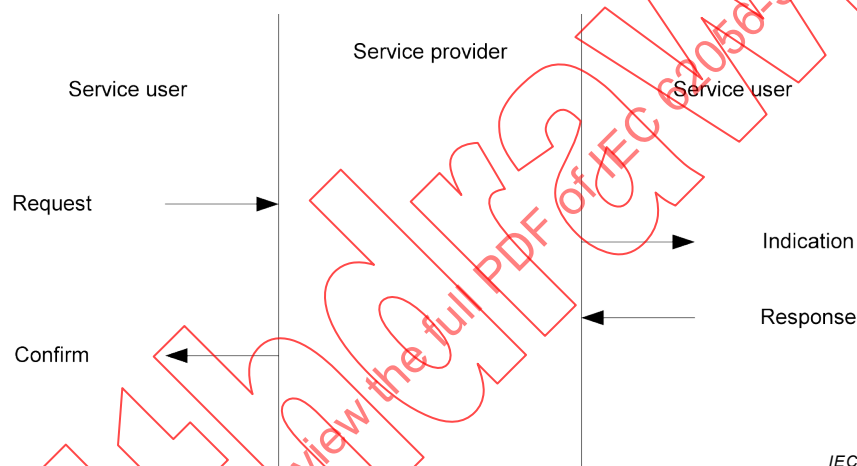


Figure 7 – Service primitives

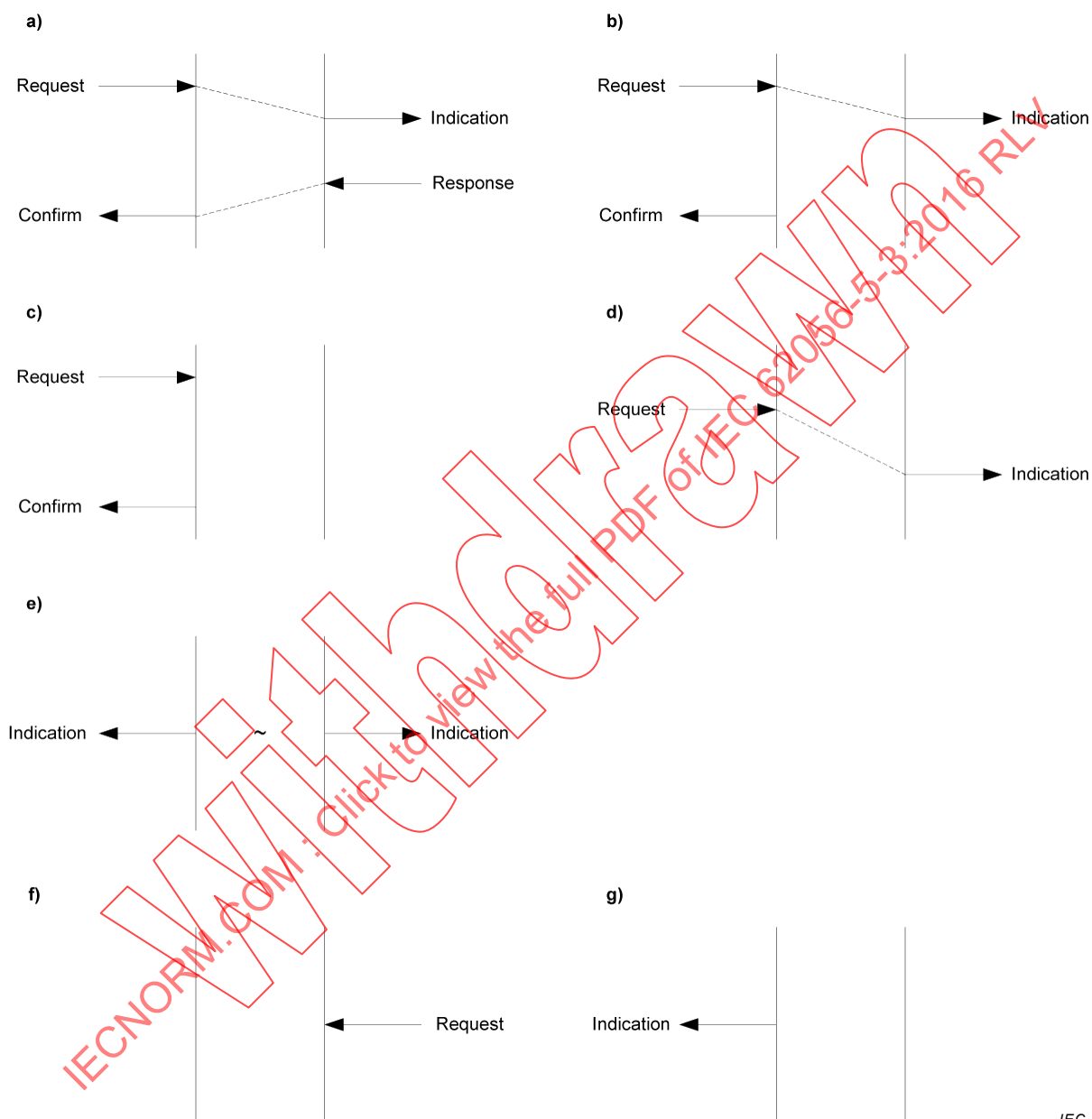
Services are specified by describing the information flow between the N-user and the N-layer. This information flow is modelled by discrete, instantaneous events, which characterize the provision of a service. Each event consists of passing a service primitive from one layer to the other through an N-layer service access point associated with an N-user. Service primitives convey the information required in providing a particular service. These service primitives are an abstraction in that they specify only the service provided rather than the means by which the service is provided. This definition of service is independent of any particular interface implementation.

Services are specified by describing the service primitives and parameters that characterize each service. A service may have one or more related primitives that constitute the activity that is related to the particular service. Each service primitive may have zero or more parameters that convey the information required to provide the service. Primitives are of four generic types:

- **REQUEST:** The request primitive is passed from the N-user to the N-layer to request that a service be initiated;
- **INDICATION:** The indication primitive is passed from the N-layer to the N-user to indicate an internal N-layer event that is significant to the N-user. This event may be logically related to a remote service request, or may be caused by an event internal to the N-layer;
- **RESPONSE:** The response primitive is passed from the N-user to the N-layer to complete a procedure previously invoked by an indication primitive;

- **CONFIRM:** The confirm primitive is passed from the N-layer to the N-user to convey the results of one or more associated previous service request(s).

Possible relationships among primitive types are illustrated by the time-sequence diagrams shown in Figure 8. The figure also indicates the logical relationship of the primitive types. Primitive types that occur earlier in time and are connected by dotted lines in the diagrams are the logical antecedents of subsequent primitive types.



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Figure 8 – Time sequence diagrams

The service parameters of the COSEM AL service primitives are presented in a tabular format. Each table consists of two to five columns describing the service primitives and their parameters. In each table, one parameter – or a part of it – is listed on each line. In the appropriate service primitive columns, a code is used to specify the type of usage of the parameter. The codes used are listed in Table 10.

Some parameters may contain sub-parameters. These are indicated by labelling of the parameters as M, U, S or C, and indenting all sub-parameters under the parameter. Presence of the sub-parameters is always dependent on the presence of the parameter that they appear

under. For example, an optional parameter may have sub-parameters; if the parameter is not supplied, then no sub-parameters may be supplied.

Table 10 – Codes for AL service parameters

M	The parameter is mandatory for the primitive.
U	The parameter is a user option, and may or may not be provided depending on dynamic usage by the ASE user.
S	The parameter is selected among other S-parameters as internal response of the server ASE environment.
C	The parameter is conditional upon other parameters or the environment of the ASE user.
(–)	The parameter is never present.
=	The " (=) " code following one of the M, U, S or C codes indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table. For instance, an " M (=) " code in the .indication service primitive column and an "M" in the .request service primitive column means that the parameter in the .indication primitive is semantically equivalent to the one in the .request primitive.

Throughout this standard, the following rules are observed regarding the naming of terms:

- the name of ACSE services and the data transfer services using LN referencing is written in uppercase. Examples are: COSEM-OPEN, GET;
- the name of the data transfer services using SN referencing is written in title case. Examples are: Read, Write;
- camel notation is used in the following cases: **DataNotification**, EventNotification, TriggerEventNotificationSending, UnconfirmedWrite, InformationReport;
- the types of the LN service primitives may be mentioned in two alternative forms. Examples: "GET.request service primitive of Request_Type == NORMAL" or "GET-REQUEST-NORMAL service primitive";
- service parameter name elements are capitalized and joined with an underscore to signify a single entity: Examples are Protocol_Connection_Parameters and COSEM_Attribute_Descriptor;
- when the same parameter may occur several times, this is indicated by repeating the parameter in curly brackets. Example: Data { Data };
- in the data transfer service specifications, parameters used with block transfer only are shown in bold. Example: **DataBlock_G**;
- direct reference to a service parameter uses the capitalized form, while indirect (non-specific) reference uses the normal text without underscore joining. A direct reference example is: "The COSEM_Attribute_Descriptor parameter references a COSEM object attribute." An indirect (non-specific) reference example is: "A GET-REQUEST-NORMAL service primitive contains a single COSEM attribute descriptor";
- the names of COSEM data transfer APDUs using LN referencing are capitalized and joined with a dash to signify a single entity. Example: Get-Request-Normal;
- the names of COSEM data transfer APDUs using SN referencing use the camel notation. Example: ReadRequest.

6.2 The COSEM-OPEN service

~~NOTE The description has been amended to cover the new data transport security features. The order of the service parameters has been aligned with the order of the fields of the AARQ / AARE APDUs.~~

Function

The function of the COSEM-OPEN service is to establish an AA between peer COSEM APs. It uses the A-ASSOCIATE service of the ACSE. The COSEM-OPEN service provides only the

framework for *transporting* this information. To provide and verify that information is the job of the appropriate COSEM AP.

Semantics of the service primitives

The COSEM-OPEN service primitives shall provide parameters as shown in Table 11.

Table 11 – Service parameters of the COSEM-OPEN service primitives

	.request	.indication	.response	.confirm
Protocol_Connection_Parameters	M	M (=)	M	M (=)
ACSE_Protocol_Version	U	U (=)	U	U (=)
Application_Context_Name	M	M (=)	M	M (=)
Called_AP_Title	U	U (=)	–	–
Called_AE_Qualifier	U	U(=)	–	–
Called_AP_Invocation_Identifier	U	U(=)	–	–
Called_AE_Invocation_Identifier	U	U(=)	–	–
Calling_AP_Title	C	C(=)	–	–
Calling_AE_Qualifier	U	U(=)	–	–
Calling_AP_Invocation_Identifier	U	U(=)	–	–
Calling_AE_Invocation_Identifier	U	U(=)	–	–
Local_Or_Remote	–	–	–	M
Result	–	–	M	M
Failure_Type	–	–	M	M
Responding_AP_Title	–	–	C	C(=)
Responding_AE_Qualifier	–	–	U	U(=)
Responding_AP_Invocation_Identifier	–	–	U	U(=)
Responding_AE_Invocation_Identifier	–	–	U	U(=)
ACSE_Requirements	U	U(=)	U	U(=)
Security_Mechanism_Name	C	C(=)	C	C(=)
Calling_Authentication_Value	C	C(=)	–	–
Responding_Authentication_Value	–	–	C	C(=)
Implementation_Information	U	U(=)	U	U(=)
Proposed_xDLMS_Context	M	M(=)	–	–
Dedicated_Key	C	C(=)	–	–
Response_Allowed	C	C(=)	–	–
Proposed_DLMS_Version_Number	M	M(=)	–	–
Proposed_DLMS_Conformance	M	M(=)	–	–
Client_Max_Receive_PDU_Size	M	M(=)	–	–
Negotiated_xDLMS_Context	–	–	S	S(=)
Negotiated_DLMS_Version_Number	–	–	M	M(=)
Negotiated_DLMS_Conformance	–	–	M	M(=)
Server_Max_Receive_PDU_Size	–	–	M	M(=)
VAA_Name	–	–	M	M(=)
XLMS_Initiate_Error	–	–	S	S(=)
User_Information	U	C(=)	–	–
Service_Class	M	M(=)	–	–

The service parameters of the COSEM-OPEN.request service primitive, except the Protocol_Connection_Parameters, the User_Information parameter and – depending on the communication profile – the Service_Class parameter are carried by the fields of the AARQ APDU sent by the client.

The service parameters of the COSEM-OPEN.response service primitive, except the Protocol_Connection_Parameters is carried by the fields of the AARE APDU sent by the server.

The A-ASSOCIATE service and the AARQ and AARE APDUs are specified in 7.2. Encoding examples are given in Annex C and Annex D.

The Protocol_Connection_Parameters parameter is mandatory. It contains all information necessary to use the layers of the communication profile, including the communication profile (protocol) identifier and the addresses required. It identifies the participants of the AA. The elements of this parameter are passed to the entities managing lower layer connections and to the lower layers as appropriate.

The ACSE_Protocol_Version parameter is optional. If present, the default value shall be used.

The Application_Context_Name parameter is mandatory. In the request primitive, it holds the value proposed by the client. In the response primitive, it holds the same value or the value supported by the server.

The Calling_AP_Title parameter is conditional. When the Application_Context_Name indicates an application context using ciphering, it ~~shall~~ may carry the client system title specified in 5.4.8.3.4.6.

The use of the Called_AP_Title, Called_AE_Qualifier, Called_AP_Invocation_Identifier, Called_AE_Invocation_Identifier, Calling_AE_Qualifier, Calling_AP_Invocation_Identifier and Calling_AE_Invocation_Identifier parameters is optional. The Calling_AE_Invocation_Identifier parameter carries the identifier of the client-side user of the AA. The use of the other parameters is not specified in this international standard.

NOTE 1 The client user identification mechanism is specified in IEC 62056-6-2:2016, 5.3.2.

The Local_or_Remote parameter is mandatory. It indicates the origin of the COSEM-OPEN.confirm primitive. It is set to Remote if the primitive has been generated following the reception of an AARE APDU from the server. It is set to Local if the primitive has been locally generated.

The Result parameter is mandatory. In the case of remote confirmation, it indicates whether the Server accepted the proposed AA or not. In the case of local confirmation, it indicates whether the client side protocol stack accepted the request or not.

The Failure_type parameter is mandatory. In the case of remote confirmation, it carries the information provided by the server. In the case of local and negative confirmation, it indicates the reason for the failure.

The use of the Responding_AP_Title parameter is conditional. When the Application_Context_Name parameter indicates an application context using ciphering, it ~~shall~~ may carry the server system title specified in 5.4.8.3.4.6.

The use of the Responding_AE_Qualifier, Responding_AP_Invocation_Identifier and Responding_AE_Invocation_Identifier parameters is optional. Their use is not specified in this international standard.

The ACSE_Requirements parameter is optional. It is used to select the optional authentication functional unit of the A-Associate service for the association; see 7.2.1.

The presence of the ACSE_Requirements parameter depends on the security mechanism used:

- in the case of Lowest Level Security, it shall not be present; only the Kernel functional unit will be used;
- in the case of Low Level Security (LLS) it shall be present in the .request primitive and it may be present in the .response service primitive **and it shall indicate authentication**;
- in the case of High Level Security (HLS), it shall be present both in the .request and the .response service primitives **and it shall indicate authentication**.

The Security_Mechanism_Name parameter is conditional. It is present only if the authentication functional unit has been selected. If present, the .request primitive holds the value proposed by the client and the .response primitive holds the value required by the server, i.e. the one to be used by the client.

The Calling_Authentication_Value parameter and the Responding_Authentication_Value parameters are conditional. They are present only if the authentication functional unit has been selected. They hold the client authentication value / server authentication value respectively, appropriate for the Security_Mechanism_Name.

The Implementation_Information parameter is optional. Its use is not specified in this international standard.

The Proposed_xDLMS_Context parameter holds the elements of the proposed xDLMS context carried by the xDLMS InitiateRequest APDU, placed in the user-information field of the AARQ APDU.

The Dedicated_Key element is conditional. It may be present only, when the Application_Context_Name parameter indicates an application context using ciphering. The dedicated key is used for dedicated ciphering of xDLMS APDUs exchanged within the AA established.

When the dedicated key is present, the xDLMS InitiateRequest APDU shall be authenticated and encrypted using the AES-GCM-128 algorithm, the global unicast encryption key and the authentication key (if in use). The xDLMS InitiateRequest APDU shall be ciphered the same way when the dedicated key is not present but it is necessary to protect the RLRQ APDU by including the ciphered xDLMS InitiateRequest in its user-information field; see 6.3.

The use of Response_Allowed element is conditional. It indicates if the server is allowed to respond with an AARE APDU, i.e. if the AA to be established is confirmed (Response_Allowed == TRUE) or not confirmed (Response_Allowed == FALSE).

The Proposed_DLMS_Version_Number element holds the proposed DLMS version number; see 4.2.3.1.

The Proposed_DLMS_Conformance element holds the proposed conformance block; see 7.3.1.

The Client_Max_Receive_PDU_Size element holds the maximum length of the xDLMS APDUs the client can receive; see Table 1.

If the xDLMS context proposed by the client is acceptable for the server, then the response service primitive shall contain the Negotiated_xDLMS_Context parameter. It holds the elements of the negotiated xDLMS context, carried by the xDLMS InitiateResponse APDU,

placed in the user-information field of the AARE APDU. If the xDLMS InitiateRequest APDU has been ciphered, the xDLMS InitiateResponse APDU shall be also ciphered the same way.

The Negotiated_DLMS_Version_Number element holds the negotiated DLMS version number. See 4.2.3.1.

The Negotiated_DLMS_Conformance element holds the negotiated conformance block. See 7.3.1.

The Server_Max_Receive_PDU_Size element carries the maximum length of the xDLMS APDUs the server can receive; see Table 1.

The VAA_name element carries the dummy value of 0x0007 in the case of LN referencing, and the base_name of the current Association object, 0xFA00, in the case of SN referencing.

If the xDLMS context proposed by the client is not acceptable for the server, then the response service primitive shall carry the xDLMS_Initiate_Error parameter. It is carried by the ConfirmedServiceError APDU, with appropriate diagnostic elements, placed in the user-information field of the AARE APDU.

The User_Information parameter is optional. If present, it shall be passed on to the supporting layer, provided it is capable to carry it. The indication primitive shall then contain the user-specific information carried by the supporting lower protocol layer(s); see Annex A.

NOTE 2 The User_Information parameter of the COSEM-OPEN service is not to be confused with the user-information field of the AARQ / AARE APDUs.

The Service_Class parameter is mandatory. It indicates whether the service shall be invoked in a confirmed or in an unconfirmed manner. The handling of this parameter may depend on the communication profile; see Annex A.

Use

Possible logical sequences of the COSEM-OPEN service primitives are illustrated in Figure 8:

- for confirmed AA – successful or unsuccessful – establishment, item a);
- for unconfirmed AA establishment, item b);
- in the case of a pre-established AA or an unsuccessful attempt due to a local error, item c).

The .request primitive is invoked by the client AP to request the establishment of a confirmed or an unconfirmed AA with a server AP⁷.

NOTE 3 Before the invocation of the COSEM-OPEN.request primitive, the physical layers shall be connected. Depending on the communication profile, the invocation of this primitive may also imply the connection of other lower layers.

Upon reception of the request invocation, the AL constructs and sends an AARQ APDU to the server.

The .indication primitive is generated by the server AL when a correctly formatted AARQ APDU is received.

⁷

The .response primitive is invoked by the server AP to indicate to the AL whether the proposed AA is accepted or not. It is invoked only if the proposed AA is confirmed. The AL constructs then an AARE APDU and sends it to its peer, containing the service parameters received from the AP.

The .confirm primitive is generated by the client AL to indicate to the client AP whether the AA previously requested is accepted or not:

- remotely, when an AARE APDU is received;
- locally, if the requested AA already exists; this includes pre-established AAs;
- locally, if the corresponding .request primitive has been invoked with Service_Class == Unconfirmed;
- locally, if the requested AA is not allowed;
- locally, if an error is detected: missing or not correct parameters, failure during the establishment of the requested lower layer connections, missing physical connection, etc.

The protocol for establishing an AA is specified in 7.2.4. Communication profile specific rules are specified in Annex A.

6.3 The COSEM-RELEASE service

~~NOTE 1 The description has been amended to better align with the A-Release service and to allow the user information field of the RLRQ / RLRE to carry a ciphered xDLMS InitiateRequest / InitiateResponse APDU, to secure the COSEM-RELEASE service.~~

Function

The function of the COSEM-RELEASE service is to gracefully release an existing AA. Depending on the way it is invoked, it uses the A-RELEASE service of the ACSE or not.

Semantics of the service primitives

The COSEM-RELEASE service primitives shall provide parameters as shown in Table 12.

Table 12 – Service parameters of the COSEM-RELEASE service primitives

	.request	.indication	.response	.confirm
Use_RLRQ_RLRE	U	C(=)	C(=)	-
Reason	U	U(=)	U	U(=)
Proposed_xDLMS_Context	C	C(=)	–	–
Negotiated_xDLMS_Context	–	–	C	C(=)
Local_Or_Remote	–	–	–	M
Result	–	–	M	M
Failure_Type	–	–	–	C
User_Information	U	C(=)	U	C(=)

The Use_RLRQ_RLRE parameter in the .request primitive is optional. If present, its value may be FALSE (default) or TRUE. It indicates whether the ACSE A-RELEASE service – involving an RLRQ / RLRE APDU exchange – should be used or not. The A-RELEASE service and the RLRQ / RLRE APDUs are specified in 7.2. The Use_RLRQ_RLRE parameter in the .response primitive is conditional. If it was present in the .indication primitive and if its value was TRUE, it shall also be present and its value shall be TRUE. Otherwise, it shall not be present or its value shall be FALSE.

If the value of the Use_RLRQ_RLRE parameter is FALSE, then the AA can be released by disconnecting the supporting layer of the AL.

The Reason parameter is optional. It may be present only if the value of the Use_RLRQ_RLRE is TRUE. It is carried by the reason field of the RLRQ / RLRE APDU respectively.

When used on the .request primitive, this parameter identifies the general level of urgency of the request. It takes one of the following symbolic values:

- normal;
- urgent (not available in DLMS/COSEM); or
- user defined.

When used on the .response primitive, this parameter identifies information about why the acceptor accepted or rejected the release request. Note that in DLMS/COSEM, the server cannot reject the release request. It takes one of the following symbolic values:

- normal;
- not finished; or
- user defined.

NOTE The value "not finished" is used in the .response primitive when the acceptor is forced to release the association but wishes to give a warning that it has additional information to send or receive.

The Proposed_xDLMS_Context parameter is conditional. It is present only if the value of the Use_RLRQ_RLRE is TRUE and the AA to be released has been established with an application context using ciphering. This option allows securing the COSEM-RELEASE service, and avoiding thereby a denial-of-service attack that may be carried out by unauthorized releasing of the AA.

In the .request primitive, the Proposed_xDLMS_Context parameter shall be the same as in the COSEM-OPEN.request service primitive, having established the AA to be released. It is carried by the xDLMS InitiateRequest APDU, authenticated and encrypted the same way as in the AARQ and placed in the user-information field of the RLRQ APDU.

If the xDLMS InitiateRequest APDU can be successfully deciphered, then the .response primitive shall carry the same Negotiated_xDLMS_Context parameter as in the COSEM-OPEN.response primitive. It is carried by the xDLMS InitiateResponse APDU, authenticated and encrypted the same way as in the AARE and placed in the user-information field of the RLRE APDU.

Otherwise, the RLRQ APDU is silently discarded.

The Local_or_Remote parameter is mandatory. It indicates the origin of the COSEM-RELEASE.confirm primitive.

It is set to Remote if either:

- a RLRE APDU has been received from the server; or
- a disconnect confirmation service primitive has been received.

It is set to Local if the primitive has been locally generated.

The Result parameter is mandatory. In the .response primitive, it indicates whether the server AP can accept the request to release the AA or not. As servers cannot refuse such requests, its value should normally be SUCCESS unless the AA referenced does not exist.

The `Failure_Type` parameter is conditional. It is present if `Result == ERROR`. In this case, it indicates the reason for the failure. It is a locally generated parameter on the client side.

The `User_Information` parameter in the `.request` primitive is optional. If present, it is passed to the supporting layer, provided it is able to carry it. The `.indication` primitive contains then the user-specific information carried by the supporting lower protocol layer(s). Similarly, it is optional in the `.response` primitive. If present, it is passed to the supporting layer. In the `.confirm` primitive, it may be present only when the service is remotely confirmed. It contains then the user-specific information carried by the supporting lower protocol layer(s).

The specification of the content of the `User_Information` parameter is not within the scope of this international standard. See also Annex A.

Use

Possible logical sequences of the COSEM-RELEASE service primitives are illustrated in Figure 8:

- for successful release of a confirmed AA , item a);
- for release of an unconfirmed AA , item b); and
- for an unsuccessful attempt due to a local error, item c).

The use of the COSEM-RELEASE service depends on the value of the `Use_RLRQ_RLRE` parameter. When it is invoked with `Use_RLRQ_RLRE == TRUE`, the service is based on the ACSE A-RELEASE service. Otherwise, the invocation of the service leads to the disconnection of the supporting layer.

The `.request` primitive is invoked by the client AP to request the release of a confirmed or an unconfirmed AA with a server AP. Upon reception of the request invocation with `Use_RLRQ_RLRE == TRUE`, the AL constructs and sends an RLRQ APDU to the server. Otherwise, it sends an `XX-DISCONNECT.request` primitive (where XX is the supporting lower protocol layer).

The `.indication` primitive is generated by the server AL if:

- a RLRQ APDU is received. If a deciphering error occurs, the RLRQ APDU is silently discarded (no `.indication` primitive is generated); or
- an `XX-DISCONNECT.request` is received.

The `.response` primitive is invoked by the server AP, but only if the AA to be released is confirmed. Note, that the server AP cannot refuse this request. Upon reception of the `.response` service primitive, the server AL:

- sends a RLRE APDU, if the `Use_RLRQ_RLRE` parameter is TRUE; or
- sends an `XX-DISCONNECT.response` otherwise.

The `.confirm` primitive is generated by the client AL to indicate to the client AP whether the requested release of the AA is accepted or not:

- remotely, when an `XX-DISCONNECT.cnf` primitive is received. The supporting layer is disconnected; or
- remotely, when a RLRE APDU is received. The supporting layer is not disconnected; or
- locally, upon the expiry of a time-out on waiting for an RLRE APDU; or
- locally, when an RLRQ APDU to release an unconfirmed AA is sent out; or
- locally, when a local error is detected: missing or incorrect parameters, or communication failure at lower protocol layer level, etc.

If the RLRE APDU received contains a ciphered xDLMS InitiateResponse APDU but it cannot be deciphered, then the RLRE APDU shall be discarded. It is left to the client to cope with the situation.

The protocol for releasing an AA is specified in 7.2.5. Communication profile specific rules are specified in Annex A. See also 7.2.1.

6.4 COSEM-ABORT service

Function

The function of the COSEM-ABORT service is to indicate an unsolicited disconnection of the supporting layer.

Semantics

The COSEM-ABORT service primitives shall provide parameters as shown in Table 13.

Table 13 – Service parameters of the COSEM-ABORT service primitives

Diagnostics	.indication U

The Diagnostics parameter is optional. It shall indicate the possible reason for the disconnection, and may carry lower protocol layer dependent information as well. Specification of the contents of this parameter is not within the scope of this international standard.

Use

The COSEM-ABORT.indication primitive is locally generated both on the client and on the server side to indicate to the COSEM AP that a lower layer connection closed in an unsolicited manner. The origin of such an event can be an external event (for example the physical line is broken), or an action of a supporting layer connection manager AP, present in some profiles, when the supporting layer connection is not managed by the COSEM AL. This shall cause the COSEM APs to abort any existing AAs, except the pre-established ones on the server side.

The protocol for the COSEM-ABORT service is specified in 7.2.5.3.

6.5 ~~Security parameters~~

~~When ciphering is used, the COSEM data transfer services carry additional security parameters, as shown in Table 12. These parameters are common for all services.~~

~~The Security_Options parameter is conditional. It shall contain the following information:~~

- ~~• the security control field; see Table 3;~~
- ~~• whether global or dedicated ciphering shall be used (this information determines the tag of the ciphered APDU).~~

~~The .request and .response service primitives shall use the same security suite and the same kind of ciphering (global or dedicated).~~

~~The Security_Status parameter is conditional. It shall contain the following information:~~

- ~~• the security control field;~~

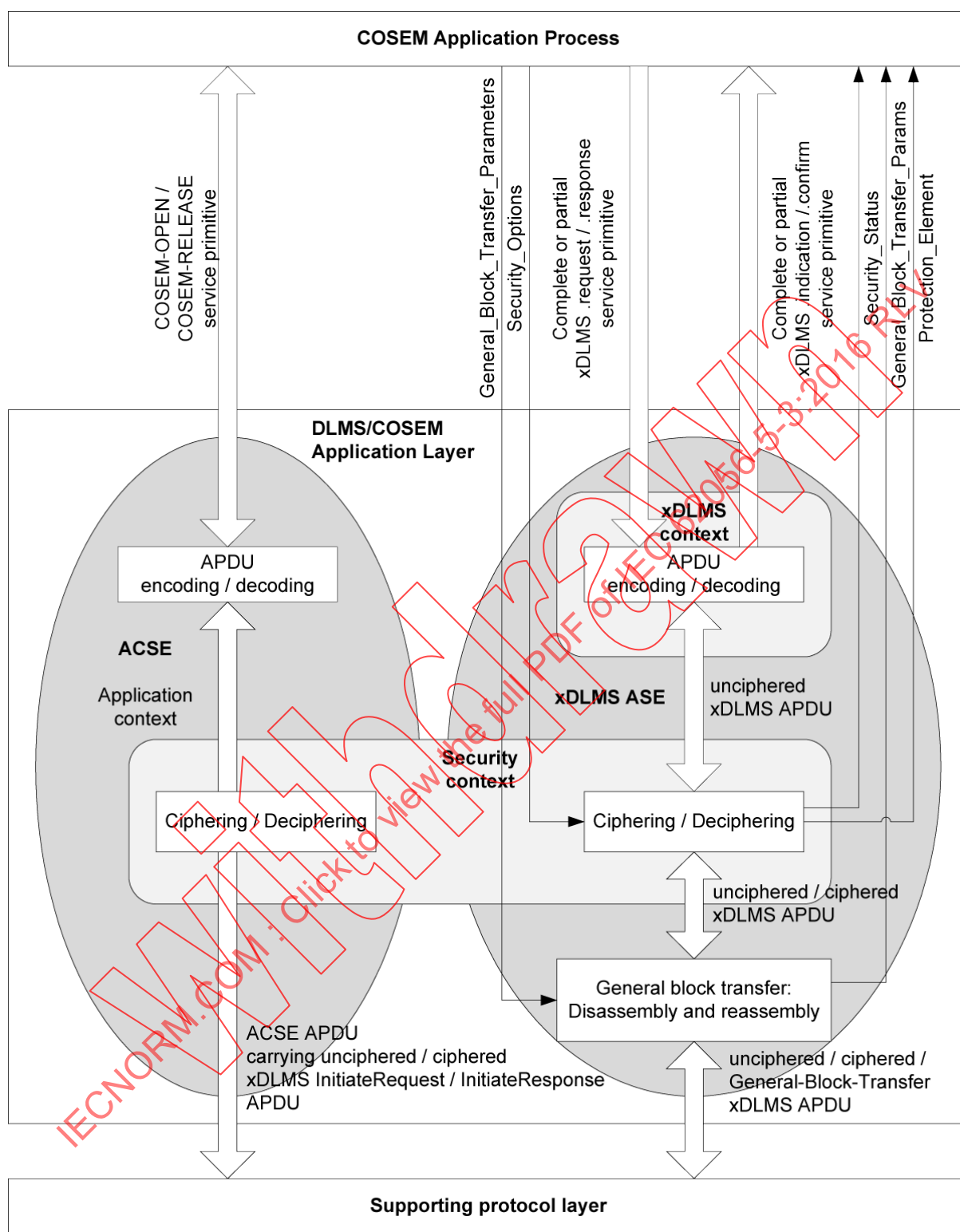
- ~~• whether global or dedicated ciphering has been used (this information is derived from the tag of the ciphered APDU).~~

~~The Authentication_Tag parameter is conditional. It is present only if the APDU has been authenticated or authenticated and encrypted. It carries the authentication tag calculated using the given security suite and keys.~~

6.5 Protection and general block transfer parameters

To control cryptographic protection of xDLMS APDUs and the GBT mechanism, additional service parameters are passed between the AL and the AP as shown in Figure 9 and Table 14.

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NOTE For services initiated by the client, the service primitives are .request, .indication, .response and .confirm. For unsolicited services – initiated by the server – the service primitives are .request and .indication.

Figure 9 – Additional service parameters to control cryptographic protection and general block transfer

Table 14 – Additional service parameters

	.request	.indication	.response	.confirm
Additional_Service_Parameters	U	–	U (=)	
Invocation_Type	M	–	M (=)	–
Security_Options	C	–	C (=)	–
General_Block_Transfer_Parameters	C	–	C (=)	–
Block_Transfer_Streaming	M	–	M (=)	–
Block_Transfer_Window	M	–	M (=)	–
Service_Parameters	M	–	M (=)	–
Additional_Service_Parameters	–	U	–	U (=)
Invocation_Type	–	U	–	U (=)
Security_Status	–	C	–	C (=)
General_Block_Transfer_Parameters	–	C	–	C (=)
Block_Transfer_Window	–	M	–	M (=)
Service_Parameters	–	M	–	M (=)
Protection_Element	–	C	–	C (=)
NOTE The service primitives available depend on the kind of the service.				

The Additional_Service_Parameters are present only if ciphering or GBT is used.

The Invocation_Type parameter indicates if the service invocation is complete or partial. Possible values: COMPLETE, FIRST-PART, ONE-PART and LAST-PART.

NOTE 1 Partial service invocations may be useful when the service parameters are long. However, there is no direct relationship between the partial service invocations and the General-Block-Transfer APDUs.

The Security_Options parameter holds information on the protection to be applied by the AL. See Table 15. It is present only if Invocation_Type = COMPLETE or FIRST-PART.

The General_Block_Transfer_Parameters parameter provides information on the GBT streaming capabilities:

- the Block_Transfer_Streaming parameter is present only in .request and .response service primitives. It is passed by the AP to the AL to indicate that the AL is allowed to send General-Block-Transfer APDUs using streaming (TRUE) or not (FALSE);
- the Block_Transfer_Window parameter indicates the window size supported, i.e. the maximum number of blocks that can be received in a window.

The General_Block_Transfer_Parameters parameter is present only if Invocation_Type = COMPLETE or FIRST-PART.

The streaming process itself is managed by the AL. See 7.3.12.

The Service_Parameters are mandatory: they include the parameters of the COSEM object attribute or method related xDLMS service invocation. If Invocation_Type != COMPLETE, then it includes a part of the service parameters.

The Security_Status parameter is conditional: it is present only if cryptographic protection has been applied. It carries information on the protection that has been verified / removed by the AL. It may be present in all type of service invocations. See Table 15.

The Protection_Element parameter is conditional: it is present only if the APDU has been authenticated. See Table 15.

Table 15 – Security parameters

	.request	.indication	.response	.confirm
Security_Options	C	–	C (=)	–
Security_Options_Element	M		M (=)	
Security_Protection_Type	M	–	M (=)	–
Glo_Ciphering	S	–	S (=)	–
Ded_Ciphering	S	–	S (=)	–
General_Glo_Ciphering	S	–	S (=)	–
General_Ded_Ciphering	S	–	S (=)	–
System_Title	C	–	C (=)	–
Security_Control	M	–	M (=)	–
Security_Status	–	C	–	C (=)
Security_Status_Element	–	M	–	M (=)
Security_Protection_Type		M		M (=)
Glo_Ciphering	–	S	–	S (=)
Ded_Ciphering	–	S	–	S (=)
General_Glo_Ciphering	–	S	–	S (=)
General_Ded_Ciphering	–	S	–	S (=)
System_Title	–	C	–	C (=)
Security_Control	–	M	–	M (=)
Service parameters depending on the kind of service:				
– GET, SET, ACTION;				
– Read, Write, UnconfirmedWrite				
Protection_Element	–	C	–	C (=)
Frame_Counter	–	M	–	M (=)
Authentication_Tag	–	⊕ M	–	⊕ M (=)
NOTE The service primitives available depend on the kind of the service.				

The Security_Options parameter is present only if the application context is a ciphered one and the .request / .response service primitive has to be ciphered. It contains the Security_Options_Element sub-parameter. It is present only if Invocation_Type = COMPLETE or FIRST-PART.

The Security_Status parameter is present only if the application context is a ciphered one and if the .indication / .confirm service primitive has been ciphered. It contains the Security_Status_Element sub-parameter. It may be present in all type of service invocations.

The Security_Options_Element and Security_Status_Element include:

- Security_Protection_Type, identifies the ciphered APDU that shall be / has been used:
 - Glo_Ciphering: the service specific glo-ciphering APDU shall be / has been used (e.g. glo-get-response);
 - Ded_Ciphering: the service specific ded-ciphering APDU shall be / has been used (e.g. ded-get-response);
 - General_Glo_Ciphering: the general-glo-ciphering APDU shall be / has been used;

- General_Ded_Ciphering: the general-ded-ciphering APDU shall be / has been used.
 - The System_Title parameter is present only with General_Glo_Ciphering and General_Ded_Ciphering. It holds the system title of the sender.
- NOTE 2 The purpose to include system-title of the sender is to allow the other party to build the initialization vector where the system-title has not been exchanged in another way; see 5.4.8.3.4.6.
- The Security_Control field contains the Security Control byte, see Table 6.

The Protection_Element parameter is present only if the APDU has been authenticated. It may be present in all type of service invocations, but it may be empty if it is not yet available. It contains:

- the Frame_Counter, holding the invocation field of the initialization vector, see 5.4.8.3.4.5.
- the Authentication tag.

6.6 The GET service

~~NOTE The following specification of the services using LN referencing has been amended for a coherent presentation with that of the services using SN referencing. No technical changes have been introduced.~~

Function

The GET service is used with LN referencing. It can be invoked in a confirmed or unconfirmed manner. Its function is to read the value of one or more COSEM interface object attributes. The result can be delivered in a single response or – if it is too long to fit in a single response – in multiple responses, with block transfer.

Semantics

The GET service primitives shall provide parameters as shown in Table 16.

Table 16 – Service parameters of the GET service

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	– M (=)	– M (=)
Request_Type	M	M (=)	–	–
COSEM_Attribute_Descriptor { COSEM_Attribute_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Attribute_Id	M	M (=)		
Access_Selection_Parameters	U	U (=)		
Access_Selector	M	M (=)		
Access_Parameters	M	M (=)		
Block_Number	C	C (=)	–	–
Response_Type	–	–	M	M (=)
Result	–	–	M	M (=)
Get_Data_Result { Get_Data_Result }	–	–	S	S (=)
Data			S	S (=)
Data_Access_Result			S	S (=)

DataBlock_G	–	–	S	S (=)
Last_Block			M	M (=)
Block_Number			M	M (=)
Result			M	M (=)
Raw_Data			S	S (=)
Data_Access_Result			S	S (=)
NOTE For security parameters see Table 15.				

The Invoke_Id parameter identifies the instance of the service invocation.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Service_Class parameter indicates whether the service is confirmed or unconfirmed. The handling of this parameter depends on the communication profile; see Annex A.

The use of the Request_Type and Response_Type parameters is shown in Table 17.

Table 17 – GET service request and response types

Request type		Response type	
NORMAL	The value of a single attribute is requested.	NORMAL	The complete result is delivered.
		ONE-BLOCK	One block of the result is delivered.
NEXT	The next data block is requested.	ONE-BLOCK	As above.
		LAST-BLOCK	The last block of the result is delivered.
WITH-LIST	The value of a list of attributes is requested.	WITH-LIST	The complete result is delivered.
		ONE-BLOCK	As above.
NOTE The same Response_Type can be present more than once, to show the possible responses to each kind of request.			

The COSEM_Attribute_Descriptor parameter references a COSEM object attribute. It is present when Request_Type == NORMAL or WITH-LIST. It is a composite parameter:

- the (COSEM_Class_Id, COSEM_Object_Instance_Id) doublet non-ambiguously references one and only one COSEM object instance;
- the COSEM_Object_Attribute_Id element identifies the attribute(s) of the object instance. COSEM_Object_Attribute_Id == 0 references all public attributes of the object (Attribute_0 feature; see 4.2.3.11);
- the Access_Selection_Parameters is present only when COSEM_Object_Attribute_Id != 0 and if selective access to the given attribute is available; see 4.2.3.9. The Access_Selector and Access_Parameters sub-parameters are defined in the COSEM interface object definitions; see IEC 62056-6-2:2016.

A GET-REQUEST-NORMAL service primitive contains a single COSEM attribute descriptor. A GET-REQUEST-WITH-LIST service primitive contains a list of COSEM attribute descriptors; their number is limited by the server-max-receive-pdu-size: a GET.request service primitive shall always fit in a single APDU.

The Block_Number parameter is used in the GET-REQUEST-NEXT service primitive. It carries the number of the latest data block received correctly.

If the encoded form of the response fits in a single APDU, the Result is of type `Get_Data_Result`:

- the Data choice carries the value of the attribute at the time of access; or
- the `Data_Access_Result` choice carries the reason for the read to fail for this attribute.

A GET-RESPONSE-NORMAL service primitive carries a single `Get_Data_Result` parameter. A GET-RESPONSE-WITH-LIST service primitive carries a list of `Get_Data_Result` parameters; their number and order shall be the same as that of the `COSEM_Attribute_Descriptor` parameters in the request.

If `COSEM_Object_Attribute_Id == 0` (`Attribute_0`), the Data shall be a structure containing the value of all public attributes in the order of their appearance in the given object specification. For attributes to which no access right is granted within the given AA, or which cannot be accessed for any other reason, null-data shall be returned.

If the encoded form of the response does not fit in a single APDU, it can be transported in data blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used, the Result is of type `DataBlock_G`. It carries block transfer control information and raw-data:

- the `Last_Block` element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the `Block_Number` element carries the number of the actual block sent;
- the (inner) Result element carries either `Raw_Data` or `Data_Access_Result`. Within this:
 - if the value of a single attribute was requested, `Raw_Data` carries a part of the value of the attribute (Data). If the Data cannot be delivered, the response shall be GET-RESPONSE-NORMAL with `Data_Access_Result`;
 - if the value of a list of attributes was requested, `Raw_Data` carries a part of the list of `Get_Data_Results`, either Data or `Data_Access_Result` for each attribute;
 - if the raw data cannot be delivered, `Data_Access_Result` shall carry the reason. For error cases, see 7.3.3.

Use

Possible logical sequences of the GET service primitives are illustrated in Figure 8:

- for a successful confirmed GET, item a);
- for an unconfirmed GET, item d); and
- for an unsuccessful attempt due to a local error, item c).

The GET.request primitive is invoked by the client AP to read the value of one or all attributes of one or more COSEM objects of the server AP. The first request shall always be of `Request_Type == NORMAL` or `WITH-LIST`. A GET-REQUEST-NEXT service primitive is invoked only when the server could not deliver the complete data in a single response, i.e. following the reception of a .confirm primitive of `Response_Type == ONE-BLOCK`. Upon reception of the .request primitive, the client AL builds the Get-Request APDU appropriate for the request type and sends it to the server.

The GET.indication primitive is generated by the server AL upon reception of a Get-Request APDU.

The GET.response primitive is invoked by the server AP, if `Service_Class == Confirmed`, to send a response to an .indication primitive received. If the complete data requested fits in a single APDU, the .response primitive is invoked with `Response_Type == NORMAL` or `WITH-`

LIST as appropriate. Otherwise, it is invoked with Response_Type == ONE-BLOCK and finally with LAST-BLOCK.

The GET.confirm primitive is generated by the client AL to indicate the reception of a Get-Response APDU.

The protocol for the GET service is specified in 7.3.3.

6.7 The SET service

Function

The SET service is used with LN referencing. It can be invoked in a confirmed or unconfirmed manner. Its function is to write the value of one or more COSEM interface object attributes. The data to be written can be sent in a single request or – if it is too long to fit in a single request – in multiple requests, with block transfer.

Semantics

The SET service primitives shall provide parameters as shown in Table 18.

Table 18 – Service parameters of the SET service

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	– M (=)	– M (=)
Request_Type	M	M (=)	–	–
COSEM_Attribute_Descriptor { COSEM_Attribute_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Attribute_Id	M	M (=)		
Access_Selection_Parameters	U	U (=)		
Access_Selector	M	M (=)		
Access_Parameters	M	M (=)		
Data {Data }	C	C (=)	–	–
DataBlock_SA	C	C (=)	–	–
Last_Block	M	M (=)		
Block_Number	M	M (=)		
Raw_Data	M	M (=)		
Response_Type	–	–	M	M (=)
Result { Result }	–	–	C	C (=)
Block_Number	–	–	C	C (=)
NOTE For security parameters, see Table 15.				

The Invoke_Id parameter identifies the instance of the service invocation.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Service_Class parameter indicates whether the service is confirmed or unconfirmed. The handling of this parameter depends on the communication profile; see Annex A.

The use of the Request_Type and Response_Type parameters is shown in Table 19.

Table 19 – SET service request and response types

Request type		Response type	
NORMAL	The reference of a single attribute and the complete data to be written is sent.	NORMAL	The result is delivered.
FIRST-BLOCK	The reference of a single attribute and the first block of the data to be written is sent.	ACK-BLOCK	The correct reception of the block is acknowledged.
ONE-BLOCK	One block of the data to be written is sent.		
LAST-BLOCK	The last block of the data to be written is sent.	LAST-BLOCK	The correct reception of the last block is acknowledged and the result is delivered.
		LAST-BLOCK-WITH-LIST	The correct reception of the last block is acknowledged and the list of results is delivered.
WITH-LIST	The reference of a list of attributes and the complete data to be written is sent.	WITH-LIST	The list of results is delivered.
FIRST-BLOCK-WITH-LIST	The reference of a list of attributes and the first block of data to be written is sent.	ACK-BLOCK	The correct reception of the block is acknowledged.
NOTE The same Response_Type can be present more than once, to show the possible responses to each request.			

The COSEM_Attribute_Descriptor parameter references a COSEM object attribute. It is present when Request_Type == NORMAL, FIRST-BLOCK, WITH-LIST and FIRST-BLOCK-WITH-LIST. It is a composite parameter:

- the (COSEM_Class_Id, COSEM_Object_Instance_Id) doublet non-ambiguously references one and only one COSEM object instance;
- the COSEM_Object_Attribute_Id identifies the attribute(s) of the object instance. COSEM_Object_Attribute_Id == 0 references all public attributes of the object (Attribute_0 feature; see 4.2.3.11);
- the Access_Selection_Parameters is present only when COSEM_Object_Attribute_Id != 0 and if selective access to the given attribute is available; see 4.2.3.9. The Access_Selector and the Access_Parameters sub-parameters are defined in the COSEM interface object definitions; see IEC 62056-6-2:2016.

A SET-REQUEST-NORMAL or SET-REQUEST-WITH-FIRST-BLOCK service primitive contains a single COSEM attribute descriptor. A SET-REQUEST-WITH-LIST or a SET-REQUEST-FIRST-BLOCK-WITH-LIST service primitive contains a list of COSEM attribute descriptors; their number is limited by the server-max-receive-pdu-size: all COSEM attribute descriptors – together with (a part of) the data to be written – shall fit in a single APDU.

The Data parameter contains the data necessary to write the value of the referenced attributes. The number and the order of the Data parameters shall be the same as that of the COSEM_Attribute_Descriptor parameters.

If COSEM_Object_Attribute_Id == 0 (Attribute_0), the Data sent shall be a structure, containing, for each public attribute, in the order of their appearance in the given object specification, either a value or null-data, meaning that the given attribute needs not be set.

If the encoded form of the Data parameter does not fit in a single APDU, it can be transported in blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used, the DataBlock_SA parameter carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the data to be written.

The Result parameters are present in the .response primitive when Response_Type != ACK-BLOCK. Their number and order shall be the same as that of the COSEM_Attribute_Descriptor parameters in the request. Each Result shall contain either the information "success" or a reason for failing to write the attribute referenced (Data_Access_Result). When in the .request primitive COSEM_Object_Attribute_Id == 0 (Attribute_0), the Result shall carry a list of results, either the information "success" or a reason for failing to write the attribute (Data_Access_Result), for each public attribute, in the order of their appearance in the given object specification.

The Block_Number parameter shall be present when Response_Type == ACK-BLOCK, LAST-BLOCK, or LAST-BLOCK-WITH-LIST. It carries the number of the latest data block received correctly.

Use

Possible logical sequences of the SET service primitives are illustrated in Figure 8:

- for a successful confirmed SET, item a);
- for an unconfirmed SET, item d); and
- for an unsuccessful attempt due to a local error, item c).

The SET.request primitive is invoked by the client AP to write the value of one or all attributes of one or more COSEM objects of the server AP. If the complete data to be sent fits in a single APDU, the .request primitive shall be invoked with Request_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it shall be invoked with Request_Type == FIRST-BLOCK or FIRST-BLOCK-WITH-LIST, then with Request_Type == ONE-BLOCK and finally with LAST-BLOCK as appropriate. Upon reception of the .request primitive, the client AL builds the Set-Request APDU appropriate for the Request_Type and sends it to the server.

The SET.indication primitive is generated by the server AL upon reception of a Set-Request APDU.

The SET.response primitive is invoked by the server AP, if Service_Class == Confirmed, to send a response to an .indication primitive received. If the data were sent in a single APDU, the .response primitive is invoked with Response_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it is invoked with Response_Type == ACK-BLOCK, and finally with LAST-BLOCK or LAST-BLOCK-WITH-LIST as appropriate.

The SET.confirm primitive is generated by the client AL to indicate the reception of a Set-Response APDU.

The protocol for the SET service is specified in 7.3.4.

6.8 The ACTION service

Function

The ACTION service is used with LN referencing. It can be invoked in a confirmed or unconfirmed manner. Its function is to invoke one or more COSEM interface objects methods. It comprises two phases:

- in the first phase, the client sends the reference(s) of the method(s) to be invoked, with the method invocation parameters necessary;
- in the second phase, after invoking the methods, the server sends back the result and the return parameters generated by the invocation of the method(s), if any.

If the method invocation parameters are too long to fit in a single request, they are sent in multiple requests (block transfer from the client to the server). If the result and the return parameters are too long to fit in a single response, they are returned in multiple responses (block transfer from the server to the client.)

Semantics

The ACTION service primitives shall provide parameters as shown in Table 20.

Table 20 – Service parameters of the ACTION service

	.request	.indication	response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	– M (=)	– M (=)
Request_Type	M	M (=)	–	–
COSEM_Method_Descriptor { COSEM_Method_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Method_Id	M	M (=)		
Method_Invocation_Parameters { Method_Invocation_Parameters }	U	U (=)	–	–
Response_Type	–	–	M	M (=)
Action_Response { Action_Response }	–	–	M	M (=)
Result			M	M (=)
Response_Parameters			U	U (=)
Data			S	S (=)
Data_Access_Result			S	S (=)
DataBlock_SA	C	C (=)	C	C (=)
Last_Block	M	M (=)	M	M (=)
Block_Number	M	M (=)	M	M (=)
Raw_Data	M	M (=)	M	M (=)
Block_Number	C	C (=)	C	C (=)
NOTE For security parameters, see Table 15.				

The Invoke_Id parameter identifies the instance of the service invocation.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Service_Class parameter indicates whether the service is confirmed or unconfirmed. The handling of this parameter depends on the communication profile; see Annex A.

The use of the Request_Type and Response_Type parameters is shown in Table 21.

Table 21 – ACTION service request and response types

Request type		Response type	
NORMAL	The reference of a single method and the complete method invocation parameter is sent.	NORMAL	The result and the complete return parameter are sent.
		ONE-BLOCK	One block of the result and of the return parameter is sent.
NEXT	The next data block is requested.	ONE-BLOCK	As above.
		LAST-BLOCK	The last block of the result(s) and of the return parameter(s) is sent.
FIRST-BLOCK	The reference of a single method and the first block of the method invocation parameters is sent.	NEXT	Correct reception of the block is acknowledged.
ONE-BLOCK	One block of the method invocation parameters is sent.		
LAST-BLOCK	The last block of the method invocation parameters is sent.	NORMAL	As above.
		ONE-BLOCK	As above.
WITH-LIST	The reference of a list of methods and the complete list of method invocation parameters is sent.	WITH-LIST	The complete list of results and return parameters is sent.
		ONE-BLOCK	See above.
WITH-LIST-AND-FIRST-BLOCK	The reference of a list of methods and the first block of the method invocation parameters is sent.	NEXT	The correct reception of the block is acknowledged.
NOTE The same Response_Type can be present more than once, to show the possible responses to each request.			

The COSEM_Method_Descriptor parameter references a COSEM object method. It is present if Request_Type == NORMAL, FIRST-BLOCK, WITH-LIST and WITH-LIST-AND-FIRST-BLOCK. It is a composite parameter:

- the (COSEM_Class_Id, COSEM_Object_Instance_Id) doublet non-ambiguously references one and only one COSEM object instance;
- the COSEM_Method_Id identifies one method of the COSEM object referenced.

An ACTION-REQUEST-NORMAL or ACTION-REQUEST-FIRST-BLOCK service primitive shall contain a single COSEM method descriptor. An ACTION-REQUEST-WITH-LIST or ACTION-REQUEST-WITH-LIST-AND-FIRST-BLOCK service primitive shall contain a list of COSEM method descriptors; their number is limited by the server-max-receive-pdu-size: all COSEM method references – together with (a part of) the method invocation parameters – shall fit in a single APDU.

The Method_Invocation_Parameter parameter carries the parameter(s) necessary for the invocation of the method(s) referenced.

- if Request_Type == NORMAL, the Method_Invocation_Parameter parameter is optional;
- if Request_Type == WITH-LIST, the service primitive shall contain a list of Method invocation parameters (or null data) Invocation_Parameters. The number and the order of the method invocation parameters shall be the same as that of the COSEM ~~attribute descriptors~~ Method_Descriptor-s. If the invocation of any of the methods does not require additional parameters, it shall be nevertheless present, but it shall be null data.

If the encoded form of the COSEM method descriptor(s) and method invocation parameter(s) does not fit in a single APDU, it can be transported in blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used the DataBlock_SA parameter carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the method invocation parameters.

The Action_Response parameters are present in the .response primitive when Response_Type == NORMAL, or WITH-LIST. Their number and the order shall be the same as that of the of COSEM method descriptors. It consists of two elements:

- the Result parameter. It contains either the information “success” or a reason for failing to invoke the method referenced (Action-Result);
- the Response_Parameter(s). Each response parameter shall contain either the Data returned as a result of invoking the method, or a reason for returning the parameters to fail (Data-Access-Result). If the invocation of any of the methods does not return parameters, null data shall be returned.

If the response does not fit in a single APDU, it can be transported in blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used, the DataBlock_SA parameter carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the response:
 - if a single method was invoked, Raw_Data carries the result and the Response_Parameters if any. If no Response_Parameters are returned, the response shall be of type ACTION-RESPONSE-NORMAL;
 - if a list of methods was invoked, Raw_Data carries a part of the list of Action_Responses and optional data.

The Block_Number parameter in an ACTION-REQUEST-NEXT service primitive shall carry the number of the latest data block received from the server correctly.

The Block_Number parameter in an ACTION-RESPONSE-NEXT service primitive shall carry the number of the latest data block received from the client correctly.

Use

Possible logical sequences of the ACTION service primitives are illustrated in Figure 8:

- for a successful confirmed ACTION, item a);
- for an unconfirmed ACTION, item d); and
- for an unsuccessful attempt due to a local error, item c).

In the first phase, the ACTION.request primitive is invoked by the client AP to invoke one or more methods of one or more COSEM interface objects of the server AP. If the complete list of COSEM method descriptors and method invocation parameters fits in a single APDU, the .request primitive is invoked with Request_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it is invoked with Request_Type == FIRST-BLOCK or WITH-LIST-AND-FIRST-BLOCK as appropriate, then with Request_Type == ONE-BLOCK and finally with LAST-BLOCK. Upon reception of the .request primitive, the client AL builds the Action-Request APDU appropriate for the Request_Type and sends it to the server.

The ACTION.indication primitive is generated by the server AL upon reception of an Action-Request APDU.

During the block transfer of the method invocation parameters, the server AP invokes the ACTION.response primitive with Request_Type == NEXT until the last block is received.

The ACTION.confirm primitive is generated by the client AL upon reception of an Action-Response APDU.

Once all method invocation parameters are transferred, the server invokes the methods of COSEM interface objects referenced, and the second phase commences.

If the complete response fits in a single APDU, the ACTION.response primitive is invoked by the server AP with Response_Type == NORMAL or WITH-LIST, as appropriate. Otherwise, it is invoked with Response_Type == ONE-BLOCK and finally with LAST-BLOCK. Upon reception of the .response primitive, the server AL builds the Action-Response APDU appropriate for the Response_Type and sends it to the client.

The ACTION.confirm primitive is generated by the client AL to indicate the reception of an Action-Response APDU.

During the block transfer of the return parameters, the client AP invokes the .request primitive with Request_Type == NEXT until the last block is received.

The protocol for the ACTION service is specified in 7.3.5.

6.9 The DataNotification service

Function

The DataNotification service is an unsolicited, unconfirmed service. It is used by the server to push data to the client. It is an unconfirmed service. The push process is configured by “Push setup” objects; see IEC 62056-6-2:2016, 5.3.8.

Semantics

The DataNotification service primitives shall provide parameters as shown in Table 22.

Table 22 – Service parameters of the DataNotification service primitives

	.request	.indication
Long_Invoke_Id	M	M (=)
Self_Descriptive	–	–
Processing_Option	–	–
Service_Class	–	–
Priority	M	M (=)
Date_Time	U	U (=)
Notification_Body	M	M (=)

The Long_Invoke_Id parameter identifies the instance of the service invocation.

The Self_Descriptive, Processing_Option and Service_Class parameters are not used in the case of this service.

The **Priority** parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The **Date_Time** parameter indicates the time at which the **DataNotification.request** service primitive is invoked. It is octet-string, which may be of length zero when transmitting the **Date_Time** is not required.

The **Notification_Body** parameter contains the push data.

Use

A possible logical sequence of the **DataNotification** service primitives is illustrated in Figure 8 f) and g).

The **.request** primitive is invoked by the server AP to push data to the remote client AP. Upon reception of the **.request** primitive, the server AL builds the **DataNotification** APDU.

The **.indication** primitive is generated by the client AL upon reception of a **DataNotification** APDU.

The protocol for the **DataNotification** service is specified in 7.3.6.

6.10 The EventNotification service

Function

The **EventNotification** service is an unsolicited, non-client/server type service. It is requested by the server, upon occurrence of an event, in order to inform the client of the value of an attribute, as though it had been requested by the COSEM. It is an unconfirmed service.

Semantics

The **EventNotification** service primitives shall provide parameters as shown in Table 23.

Table 23 – Service parameters of the EventNotification service primitives

	.request	.indication
Time	U	U (=)
Application_Addresses	U	U (=)
COSEM_Attribute_Descriptor	M	M (=)
COSEM_Class_Id	M	M (=)
COSEM_Object_Instance_Id	M	M (=)
COSEM_Object_Attribute_Id	M	M (=)
Attribute_Value	M	M (=)

The optional **Time** parameter indicates the time at which the **EventNotification.request** service primitive was issued.

The **Application_Addresses** parameter is optional. It is present only when the **EventNotification** service is invoked outside of an established AA. In this case, it contains all protocol specific parameters required to identify the sender and destination APs.

When the **.request** primitive does not contain the optional **Application_Addresses** parameter, default addresses shall be used, those of the server management logical device and the client

management AP. Both APs are always present and in any protocol profile, they are bound to known, pre-defined addresses.

The (COSEM_Class_Id, COSEM_Object_Instance_Id, COSEM_Object_Attribute_Id) triplet references non-ambiguously one and only one attribute of a COSEM interface object instance.

The Attribute_Value parameter carries the value of this attribute. More information about the notified event may be obtained by interrogating this COSEM interface object.

If the encoded form of the request does not fit in a single APDU, it can be transported in data blocks using the general block transfer mechanism.

Use

A possible logical sequence of the EventNotification service primitives is illustrated in Figure 8 f) and g).

The .request primitive is invoked by the server AP to send the value of a COSEM interface object attribute to the remote client AP. Upon reception of the .request primitive, the Server AL builds the EventNotificationRequest APDU.

In some cases, the supporting lower layer protocol(s) do (does) not allow sending a protocol data unit in a real, unsolicited manner. In these cases, the client has to explicitly solicit sending an EventNotification frame, by invoking the Trigger_EventNotification_Sending service primitive.

The EventNotification.indication primitive is generated by the client AL upon reception of an EventNotificationRequest APDU.

The protocol for the EventNotification service is specified in 7.3.7.

6.11 The TriggerEventNotificationSending service

Function

The function of the TriggerEventNotificationSending service is to trigger the server by the client to send the frame carrying the EventNotification.request APDU.

NOTE This service is ~~used~~ necessary in the case of protocols, when the server is not able to send a real non-solicited EventNotification.request APDU.

Semantics

The TriggerEventNotificationSending.request service primitive shall provide parameters as shown in Table 24.

Table 24 – Service parameters of the TriggerEventNotificationSending.request service primitive

	.request
Protocol_Parameters	M

The Protocol_Parameters parameter contains all lower protocol layer dependent information, which is required for triggering the server to send out an eventually pending frame containing an EventNotification.request APDU. This information includes the protocol identifier, and all the required lower layer parameters.

Use

Upon reception of a TriggerEventNotificationSending.request service invocation from the client AP, the client AL shall invoke the corresponding supporting layer service to send a trigger message to the server.

6.12 Variable access specification

Variable_Access_Specification is a parameter of the xDLMS Read / Write / UnconfirmedWrite InformationReport .request / .indication service primitives. Its variants are shown in Table 25:

- Variable_Name identifies a DLMS named variable;
- Parameterized_Access provides the capability to transport additional parameters;
- Block_Number_Access transports a block number;
- Read_Data_Block_Access transports block transfer control information and raw data;
- Write_Data_Block_Access transports block transfer control information.

The use of the different variants depends on the service and it is described in the respective SN service specifications.

Table 25 – Variable Access Specification

Variable_Access_Specification	Read .request	Write .request	Unconfirmed Write.request	Information Report
Kind_Of_Access	M	M	M	M
Variable_Name	S	S	S	M
Detailed_Access	Not used in DLMS/COSEM			
Parameterized_Access	S	S	S	–
Variable_Name	M	M	M	
Selector	U	U	U	
Parameter	U	U	U	
Block_Number_Access	S	–	–	–
Block_Number	M			
Read_Data_Block_Access	S	–	–	–
Last_Block	M			
Block_Number	M			
Raw_Data	M			
Write_Data_Block_Access	–	S	–	–
Last_Block		M		
Block_Number		M		

6.13 The Read service

Function

The Read service is used with SN referencing. It is a confirmed service. Its functions are:

- to read the value of one or more COSEM interface object attributes. In this case, the encoded form of the .request service primitive shall fit in a single APDU. The result can be delivered in a single response, or – if it is too long to fit in a single response – in multiple responses, with block transfer;

- to invoke one or more COSEM interface object methods, when return parameters are expected. In this case, if either the .request (including the method references and the method invocation parameters) or the .response service primitive (including the results and return parameters) is too long to fit in a single APDU, then block transfer with multiple requests and/or responses can be used.

The Read service is specified in IEC 61334-4-41:1996, 10.4 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The Read service primitives shall provide service parameters as shown in Table 26.

Table 26 – Service parameters of the Read service

	.request	.indication	.response	.confirm
Variable_Access_Specification { Variable_Access_Specification }	M	M (=)		
Variable_Name	S	S (=)		
Parameterized_Access	S	S (=)	–	–
Variable_Name	M	M (=)		
Selector	U	U (=)		
Parameter	U	U (=)		
Read_Data_Block_Access	S	S (=)		
Last_Block	M	M (=)		
Block_Number	M	M (=)		
Raw_Data	M	M (=)		
Block_Number_Access	S	S (=)		
Block_Number	M	M (=)		
Result (+)			S	S (=)
Read_Result { Read_Result }	–	–	M	M (=)
Data			S	S (=)
Data_Access_Error			S	S (=)
Data_Block_Result			S	S (=)
Last_Block			M	M (=)
Block_Number			M	M (=)
Raw_Data			M	M (=)
Block_Number			S	S (=)
Result (–)	–	–	S	S (=)
Error_Type			M	M (=)
NOTE For security parameters, see Table 15.				

The use of the different variants of the Variable-Access-Specification service parameter of the Read.request service primitive and the different choices of the Read.response primitive are shown in Table 27.

If the encoded form of the response does not fit in a single APDU, it can be transported in data blocks using the general block transfer mechanism.

Table 27 – Use of the Variable_Access_Specification variants and the Read.response choices

Read.request Variable_Access_Specification		Read.response CHOICE	
Variable_Name (Variable_Name)	References a list ¹ of COSEM object attributes.	Data {Data}	Delivers the value of the attribute(s) referenced.
		Data_Access_Error {Data_Access_Error}	Provides the reason for the read to fail.
		Data_Block_Result	Delivers block transfer control information and one block of raw data.
Parameterized_Access {Parameterized_Access}	References a list ¹ of COSEM object attributes to be read selectively.	Data {Data}	As above.
		Data_Access_Error {Data_Access_Error}	
		Data_Block_Result	
	References a list ¹ of COSEM object methods, with method invocation parameters.	Data {Data}	Delivers the method invocation return parameters. NOTE If parameters are returned, this implies that the method invocation succeeded.
		Data_Access_Error {Data_Access_Error}	Provides the reason for the method invocation to fail.
		Data_Block_Result	As above.
Read_Data_Block_Access	Carries block transfer control information and one part of encoded form of the COSEM method references and method invocation parameters.	Block_Number	Carries the number of the latest data block received.
Block_Number_Access	Carries the number of the latest data block received.	Data_Block_Result	As above.
NOTE The same Read.response choice can be present more than once, to show the possible responses to each request.			
¹ A list may have one or more elements.			

The Read.request service primitive may have one or more Variable_Access_Specification parameters.

- the Variable_Name variant is used to reference a complete COSEM object attribute to be read. The request may include one or more variable names;
- the Parameterized_Access variant is used either:
 - to reference a COSEM object attribute to be read selectively. In this case, the Variable_Name element references the COSEM object attribute, the Selector and the Parameter elements carry the access selector and the access parameters respectively as specified in the attribute specification; or
 - to reference a COSEM object method to be invoked. In this case, the Variable_Name element references the method, the Selector element is zero and the Parameter element carries the method invocation parameters (if any) or null data;
 - the request may include one or more parameterized access parameters;

NOTE 1 With this, the Read service can transport information in both directions, just like the ACTION service used with LN referencing: method invocation parameters from the client to the server and return parameters from the server to the client.

- the Read_Data_Block_Access variant is used when one or more COSEM object methods are invoked and the encoded form of the request does not fit in a single APDU. The request may include a single Read_Data_Block_Access parameter. It carries block transfer control information and raw data:

- the Last_Block element indicates if the given block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the encoded form of the list of Variable_Access_Specification parameters (as it would be used without block transfer) including the method references and the method invocation parameters. Here, only the variants Variable_Name and Parameterized_Access are allowed.
- the Block_Number_Access variant is used when the server uses block transfer to send a long response, to confirm the reception of a data block and to request the next data block. The request may include a single Block_Number_Access parameter. It carries the number of the latest data block received correctly.

The Result (+) parameter indicates that the requested service has succeeded.

Without block transfer, the .response / .confirm service primitives contain one or more Read_Result parameters. Their number and order shall be the same as that of the Variable_Name / Parameterized_Access parameters in the .request / .indication primitives.

If the Read service is used to read attribute(s), then:

- the Data choice is taken to carry the value of the attribute at the time of access;
- the Data_Access_Error is taken to carry the reason for the read to fail for this attribute.

If the Read service is used to invoke method(s), then:

- the Data choice is taken to carry the return parameters (if data are returned, this implies that the method invocation succeeded). If there are no return parameters, Data shall be null data;
- NOTE 2 However, if no return data are expected, the Write service is used to invoke methods.
- the Data_Access_Error choice is taken to carry the reason for the method invocation to fail for this method.

In the case of block transfer, the .response / .confirm primitive contains a single Read_Result parameter. The Data_Block_Result choice is taken to carry one block of the response:

- the Last_Block element indicates whether the given block is the last one (TRUE) or not (FALSE);
- the Block_Number element shall carry the number of the block sent;
- the Raw_Data element contains a part of the encoded form of the list of Read_Results.

If the data block cannot be provided, then the .response primitive shall carry a single Result parameter using the Data_Access_Error choice, carrying an appropriate error message, for example (14) data-block-unavailable.

If the block number in the request is not the one expected, or if the next block cannot be delivered, then the Read.response service primitive shall be returned with a single Read_Result parameter, with the choice Data_Access_Error, carrying an appropriate code, for example (19) data-block-number-invalid.

The Block_Number choice is taken when the Read service is used to invoke one or more methods and the request is sent in several blocks, to confirm the correct reception of a data block and to ask for the next block. It carries the number of the latest block received.

The Result (–) parameter indicates that the service previously requested failed. The Error_Type parameter provides the reason for failure. In this case, the server shall send back a ConfirmedServiceError APDU instead of a ReadResponse APDU.

Use

A possible logical sequence of the Read service primitives is illustrated in Figure 8 item a).

The Read.request primitive is invoked following the invocation of a GET or ACTION .request primitive by the client AP and mapping this to a Read.request primitive by the SN_MAPPER ASE. The client AL builds then the ReadRequest APDU and sends it to the server. For LN / SN service mapping, see 6.18.

The Read.indication primitive is generated by the server AL upon reception of a ReadRequest APDU.

The Read.response primitive is invoked by the server AP in order to send a response to a previously received Read.indication primitive. The server AL builds then the ReadResponse APDU and sends it to the client.

The Read.confirm primitive is generated by the client AL following the reception of a ReadResponse APDU. It is then mapped back to a GET or ACTION .confirm primitive by the SN_MAPPER ASE and the GET or ACTION .confirm primitive is generated.

The protocol of the Read service is specified in 7.3.8.

6.14 The Write service

Function

The Write service is used with SN referencing. It is a confirmed service. Its functions are:

- to write the value of one or more COSEM interface object attributes;
- to invoke one or more COSEM interface object methods when no return parameters are expected.

In both cases, if the encoded form of the .request service primitive does not fit in a single APDU, then it can be sent in several requests with block transfer. The .response service primitive shall always fit in a single APDU.

The Write service is specified in IEC 61334-4-41:1996, 10.5 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The Write service primitives shall provide service parameters as shown in Table 28.

Table 28 – Service parameters of the Write service

	.request	.indication	.response	.confirm
Variable_Access_Specification { Variable_Access_Specification }	M	M(=)		
Variable_Name	S	S (=)		
Parameterized_Access	S	S (=)	–	–
Variable_Name	M	M (=)		
Selector	M	M (=)		
Parameter	M	M (=)		
Write_Data_Block_Access	S	S (=)		
Last_Block	M	M (=)	–	–
Block_Number	M	M (=)		
Data { Data }	M	M (=)	–	–
Result (+)	–	–	S	S (=)
Write_Result { Write_Result }	–	–	S	S (=)
Success			S	S (=)
Data_Access_Error			S	S (=)
Block_Number			S	S (=)
Result (–)			S	S (=)
Error_Type			M	M (=)
NOTE For security parameters, see Table 15.				

The use of the different variants of the Variable-Access-Specification service parameter of the Write.request service primitive and the different choices of the Write.response primitive are shown in Table 29. The use of the Data service parameter is also explained.

If the encoded form of the request does not fit in a single APDU, it can be transported in data blocks using either the service-specific or the general block transfer mechanism.

Table 29 – Use of the Variable_Access_Specification variants and the Write.response choices

Write.request Variable_Access_Specification		Write.response CHOICE	
Variable_Name {Variable_Name}	References a list ¹ of COSEM object attributes.	Success {Success}	Indicates that the attribute referenced could be successfully written.
	The Data service parameter carries the data to be written or the method invocation parameter(s).	Data_Access_Error {Data_Access_Error}	Provides the reason for the write to fail.
Parameterized_Access {Parameterized_Access}	References a list ¹ of COSEM object attributes to be written selectively.	Success {Success}	As above.
	The Data service parameter carries the data to be written.	Data_Access_Error {Data_Access_Error}	
Write_Data_Block_Access	Carries block transfer control information. The Data service parameter carries raw-data, including the encoded form of the list ¹ of COSEM object attribute or method references, and the list of data to be written or the list of method invocation parameters.	Block_Number	Carries the number of the latest data block received.

NOTE The same Write.response choice can be present more than once, to show the possible responses to each request.

¹ A list may have one or more elements.

The Write.request service primitive may have one or more Variable_Access_Specification parameters:

- the Variable_Name variant is used to reference a complete COSEM object attribute to be written or COSEM object method to be invoked. The request may include one or more variable names;
- the Parameterized_Access variant is used to reference a COSEM object attribute to be written selectively. In this case, the Variable_Name element references the COSEM object attribute, the Selector and the Parameter elements carry the access selector and the access parameters respectively as specified in the attribute specification. The request may include one or more Parameterized_Access parameters;

The Data service parameter carries the value(s) to be written to the attribute(s), or the method invocation parameter(s) of the method(s) to be invoked. The number and the order of the Data parameters shall be the same as that of the Variable_Access_Specification parameters.

If the Write.request service primitive does not fit into a single APDU, block transfer may be used. In this case:

- the Write_Data_Block_Access variant of the Variable_Access_Specification carries block transfer control information:
 - the Last_Block element indicates whether the given block is the last one (TRUE) or not (FALSE);
 - the Block_Number element carries the number of the actual block sent;
- the Data parameter carries one part of the list of the attribute references and the list of data to be written, or one part of the list of method references and the list of method invocation parameters.
- The request includes a single Write_Data_Block_Access and a single Data parameter.

The Result (+) parameter indicates that the service requested has succeeded.

The .response / .confirm service primitives contain a list of Write_Result parameters. Their number and order shall be the same as that of the Variable_Name / Parameterized_Access parameters in the .request / .indication service primitives.

Without block transfer, and with block transfer after receiving the last block:

- when the Write service is used to write attribute(s), each element carries either the success of the write access (Success) or a reason for the write to fail for this variable (Data_Access_Error);
- when the Write service is used to invoke method(s), each element carries either the success of the method invocation access (Success) or a reason for the method invocation to fail for this variable (Data_Access_Error).

The Block_Number choice is used during block transfer to confirm the correct reception of a data block and to ask for the next block. It carries the number of the latest block received.

If the block-number in the request is not the one expected, or if the block could not be received correctly, then the Write.response service primitive shall be returned with a single Write_Result parameter, with the choice Data_Access_Error, carrying an appropriate code, for example (19) data-block-number-invalid.

The Result (–) parameter indicates that the service requested has failed. The Error_Type parameter provides the reason for failure. In this case, the server shall send back a ConfirmedServiceError APDU instead of a WriteResponse APDU.

Use

A possible logical sequence of the Write service primitives is illustrated in Figure 8 item a).

The Write.request primitive is invoked following the invocation of a SET or ACTION .request primitive by the client AP and mapping this to a Write.request primitive by the SN_MAPPER ASE. The client AL builds then the WriteRequest APDU and sends it to the server. For LN / SN service mapping, see 6.18.

The Write.indication primitive is generated by the server AL upon reception of a WriteRequest APDU.

The Write.response primitive is invoked by the server AP in order to send a response to a previously received Write.indication primitive. The server AL builds then the WriteResponse APDU and sends it to the client.

The Write.confirm primitive is generated by the client AL following the reception of a WriteResponse APDU. It is mapped then back to a SET or ACTION .confirm primitive by the SN_MAPPER ASE and the SET or ACTION .confirm primitive is generated.

The protocol of the Write service is specified in 7.3.9.

6.15 The UnconfirmedWrite service

Function

The UnconfirmedWrite service is used with SN referencing. It is an unconfirmed service. Its functions are:

- to write the value of one or more COSEM object attributes;
- to invoke one or more COSEM interface object method when no return parameters are expected.

The UnconfirmedWrite.request service primitive shall always fit in a single APDU.

The UnconfirmedWrite service is specified in IEC 61334-4-41:1996, 10.6 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The UnconfirmedWrite service primitives shall provide service parameters as shown in Table 30.

Table 30 – Service parameters of the UnconfirmedWrite service

	.request	.indication
Variable_Access_Specification { Variable_Access_Specification }	M	M(=)
Variable_Name	S	S(=)
Parameterized_Access	S	S(=)
Variable_Name	M	M(=)
Selector	M	M(=)
Parameter	M	M(=)
Data { Data }	M	M(=)
NOTE For security parameters see Table 15.		

The use of the different variants of the Variable-Access-Specification service parameter of the UnconfirmedWrite.request service primitive is shown in Table 31. The use of the Data service parameter is also explained.

If the encoded form of the request does not fit in a single APDU, it can be transported in data blocks using the general block transfer mechanism.

Table 31 – Use of the Variable_Access_Specification variants

UnconfirmedWrite.request Variable_Access_Specification	
Variable_Name {Variable_Name}	References a COSEM object attribute. The Data service parameter carries the data to be written or the method invocation parameter(s).
Parameterized_Access {Parameterized_Access}	References a COSEM object attribute with selective access. The Data service parameter carries the data to be written.

The UnconfirmedWrite.request service primitive may have one or more Variable_Access_Specification parameters.

- the Variable_Name variant is used to reference a complete COSEM object attribute to be written or COSEM object method to be invoked;
- the Parameterized_Access variant is used to reference a COSEM object attribute to be written selectively. In this case, the Variable_Name element references the COSEM object attribute, the Selector and the Parameter elements carry the access selector and the access parameters respectively as specified in the attribute specification.

The Data service parameter carries the value(s) to be written to the attribute(s), or the method invocation parameter(s) of the method(s) to be invoked. The number and the order of the Data parameters shall be the same as that of the Variable_Access_Specification parameters.

Use

A possible logical sequence of the Write service primitives is illustrated in Figure 8 item d).

The UnconfirmedWrite.request primitive is invoked following the invocation of a SET or ACTION .request primitive with Service_Class == Unconfirmed by the client AP and mapping this to an UnconfirmedWrite.request primitive by the SN_MAPPER ASE. The client AL builds then the UnconfirmedWriteRequest APDU and sends it to the server.

The UnconfirmedWrite.indication primitive is generated by the server AL upon reception of a WriteRequest APDU.

The protocol of the UnconfirmedWrite service is specified in 7.3.10.

6.16 The InformationReport service

Function

The InformationReport service is an unsolicited, non-client/server type service. It is requested by a server using SN referencing, upon occurrence of an event, in order to inform the client of the value of one or more DLMS named variables – mapped to COSEM interface object attributes – as though they had been requested by the client. It is an unconfirmed service.

The InformationReport service is specified in IEC 61334-4-41:1996, 10.7 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the

specification of the InformationReport service is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The InformationReport service primitives shall provide parameters as shown in Table 32.

Table 32 – Service parameters of the InformationReport service

	.request	.indication
Current_Time	M	M (=)
Variable_Access_Specification { Variable_Access_Specification }	M	M (=)
Variable_Name	M	M (=)
Data { Data }	M	M(=)

The Current_Time parameter indicates the time at which the InformationReport.request service primitive was issued.

The Variable_Access_Specification parameter of choice Variable_Name specifies one or more DLMS named variables – mapped to COSEM interface object attributes – the value of which is sent by the server.

The Data parameter carries the value of the DLMS named variable(s), in the same order as the order of the Variable_Access_Specification parameter(s).

The protocol for the InformationReport service is specified in 7.3.11.

6.17 Client side layer management services: the SetMapperTable.request

Function

The function of the SetMapperTable service is to manage the client SN_MAPPER ASE.

Semantics

There is only one primitive, the .request primitive. It shall provide parameters as follows (see Table 33):

Table 33 – Service parameters of the SetMapperTable.request service primitives

	.request
Mapping_Table	M

The Mapping_table parameter is mandatory. It contains the contents of the attribute *object_list* for the requested server and AA. The structure of the content is defined in IEC 62056-6-2:2016.

Use

The SetMapperTable.request service is invoked by the client AP to provide mapping information to the client SN_MAPPER ASE. This service does not cause any data transmission between the client and the server. The client AP uses this service primitive, in order to enhance the efficiency of the mapping process if SN referencing is used.

6.18 Summary of services and LN/SN data transfer service mapping

The following Tables 34 to 36 provide a summary of the COSEM application layer services.

Table 34 – Summary of ACSE services

Client side	Server side
COSEM-OPEN.request	COSEM-OPEN.indication
COSEM-OPEN.confirm	COSEM-OPEN.response
COSEM-RELEASE.request	COSEM-RELEASE.indication
COSEM-RELEASE.confirm	COSEM-RELEASE.response
COSEM-ABORT.indication	COSEM-ABORT.indication

Table 35 – Summary of xDLMS services for LN referencing

Client side	Server side
GET.request	GET.indication
GET.confirm	GET.response
SET.request	SET.indication
SET.confirm	SET.response
ACTION.request	ACTION.indication
ACTION.confirm	ACTION.response
DataNotification.indication	DataNotification.request
EventNotification.indication	EventNotification.request
Trigger_EventNotification_Sending.request	
NOTE The DataNotification service can be used both in application contexts using SN referencing and LN referencing.	

Table 36 – Summary of xDLMS services for SN referencing

Client side	Server side
Read.request	Read.indication
Read.confirm	Read.response
Write.request	Write.indication
Write.confirm	Write.response
UnconfirmedWrite.request	UnconfirmedWrite.indication
DataNotification.indication	DataNotification.request
InformationReport.indication	InformationReport.request
NOTE The DataNotification service can be used both in application contexts using SN referencing and LN referencing.	

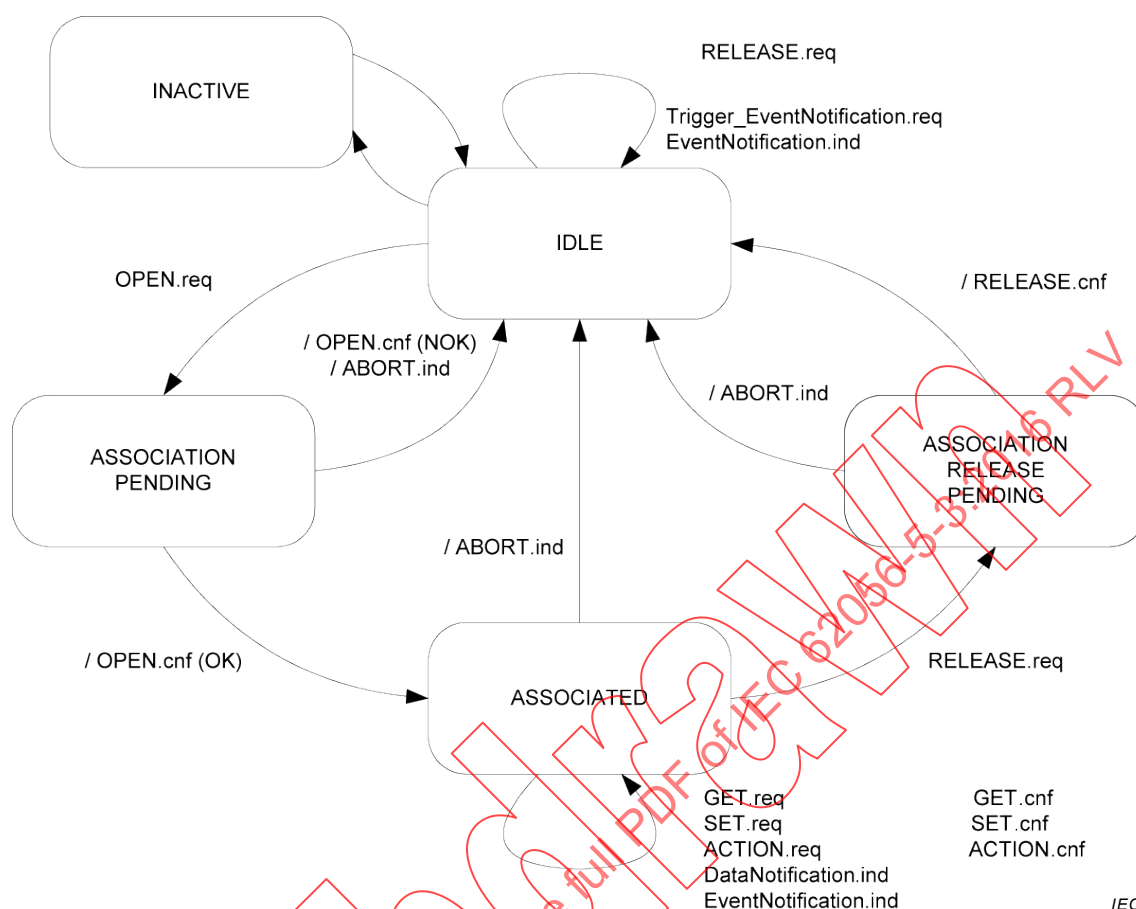
When the server uses SN referencing, a mapping between the service primitives using LN referencing and SN referencing takes place on the client side. This mapping is specified in 7.3.8, 7.3.9, 7.3.10 and 7.3.11.

7 DLMS/COSEM application layer protocol specification

7.1 The control function

7.1.1 State definitions of the client side control function

Figure 10 shows the state machine for the client side CF; see also Figure 1.



NOTE On the state diagrams of the client and server CF, the following conventions are used:

- service primitives with no “/” character as first character are “stimulants”: the invocation of these primitives is the origin of the state transition;
- service primitives with an “/” character as first character are “outputs”: the generation of these primitives is done on the state transition path.

Figure 10 – Partial state machine for the client side control function

The state definitions of the client CF – and of the AL including the CF – are as follows:

INACTIVE In this state, the CF has no activity at all: it neither provides services to the AP nor uses services of the supporting protocol layer.

IDLE This is the state of the CF when there is no AA existing, being released, or being established⁸. Nevertheless, some data exchange between the client and server – if the physical channel is already established – is possible. The CF can handle the EventNotification service.

NOTE State transitions between the INACTIVE and IDLE states are controlled outside of the protocol. For example, it can be considered that the CF makes the state transition from INACTIVE to IDLE by being instantiated and bound on the top of the supporting protocol layer. The opposite transition happens by deleting the given instance of the CF.

ASSOCIATION PENDING The CF leaves the IDLE state and enters this state when the AP requests the establishment of an AA by invoking the COSEM-OPEN.request primitive (OPEN.req). The CF may exit this state and enter either the ASSOCIATED state or return to the IDLE state, and generates the COSEM-OPEN.confirm primitive, (/OPEN.cnf(OK)) or (/OPEN.cnf(NOK)), depending on the result of the association request. The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).

⁸ Note that it is the state machine for the AL: lower layer connections, including the physical connection, are not taken into account. On the other hand, physical connection establishment is done outside of the protocol.

- ASSOCIATED** The CF enters this state when the AA has been successfully established. The client/server type data services are available in this state, and the EventNotification service can be handled. The CF remains in this state until the AP requests the release of the AA by invoking the COSEM-RELEASE.request primitive (RELEASE.req). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).
- ASSOCIATION RELEASE PENDING** The CF leaves the ASSOCIATED state and enters this state when the AP requests the release of the AA by invoking the COSEM-RELEASE.request primitive (RELEASE.req). The CF remains in this state, waiting for the response to this request from the server. As the server is not allowed to refuse a release request, after exiting this state, the CF always enters the IDLE state. The CF may exit this state by generating the COSEM-RELEASE.confirm primitive (/RELEASE.cnf). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).

7.1.2 State definitions of the server side control function

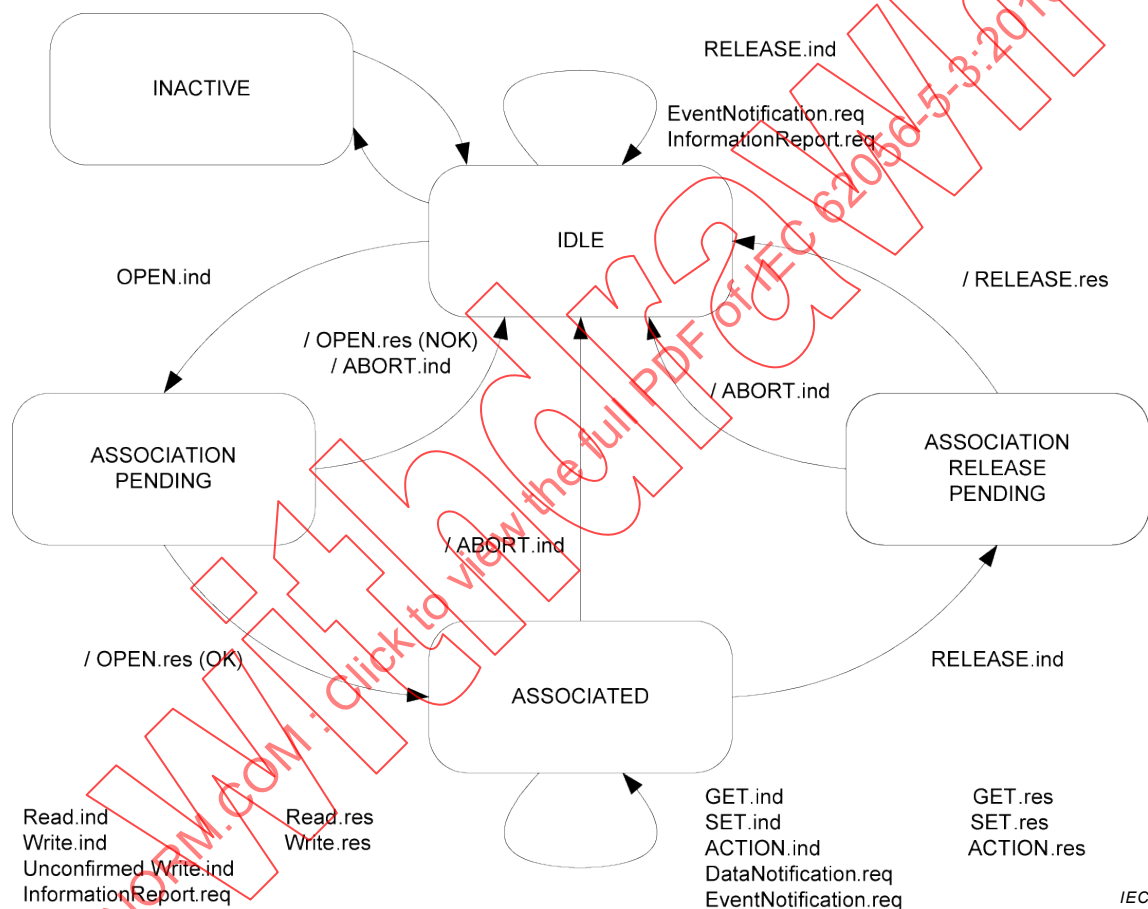


Figure 11 – Partial state machine for the server side control function

Figure 11 shows the state machine for the server side CF; see also Figure 1.

INACTIVE	In this state, the CF has no activity at all: it neither provides services to the AP nor uses services of the supporting protocol layer.
IDLE	This is the state of the CF when there is no AA existing, being released, or being established ⁹ . Nevertheless, some data exchange between the client and server – if the physical channel is already established – is possible. The CF can handle the EventNotification / InformationReport services.
ASSOCIATION PENDING	The CF leaves the IDLE state and enters this state when the client requests the establishment of an AA, and the server AL generates the COSEM-OPEN.indication primitive (/OPEN.ind). The CF may exit this state and enter either the ASSOCIATED state or return to the IDLE state, depending on the result of the association request, and invokes the COSEM-OPEN.response primitive, (/OPEN.res(OK)) or (/OPEN.res(NOK)). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).
ASSOCIATED	The CF enters this state when the AA has been successfully established. The client/server type data services are available in this state, and the EventNotification / InformationReport services can be handled. The CF remains in this state until the client requests the release of the AA, and the server AL generates the COSEM-RELEASE.ind primitive (/RELEASE.ind). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).
ASSOCIATION RELEASE PENDING	The CF leaves the ASSOCIATED state and enters this state when the client requests the release of an AA, and the server AP receives the COSEM-RELEASE.indication primitive (/RELEASE.ind). The CF remains in this state, waiting that the AP accepts the release request. As the server is not allowed to refuse a release request, after exiting this state, the CF always enters the IDLE state. The CF may exit this state when the AP accepts the release of the AA, and invokes the COSEM-RELEASE.response primitive (RELEASE.res). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).

7.2 The ACSE services and APDUs

7.2.1 ACSE functional units, services and service parameters

The **DLMS/COSEM** AL ACSE is based on the connection-oriented ACSE, as specified in ISO/IEC 15953:1999 and ISO/IEC 15954:1999.

Functional units are used to negotiate ACSE user requirements during association establishment. Three functional units are defined:

- Kernel functional unit;
- Authentication functional unit; and
- Application Context Negotiation functional unit.

The **DLMS/COSEM** AL uses only the Kernel and the Authentication functional units.

The acse-requirements parameters of the AARQ and AARE APDUs are used to select the functional units for the association.

The Kernel functional unit is always available. It is the default functional unit.

To be included, the Authentication functional unit shall be explicitly requested on the AARQ APDU and accepted on the AARE APDU. The selection of the Authentication functional unit supports additional parameters on the AARQ and AARE APDUs. The Authentication functional unit does not affect the elements of procedure.

Table 37 shows the services and parameters associated with the ACSE functional units, as used by the **DLMS/COSEM** AL. The abstract syntax of the ACSE APDUs is specified in Clause 8.

⁹ Note that it is the state machine for the AL: lower layer connections, including the physical connection, are not taken into account. On the other hand, physical connection establishment is done outside of the protocol.

Table 37 – ACSE functional units, services and service parameters

Functional unit	Service	APDU	Parameter	Presence
Kernel	A-ASSOCIATE	AARQ	protocol-version	O ¹
			application-context-name	M
			called-AP-title	U
			called-AE-qualifier	U
			called-AP-invocation-identifier	U
			called-AE-invocation-identifier	U
			calling-AP-title	U
			calling-AE-qualifier	U
			calling-AP-invocation-identifier	U
			calling-AE-invocation-identifier	U
			implementation-information	O
			user-information ²	M
			(carrying an xDLMS InitiateRequest APDU)	
			dedicated-key	U
			response-allowed	U
			proposed-quality-of-service	U
			proposed-dlms-version-number	M
			proposed-conformance	M
			client-max-receive-pdu-size	M
		AARE	protocol-version	O
			application-context-name	M
			result	M
			result-source-diagnostic	M
			responding-AP-title	U
			responding-AE-qualifier	U
			responding-AP-invocation-identifier	U
			responding-AE-invocation-identifier	U
			implementation-information	O
			user-information ²⁾	M
			(carrying an xDLMS InitiateResponse APDU)	S
			negotiated-quality-of-service	U
			negotiated-dlms-version-number	M
			negotiated-conformance	M
			server-max-receive-pdu-size	M
			vaa-name	M
			(or carrying a ConfirmedServiceError APDU)	S
	A-RELEASE	RLRQ	reason	U
			user-information	U
		RLRE	reason	U
			user-information	U
Authentication	A-ASSOCIATE	AARQ	sender-acse-requirements	U
			mechanism-name	U
			calling-authentication-value	U

Functional unit	Service	APDU	Parameter	Presence
		AARE	responder-acse-requirements	U
			mechanism-name	U
			responding-authentication-value	U
¹ O: Presence is an ACPM (COSEM Application layer) option. ² According to ISO/IEC 15953:1999, the user-information parameter is optional. However, in the DLMS/COSEM environment it is mandatory in the AARQ / AARE APDUs.				

In general, the value of each parameter of the AARQ APDU is determined by the parameters of the COSEM-OPEN.request service primitive. Similarly, the value of each parameter of the AARE is determined by the COSEM-OPEN.response primitive. The COSEM-OPEN service is specified in 6.2.

The AARQ and AARE APDU parameters are specified below. Managing these parameters is specified in 7.2.4.1.

- **protocol-version:** the COSEM AL uses the default value. For details, see ISO/IEC 15954:1999;
- **application-context-name:** COSEM application context names are specified in 7.2.2.2;
- **called-, calling- and responding- titles, qualifiers and invocation-identifiers:** these optional fields carry the value of the respective parameters of the COSEM-OPEN service. For details, see ISO/IEC 15954:1999;
- **implementation-information:** this parameter is not used by the COSEM AL. For details, see ISO/IEC 15954:1999;
- **user-information:** in the AARQ APDU, it carries an xDLMS InitiateRequest APDU holding the elements of the Proposed_xDLMS_Context parameter of the COSEM-OPEN.request service primitive. In the AARE APDU, it carries an xDLMS InitiateResponse APDU, holding the elements of the Negotiated_xDLMS_Context parameter, or an xDLMS ConfirmedServiceError APDU, holding the elements of the xDLMS_Initiate_Error parameter of the COSEM-OPEN.response service primitive;
- **sender- and responder-acse-requirements:** this parameter is used to select the optional functional units of the AARQ / AARE. In COSEM, only the Authentication functional unit is used. When present, it carries the value of BIT STRING { authentication (0) }. Bit set: authentication module selected;
- **mechanism-name:** COSEM authentication mechanism names are specified in 7.2.2.3;
- **calling- and responding- authentication-value:** see 5.3;
- **result:** the value of this parameter is determined by the COSEM AP (acceptor) or the COSEM AL (ACPM) as specified below. It is used to determine the value of the Result parameter of the COSEM-OPEN.confirm primitive:
 - if the AARQ APDU is rejected by the ACPM (i.e. the COSEM-OPEN.indication primitive is not issued by the COSEM AL), the value “rejected (permanent)” or “rejected (transient)” is assigned by the ACPM;
 - otherwise, the value is determined by the Result parameter of the COSEM-OPEN.response APDU;
- **result-source-diagnostic:** this parameter contains both the Result source value and the Diagnostic value. It is used to determine the value of the Failure_Type parameter of the COSEM-OPEN.confirm primitive:
 - Result-source value: if the AARQ is rejected by the ACPM, (i.e. the COSEM-OPEN.indication primitive is not issued by the COSEM AL) the ACPM assigns the value “ACSE service-provider”. Otherwise, the ACPM assigns the value “ACSE service-user”;

- Diagnostic value: If the AARQ is rejected by the ACPM, the appropriate value is assigned by the ACPM. Otherwise, the value is determined by the Failure_Type parameter of the COSEM-OPEN.response primitive. If the Diagnostic parameter is not included in the .response primitive, the ACPM assigns the value “null”.

The parameters of the RLRQ / RLRE APDUs – used when the COSEM-RELEASE service (see 6.3) is invoked with the parameter Use_RLRQ_RLRE == TRUE – are specified below.

- **reason:** carries the appropriate value as specified in 6.3;
- **user-information:** if present, it carries an xDLMS InitiateRequest / InitiateResponse APDU, holding the elements of the Proposed_xDLMS_Context / Negotiated_xDLMS_Context parameter of the COSEM-RELEASE.request / .response service primitive respectively; see 6.3.

7.2.2 Registered COSEM names

7.2.2.1 General

Within an OSI environment, many different types of network objects shall be identified with globally unambiguous names. These network objects include abstract syntaxes, transfer syntaxes, application contexts, authentication mechanism names, etc. Names for these objects in most cases are assigned by the committee developing the particular basic ISO standard or by implementers' workshops, and should be registered. For DLMS/COSEM, these object names are assigned by the DLMS User Association, and are specified below.

The decision no. 1999.01846 of OFCOM, Switzerland, attributes the following prefix for object identifiers specified by the DLMS User Association.

{ joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) }

For DLMS/COSEM, object identifiers are specified for naming the following items:

- COSEM application context names;
- COSEM authentication mechanism names.

7.2.2.2 The COSEM application context

In order to effectively exchange information within an AA, the pair of AE-invocations shall be mutually aware of, and follow a common set of rules that govern the exchange. This common set of rules is called the application context of the AA. The application context that applies to an AA is determined during its establishment⁴⁰.

NOTE An AA has only one application context. However, the set of rules that make up the application context of an AA may contain rules for alteration of that set of rules during the lifetime of the AA.

The following methods may be used:

- identifying a pre-existing application context definition;
- transferring an actual description of the application context.

In the COSEM environment, it is intended that an application context pre-exists and it is referenced by its name during the establishment of an AA. The application context name is specified as OBJECT IDENTIFIER ASN.1 type. COSEM identifies the application context name by the following object identifier value:

COSEM_Application_Context_Name::=

{joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) application-context(1) context_id(x)}

The meaning of these general COSEM application contexts is:

- there are two ASEs present within the AE invocation, the ACSE and the xDLMS_ASE;
- the xDLMS_ASE shall be as it is specified in IEC 61334-4-41⁴⁴:1996;

NOTE With the COSEM extensions to DLMS; see 4.2.3.1.

- the transfer syntax shall be A-XDR, specified in IEC 61334-6.

The specific context_ids and the use of ciphered and unciphered APDUs are shown in Table 38 below:

Table 38 – Use of ciphered / unciphered APDUs

Application context name	context_id	Unciphered APDUs	Ciphered APDUs
Logical_Name_Referencing_No_Ciphering::=	context_id(1)	Yes	No
Short_Name_Referencing_No_Ciphering::=	context_id(2)	Yes	No
Logical_Name_Referencing_With_Ciphering::=	context_id(3)	Yes	Yes
Short_Name_Referencing_With_Ciphering::=	context_id(4)	Yes	Yes

In order to successfully establish an AA, the application-context-name parameter of the AARQ and AARE APDUs should carry one of the “valid” names. The client proposes an application context name using the Application_Context_Name parameter of the COSEM-OPEN.request primitive. The server may return any value; either the value proposed or the value it supports.

7.2.2.3 The COSEM authentication mechanism name

Authentication of the client, the server or both is one of the security aspects addressed by the DLMS/COSEM specification. Three authentication security levels are specified:

- no authentication (lowest level) security;
- low level, password based authentication security (LLS) identifying only the client;
- high level, four-pass authentication security (HLS) identifying both the client and the server.

COSEM identifies the authentication mechanisms by the following general object identifier value:

COSEM_Authentication_Mechanism_Name::=

{joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) authentication_mechanism_name(2) mechanism_id(x)}

The value of the mechanism_id element selects one of the security mechanisms specified:

COSEM_lowest_level_security_mechanism_name::=	mechanism_id(0)
COSEM_low_level_security_mechanism_name::=	mechanism_id(1)
COSEM_high_level_security_mechanism_name::=	mechanism_id(2)
COSEM_high_level_security_mechanism_name_using_MD5::=	mechanism_id(3)
COSEM_high_level_security_mechanism_name_using_SHA-1::=	mechanism_id(4)
COSEM_high_level_security_mechanism_name_using_GMAC::=	mechanism_id(5)
NOTE With mechanism_id(2), the method of processing the challenge is secret.	

When the Authentication_Mechanism_Name is present in the COSEM-OPEN service, the authentication functional unit of the A-ASSOCIATE service shall be selected. The process of LLS and HLS authentication is described in 5.3 and 5.4.8.4.

7.2.3 APDU encoding rules

7.2.3.1 Encoding of the ACSE APDUs

The ACSE APDUs shall be encoded in BER, in accordance with ISO/IEC 8825-1. The user-information field of these APDUs shall carry the xDLMS InitiateRequest / InitiateResponse / ConfirmedServiceError APDU as appropriate, encoded in A-XDR. The resulting OCTET STRING shall be encoded in BER.

Examples for AARQ/AARE APDU encoding are given in Annex C and in Annex D.

7.2.3.2 Encoding of the xDLMS APDUs

The xDLMS APDUs shall be encoded in A-XDR, as specified in IEC 61334-6.

7.2.4 Protocol for application association establishment

7.2.4.1 Protocol for the establishment of confirmed application associations

AA establishment using the A-Associate service of the ACSE is the key element of COSEM interoperability. The participants of an AA are:

- a client AP, proposing AAs; and
- a server AP⁴², accepting them or not.

NOTE 1 To support multicast and broadcast services, an AA can also be established between a client AP and a group of server APs.

Figure 12 gives the MSC for the case, when:

- the COSEM-OPEN.request primitive requests a confirmed AA;
- the connection of the supporting lower layers is required for the establishment of this AA.

A client AP that desires to establish a confirmed AA, invokes the COSEM-OPEN.request primitive of the ASO with Service_Class == Confirmed. The response-allowed parameter of the xDLMS InitiateRequest APDU is set to TRUE. The client AL waits for an AARE APDU, prior to generating the .confirm primitive, with a positive – or negative – result.

The client CF enters the ASSOCIATION PENDING state. It examines then the Protocol_Connection_Parameters parameter. If this indicates that the establishment of the supporting layer connection is required, it establishes the connection⁴³.

NOTE 2 The PH layer shall be connected before the COSEM-OPEN service is invoked.

The CF assembles then – with the help of the xDLMS ASE and the ACSE – the AARQ APDU containing the parameters of the COSEM-OPEN.request primitive received from the AP and sends it to the server.

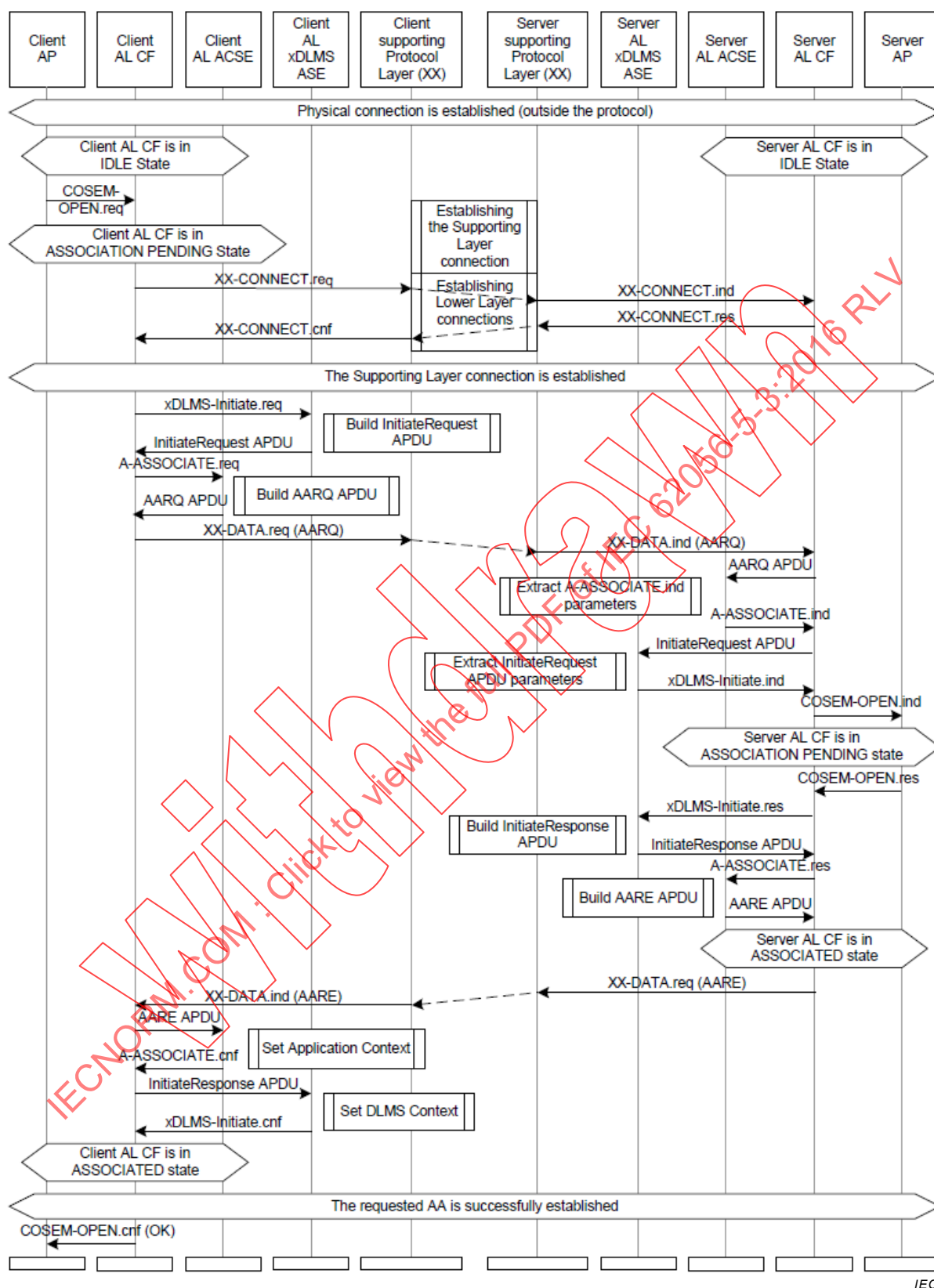


Figure 12 – MSC for successful AA establishment preceded by a successful lower layer connection establishment

The CF of the server AL gives the AARQ APDU received to the ACSE. It extracts the ACSE related parameters then gives back the control to the CF. The CF passes then the contents of the user-information parameter of the AARQ APDU – carrying an xDLMS InitiateRequest APDU – to the xDLMS_ASE. It retrieves the parameters of this APDU, then gives back the control to the CF. The CF generates the COSEM-OPEN.indication to the server AP with the parameters of the APDU⁴⁴ received and enters the ASSOCIATION PENDING state.

NOTE 3 Some service parameters of the COSEM-OPEN.indication primitive (address information, User_Information) do not come from the AARQ APDU, but from the supporting layer frame carrying the AARQ APDU. In some communication profiles, the Service_Class parameter of the COSEM-OPEN service is linked to the frame type of the supporting layer. In some other communication profiles, it is linked to the response-allowed field of the xDLMS-Initiate.request APDU. See also Annex A.

NOTE 4 The ASEs only extract the parameters; their interpretation and the decision whether the proposed AA can be accepted or not is the job of the server AP.

The server AP parses the fields of the AARQ APDU as described below.

Fields of the Kernel functional unit:

- application-context-name: it carries the COSEM_Application_Context_Name the client proposes for the association;
- calling-AP-title: when the proposed application context uses ciphering, it shall carry the client system title. If a client system title has already been sent during a registration process, like in the S-FSK PLC profile, the calling-AP-title field shall carry the same system title. Otherwise, the AA shall be rejected and appropriate diagnostic information shall be sent;
- calling-AE-invocation-identifier: this field supports the client user identification process; see IEC 62056-6-2:2016, 5.3.2.

Fields of the authentication functional unit (when present):

- sender-acse-requirements:
- if it is not present or it is present but bit 0 = 0, then the authentication functional unit is not selected. Any following fields of the authentication functional unit may be ignored;
- if present and bit 0 = 1 then the authentication functional unit is selected.
- mechanism-name: it carries the COSEM_Authentication_Mechanism_Name the client proposes for the association;
- calling-authentication-value: it carries the authentication value generated by the client.

If the value of the mechanism-name or the calling-authentication-value fields are not acceptable then the proposed AA shall be refused.

When the parsing of the fields of the Kernel and the authentication functional unit is completed, the server continues with parsing the parameters of the xDLMS InitiateRequest APDU, carried by the user-information field of the AARQ:

- dedicated-key: it carries the dedicated key to be used in the AA being established;
- response-allowed: If the proposed AA is confirmed, the value of this parameter is TRUE (default), and the server shall send back an AARE APDU. Otherwise, the server shall not respond. See also Annex A.
- proposed-dlms-version-number. See 4.2.3.1;
- proposed-conformance. See 7.3.1;

- client-max-receive-pdu-size. See 4.2.3.1.

If all elements of the proposed AA are acceptable, the server AP invokes the COSEM-OPEN.response service primitive with the following parameters:

- Application_Context_Name: the same as the one proposed;
- Result: accepted;
- Failure_Type: Result-source: acse-service-user; Diagnostic: null;
- Responding-AP-title: if the negotiated application context uses ciphering, it shall carry the server system title. If a server system title has already been sent during a registration process, like in the case of the S-FSK PLC profile, the Responding_AP_Title parameter shall carry the same system title. Otherwise, the AA shall be aborted by the client;
- Fields of the AARE authentication functional unit:
 - responder-acse-requirements:
 - a) when no security (Lowest Level Security) authentication or Low Level Security (LLS) authentication is used, this field shall not be present, or if present, bit 0 (authentication) shall be set to 0. Any following fields of the authentication functional unit may be ignored;
 - b) when High Level Security (HLS) authentication is used, this field shall be present and bit 0 (authentication) shall be set to 1;
 - mechanism-name: it shall carry the COSEM_Authentication_Mechanism_Name negotiated;
 - responding-authentication-value: it carries the authentication value generated by the server (StoC).
- User_Information: an xDLMS InitiateResponse APDU carrying the elements of the negotiated xDLMS context.

The CF assembles the AARE APDU – with the help of the xDLMS ASE and the ACSE – and sends it to the client AL via the supporting lower layer protocols, and enters the ASSOCIATED state. The proposed AA is established now, the server is able to receive xDLMS data transfer service request(s) – both confirmed and unconfirmed – and to send responses to confirmed service requests within this AA.

At the client side, the parameters of the AARE APDU received are extracted with the help of the ACSE and the xDLMS ASE, and passed to the client AP via the COSEM-OPEN.confirm service primitive. At the same time, the client AL enters the ASSOCIATED state. The AA is established now with the application context and xDLMS context negotiated.

If the application context proposed by the client is not acceptable or the authentication of the client is not successful, the COSEM-OPEN.response primitive is invoked with the following parameters:

- Application_Context_Name: the same as the one proposed, or the one supported by the server;
- Result: rejected-permanent or rejected-transient;
- Failure_Type: Result-source: acse-service-user; Diagnostic: an appropriate value;
- User_Information: an xDLMS InitiateResponse APDU with the parameters of the xDLMS context supported by the server.

If the application context proposed by the client is acceptable and the authentication of the client is successful but the xDLMS context cannot be accepted, the COSEM-OPEN.response primitive shall be invoked with the following parameters:

- Application_Context_Name: the same as the one proposed;
- Result: rejected-permanent or rejected-transient;

- **Failure_Type:** Result-source: acse-service-user; Diagnostic: no-reason-given;
- **User_Information:** an xDLMS ConfirmedServiceError APDU, indicating the reason for not accepting the proposed xDLMS context.

In these two cases, upon invocation of the .response primitive, the CF assembles and sends the AARE APDU to the client via the supporting lower layer protocols. The proposed AA is not established, the server CF returns to the IDLE state.

At the client side, the parameters of the AARE APDU received are extracted with the help of the ACSE and the xDLMS_ASE, and passed to the client AP via the COSEM-OPEN.confirm primitive. The proposed AA is not established, the client CF returns to the IDLE state.

The server ACSE may not be capable of supporting the requested association, for example if the AARQ syntax or the ACSE protocol version are not acceptable. In this situation, it returns a COSEM-OPEN.response primitive to the client with an appropriate Result parameter. The Result Source parameter is appropriately assigned the symbolic value of "ACSE service-provider". The COSEM-OPEN.indication primitive is not issued. The association is not established.

7.2.4.2 Repeated COSEM-OPEN service invocations

If a COSEM-OPEN.request primitive is invoked by the client AP referring to an already established AA, then the AL locally and negatively confirms this request with the reason that the requested AA already exists. Note, that this is always the case for pre-established AAs; see 7.2.4.4.

If, nevertheless, a server AL receives an AARQ APDU referencing to an already existing AA, it simply discards this AARQ, or, if it is implemented, it may also respond with the optional ExceptionResponse APDU.

7.2.4.3 Establishment of unconfirmed application associations

A client AP that desires to establish an unconfirmed AA, invokes the COSEM-OPEN.request primitive of the ASO with **Service_Class == Unconfirmed**. The response-allowed parameter of the xDLMS InitiateRequest APDU, carried by the user-information parameter of the AARQ is set to FALSE. The client AL does not wait any response from the server: the .confirm primitive is locally generated. Otherwise the procedure is the same as in the case of the establishment of confirmed AAs.

As the establishment of unconfirmed AAs does not require the server AP to respond to the association request coming from the client, in some cases – for example in the case of one-way communications or broadcasting – the establishment of unconfirmed AA is the only possibility.

After the establishment of an unconfirmed AA, xDLMS data transfer services using LN referencing can be invoked only in an unconfirmed manner, until the association is released. With SN referencing, only the UnconfirmedWrite service can be used.

7.2.4.4 Pre-established application associations

The purpose of pre-established AAs is to simplify data exchange. The AA establishment and release phases (phases 1 and 3 on Figure 4), using the COSEM-OPEN and COSEM-RELEASE services are eliminated and only data transfer services are used⁴⁵.

NOTE As for all AAs, the logical devices contain an Association LN / SN interface object for the pre-established associations, too.

This standard does not specify how to establish such AAs: it can be considered, that this has already been done. Pre-established AAs can be considered to exist from the moment the lower layers are able to transmit APDUs between the client and the server.

A pre-established AA can be either confirmed or unconfirmed (depending on the way it has been pre-established).

A pre-established AA cannot be released.

7.2.5 Protocol for application association release

7.2.5.1 Overview

An existing AA can be released gracefully or non-gracefully. Graceful release is initiated by the client AP. Non-graceful release takes place when an event unexpected by the AP occurs, for example a physical disconnection is detected.

7.2.5.2 Graceful release of an application association

DLMS/COSEM provides two mechanisms to release AAs:

- by disconnecting the supporting layer of the AL;
- by using the ACSE A-Release service.

The first mechanism shall be supported in all profiles where the supporting layer of the AL is connection oriented.

EXAMPLE The 3-layer, HDLC based, connection oriented profile.

To release an AA this way, the COSEM-RELEASE service shall be invoked with the Use_RLRQ_RLRE parameter not present or FALSE. Disconnecting the supporting layer shall release all AAs built on that supporting layer connection.

The second mechanism can be used to release an AA without disconnecting the supporting layer. It shall be supported in all profiles when the supporting layer is connectionless. It may be also used when the supporting layer is connection-oriented but the connection is not managed by the AL, or disconnection of the supporting layer is not practical because other applications may use it, or when there is a need to secure the COSEM-RELEASE service. It is the only way to release unconfirmed AAs.

To release an AA in this way, the COSEM-RELEASE service shall be invoked with the Use_RLRQ_RLRE parameter = TRUE. As specified in 6.3, the COSEM-RELEASE service can be secured by including a ciphered xDLMS InitiateRequest / InitiateResponse in the user-information field of the RLRQ / RLRE APDUs respectively, thus preventing a potential denial of service attack.

An example for releasing an AA using the ACSE A-RELEASE service is shown in Figure 13.

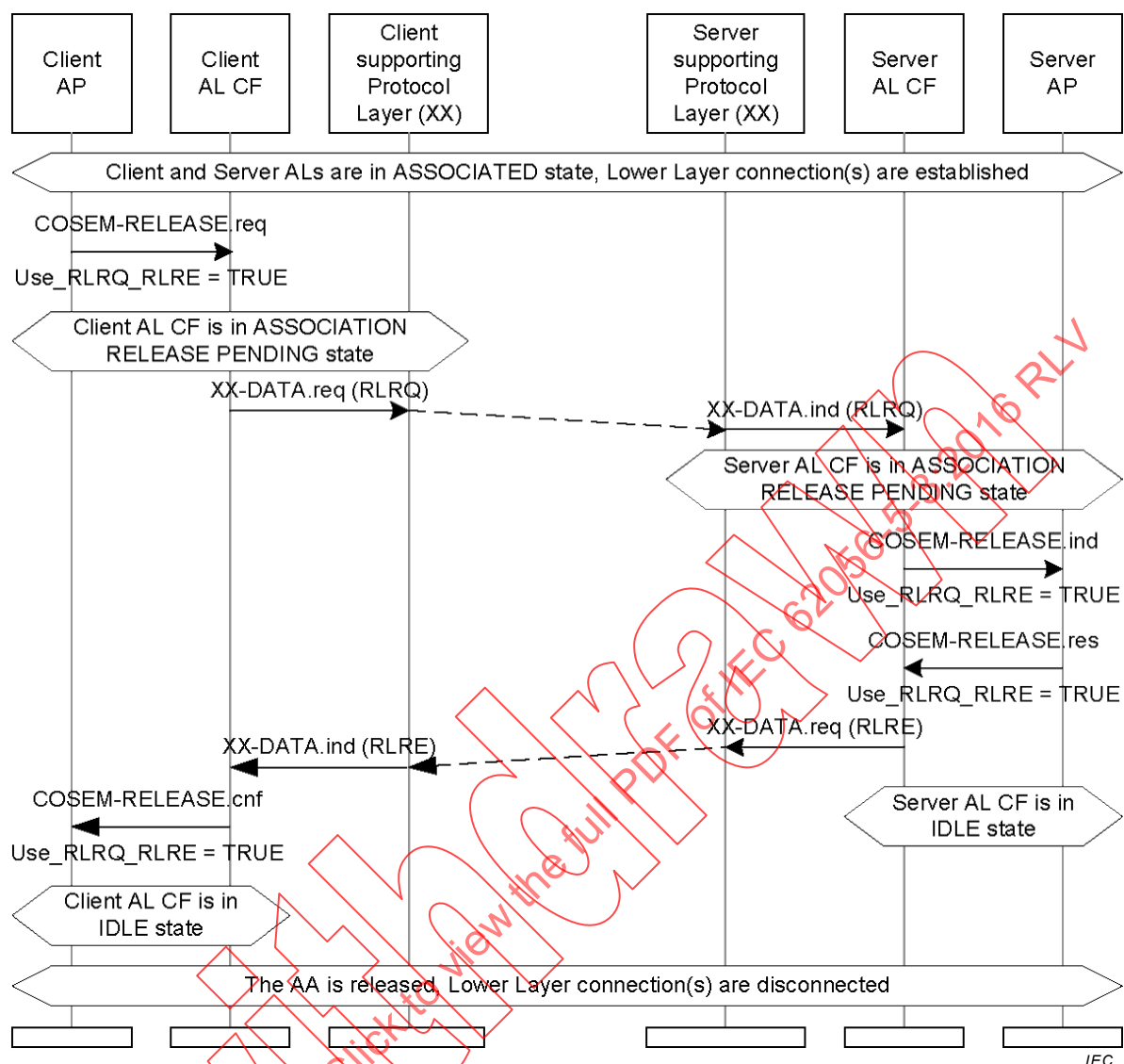


Figure 13 – Graceful AA release using the A-RELEASE service

A client AP that desires to release an AA using the A-RELEASE service, shall invoke the COSEM-RELEASE.request service primitive with Use_RLRQ_RLRE == TRUE. The client CF enters the ASSOCIATION RELEASE PENDING state. It constructs then an RLRQ APDU and sends it to the server. If the AA to be released has been established with a ciphered context, then the user information field of the RLRQ APDU may contain a ciphered xDLMS InitiateRequest APDU, see 6.3.

When the server AL CF receives the RLRQ APDU, it checks first if the user-information field contains a ciphered xDLMS InitiateRequest APDU. If so, it tries to decipher it. If this is successful, it enters the ASSOCIATION RELEASE PENDING state and generates a COSEM-RELEASE.indication primitive with Use_RLRQ_RLRE == TRUE. Otherwise, it silently discards the RLRQ APDU and stays in the ASSOCIATED state.

The .response primitive is invoked by the server AP to indicate if the release of the AA is accepted or not, but only if the AA to be released is confirmed. Note that the server AP cannot refuse a release request. Upon reception of the .response primitive the server AL CF constructs a RLRE APDU and sends it to the client. If the RLRQ APDU contained a ciphered xDLMS InitiateRequest APDU then the RLRE APDU shall contain a ciphered xDLMS InitiateResponse APDU. The server AL CF returns to the IDLE state.

The .confirm primitive is generated by the client AL CF when the RLRE APDU is received. The supporting layer is not disconnected. The client AL CF returns to the IDLE state.

If the RLRE APDU received contains a ciphered xDLMS InitiateResponse APDU but it cannot be deciphered, then the RLRE APDU shall be discarded. It is left to the client to cope with the situation.

Figure 14 gives an example of graceful releasing a confirmed AA by disconnecting the corresponding lower layer connection.

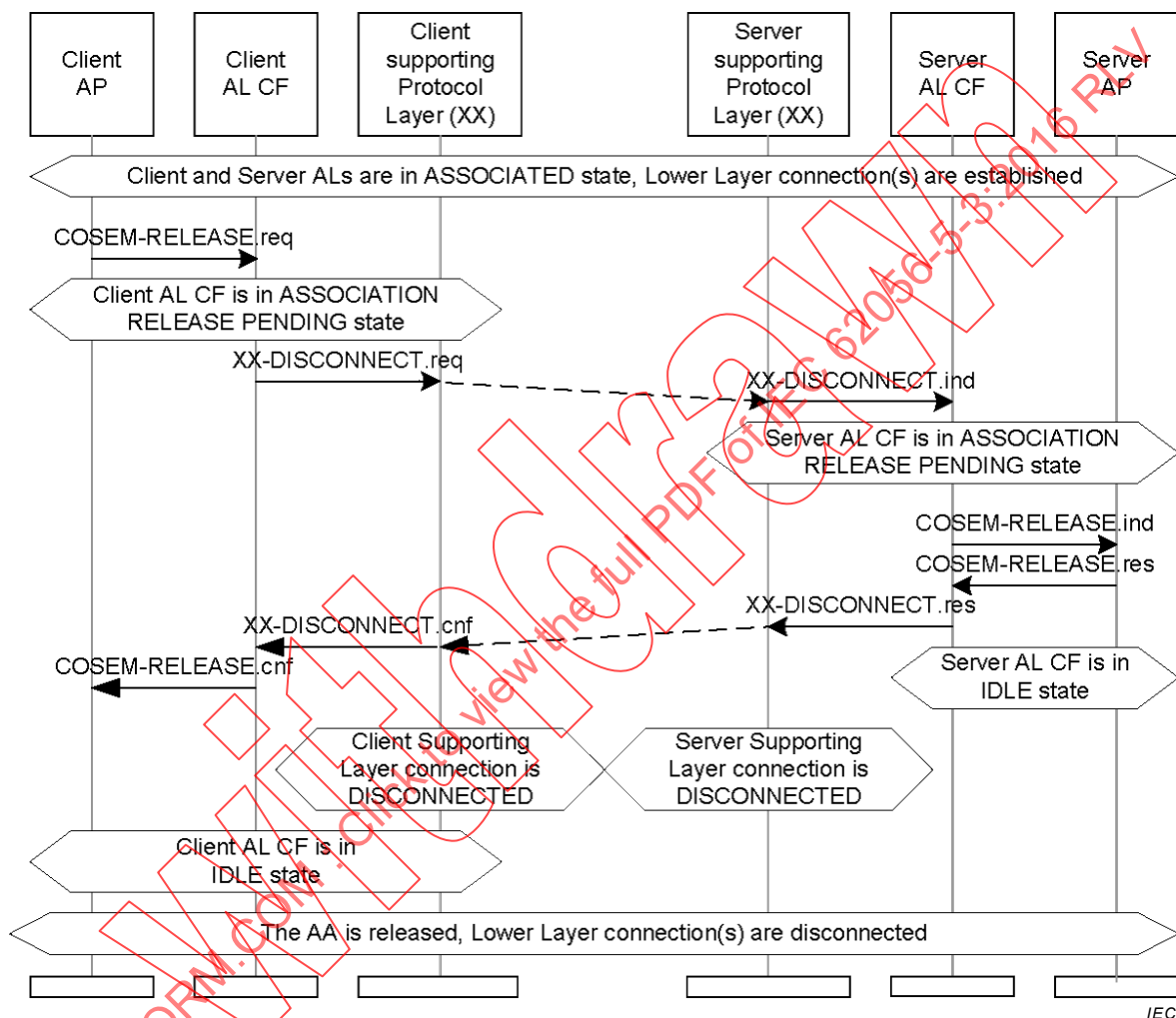


Figure 14 – Graceful AA release by disconnecting the supporting layer

A client AP that desires to release an AA not using the A-RELEASE service, invokes the COSEM-RELEASE.request primitive with `Use_RLRQ_RLRE == FALSE` or not present. The client AL CF enters the ASSOCIATION RELEASE PENDING state.

In communication profiles where the RLRQ service is mandatory, invoking the .request primitive with no `Use_RLRQ_RLRE` or with `Use_RLRQ_RLRE == FALSE` may lead to an error: the .request shall be locally and negatively confirmed. The client AL CF returns to the IDLE state.

When the client AL CF receives the .request primitive, it sends an XX-DISCONNECT.request primitive to the server.

When the server AL CF receives the XX-DISCONNECT.request primitive, the CF enters the ASSOCIATION RELEASE PENDING state. The COSEM-RELEASE.indication primitive is generated by the server AL CF with Use_RLRQ_RLRE == FALSE or not present.

The COSEM-RELEASE.response primitive is invoked by the server AP to indicate if the release of the AA is accepted or not. Note that the server AP cannot refuse a release request. Upon reception of this primitive, the server AL CF sends an XX-DISCONNECT.response primitive to the client and returns to the IDLE state.

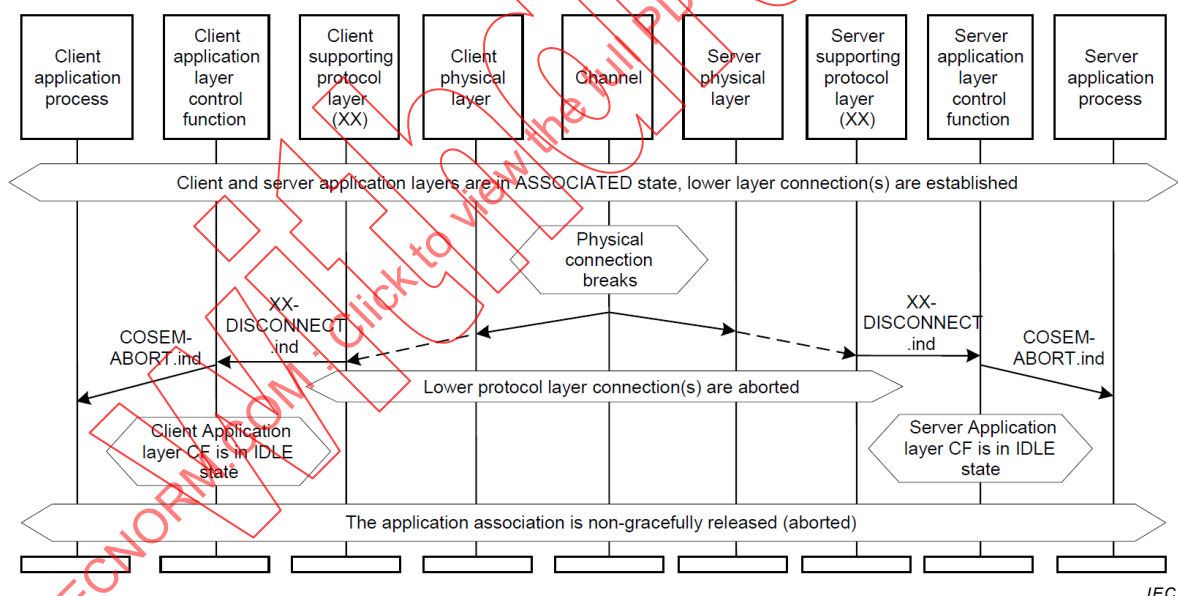
The COSEM-RELEASE.confirm primitive is generated by the client AL when the XX-DISCONNECT.confirm primitive is received. The supporting layer is disconnected. The client AL CF returns to the IDLE state.

7.2.5.3 Non-graceful release of an application association

Various events may result in a non-graceful release of an AA: detection of the disconnection of any lower layer connection (including the physical connection), detecting a local error, etc.

Non-graceful release – abort – of an AA is indicated to the COSEM-AP with the help of the COSEM-ABORT service. The Diagnostics parameter of this service indicates the reason for the non-graceful AA release. The non-graceful release of AA is not selective: if it happens, all the existing association(s) – except the pre-established ones – shall be aborted.

Figure 15 shows the message sequence chart for aborting the AA, due to the detection of a physical disconnection.



NOTE The release of an AA may require internal communication between the ASEs of the CF. These are not shown on the figures.

Figure 15 – Aborting an AA following a PH-ABORT.indication⁴⁶

7.3 Protocol for the data transfer services

7.3.1 Negotiation of services and options – the conformance block

The conformance block allows clients and servers using the same DLMS/COSEM protocol, but supporting different capabilities to negotiate a compatible set of capabilities so that they

can communicate. It is carried by the DLMS_Conformance parameter of the COSEM-OPEN service.

In DLMS/COSEM none of the services or options are mandatory: the ones to be used are negotiated via the COSEM-OPEN service (the proposed-conformance parameter of the xDLMS InitiateRequest APDU and the negotiated-conformance parameter of the xDLMS InitiateResponse APDU). An implemented service shall be fully conforming to its specification. If a service or option is not present in the negotiated conformance block, it may not be requested by the client.

The xDLMS conformance block can be distinguished from the DLMS conformance block specified in IEC 61334-4-41:1996 by its tag: APPLICATION 31. It is shown in Table 39.

Table 39 – xDLMS Conformance block

Conformance block bit	Reserved	LN referencing	SN referencing
0	x		
1	*	general-protection ¹	general-protection ¹
2	*	general-block-transfer	general-block-transfer
3			read
4			write
5			unconfirmed-write
6	x		
7	x		
8		attribute0-supported-with-set	
9		priority-mgmt-supported	
10		attribute0-supported-with-get	
11		block-transfer-with-get-or-read	block-transfer-with-get-or-read
12		block-transfer-with-set-or-write	block-transfer-with-set-or-write
13		block-transfer-with-action	
14		multiple-references	multiple-references
15			information-report
16	*	data-notification	data-notification
17	x		
18			parameterized-access
19		get	
20		set	
21		selective-access	
22		event-notification	
23		action	
¹ general-protection includes general-glo-ciphering and general-ded-ciphering.			

7.3.2 Confirmed and unconfirmed service invocations

In general, data transfer services may be invoked in a confirmed or an unconfirmed manner. The time sequence of the service primitives corresponds to:

- Figure 8 item a) in case of confirmed service invocations; and
- Figure 8 item d) in case of unconfirmed service invocations.

A client AP that desires to access an attribute or a method of a COSEM interface object invokes the appropriate .request service primitive. The client AL constructs the APDU corresponding to the .request primitive and sends it to the server.

The server AP, upon receipt of the .indication primitive, checks whether the service can be provided or not (validity, client access rights, availability, etc.). If everything is OK, it locally applies the service required on the corresponding “real” object. In the case of confirmed services, the server AP invokes the appropriate .response primitive. The server AL constructs the APDU corresponding to the .response primitive and sends it to the server. The client AL generates the .confirm primitive.

If a confirmed service request cannot be processed by the server AL – for example the request has been received without establishing an AA first, or the request is otherwise erroneous – it is either discarded, or when possible, the server AL responds with a ConfirmedServiceError APDU, or, when implemented, with an ExceptionResponse APDU. These APDUs may contain diagnostic information about the reason of not being able to process the request. They are defined in Clause 8.

Within confirmed AAs, client/server type data transfer services can be invoked in a confirmed or unconfirmed manner.

Within unconfirmed AAs, client/server type data transfer services may be invoked in an unconfirmed manner only. With this, collisions due to potential multiple responses in the case of multicasting and/or broadcasting can be avoided.

In the case of unconfirmed services, three different kinds of destination addresses are possible: individual, group or broadcast. Depending on the destination address type, the receiving station shall handle incoming APDUs differently, as follows:

- XX-APDUs with an individual address of a COSEM logical device. If they are received within an established AA they shall be sent to the COSEM logical device addressed, otherwise they shall be discarded;
- XX-APDUs with a group address of a group of COSEM logical devices. These shall be sent to the group of COSEM logical devices addressed. However, the message received shall be discarded if there is no AA established between a client and the group of COSEM logical devices addressed;
- XX-APDUs with the broadcast address shall be sent to all COSEM logical devices addressed. However, the message received shall be discarded if there is no AA established between a client and the All-station address.

NOTE Unconfirmed AA-s between a client and a group of logical devices are established with a COSEM-OPEN service with Service_Class == Unconfirmed and a group of logical device addresses (for example broadcast address).

7.3.3 Protocol for the GET service

When the client AP desires to read the value of one or more COSEM interface object attributes, it uses the GET service.

As explained in 6.6, the encoded form of the request shall always fit in a single APDU.

On the other hand, the result may be too long to fit in a single APDU. In this case, **either the service-specific or the general block transfer mechanism** may be used. It is negotiated via **bit 2 or bit 11** of the conformance block; see 7.3.1.

~~NOTE 1 The supporting layer can also provide a mechanism for transferring long messages.~~

NOTE In some DLMS/COSEM communication profiles segmentation is available to transfer long APDUs.

The GET service primitive types and the corresponding APDUs are shown in Table 40.

Table 40 – GET service types and APDUs

GET .req / .ind	Request APDU	Response APDU	GET .res / .cnf
NORMAL	Get-Request-Normal	Get-Response-Normal	NORMAL
		Get-Response-With-Datablock with Last-Block = FALSE	ONE-BLOCK
NEXT	Get-Request-Next	Get-Response-With-Datablock with Last-Block = FALSE	ONE-BLOCK
		Get-Response-With-Datablock with Last-Block = TRUE	LAST-BLOCK
WITH-LIST	Get-Request-With-List	Get-Response-With-List	WITH-LIST
		Get-Response-With-Datablock with Last-Block = FALSE	ONE-BLOCK

Figure 16 shows the MSC for a confirmed GET service in the case of success, without block transfer.

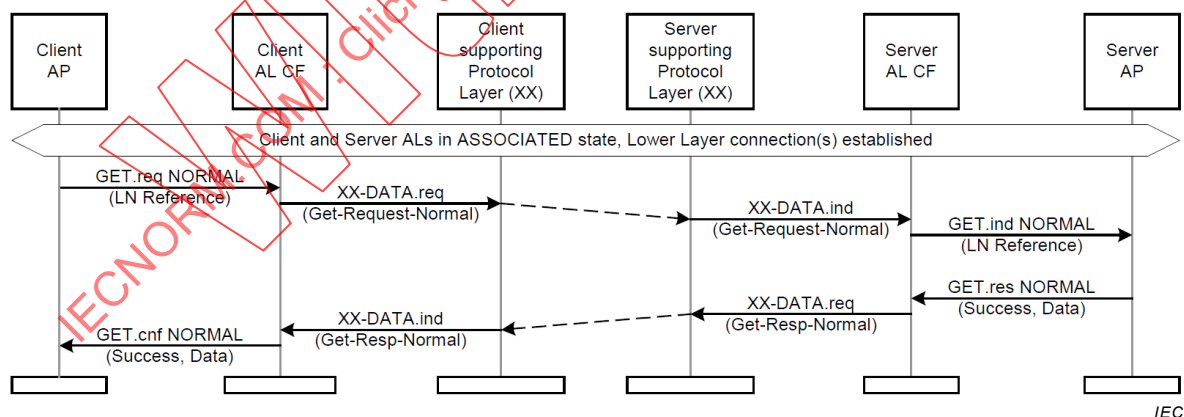


Figure 16 – MSC of the GET service

Figure 17 shows the MSC of a confirmed GET service in the case of success, with the result returned in three blocks.

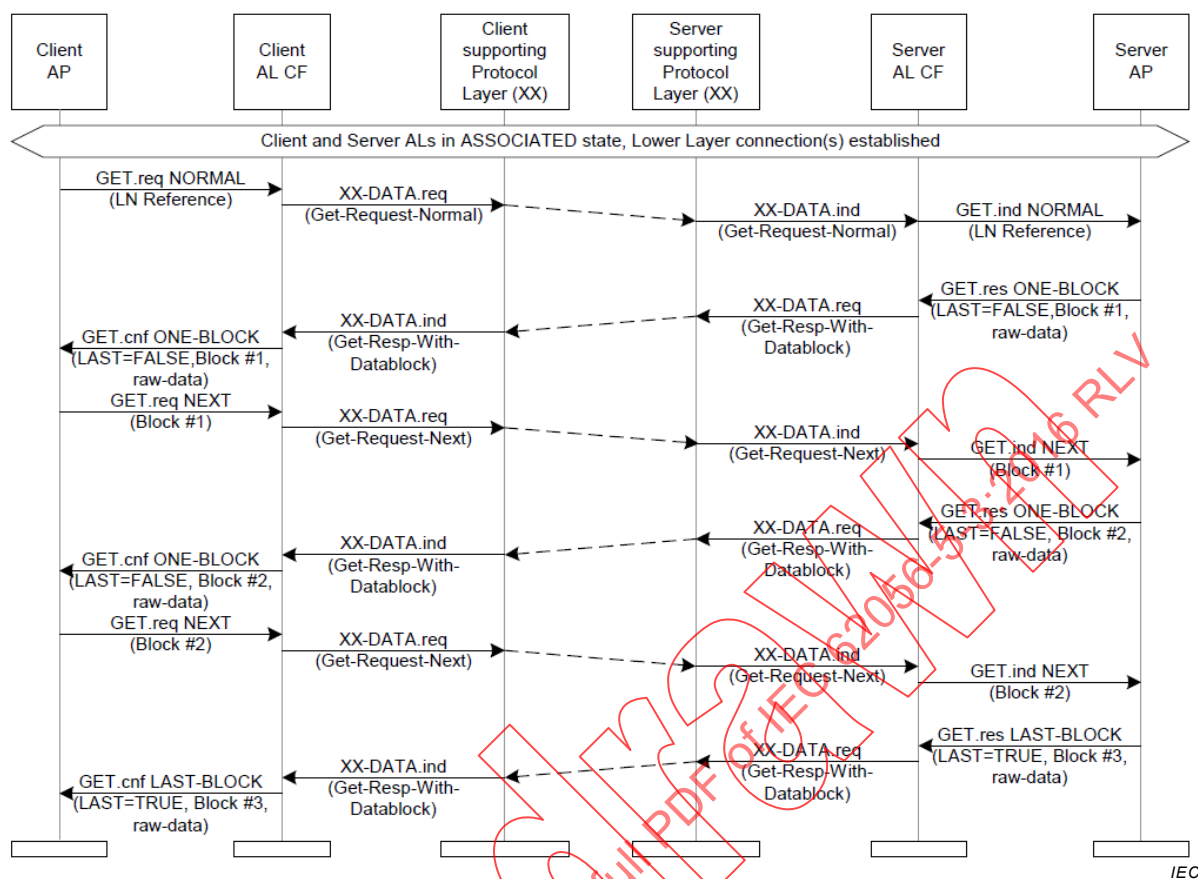


Figure 17 – MSC of the GET service with block transfer

The GET.request primitive is invoked with Request_Type == NORMAL or WITH-LIST as appropriate. As in this case the data to be returned is too long to fit in a single APDU, the server AP sends it in blocks. First, the data is encoded, as if it would fit into a single APDU:

- if the value of a single attribute was requested, only the type and value shall be encoded (Data). If the Data cannot be delivered, the response shall be of type GET-NORMAL with Data_Access_Result;
- if the value of a list of attributes was requested, then the list of results shall be encoded: for each attribute, either Data or Data_Access_Result.

The result is a series of bytes, $B_1, B_2, B_3, \dots, B_N$.

NOTE 2 The server can generate the complete response upon receipt of the first GET.indication primitive or dynamically (on the fly).

The server AP assembles then a DataBlock_G structure:

- Last_Block == FALSE;
- Block_Number == 1;
- Result (Raw_Data) == the first K bytes of the encoded data: $B_1, B_2, B_3, \dots, B_K$.

It is recommended to start the numbering of the blocks from 1.

The server AP invokes then the GET-RESPONSE-ONE-BLOCK service primitive with Response_Type == ONE-BLOCK carrying this DataBlock-G structure.

Upon reception of the .response primitive, the server AL builds a Get-Response-With-Datablock APDU carrying the parameters of the .response primitive and sends it to the client.

Upon reception of this APDU, the client AL generates a .confirm primitive with Response_Type == ONE-BLOCK. The client AP is informed now that the response is provided in several blocks. It stores the data block received ($B_1, B_2, B_3, \dots, B_K$), then acknowledges its reception and asks for the next one by invoking a GET-REQUEST-NEXT service primitive. The block number shall be the same as the block number of the data block received. The client AL builds a Get-Request-Next APDU and sends it to the server.

When the server AL invokes the GET.indication primitive with Request_Type == NEXT, the server AP prepares and sends the next data block, including $B_{K+1}, B_{K+2}, B_{K+3}, \dots, B_L$ with block-number == 2. This exchange of sending data blocks and acknowledgements continues until the last data block, carrying $B_M, B_{M+1}, B_{M+2}, \dots, B_N$ is sent. The last GET.response primitive is invoked with Response_Type == LAST-BLOCK: in the DataBlock-G structure Last_Block == TRUE. This last data block is not acknowledged by the client.

Throughout the whole procedure, the Invoke_Id and the Priority parameters shall be the same in each primitive.

If during a long data transfer the server receives another service request, it is served according to the priority rules and the priority management settings (Conformance block bit 9).

If any error occurs during the long data transfer, the transfer is aborted. The error cases are:

- a) The server is not able to provide the next block of data for any reason. In this case, the server AP shall invoke a GET-RESPONSE-LAST-BLOCK service primitive. The Result parameter shall contain a DataBlock_G structure with:
 - Last_Block == TRUE;
 - Block_Number == number of the block confirmed by the client + 1;
 - Result == Data_Access_Result, indicating the reason of the failure.
- b) The Block_Number parameter in a GET-REQUEST-NEXT service primitive is not equal to the number of the previous block sent by the server. The server interprets this, as if the client would like to abort the ongoing transfer. In this case, the server AP shall invoke a GET-RESPONSE-LAST-BLOCK service primitive. The Result parameter shall contain a DataBlock_G structure with:
 - Last_Block == TRUE;
 - Block_Number == equal to the block number received from the client;
 - Result == Data-Access-Result, long-get-aborted.
- c) The server may receive a Get-Request-Next APDU when no long data transfer is in progress. In this case, the server AP shall invoke a GET-RESPONSE-LAST-BLOCK service primitive. The Result parameter shall contain a DataBlock_G structure with:
 - Last-block == TRUE;
 - Block-Number == equal to the block number received from the client;
 - Result == Data-Access-Result, no-long-get-in-progress.
- d) The block number sent by the server is not equal to the next in sequence. In this case, the client shall abort the block transfer (see case b).

If, in the error cases above, the server is not able to invoke a GET-RESPONSE-LAST-BLOCK service primitive for any reason, it shall invoke a GET-RESPONSE-NORMAL service primitive, with the Data-Access-Result parameter indicating the reason of the failure. The server shall send a Get-Response-Normal APDU.

The MSC for error case b), long get aborted, is shown in Figure 18:

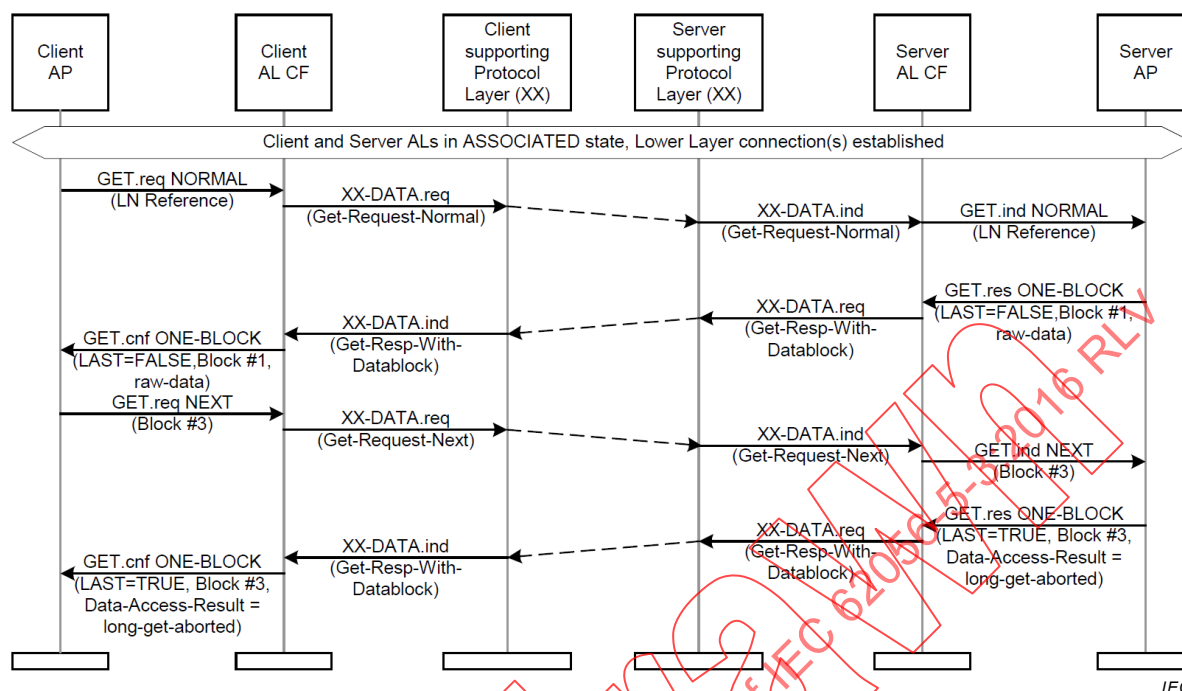


Figure 18 – MSC of the GET service with block transfer, long GET aborted

7.3.4 Protocol for the SET service

When the client AP desires to write the value of one or more COSEM interface object attributes, it uses the SET service.

As explained in 6.7, the encoded form of the request may fit in a single request or not. In this latter case, either the service-specific or the general block transfer mechanism may be used. It is negotiated via bit 2 or bit 12 of the conformance block, see 7.3.1.

NOTE 1 The supporting layer can also provide a mechanism for transferring long messages.

NOTE In some DLMS/COSEM communication profiles segmentation is available to transfer long APDUs.

The SET service primitive types and the corresponding APDUs are shown in Table 41.

Table 41 – SET service types and APDUs

SET .req / .ind	Request APDU	Response APDU	SET .res / .cnf
NORMAL	Set-Request-Normal	Set-Response-Normal	NORMAL
FIRST-BLOCK	Set-Request-With-First-Datablock Last-Block = FALSE	Set-Response-Datablock	ACK-BLOCK
ONE-BLOCK	Set-Request-With-Datablock Last-Block = FALSE		
LAST-BLOCK	Set-Request-With-Datablock Last-Block = TRUE	Set-Response-Last-Datablock	LAST-BLOCK
WITH-LIST	Set-Request-With-List	Set-Response-With-List	WITH-LIST
FIRST-BLOCK-WITH-LIST	Set-Request-With-List-And-With-First-Datablock	Set-Response-Datablock	ACK-BLOCK

Figure 19 shows the MSC of a confirmed SET service, in the case of success, without block transfer.

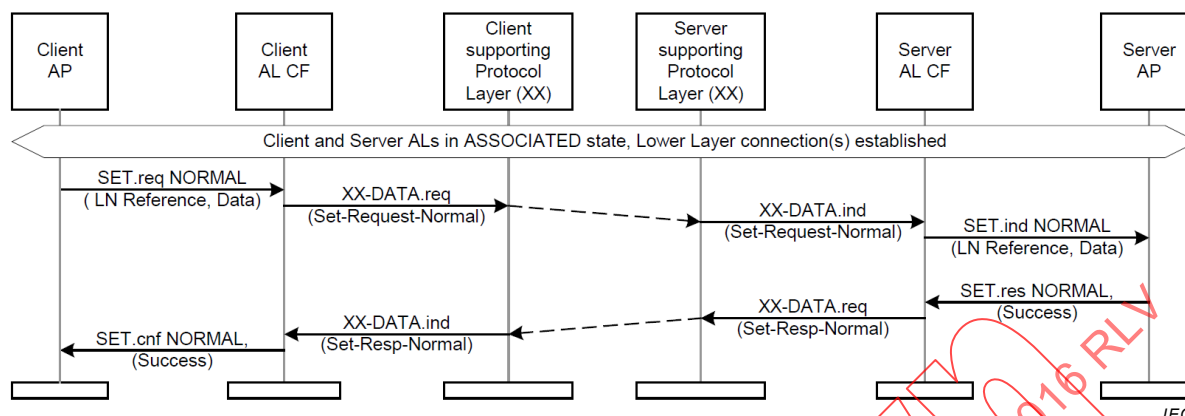


Figure 19 – MSC of the SET service

Figure 20 shows the MSC of a confirmed SET service in the case of success, with the request sent in three blocks.

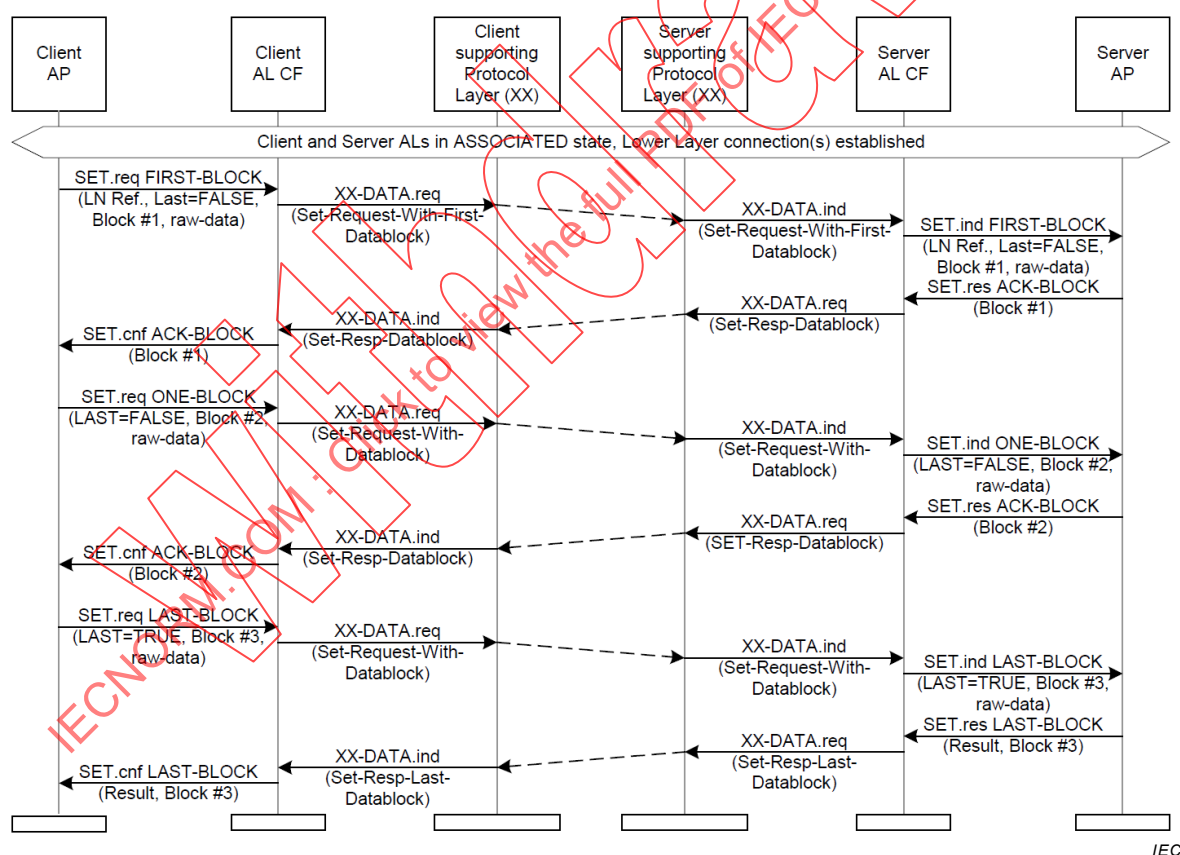


Figure 20 – MSC of the SET service with block transfer

As the data to be sent is too long to fit in a single APDU in this case, the client AP sends it in blocks. First, the data is encoded as if it would fit in a single APDU. The result is a series of bytes, $B_1, B_2, B_3, \dots, B_N$.

NOTE 2 The client can generate the complete request ($B_1, B_2, B_3, \dots, B_N$) in one step or dynamically (on the fly).

The client AP assembles then a DataBlock_SA structure:

- Last_Block == FALSE;
- Block_Number == 1;
- Raw_Data == the first K bytes of the encoded data: $B_1, B_2, B_3, \dots, B_K$.

The client AP invokes then the SET-REQUEST-FIRST-BLOCK or SET-REQUEST-FIRST-BLOCK-WITH-LIST service primitive as appropriate, carrying the attribute reference(s) and this DataBlock-SA structure.

Upon reception of the .request primitive, the client AL builds the appropriate Set-Request APDU carrying the parameters of the .request primitive and sends it to the server.

The server stores the data block received, then acknowledges its reception and asks for the next one by invoking a SET.response primitive with Response_Type == ACK-BLOCK and with the same block number as the number of the block received.

To send the next data block carrying $B_{K+1}, B_{K+2}, B_{K+3}, \dots, B_L$, the client AP invokes a SET-REQUEST-ONE-BLOCK service primitive. This exchange of sending data blocks and acknowledgements continues until the last data block carrying $B_M, B_{M+1}, B_{M+2}, \dots, B_N$ is sent, by invoking a SET-REQUEST-LAST-BLOCK service primitive with Last_Block == TRUE.

When these primitives are invoked, the client AL builds a Set-Request-With-Datablock APDU, carrying a DataBlock_SA structure and sends these APDUs to the server.

When the server AP receives the last datablock, it invokes a SET-RESPONSE-LAST-BLOCK or SET-RESPONSE-LAST-BLOCK-WITH-LIST service primitive as appropriate. The Result parameter carries the result of the complete SET service invocation. The Block_Number parameter confirms the reception of the last block.

Throughout the whole procedure, the Invoke_Id and the Priority parameters shall be the same in each primitive.

If during a long data transfer the server receives another service request, it is served according to the priority rules and the priority management settings (Conformance block bit 9).

If any error occurs during the long data transfer, the transfer is aborted. The error cases are:

- a) The server is not able to handle the data block received, for any reason. In this case, the server AP shall invoke a SET-RESPONSE-LAST-BLOCK or SET-RESPONSE-LAST-BLOCK-WITH-LIST service primitive as appropriate. The Result parameter indicates the reason for aborting the transfer;
- b) The Block_Number parameter in a SET-REQUEST-ONE-BLOCK service primitive is not equal to the block number expected by the server (last received + 1). The server interprets this as if the client would like to abort the ongoing transfer. In this case, the server AP shall invoke a SET-RESPONSE-LAST-BLOCK or SET-RESPONSE-LAST-BLOCK-WITH-LIST service primitive as appropriate with the Result parameter Data_Access_Result == long-set-aborted;
- c) The server may receive a Set-Request-With-Datablock APDU when no long data transfer is in progress. In this case, the server AP shall invoke a SET-RESPONSE-LAST-BLOCK service primitive with the Result parameter Data_Access_Result == no-long-set-in-progress.

If, in the error cases above, for any reason the server is not able to invoke a SET-RESPONSE-LAST-BLOCK service primitive, it invokes a SET-RESPONSE-NORMAL service primitive with the Data-Access-Result parameter indicating the reason of the failure.

7.3.5 Protocol for the ACTION service

When the client AP desires to invoke one or more COSEM interface objects methods, it uses the ACTION service. As explained in 6.8, the ACTION service comprises two phases.

If the method references and method invocation parameters or the return parameters do not fit in a single APDU, **either the service-specific or the general block transfer mechanism** may be used ~~from the client to the server and/or from the server to the client respectively~~. It is negotiated via bit 2 or bit 13 of the conformance block, see 7.3.1.

~~NOTE The supporting layer can also provide a mechanism for transferring long messages.~~

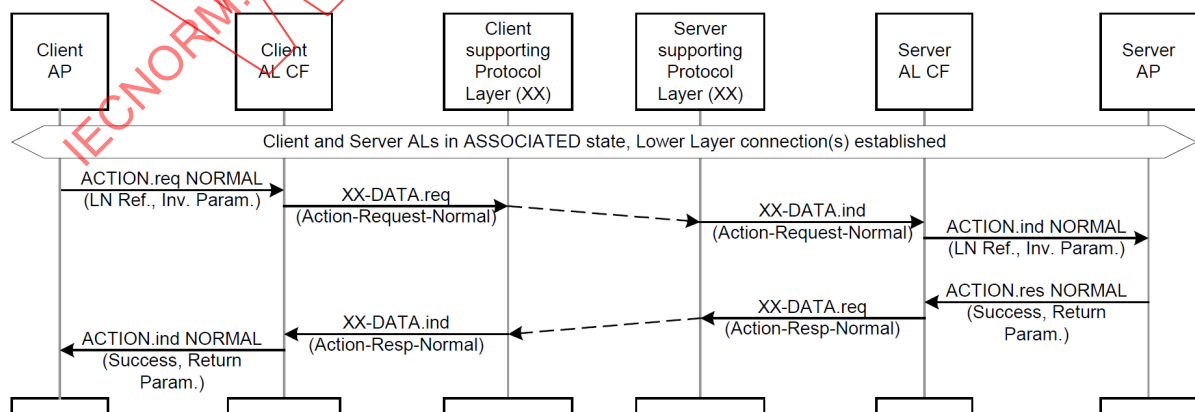
NOTE In some DLMS/COSEM communication profiles segmentation is available to transfer long APDUs.

The ACTION service primitive types and the corresponding APDUs are shown in Table 42.

Table 42 – ACTION service types and APDUs

ACTION .req / .ind	Request APDU	Response APDU	SET .res / .cnf
NORMAL	Action-Request-Normal	Action-Response-Normal	NORMAL
		Action-Response-With-Pblock	ONE-BLOCK
NEXT	Action-Request-Next-Pblock	Action-Response-With-Pblock	ONE-BLOCK
		Action-Response-With-Pblock	LAST-BLOCK
FIRST-BLOCK	Action-Request-With-First-Pblock	Action-Response-Next-Pblock	NEXT
ONE-BLOCK	Action-Request-With-Pblock		
LAST-BLOCK	Action-Request-With-Pblock	Action-Response-Normal	NORMAL
		Action-Response-With-Pblock	ONE-BLOCK
WITH-LIST	Action-Request-With-List	Action-Response-With-List	WITH-LIST
		Action-Response-With-Pblock	ONE-BLOCK
WITH-LIST-AND-FIRST-BLOCK	Action-Request-With-List-And-With-First-Pblock	Action-Response-Next-Pblock	NEXT

Figure 21 illustrates the MSC of a confirmed ACTION service in the case of success, without block transfer.



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Figure 21 – MSC of the ACTION service

The ACTION service can transport data in both directions:

- in the first phase, the client sends the ACTION.request with the method invocation parameters for the method(s) referenced and the server acknowledges them. The process is essentially the same as in the case of the SET service;
- in the second phase, the server sends the ACTION.response with the result of invoking the method(s) and the return parameters. The process is essentially the same as in the case of the GET service.

Throughout the whole procedure, the Invoke_Id and the Priority parameters shall be the same in each primitive.

If during a long data transfer the server receives another service request, it is served according to the priority rules and the priority management settings (Conformance block bit 9).

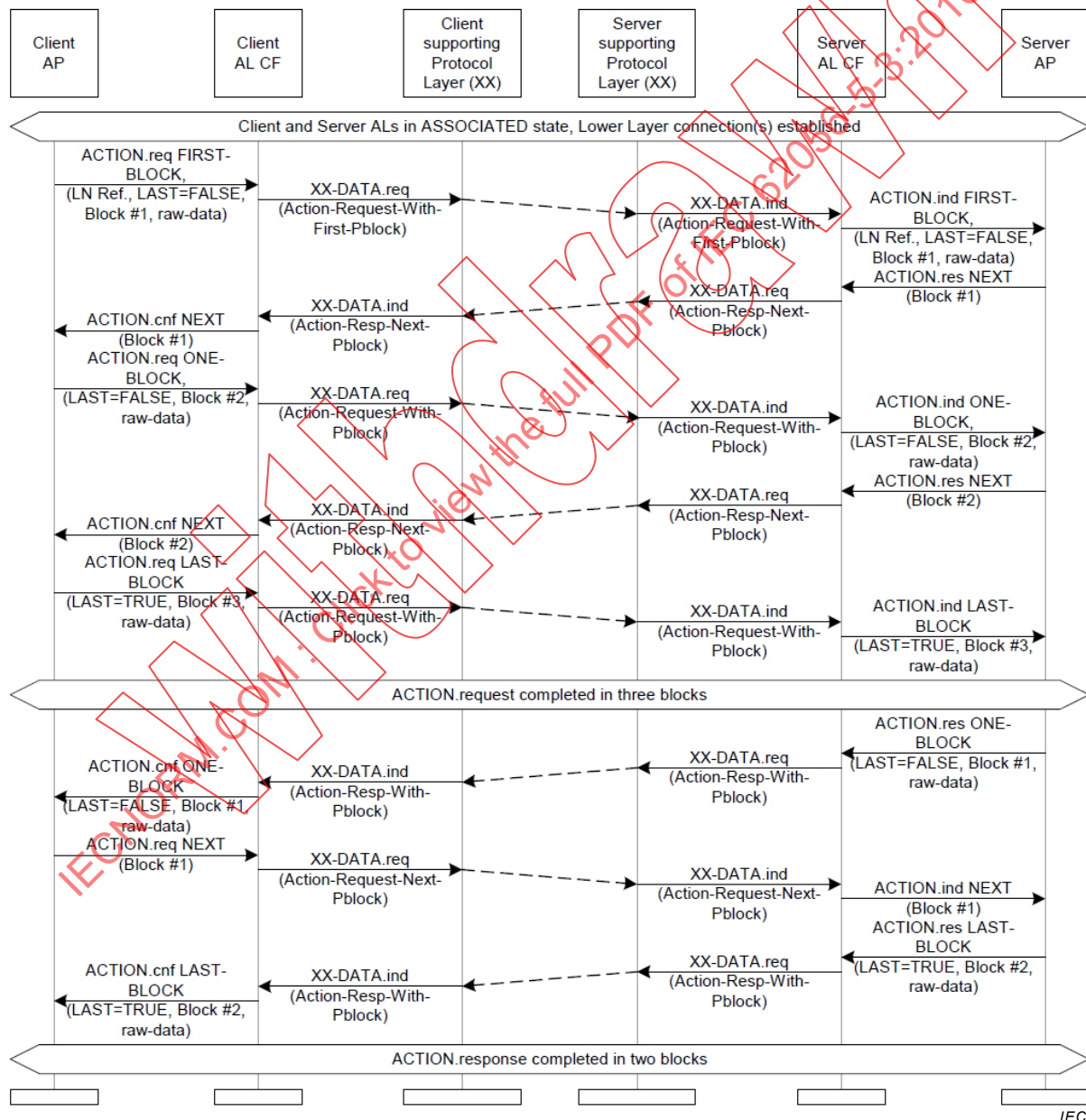


Figure 22 – MSC of the ACTION service with block transfer

Figure 22 illustrates the MSC in the case when block transfer takes place in both directions.

If any error occurs during the long data transfer, the transfer shall be aborted. Error cases are the same as in the case of the GET and SET services.

7.3.6 Protocol of the DataNotification service

When the server AP invokes a DataNotification.request service primitive, the server AL builds the DataNotification APDU and sends it to the client.

When the client AL receives this APDU, it invokes the DataNotification.indication service primitive.

If the service primitives are long partial service invocations can be used.

If the encoded form of the service primitive is too long, then the general block transfer mechanism can be used. See also Figure 37.

7.3.7 Protocol for the EventNotification service

Upon invocation of the EventNotification.request service, the Server AL builds an EventNotificationRequest APDU. The possibilities to send out this APDU depend on the communication profile and the connection status of the lower layers. Therefore, the protocol of the EventNotification service is further discussed in the parts of IEC 62056 describing the communication profiles;

In any case, in order to send the value(s) of attribute(s) to the client, without the client requesting it:

- the server uses the EventNotification.request service primitive;
- upon invocation of this primitive, the server AL builds an EventNotificationRequest APDU;
- this APDU is carried by the supporting layer service at the first opportunity to the client. The service type and the availability of this first opportunity depends on the communications profile used;
- upon reception of the EventNotificationRequest APDU, the client AL generates an EventNotification.indication primitive⁴⁷ to the COSEM client AP;

NOTE At the client side, it is always EventNotification.indication, independently of the referencing scheme (LN or SN) used by the server.

- by default, event notifications are sent from the management logical device (server) to the management AP (client).

7.3.8 Protocol for the Read service

As explained in 6.13, the Read service is used when the server uses SN referencing, either to read (a) COSEM interface object attribute(s), or to invoke (a) method(s) when return parameters are expected:

- in the first case, the GET.request service primitives are mapped to Read.request primitives and the Read.confirm primitives are mapped to GET.confirm primitives. The mapping and the corresponding SN APDUs are shown in Table 43;
- in the second case, the ACTION.request service primitives are mapped to Read.request primitives and the Read.response primitives are mapped to ACTION.response primitives. The mapping and the corresponding SN APDUs is shown in Table 44.

NOTE In the mapping tables below, the following notation is used:

- for LN services, only the request and response types are shown without service parameters;
- for SN services, the name of the service primitive is followed by the service parameters in brackets. Service parameter name elements are capitalized and joined with an underscore to signify a single entity. Parameters that may be repeated are shown in curly brackets. The choices that can be taken for the Variable_Access_Specification parameter are listed following the symbol “=”. Alternatives are separated by the vertical bar “|”;
- for SN APDUs, the name of the APDU is followed by the symbol “::=” and the fields in brackets. The field name elements are not capitalized and are joined with a dash to signify a single entity. Fields that may be repeated are shown in curly brackets. Alternatives are separated by the vertical bar “|”.

Table 43 – Mapping between the GET and the Read services

From GET.request of type	To Read.request	SN APDU
NORMAL	Read.request (Variable_Access_Specification) Variable_Access_Specification = Variable_Name Parameterized_Access;	ReadRequest::= (variable-name parameterized-access)
NEXT	Read.request (Variable_Access_Specification) Variable_Access_Specification = Block_Number_Access;	ReadRequest::= (block-number-access)
WITH-LIST	Read.request (Variable_Access_Specification) Variable_Access_Specification = Variable_Name Parameterized_Access;	ReadRequest::= (variable-name parameterized-access)
To GET.confirm of type	SN APDU	From Read.response
NORMAL	ReadResponse::= (data data-access-error)	Read.response (Data Data_Access_Error)
ONE-BLOCK	ReadResponse::= (data-block-result)	Read.response (Data_Block_Result) with Last_Block = FALSE
LAST-BLOCK	ReadResponse::= (data-block-result)	Read.response (Data_Block_Result) with Last_Block = TRUE
WITH-LIST	ReadResponse::= (data data-access-error)	Read.response (Data Data_Access_Error)

Table 44 – Mapping between the ACTION and the Read services

From ACTION.request of type	To Read.request	SN APDU
NORMAL	Read.request (Variable_Access_Specification) Variable_Access_Specification = Parameterized_Access; with Variable_Name = method reference, Selector = 0, Parameter = method invocation parameter or null-data	ReadRequest::= (parameterized-access)
NEXT	Read.request (Variable_Access_Specification) Variable_Access_Specification = Block_Number_Access;	ReadRequest:: = (block-number-access)

From ACTION.request of type	To Read.request	SN APDU
FIRST-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Raw_Data = one part of the method reference(s) and method invocation parameter	ReadRequest::= (read-data-block-access)
ONE-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = FALSE, Block_Number = next number, Raw_Data = as above	ReadRequest::= (read-data-block-access)
LAST-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = TRUE, Block_Number = next number, Raw_Data = as above	ReadRequest::= (read-data-block-access)
WITH-LIST	Read.request ({Variable_Access_Specification}) Variable_Access_Specification = Parameterized_Access; with Variable_Name = method reference, Selector = 0, Parameter = method invocation parameter or null-data	ReadRequest::= ({parameterized-access})
WITH-LIST-AND-FIRST-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Raw_Data = as above	ReadRequest::= (read-data-block-access)
To ACTION.confirm	SN APDU	From Read.response
NORMAL	ReadResponse::= (data data-access-error)	Read.response (Read_Result) Read_Result = Data Data_Access_Error;
ONE-BLOCK	ReadResponse::= (data-block-result)	Read.response (Read_Result) Read_Result = Data_Block_Result; with Last_Block = FALSE
LAST-BLOCK	ReadResponse::= (data-block-result)	Read.response (Read_Result) Read_result = Data_Block_Result; with Last_Block = TRUE
NEXT	ReadResponse::= (block-number)	Read.confirm (Read_Result) Read_Result = Block_Number;

From ACTION.request of type	To Read.request	SN APDU
WITH-LIST	ReadResponse ::= ({data data-access-error})	Read.response ({Read_Result}) Read_Result = Data Data_Access_Error;

Figure 23 shows the MSC of a Read service used to **invoke read the value of a single-method attribute**.

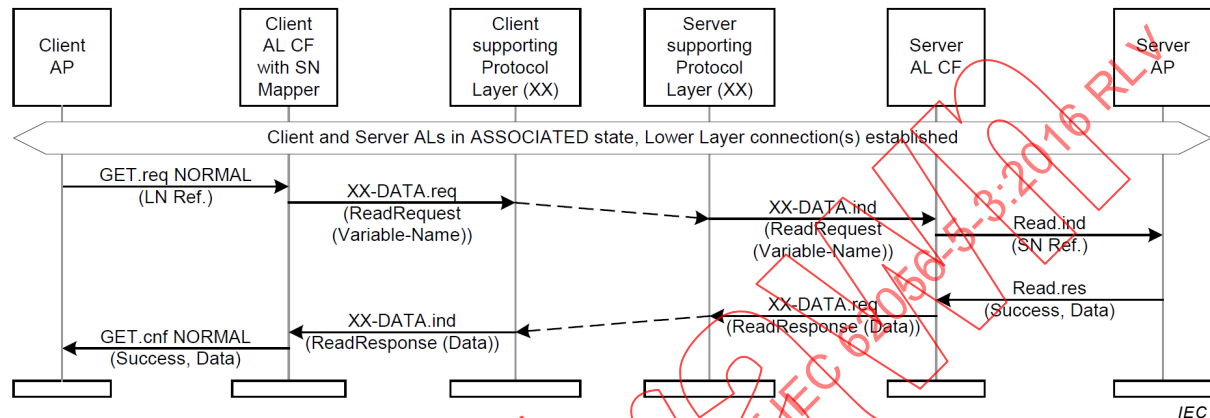


Figure 23 – MSC of the Read service used for reading an attribute

Figure 24 shows the MSC of a Read service used to invoke a single method.

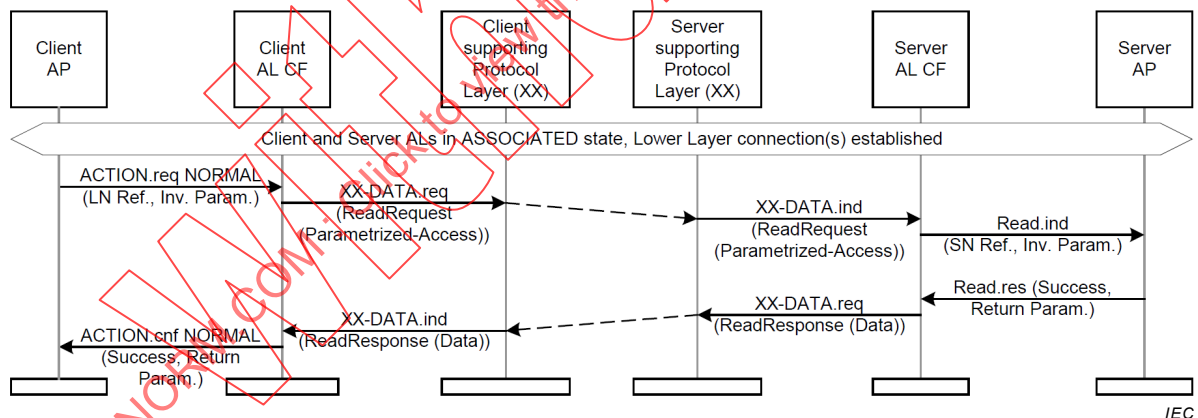


Figure 24 – MSC of the Read service used for invoking a method

Figure 25 shows the MSC of a Read service for reading a single attribute, with the result returned in three blocks **using the service-specific block transfer mechanism**.

Alternatively, the general block transfer mechanism can be used.

- in the second case, the ACTION.request service primitives are mapped to Write.request primitives and the Write.response primitives to ACTION.confirm primitives. The mapping and the corresponding SN APDUs are shown in Table 46.

Table 45 – Mapping between the SET and the Write services

From SET.request of type	To Write.request	SN APDU
NORMAL	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name I Parameterized_Access;	WriteRequest ::= (variable-name I parameterized-access, data)
FIRST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Data = raw-data, carrying the encoded form of the attribute reference(s) and write data.	WriteRequest ::= (write-data-block-access, data)
ONE-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = next number, Data = as above	WriteRequest ::= (write-data-block-access, data)
LAST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = TRUE, Block_Number = next number, Data = as above	WriteRequest ::= (write-data-block-access, data)
WITH-LIST	Write.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name I Parameterized_Access;	WriteRequest ::= ({variable-name I parameterized- access}, {data})
FIRST-BLOCK-WITH- LIST	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1 Data = as above	WriteRequest ::= (write-data-block-access, data)
To SET.confirm of type	SN APDU	From Write.response
NORMAL	WriteResponse ::= (success I data-access-error)	Write.response (Write_Result) Write_Result = Success I Data_Access_Error;
ACK-BLOCK	WriteResponse ::= (block-number)	Write.response (Write_Result) Write_Result = Block_Number;

From SET.request of type	To Write.request	SN APDU
LAST-BLOCK	WriteResponse::= (success data-access-error)	Write.response (Write_Result) Write_Result = Success Data_Access_Error;
WITH-LIST	WriteResponse::= ({success data-access-error})	Write.response ({Write_Result}) Write_Result = Success Data_Access_Error;
LAST-BLOCK-WITH-LIST	WriteResponse::= ({success data-access-error})	Write.response ({Write_Result}) Write_Result = Success Data_Access_Error;

Table 46 – Mapping between the ACTION and the Write service

From ACTION.request of type	To Write.request	SN APDU
NORMAL	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name; Data = method invocation parameters or null-data	WriteRequest::= (variable-name, data)
FIRST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Data = raw-data, carrying the encoded form of the method reference(s) and method invocation parameters;	WriteRequest::= (write-data-block-access, data)
ONE-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = next number, Data = as above	WriteRequest::= (write-data-block-access, data)
LAST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = TRUE, Block_Number = next number, Data = as above	WriteRequest::= (write-data-block-access, data)
WITH-LIST	Write.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name; Data = method invocation parameters or null data	WriteRequest::= ({variable-name}, {data})

From ACTION.request of type	To Write.request	SN APDU
WITH-LIST-AND-FIRST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Data = as with first block	WriteRequest::= (write-data-block-access, data)
To ACTION.confirm	SN APDU	From Write.response
NORMAL	WriteResponse::= (success data-access-error)	Write.response (Write_Result) Write_Result = Success Data_Access_Error
NEXT	WriteResponse::= (block-number)	Write.response (Block_Number)
To ACTION.confirm	SN APDU	From Write.response
WITH-LIST	WriteResponse::= ({success data-access-error})	Write.response ({Write_Result}) Write_Result = Success Data_Access_Error

Figure 26 shows the MSC of a Write service used to write the value of a single attribute, in the case of success.

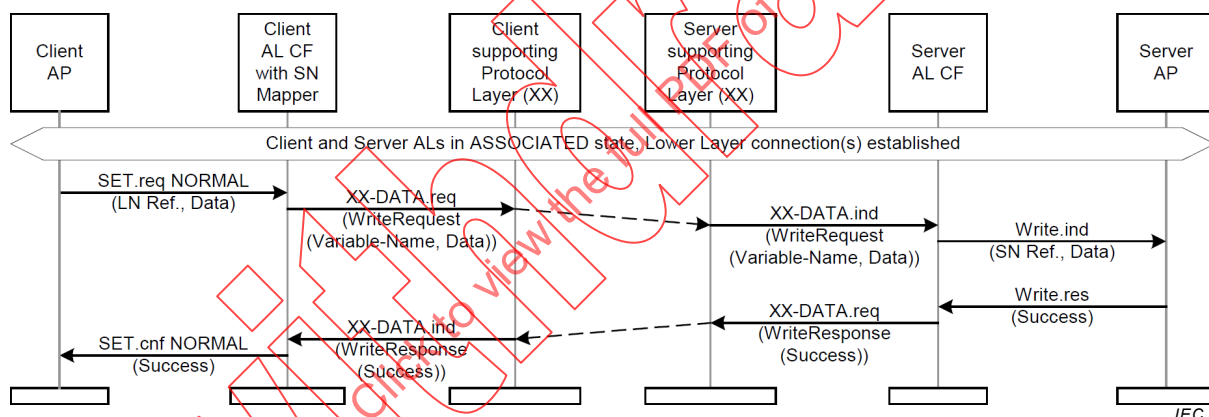


Figure 26 – MSC of the Write service used for writing an attribute

Figure 27 shows the MSC of a Write service used to invoke a single method, in the case of success.

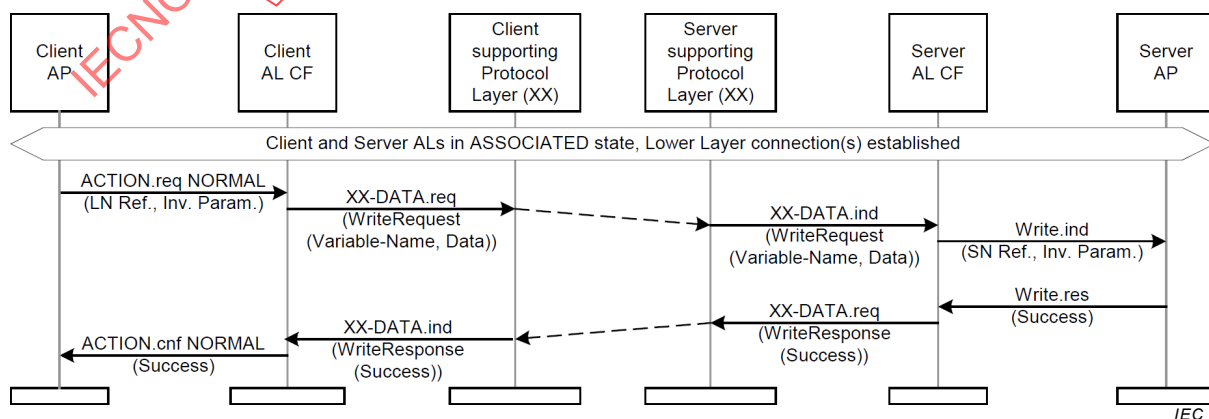


Figure 27 – MSC of the Write service used for invoking a method

Figure 28 shows the MSC of a Write service for writing a single attribute with the result returned in three blocks using the service-specific block transfer mechanism.

Alternatively, the general block transfer mechanism can be used.

The process of preparing and transporting the long data is essentially the same as in the case of the SET and ACTION services:

If an error occurs, the server should return a Write.response service primitive with the Data_Access_Error carrying appropriate diagnostic information; for example data-block-number-invalid.

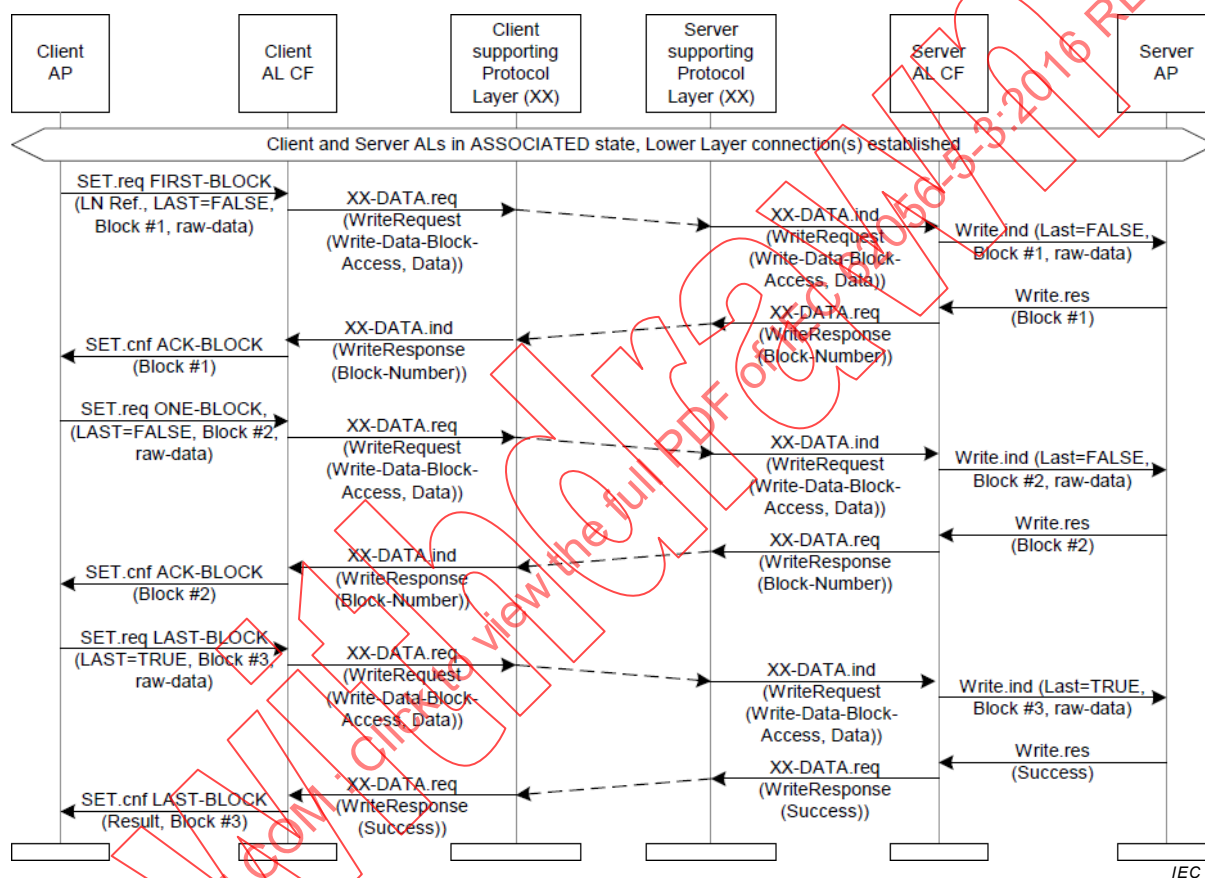


Figure 28 – MSC of the Write service used for writing an attribute, with block transfer

7.3.10 Protocol for the UnconfirmedWrite service

This service may be invoked only when an AA has already been established. Depending on the communication profile, the APDU corresponding to the request may be transported using the connection-oriented (CO) or connectionless data (CL) services of the supporting protocol layer.

As explained in 6.15, the UnconfirmedWrite service may be used either to write (a) COSEM object attribute(s), or to invoke (a) method(s) when no return parameters are expected:

- in the first case, the SET.request service primitives are mapped to UnconfirmedWrite.request primitives. The mapping and the corresponding SN APDUs are shown in Table 47;

- in the second case, the ACTION.request service primitives are mapped to UnconfirmedWrite.request primitives. The mapping and the corresponding SN APDUs are shown in Table 48.

Table 47 – Mapping between the SET and the UnconfirmedWrite services

From SET.request of type	To UnconfirmedWrite.request	SN APDU
NORMAL	UnconfirmedWrite.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name I Parameterized_Access;	UnconfirmedWriteRequest ::= (variable-name I parameterized-access, data)
WITH-LIST	UnconfirmedWrite.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name I Parameterized_Access;	UnconfirmedWriteRequest ::= ({variable-name I parameterized- access}, {data})

Table 48 – Mapping between the ACTION and the UnconfirmedWrite services

From ACTION.request of type	To UnconfirmedWrite.request	SN APDU
NORMAL	UnconfirmedWrite.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name; Data = method invocation parameters or null data	UnconfirmedWriteRequest ::= (variable-name, data)
WITH-LIST	UnconfirmedWrite.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name; Data = as above	UnconfirmedWriteRequest ::= ({variable-name}, {data})

Figure 29 shows the MSC of a Write service used to write the value of a single attribute, in the case of success.

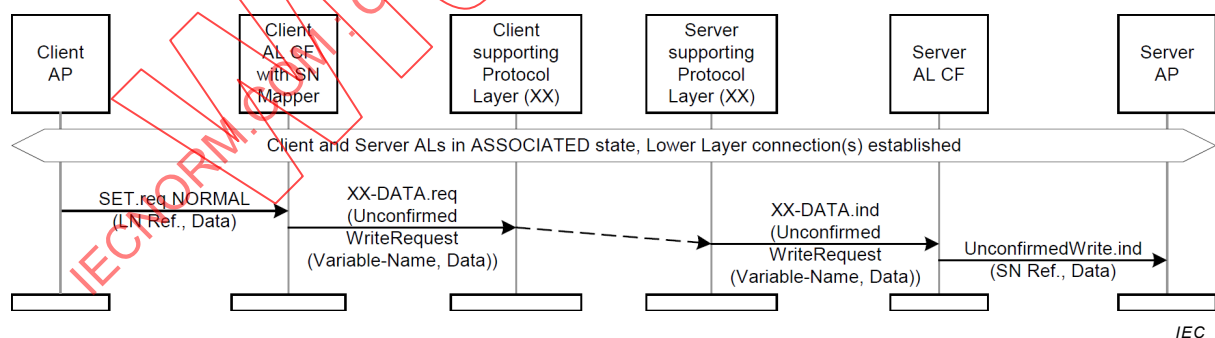


Figure 29 – MSC of the Unconfirmed Write service used for writing an attribute

When the service parameters are long, the general block transfer mechanism can be used.

7.3.11 Protocol for the InformationReport service

The protocol for the InformationReport service, specified in 6.16, is essentially the same as that of the EventNotification service, see 7.3.7.

As the InformationReport service does not contain the optional Application_Addresses parameter, unlike the EventNotification service, the information report is always sent by the Server Management Logical Device to the Client Management AP.

Upon invocation of the InformationReport.request service, the server AP builds an InformationReportRequest APDU. This APDU is sent from the SAP of the management logical device to the SAP of the client management device, using data services of the lower layers, in a non-solicited manner, at the first available opportunity.

The possibilities to send out this APDU depend on the communication profile and the connection status of the lower layers. Therefore, the protocol of the InformationReport service is further discussed in Annex A.

The InformationReport service may carry several attribute names and their contents. On the other hand, the EventNotification service specified in 6.10 contains only one attribute reference. Therefore, when the InformationReportRequest APDU contains more than one attribute, it shall be mapped to several EventNotification.ind services, as shown in Table 49.

Table 49 – Mapping between the EventNotification and InformationReport services

EventNotification.ind (one or more)	InformationReport.ind
Time (optional)	Current-time (optional)
COSEM_Class_Id, COSEM_Object_Instance_Id, COSEM_Object_Attribute_Id	Variable_Name {Variable_Name}
Attribute_Value	Data {Data}

7.3.12 Protocol of general block transfer mechanism

The general block transfer (GBT) mechanism can be used to carry any xDLMS service primitive when the service parameters are long i.e. their encoded form is longer than the Max Receive PDU Size negotiated. In this case, the AL uses one or more General-Block-Transfer (GBT) xDLMS APDUs to transport such long messages.

The service primitive invocations may be complete including all the service parameters or partial including only one part of the service parameters. Using complete or partial service invocations is left to the implementation.

Following the reception of a service .request / .response service primitive from the AP, the AL:

- builds the APDU that carries the service primitive;
- when ciphering is required it applies the protection as required by the Security_Options and builds the appropriate ciphered APDU;
- when the resulting APDU is longer than the negotiated max APDU size, then the AL uses the GBT mechanism to send the complete message in several GBT APDUs.

However, there is no direct relationship between partial invocations and the GBT APDUs sent. The AL may apply the protection using complete or partial service invocations.

Following the reception of GBT APDUs from a remote party, the AL:

- assembles the block-data fields of the GBT APDUs received together;
- when the resulting complete APDU is ciphered, it checks and removes the protection;
- it invokes the appropriate service primitive, passing the additional Security_Status, the General_Block_Transfer_Parameters and the Protection_Element.

However, there is no direct relationship between the GBT APDUs received and the partial service invocations. The AL may verify and remove the protection processing the GBT APDUs or processing the complete, assembled APDU.

See also Figure 9.

A message exchange may be started without or with using GBT. However, if one party sends a request or a response using GBT, the other party shall follow. The parties continue then using GBT until the end, i.e. until the complete response will have been received.

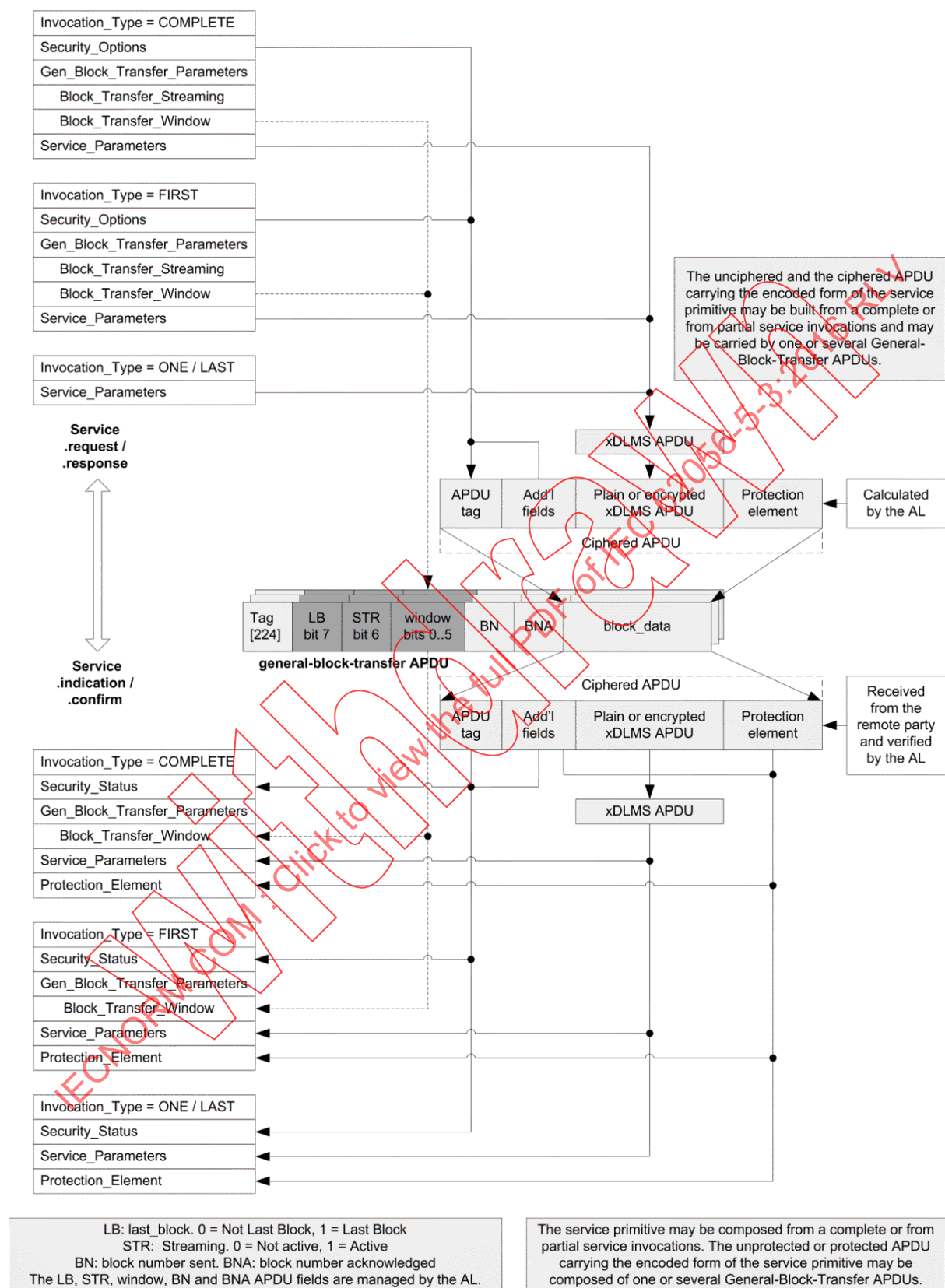
Streaming of blocks is managed by the AL taking into account the GBT parameters passed from the local AP to the AL – see 6.5 – and the fields of GBT APDUs – see Figure 30 – received from the remote AL.

The various service invocation types – COMPLETE, FIRST-PART, ONE-PART or LAST-PART – and the relationship between these invocations, the service parameters and the fields of the ciphered APDUs and the General-Block-Transfer (GBT) APDUs are shown in Figure 30.

The Block_Transfer_Streaming (BTS) parameter is passed by the AP to the AL to indicate that the AL can send blocks in streams, i.e. without waiting for a confirmation of each block received by the remote party. This parameter is not included in the APDU.

The Block_Transfer_Window (BTW) parameter indicates the size of the streaming window supported, i.e. the maximum number of blocks that can be received. The Block_Transfer_Window parameter of the other party may be known *a priori* by the parties. However, the window size is managed by the AL: it can use a lower value, for example during lost block recovery.

NOTE 1 This relationship is indicated using a dotted line in Figure 30 between the Block_Transfer_Window parameter and the window field of the APDU.



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NOTE Applying and checking/removing cryptographic protection on APDUs are independent from the GBT process. They are included here for completeness.

Figure 30 – Partial service invocations and GBT APDUs

In the case of unconfirmed services the `Block_Transfer_Streaming` parameter shall be set to `FALSE` and `Block_Transfer_Window` shall be set to 0. This indicates to the AL that it shall send the encoded form of the whole service primitive in as many GBT APDUs as needed without waiting for confirmation of the blocks sent.

The use of the fields of the GBT APDU is specified below:

- the last-block (LB) bit indicates if the block is the last one (LB = 1) or not (LB = 0);
- the streaming bit indicates if streaming is in progress (STR = 1) or finished (STR = 0). When streaming is finished, the remote party shall confirm the blocks received. When the `Block_Transfer_Streaming` parameter has been set to `FALSE`, the streaming bit shall be also set to 0;
- the window field indicates the number of blocks that can be received by the party sending the APDU. Its maximum value is equal to the `Block_Transfer_Window` parameter passed by the AP to the AL. Note, that the AL may use a lower value during lost block recovery. In the case when the GBT APDUs carry an unconfirmed service (BTS = `FALSE`, BTW = 0; see above), the value of the window shall be 0 indicating that no GBT APDUs shall be confirmed (and hence no lost blocks can be recovered);
- the block-number (BN) field indicates the number of the block sent. The first block sent shall have block-number = 1. Block-number shall be increased with each GBT APDU sent, even if block-data (BD) is empty. However, during lost block recovery a block number may be repeated;
- the block-number-acknowledged (BNA) field indicates the number of the block acknowledged. If no blocks have been lost, it shall be equal to the number of the last block received. However, if one or more blocks are lost, it shall be equal to the number of the block up to which no blocks are missing;
- the block-data (BD) field carries one part of the xDLMS APDU that is sent using the GBT mechanism.

If a party has no blocks to send, then the last-block bit of the APDU shall be set to 1 and the streaming bit shall be set to 0.

The protocol of the GBT mechanism is further explained with the help of Figure 31, Figure 32, Figure 33, Figure 34, Figure 35, Figure 36 and Figure 37. In these examples, it is assumed that both parties support GBT and six blocks are required to transfer the complete response or request (except in the DataNotification example, where four blocks are required).

NOTE 2 In these examples the service specific block transfer mechanism is not used.

Abbreviations used in the Figures:

- BTS: `Block_Transfer_Streaming`, BTW: `Block_Transfer_Window`;
- GBT: General-Block-Transfer APDU;
- LB: last-block;
- STR: Streaming;
- BN: block-number, BNA: block-number-acknowledged;
- BD (APDU): block-data containing one block of the APDU.

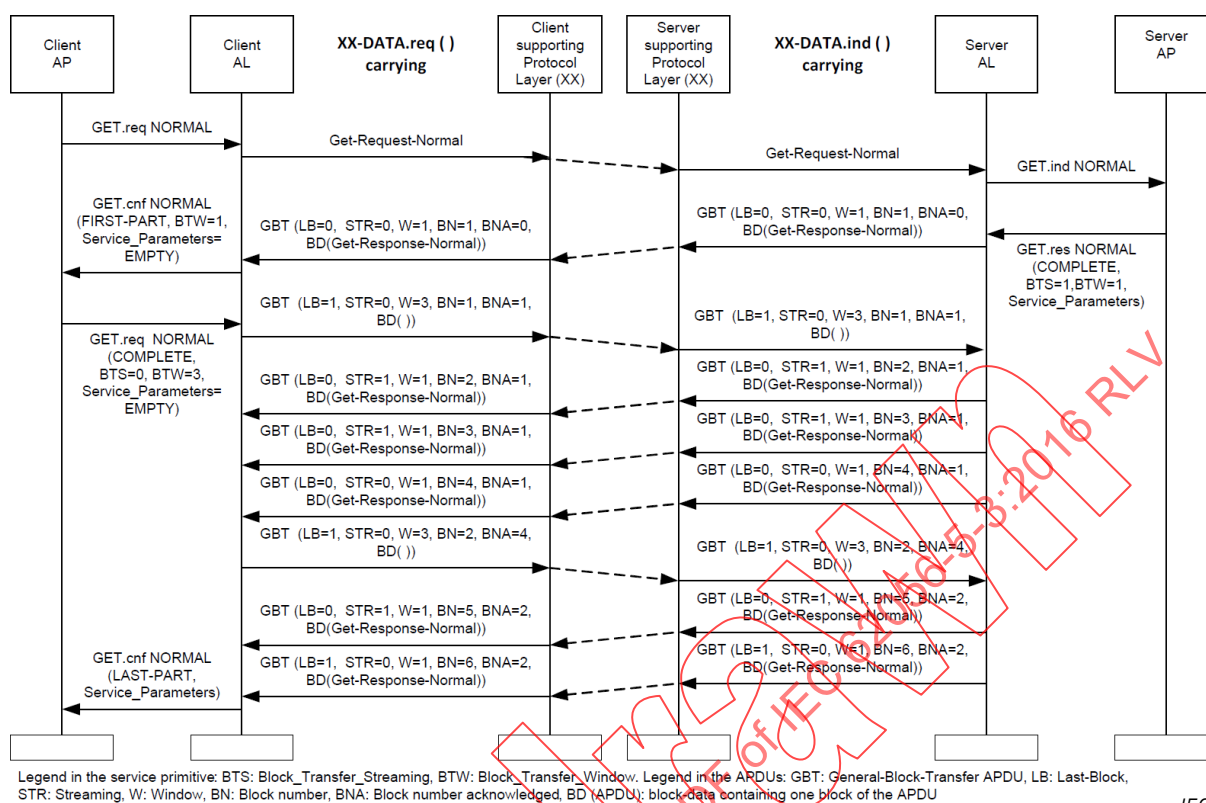


Figure 31 – GET service with GET, switching to streaming

Figure 31 shows a GET service using GBT. After receiving the first GBT APDU, the client informs the server that it supports streaming. The server switches then to streaming. The process is the following:

- the client AP invokes a GET.request NORMAL service primitive, without additional service parameters. The client AL sends the request in a Get-Request-Normal APDU;
- the GET.response service parameters are long so the server invokes a GET.response NORMAL service primitive with additional service parameters: Invocation_Type = COMPLETE, BTS = 1, BTW = 1 meaning that the server allows sending block streams, but it does not accept block streams from the client. The server AL sends a GBT APDU, containing the first block of the response;
- the client AL invokes a GET.confirm NORMAL service primitive, Invocation_Type = FIRST-PART, BTW = 1. The Service_Parameters are empty. With this, it informs the AP that the response from the server is long;
- the client AP invokes a GET.request NORMAL service primitive, with Invocation_Type = COMPLETE, BTS = 0, BTW = 3, to advertise its capabilities to receive block streams. Note that the Service_Parameters are empty, as these have been passed already in the first GET.request NORMAL service invocation. The client AL sends a GBT APDU. The last-block bit in the APDU is set to 1 and the streaming bit is set to 0 as the client has no blocks to send;
- the server sends then the 2nd (STR = 1, BN = 2), 3rd (STR = 1, BN = 3) and 4th (STR = 0, BN = 4) blocks;
- the client AL sends a GBT APDU to confirm the reception of the 2nd, 3rd and 4th blocks (LB = 1, STR = 0, W = 3, BNA = 4);
- the server AL sends the 5th block (STR = 1, BN = 5) and the 6th, last block (LB = 1, STR = 0, BN = 6);

NOTE 3 The last block is not confirmed. However, when lost, it can be recovered. See Figure 34.

- the client AL invokes a GET.confirm NORMAL service primitive with Invocation_Type = LAST-PART. The service parameters include the complete response to the GET.request.

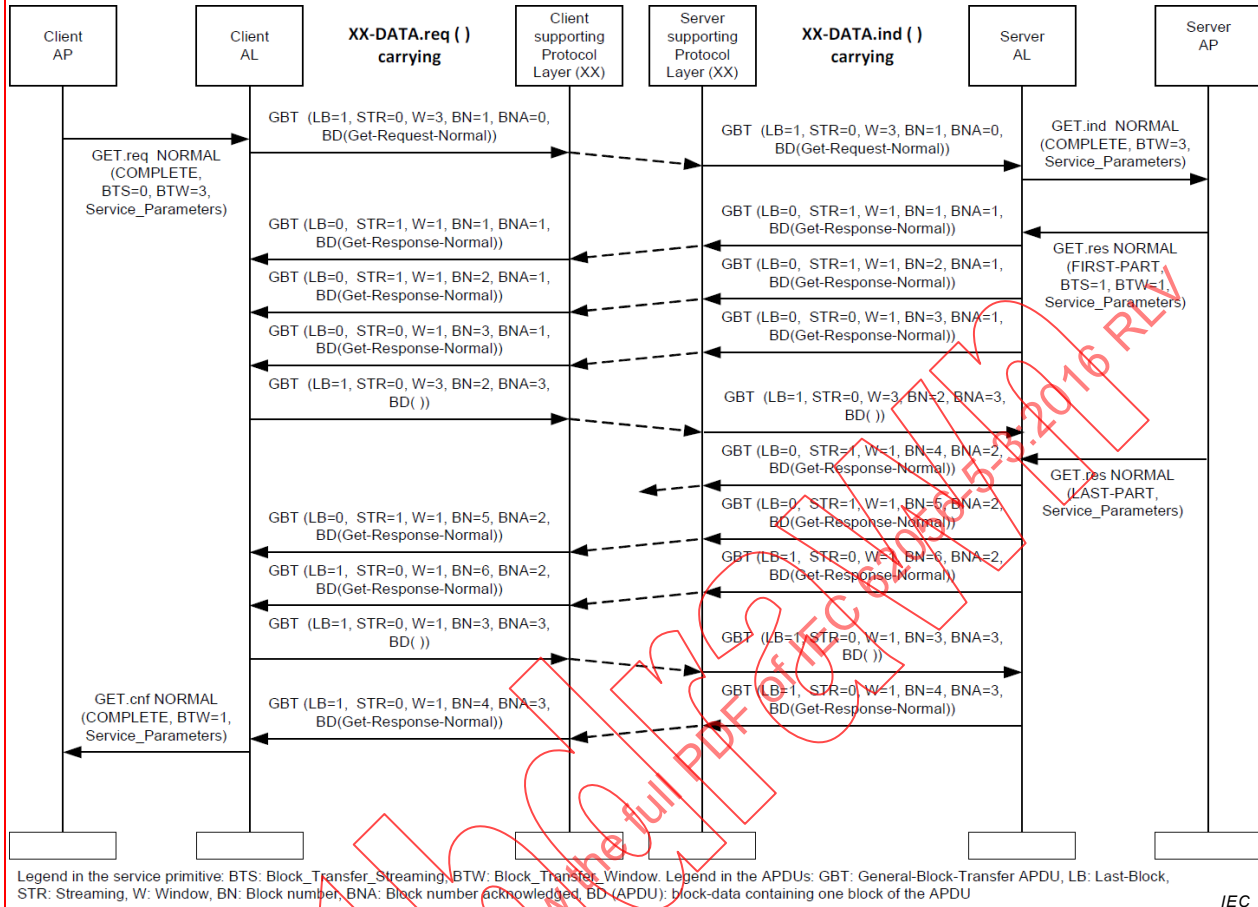
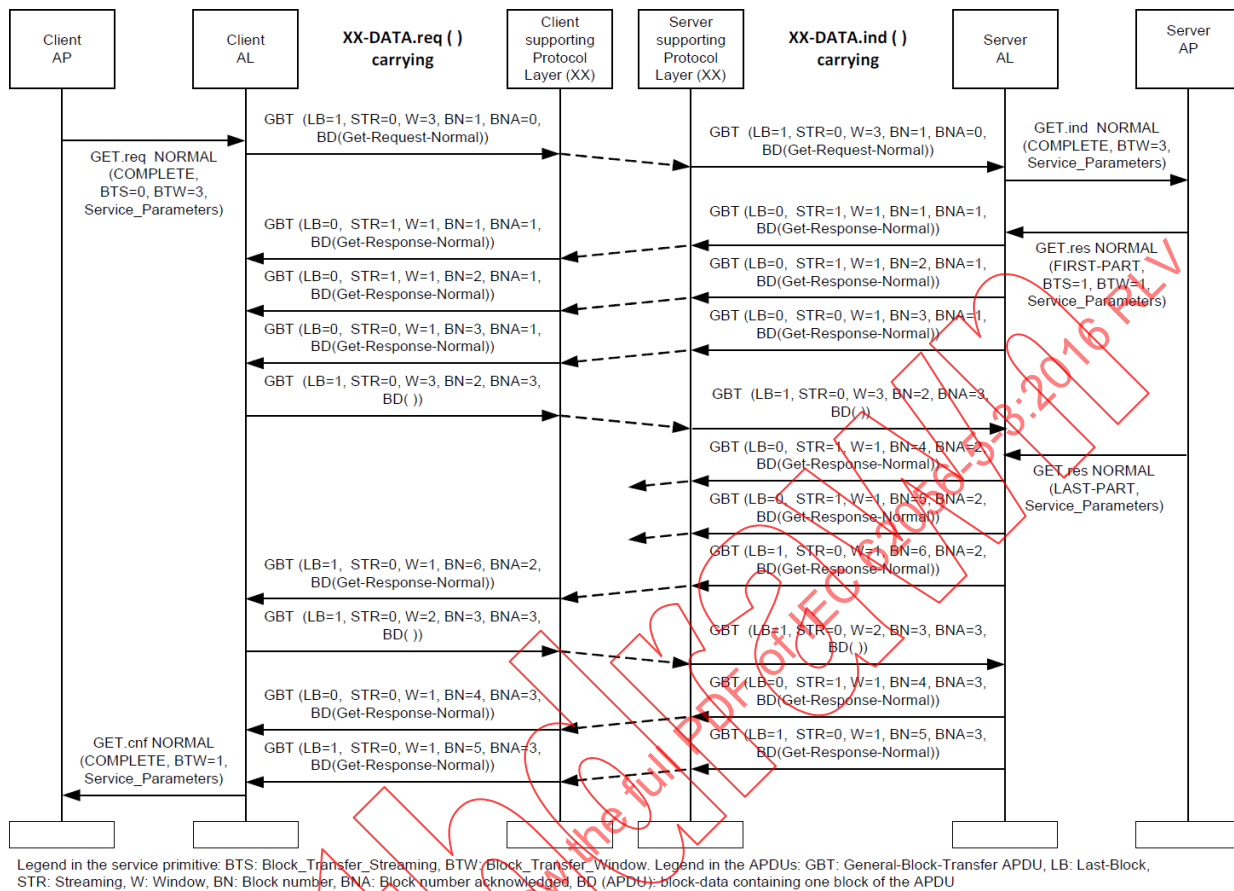


Figure 32 – GET service with partial invocations, GBT and streaming, recovery of 4th block sent in the 2nd stream

Figure 32 shows a GET service using GBT, with partial service invocations on the server side and streaming. The client advertises in the first request its streaming capabilities (BTW = 3; BTW > 1 means that block streams can be received). The 4th block, sent in the second stream by the server is lost and it is recovered. The process is the following:

- the client AP invokes a GET.request NORMAL service primitive, with Invocation_Type = COMPLETE, BTS = 0, BTW = 3. The client AL sends a GBT APDU with STR = 0, Window = 3. The server AL invokes the GET.indication NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 3;
- the server AP invokes a GET.response NORMAL service primitive with Invocation_Type = FIRST-PART, BTS = 1, BTW = 1. Service_Parameters include the first part of the response. The server AL sends the 1st, 2nd and 3rd blocks;
- the client AL sends a GBT APDU to confirm the reception of the three blocks. The server AP invokes a GET.response NORMAL service primitive with Invocation_Type = LAST-PART. Service_Parameters include the second, last part of the response. The server AL sends the 4th, 5th and 6th blocks (LB = 1, STR = 0, BN = 6). However, the 4th block gets lost;
- the client AL indicates that the 4th block has not been received by sending a GBT APDU confirming the reception of the 3rd block (STR = 0, window = 1, BNA = 3). Notice that the client AL drops down the window size to 1 to indicate that only one block has to be re-sent;
- the server sends again the 4th block (LB = 1, STR = 0, BN = 4, BNA = 3);

- as the client has already received all blocks, it invokes a GET.confirm NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 1. The Service_Parameters of this invocation contain the complete response to the GET.request.

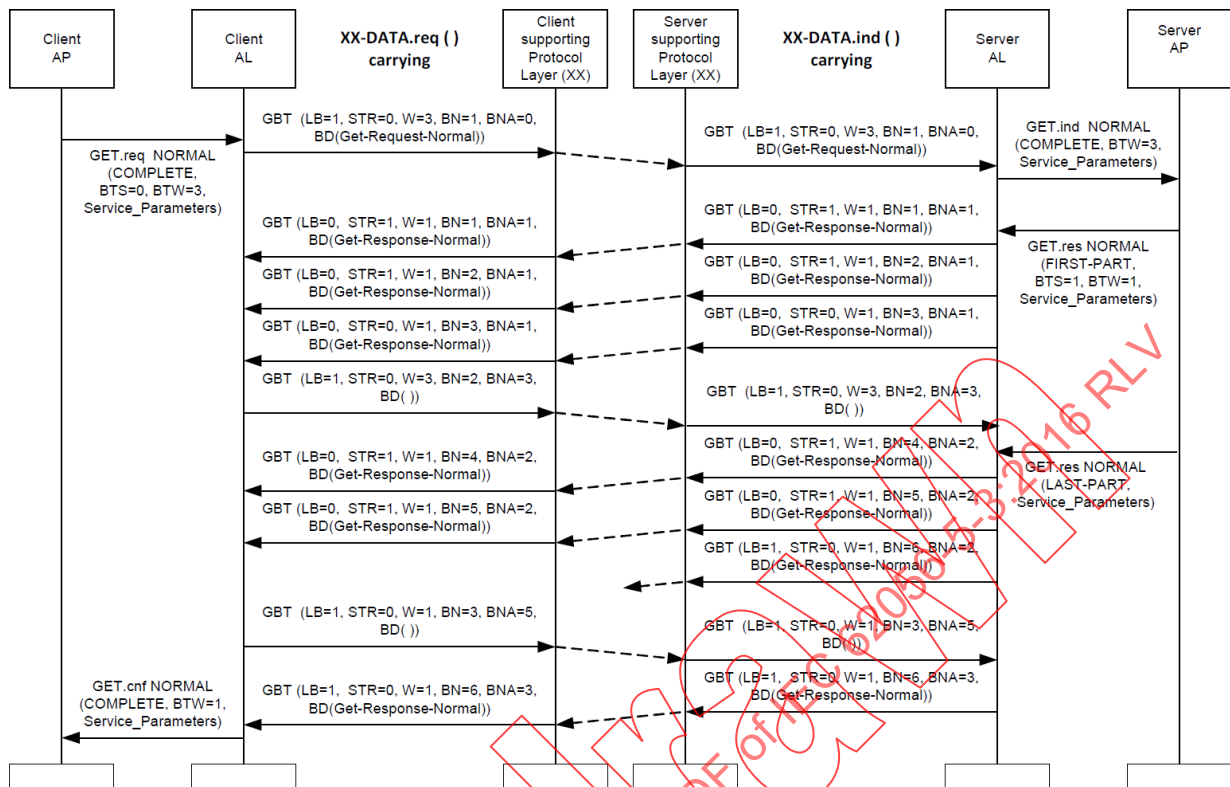


IEC

Figure 33 – GET service with partial invocations, GBT and streaming, recovery of 4th and 5th blocks

Figure 33 shows a scenario which is essentially the same as in Figure 32 except that the 4th and 5th blocks are lost and recovered. The process is the following:

- the client receives the 6th block (LB = 1, STR = 0, BN = 6, BNA = 2);
- the client indicates that the 4th and the 5th blocks have been lost, by sending a GBT APDU with W = 2, BNA = 3, i.e. meaning that no blocks are missing up to the 3rd block but two blocks have been lost and that the server can send these two using streaming;
- the server sends then the lost (not confirmed) 4th (LB = 0, STR = 1, BN = 4) and 5th block (LB = 1, STR = 0, BN = 5). Notice here that LB has been set to 1;
- the client has received now each block. It invokes then a GET.confirm NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 1. The Service_Parameters include the parameters of the complete response to the GET.request.

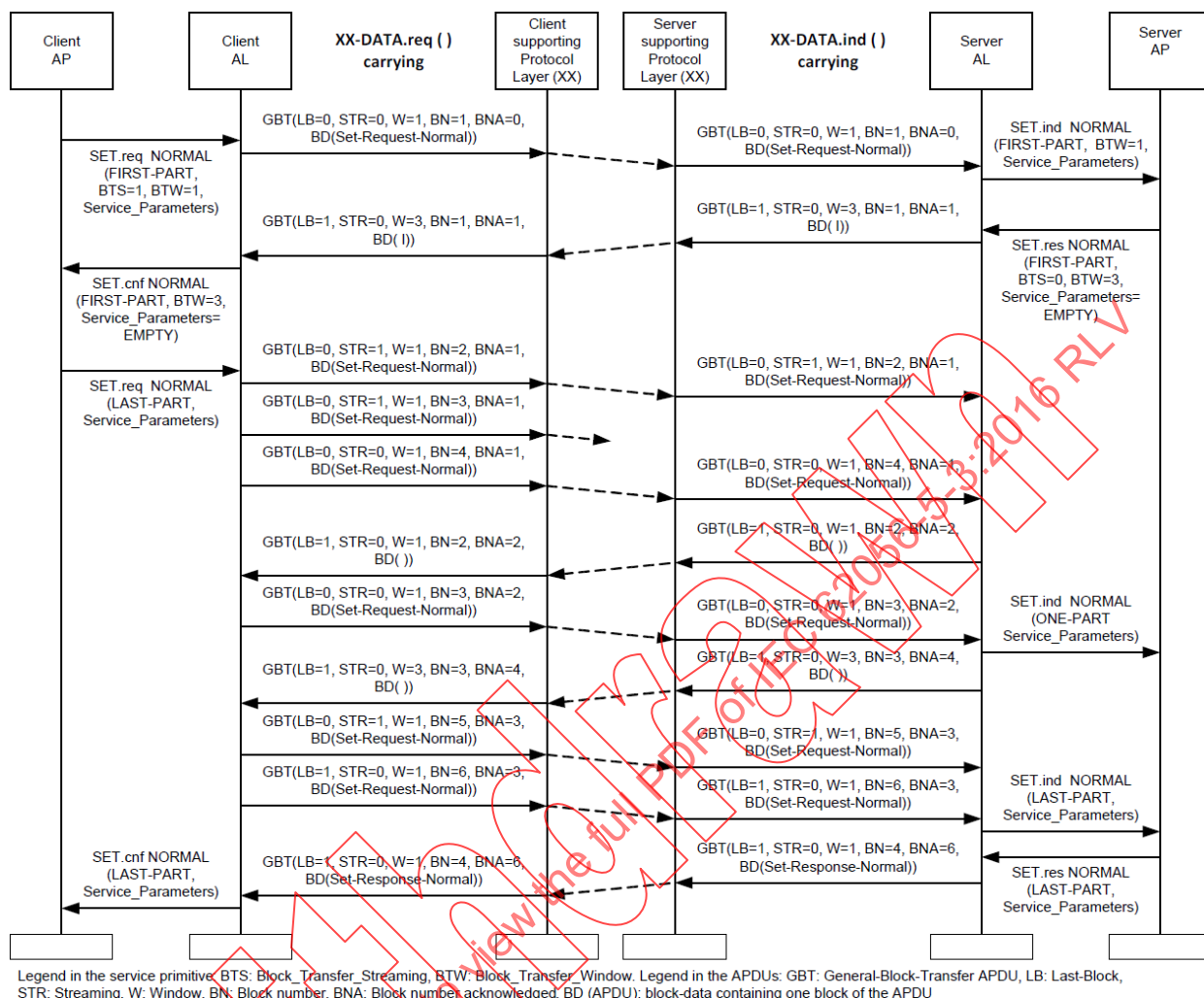


IEC

Figure 34 – GET service with partial invocations, GBT and streaming, recovery of last block

Figure 34 shows a scenario when the last block sent in the second stream gets lost and is recovered. The process is the following:

- the client receives the 5th block carried by a GBT APDU (LB = 0, STR = 1, BN = 5);
- as this is not the last block, after an implementation specific timeout the client sends a GBT APDU (LB = 1, STR = 0, BN = 3, BNA = 5);
- the server sends then the lost (not confirmed) 6th block carried by a GBT APDU (LB = 1, STR = 0, W = 1, BN = 6 and BNA = 3);
- when the client receives this APDU, it invokes a GET.confirm NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 1. The Service_Parameters include the parameters of the complete response to the GET.request.



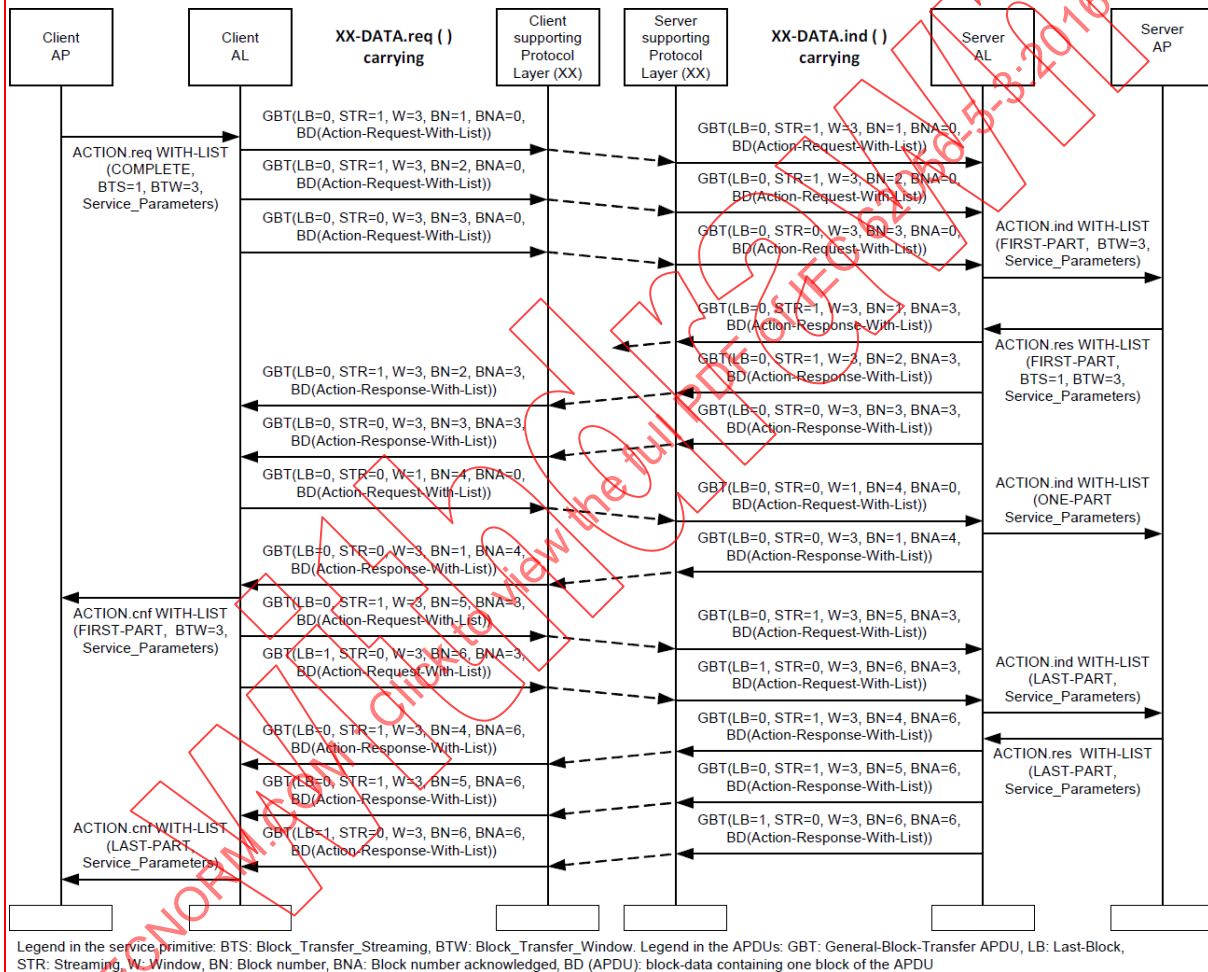
IEC

Figure 35 – SET service with GBT, with server not supporting streaming, recovery of 3rd block

Figure 35 shows a SET service with GBT and streaming. The 3rd block sent by the client is lost and recovered. The process is the following:

- the client AP invokes a SET.request NORMAL service primitive with Invocation_Type = FIRST-PART, BTS = 1, BTW = 1. The Service_Parameters include the first part of the SET request. The client AL sends the first block only because it does not know the streaming window size supported by the server;
- the server AL invokes a SET.indication NORMAL service primitive with Invocation_Type = FIRST-PART, BTW = 1. The Service_Parameters include the first part of the parameters of the SET.request;
- the server AP responds with a SET.response NORMAL service primitive with Invocation_Type = FIRST-PART, BTS = 0, BTW = 3. The Service_Parameters are empty. The server AL sends a GBT APDU with LB = 1, STR = 0, Window = 3; block-data is empty. From this, the client knows that the server can receive block streams and the window size = 3. Therefore it sends the 2nd, 3rd and 4th blocks in a stream. However, the 3rd block gets lost;
- the server indicates that block 3 is lost by confirming the reception of the 2nd block and dropping down the window size to 1 (LB = 1, STR = 0, W = 1, BN = 2, BNA = 2). The client sends then again the 3rd block (LB = 0, STR = 0, BN = 3, BNA = 2);

- the server invokes a SET.indication NORMAL service primitive with Invocation_Type = ONE-PART. The server AL confirms the reception of the blocks up to the 4th block (LB = 1, STR = 0, W = 3, BNA = 4). Notice that the window size has been raised again to 3;
- the client sends then the 5th and the 6th blocks using streaming;
- when the server AL receives the 6th, last block it invokes a SET.indication NORMAL service primitive with Invocation_Type = LAST-PART. Service_Parameters include the last part of the parameters of the SET.request;
- the server AP invokes a SET.request NORMAL service primitive with Invocation_Type = LAST-PART, and with the Service_Parameters containing the result of the set operation(s). This is sent by the server AL in a GBT APDU. The client AL invokes the SET.confirm NORMAL service primitive with Invocation_Type = LAST-PART. Service_Parameters include the result of the set operations.



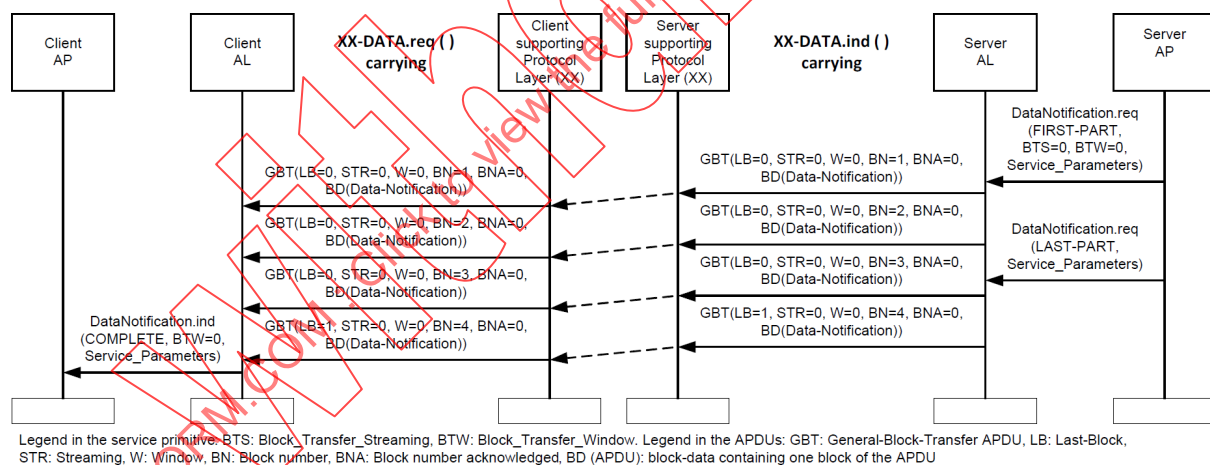
IEC

Figure 36 – ACTION-WITH-LIST service with bi-directional GBT and block recovery

Figure 36 shows an ACTION-WITH-LIST service with partial service invocations, bidirectional block transfer and streaming. Both parties know *a priori* that the other party supports streaming with window size = 3. The first block sent by the server is lost and recovered. The process is the following:

- the client invokes an ACTION.request of type WITH-LIST service primitive with Invocation_Type = COMPLETE, BTS = 1, BTW = 3. The client AL sends the first three blocks that carry a part of this request to the server. The server AL invokes an ACTION.indication of type WITH-LIST service primitive with Invocation_Type = FIRST-PART, BTW = 3. Service parameters contain the first part of the request;

- the server AP processes this request and has the first part of the response available. It invokes an ACTION.response of type WITH-LIST service primitive with Invocation_Type = FIRST-PART, BTS = 1, BTW = 3. The server AL sends this in three blocks using streaming. However, the 1st block is lost;
- the client AL asks the server to send the lost 1st block again by not confirming any blocks received. It also sends its 4th block (LB = 0, STR = 0, W = 1, BN = 4, BNA = 0). Notice that the client AL has dropped down the window size to 1;
- the server AL invokes an ACTION.indication of type WITH-LIST service primitive with INVOCATION_Type = ONE-PART. Service_Parameters contain one part of the request;
- the server sends the lost 1st block and confirms the 4th block received from the client (BN = 1, BNA = 4);
- the client AL invokes an ACTION.confirm of type WITH-LIST service primitive with additional parameters: Invocation_Type = FIRST-PART, BTW = 3. The Service_Parameters include one part of the response from the server;
- the client AL sends the 5th block and the 6th, last block. Window size is raised again to 3;
- the server AL invokes an ACTION.indication of type WITH-LIST service primitive with Invocation_Type = LAST-PART and with Service_Parameters containing the last part of the ACTION.request;
- the server AP processes this and invokes an ACTION.response of type WITH-LIST service primitive with Invocation_Type = LAST-PART; the Service_Parameters contain the remaining part of the response. This is sent to client in three blocks using streaming;
- the client AL invokes an ACTION.confirm of type WITH-LIST service primitive with Invocation_Type = LAST-PART. The Service_Parameters include the last part of the response from the server.



IEC

Figure 37 – DataNotification service with GBT with partial invocation

Figure 37 shows a DataNotification service with GBT, with partial service invocations on the server side. The process is the following:

- the server AP invokes a DataNotification.request service primitive with Invocation_Type = FIRST-PART, BTS = 0, BTW = 0. The Service_Parameters include one part of the DataNotification.request;
- the server AL sends the GBT APDUs to the client. The reception of the blocks is not confirmed, block recovery is not available;
- when the client AL receives the last block, it assembles the block-data together and invokes a DataNotification.indication service primitive with Invocation_Type = COMPLETE, BTW = 0. The Service_Parameters include the complete DataNotification service parameters.

Aborting the GBT process

The client or the server may want to abort the GBT process. To do so, it shall send a GBT APDU with LB = 1, STR = 0, BN = 0 and BNA = 0. The block transfer process shall also be aborted if a party confirms the reception of a block not yet sent by the other party.

It is not possible to abort GBT with DataNotification.

8 Abstract syntax of ACSE and COSEM APDUs

The abstract syntax of COSEM APDUs is specified in this Clause 8 using ASN.1. See ISO/IEC 8824-1..

COSEMpdu DEFINITIONS ::= BEGIN

CI-PDU ::= CHOICE

```
{
    pingRequestPDU                [25] PingRequestPDU,
    pingResponsePDU              [26] PingResponsePDU,
    -- reserved                    [27]
    registerPDU                  [28] RegisterPDU,
    discoverPDU                  [29] DiscoverPDU,
    discoverReportPDU            [30] DiscoverReportPDU,
    repeaterCallPDU              [31] RepeaterCallPDU,
    clearAlarmPDU                [57] ClearAlarmPDU

    -- CI-PDU tags are above 24, corresponding to the last unciphered DLMS APDU specified
    -- in IEC 61334-4-41.
```

-- IEC 62056-8-3 specifies the abstract syntax of the CIASE APDUs.

}

ACSE-APDU ::= CHOICE

```
{
    aarq                         AARQ-apdu,
    aare                         AARE-apdu,
    rlrq                         RLREQ-apdu, -- OPTIONAL
    rlre                         RLRE-apdu -- OPTIONAL
}
```

xDLMS-APDU ::= CHOICE

```
{
    -- standardised xDLMS pdus used in DLMS/COSEM
    -- standardized DLMS pdus
    -- with no ciphering

    initiateRequest              [1]  IMPLICIT    InitiateRequest,
    readRequest                  [5]  IMPLICIT    ReadRequest,
    writeRequest                 [6]  IMPLICIT    WriteRequest,

    initiateResponse             [8]  IMPLICIT    InitiateResponse,
    readResponse                 [12] IMPLICIT    ReadResponse,
    writeResponse                [13] IMPLICIT    WriteResponse,

    confirmedServiceError        [14]

    -- data-notification

    data-notification            [15] IMPLICIT    Data-Notification,

    unconfirmedWriteRequest      [22] IMPLICIT    UnconfirmedWriteRequest,
    informationReportRequest     [24] IMPLICIT    InformationReportRequest,

    -- The APDU tag of each ciphered xDLMS APDU indicates the type of the unciphered APDU
    -- and whether global or dedicated key is used. The type of the key is carried by the
    -- security header, and after removing the encryption and/or verifying the
    -- authentication tag, the original APDU with its APDU tag is restored. Therefore, the
    -- APDU tags of the ciphered APDUs carry redundant information, but they are retained
    -- for consistency.

    -- with global ciphering
```

glo-initiateRequest	[33]	IMPLICIT	OCTET STRING,
glo-readRequest	[37]	IMPLICIT	OCTET STRING,
glo-writeRequest	[38]	IMPLICIT	OCTET STRING,
glo-initiateResponse	[40]	IMPLICIT	OCTET STRING,
glo-readResponse	[44]	IMPLICIT	OCTET STRING,
glo-writeResponse	[45]	IMPLICIT	OCTET STRING,
glo-confirmedServiceError	[46]	IMPLICIT	OCTET STRING,
glo-unconfirmedWriteRequest	[54]	IMPLICIT	OCTET STRING,
glo-informationReportRequest	[56]	IMPLICIT	OCTET STRING,
-- with dedicated ciphering			
-- not used in DLMS/COSEM			
ded-initiateRequest	[65]	IMPLICIT	OCTET STRING,
ded-readRequest	[69]	IMPLICIT	OCTET STRING,
ded-writeRequest	[70]	IMPLICIT	OCTET STRING,
-- not used in DLMS/COSEM			
ded-initiateResponse	[72]	IMPLICIT	OCTET STRING,
ded-readResponse	[76]	IMPLICIT	OCTET STRING,
ded-writeResponse	[77]	IMPLICIT	OCTET STRING,
ded-confirmedServiceError	[78]	IMPLICIT	OCTET STRING,
ded-unconfirmedWriteRequest	[86]	IMPLICIT	OCTET STRING,
ded-informationReportRequest	[88]	IMPLICIT	OCTET STRING,
~~the four ACSE APDUs~~			
~~aarg~~	~~AARG apdu,~~		
~~aarc~~	~~AARC apdu,~~		
~~rlrq~~	~~RLRQ apdu,~~		OPTIONAL
~~rlrc~~	~~RLRE apdu,~~		OPTIONAL
-- xDLMS APDUs used with LN referencing			
-- with no ciphering			
get-request	[192]	IMPLICIT	GET-Request,
set-request	[193]	IMPLICIT	SET-Request,
event-notification-request	[194]	IMPLICIT	EVENT-NOTIFICATION-Request,
action-request	[195]	IMPLICIT	ACTION-Request,
get-response	[196]	IMPLICIT	GET-Response,
set-response	[197]	IMPLICIT	SET-Response,
action-response	[199]	IMPLICIT	ACTION-Response,
-- with global ciphering			
glo-get-request	[200]	IMPLICIT	OCTET STRING,
glo-set-request	[201]	IMPLICIT	OCTET STRING,
glo-event-notification-request	[202]	IMPLICIT	OCTET STRING,
glo-action-request	[203]	IMPLICIT	OCTET STRING,
glo-get-response	[204]	IMPLICIT	OCTET STRING,
glo-set-response	[205]	IMPLICIT	OCTET STRING,
glo-action-response	[207]	IMPLICIT	OCTET STRING,
-- with dedicated ciphering			
ded-get-request	[208]	IMPLICIT	OCTET STRING,
ded-set-request	[209]	IMPLICIT	OCTET STRING,
ded-event-notification-request	[210]	IMPLICIT	OCTET STRING,
ded-actionRequest	[211]	IMPLICIT	OCTET STRING,
ded-get-response	[212]	IMPLICIT	OCTET STRING,
ded-set-response	[213]	IMPLICIT	OCTET STRING,
ded-action-response	[215]	IMPLICIT	OCTET STRING
-- the exception response pdu			
exception-response	[216]	IMPLICIT	ExceptionResponse
-- general APDUs			
general-glo-ciphering	[219]	IMPLICIT	General-Glo-Ciphering,
general-ded-ciphering	[220]	IMPLICIT	General-Ded-Ciphering,

```

    general-block-transfer                [224] IMPLICIT General-Block-Transfer

-- The tags 230 and 231 are reserved for DLMS Gateway
-- reserved                             [230] -- 0xE6
-- reserved                             [231] -- 0xE7
}
AARQ-apdu ::= [APPLICATION 0] IMPLICIT SEQUENCE
{
-- [APPLICATION 0] == [ 60H ] = [ 96 ]

    protocol-version                     [0] IMPLICIT    BIT STRING {version1 (0)}
                                         DEFAULT {version1},
    application-context-name             [1]
    called-AP-title                      [2]             AP-title OPTIONAL,
    called-AE-qualifier                  [3]             AE-qualifier OPTIONAL,
    called-AP-invocation-id              [4]             AP-invocation-identifier OPTIONAL,
    called-AE-invocation-id              [5]             AE-invocation-identifier OPTIONAL,
    calling-AP-title                    [6]             AP-title OPTIONAL,
    calling-AE-qualifier                 [7]             AE-qualifier OPTIONAL,
    calling-AP-invocation-id             [8]             AP-invocation-identifier OPTIONAL,
    calling-AE-invocation-id             [9]             AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
    sender-acse-requirements             [10] IMPLICIT    ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    mechanism-name                      [11] IMPLICIT    Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    calling-authentication-value         [12] EXPLICIT    Authentication-value OPTIONAL,
    implementation-information           [29] IMPLICIT    Implementation-data OPTIONAL,
    user-information                    [30] EXPLICIT    Association-information OPTIONAL
}

-- The user-information field shall carry an xDLMS InitiateRequest APDU encoded in
-- A-XDR. The resulting OCTET STRING shall be encoded in BER.

AARE-apdu ::= [APPLICATION 1] IMPLICIT SEQUENCE
{
-- [APPLICATION 1] == [ 61H ] = [ 97 ]

    protocol-version                     [0] IMPLICIT    BIT STRING {version1 (0)}
                                         DEFAULT {version1},
    application-context-name             [1]
    result                              [2]             Association-result,
    result-source-diagnostic             [3]             Associate-source-diagnostic,
    responding-AP-title                  [4]             AP-title OPTIONAL,
    responding-AE-qualifier              [5]             AE-qualifier OPTIONAL,
    responding-AP-invocation-id          [6]             AP-invocation-identifier OPTIONAL,
    responding-AE-invocation-id          [7]             AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
    responder-acse-requirements          [8] IMPLICIT    ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    mechanism-name                      [9] IMPLICIT    Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    responding-authentication-value       [10] EXPLICIT    Authentication-value OPTIONAL,
    implementation-information           [29] IMPLICIT    Implementation-data OPTIONAL,
    user-information                    [30] EXPLICIT    Association-information OPTIONAL
}

-- The user-information field shall carry either an InitiateResponse (or, when the
-- proposed xDLMS context is not accepted by the server, a ConfirmedServiceError) APDU
-- encoded in A-XDR. The resulting OCTET STRING shall be encoded in BER.

RLRQ-apdu ::= [APPLICATION 2] IMPLICIT SEQUENCE
{
-- [APPLICATION 2] == [ 62H ] = [ 98 ]

    reason                              [0] IMPLICIT    Release-request-reason OPTIONAL,
    user-information                    [30] EXPLICIT    Association-information OPTIONAL
}

```

```

RLRE-apdu ::= [APPLICATION 3] IMPLICIT SEQUENCE
{
  -- [APPLICATION 3] == [ 63H ] = [ 99 ]

  reason [0] IMPLICIT Release-response-reason OPTIONAL,
  user-information [30] EXPLICIT Association-information OPTIONAL
}

-- The user-information field of the RLRQ / RLRE APDU may carry an InitiateRequest APDU
-- encoded in A-XDR, and then encoding the resulting OCTET STRING in BER, when the AA
-- to be released uses ciphering.

-- types used in the fields of the ACSE APDUs, in the order of their occurrence

Application-context-name ::= OBJECT IDENTIFIER

AP-title ::= OCTET STRING

AE-qualifier ::= OCTET STRING

AP-invocation-identifier ::= INTEGER

AE-invocation-identifier ::= INTEGER

ACSE-requirements ::= BIT STRING {authentication(0)}

Mechanism-name ::= OBJECT IDENTIFIER

Authentication-value ::= CHOICE
{
  charstring [0] IMPLICIT GraphicString,
  bitstring [1] IMPLICIT BIT STRING,
  external [2] IMPLICIT EXTERNAL,
  other [3] IMPLICIT SEQUENCE
  {
    other-mechanism-name Mechanism-name,
    other-mechanism-value ANY DEFINED BY other-mechanism-name
  }
}

Implementation-data ::= GraphicString

Association-information ::= OCTET STRING

Association-result ::= INTEGER
{
  accepted (0),
  rejected-permanent (1),
  rejected-transient (2)
}

Associate-source-diagnostic ::= CHOICE
{
  acse-service-user [1] INTEGER
  {
    null (0),
    no-reason-given (1),
    application-context-name-not-supported (2),
    calling-AP-title-not-recognized (3),
    calling-AP-invocation-identifier-not-recognized (4),
    calling-AE-qualifier-not-recognized (5),
    calling-AE-invocation-identifier-not-recognized (6),
    called-AP-title-not-recognized (7),
    called-AP-invocation-identifier-not-recognized (8),
    called-AE-qualifier-not-recognized (9),
    called-AE-invocation-identifier-not-recognized (10),
    authentication-mechanism-name-not-recognised (11),
    authentication-mechanism-name-required (12),
    authentication-failure (13),
    authentication-required (14)
  },
  acse-service-provider [2] INTEGER
  {
    null (0),
    no-reason-given (1),
    no-common-acse-version (2)
  }
}

```

```

    }
}

Release-request-reason ::= INTEGER
{
    normal          (0),
    urgent          (1),
    user-defined    (30)
}

Release-response-reason ::= INTEGER
{
    normal          (0),
    not-finished    (1),
    user-defined    (30)
}

-- Useful types

Integer8          ::= INTEGER(-128..127)
Integer16         ::= INTEGER(-32768..32767)
Integer32         ::= INTEGER(-2147483648..2147483647)
Integer64         ::= INTEGER(-9223372036854775808..9223372036854775807)
Unsigned8         ::= INTEGER(0..255)
Unsigned16        ::= INTEGER(0..65535)
Unsigned32        ::= INTEGER(0..4294967295)
Unsigned64        ::= INTEGER(0..18446744073709551615)

-- IEC 62056-5-3 specifies the abstract syntax of the COSEM APDUe issued in the PLC S-
-- FSK profile.

-- xDLMS APDU-s used during Association establishment

InitiateRequest ::= SEQUENCE
{
    -- shall not be encoded in DLMS without ciphering
    dedicated-key          OCTET STRING OPTIONAL,
    response-allowed       BOOLEAN DEFAULT TRUE,
    proposed-quality-of-service [0] IMPLICIT Integer8 OPTIONAL,
    proposed-dlms-version-number Unsigned8,
    proposed-conformance    Conformance -- Shall be encoded in BER
    client-max-receive-pdu-size Unsigned16
}
-- In DLMS/COSEM, the quality-of-service parameter is not used. Any value shall be
-- accepted.

-- The Conformance field shall be encoded in BER. See IEC 61334-6:2000, Annex C,
-- Example 1.

InitiateResponse ::= SEQUENCE
{
    negotiated-quality-of-service [0] IMPLICIT Integer8 OPTIONAL,
    negotiated-dlms-version-number Unsigned8,
    negotiated-conformance        Conformance, -- Shall be encoded in BER
    server-max-receive-pdu-size   Unsigned16,
    vaa-name                      ObjectName
}

-- In the case of LN referencing, the value of the vaa-name is 0x0007
-- In the case of SN referencing, the value of the vaa-name is the base name of the
-- Current Association object, 0xFA00

-- Conformance Block

-- SIZE constrained BIT STRING is extension of ASN.1 notation

Conformance ::= [APPLICATION 31] IMPLICIT BIT STRING
{
    -- the bit is set when the corresponding service or functionality is available
    reserved-zero          (0),
    -- The actual list of general protection services depends on the security suite
    reserved-one general-protection (1),
    reserved-two general-block-transfer (2),
    read                  (3),
    write                 (4),
    unconfirmed-write     (5),
    reserved-six          (6),

```

```

    reserved-seven (7),
    attribute0-supported-with-set (8),
    priority-mgmt-supported (9),
    attribute0-supported-with-get (10),
    block-transfer-with-get-or-read (11),
    block-transfer-with-set-or-write (12),
    block-transfer-with-action (13),
    multiple-references (14),
    information-report (15),
    reserved-sixteen data-notification (16),
    reserved-seventeen (17),
    parameterized-access (18),
    get (19),
    set (20),
    selective-access (21),
    event-notification (22),
    action (23)
}

} (SIZE(24))

ObjectName ::= Integer16
-- for named variable objects (short names), the last three bits shall be set to 000;
-- for vaa-name objects, the last three bits shall be set to 111.

-- The Confirmed ServiceError APDU is used only with the InitiateRequest, ReadRequest
--and WriteRequest APDUs when the request fails, to provide diagnostic information.

ConfirmedServiceError ::= CHOICE
{
    -- tag 0 is reserved
    -- In DLMS/COSEM only initiateError, read and write are relevant

    initiateError [1] ServiceError,
    getStatus [2] ServiceError,
    getNameList [3] ServiceError,
    getVariableAttribute [4] ServiceError,
    read [5] ServiceError,
    write [6] ServiceError,
    getDataSetAttribute [7] ServiceError,
    getTIAAttribute [8] ServiceError,
    changeScope [9] ServiceError,
    start [10] ServiceError,
    stop [11] ServiceError,
    resume [12] ServiceError,
    makeUsable [13] ServiceError,
    initiateLoad [14] ServiceError,
    loadSegment [15] ServiceError,
    terminateLoad [16] ServiceError,
    initiateUpLoad [17] ServiceError,
    upLoadSegment [18] ServiceError,
    terminateUpLoad [19] ServiceError
}

ServiceError ::= CHOICE
{
    application-reference [0] IMPLICIT ENUMERATED
    {
        -- DLMS provider only
        other (0),
        time-elapsed (1), -- time out since request sent
        application-unreachable (2), -- peer AEi not reachable
        application-reference-invalid (3), -- addressing trouble
        application-context-unsupported (4), -- application-context incompatibility
        provider-communication-error (5), -- error at the local or distant equipment
        deciphering-error (6) -- error detected by the deciphering function
    },

    hardware-resource [1] IMPLICIT ENUMERATED
    {
        -- VDE hardware troubles
        other (0),
        memory-unavailable (1),
        processor-resource-unavailable (2),
        mass-storage-unavailable (3),
        other-resource-unavailable (4)
    },

```



```

vde-state-error          [2] IMPLICIT ENUMERATED
{
-- Error source description
    other                  (0),
    no-dlms-context        (1),
    loading-data-set       (2),
    status-nochange        (3),
    status-inoperable      (4)
},

service                  [3] IMPLICIT ENUMERATED
{
-- service handling troubles
    other                  (0),
    pdu-size               (1), -- pdu too long
    service-unsupported    (2)  -- as defined in the conformance block
},

definition                [4] IMPLICIT ENUMERATED
{
-- object bound troubles in a service
    other                  (0),
    object-undefined       (1), -- object not defined at the VDE
    object-class-inconsistent (2), -- class of object incompatible with asked
                                -- service
    object-attribute-inconsistent (3) -- object attributes are inconsistent
},

access                    [5] IMPLICIT ENUMERATED
{
-- object access error
    other                  (0),
    scope-of-access-violated (1), -- access denied through authorisation reason
    object-access-violated  (2), -- access incompatible with object attribute
    hardware-fault          (3), -- access fail for hardware reason
    object-unavailable      (4)  -- VDE hands object for unavailable
},

initiate                  [6] IMPLICIT ENUMERATED
{
-- initiate service error
    other                  (0),
    dlms-version-too-low   (1), -- proposed DLMS version too low
    incompatible-conformance (2), -- proposed service not sufficient
    pdu-size-too-short     (3), -- proposed PDU size too short
    refused-by-the-VDE-Handler (4) -- vaa creation impossible or not allowed
},

load-data-set             [7] IMPLICIT ENUMERATED
{
-- data set load services error
    other                  (0),
    primitive-out-of-sequence (1), -- according to the DataSet loading state
                                -- transitions
    not-loadable           (2), -- loadable attribute set to FALSE
    dataset-size-too-large (3), -- evaluated Data Set size too large
    not-awaited-segment    (4), -- proposed segment not awaited
    interpretation-failure (5), -- segment interpretation error
    storage-failure        (6), -- segment storage error
    data-set-not-ready      (7)  -- Data Set not in correct state for
                                -- uploading
},

-- change-scope           [8] IMPLICIT ENUMERATED

task                      [9] IMPLICIT ENUMERATED
{
-- TI services error
    other                  (0),
    no-remote-control      (1), -- Remote Control parameter set to FALSE
    ti-stopped             (2), -- TI in stopped state
    ti-running             (3), -- TI in running state
    ti-unusable            (4)  -- TI in unusable state
},

-- other                  [10] IMPLICIT ENUMERATED

```

```

}

-- COSEM APDUs using short name referencing

ReadRequest          ::= SEQUENCE OF Variable-Access-Specification

ReadResponse         ::= SEQUENCE OF CHOICE
{
    data                      [0] Data,
    data-access-error         [1] IMPLICIT Data-Access-Result,
    data-block-result         [2] IMPLICIT Data-Block-Result,
    block-number              [3] IMPLICIT Unsigned16
}

WriteRequest         ::= SEQUENCE
{
    variable-access-specification SEQUENCE OF Variable-Access-Specification,
    list-of-data                 SEQUENCE OF Data
}

WriteResponse        ::= SEQUENCE OF CHOICE
{
    success                 [0] IMPLICIT NULL,
    data-access-error       [1] IMPLICIT Data-Access-Result,
    block-number            [2] Unsigned16
}

UnconfirmedWriteRequest ::= SEQUENCE
{
    variable-access-specification SEQUENCE OF Variable-Access-Specification,
    list-of-data                 SEQUENCE OF Data
}

InformationReportRequest ::= SEQUENCE
{
    current-time             GeneralizedTime OPTIONAL,
    variable-access-specification SEQUENCE OF Variable-Access-Specification,
    list-of-data             SEQUENCE OF Data
}

-- COSEM APDUs using logical name referencing

Get-Request ::= CHOICE
{
    get-request-normal      [1] IMPLICIT Get-Request-Normal,
    get-request-next        [2] IMPLICIT Get-Request-Next,
    get-request-with-list   [3] IMPLICIT Get-Request-With-List
}

Get-Request-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-attribute-descriptor Cosem-Attribute-Descriptor,
    access-selection            Selective-Access-Descriptor OPTIONAL
}

Get-Request-Next ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    block-number               Unsigned32
}

Get-Request-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    attribute-descriptor-list   SEQUENCE OF Cosem-Attribute-Descriptor-With-Selection
}

Get-Response ::= CHOICE
{
    get-response-normal      [1] IMPLICIT Get-Response-Normal,
    get-response-with-datablock [2] IMPLICIT Get-Response-With-Datablock,
    get-response-with-list    [3] IMPLICIT Get-Response-With-List
}

Get-Response-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,

```

```

    result                                Get-Data-Result
}
Get-Response-With-Datablock ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    result                                DataBlock-G
}

Get-Response-With-List ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    result                                SEQUENCE OF Get-Data-Result
}

Set-Request ::= CHOICE
{
    set-request-normal                    [1] IMPLICIT Set-Request-Normal,
    set-request-with-first-datablock      [2] IMPLICIT Set-Request-With-First-Datablock,
    set-request-with-datablock            [3] IMPLICIT Set-Request-With-Datablock,
    set-request-with-list                 [4] IMPLICIT Set-Request-With-List,
    set-request-with-list-and-first-datablock [5] IMPLICIT Set-Request-With-List-And-First-Datablock
}

Set-Request-Normal ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    cosem-attribute-descriptor            Cosem-Attribute-Descriptor,
    access-selection                      Selective-Access-Descriptor OPTIONAL,
    value                                Data
}

Set-Request-With-First-Datablock ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    cosem-attribute-descriptor            Cosem-Attribute-Descriptor,
    access-selection                      Selective-Access-Descriptor OPTIONAL,
    datablock                            DataBlock-SA
}

Set-Request-With-Datablock ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    datablock                            DataBlock-SA
}

Set-Request-With-List ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    attribute-descriptor-list             SEQUENCE OF Cosem-Attribute-Descriptor-With-Selection,
    value-list                            SEQUENCE OF Data
}

Set-Request-With-List-And-First-Datablock ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    attribute-descriptor-list             SEQUENCE OF Cosem-Attribute-Descriptor-With-Selection,
    datablock                            DataBlock-SA
}

Set-Response ::= CHOICE
{
    set-response-normal                    [1] IMPLICIT Set-Response-Normal,
    set-response-datablock                [2] IMPLICIT Set-Response-Datablock,
    set-response-last-datablock           [3] IMPLICIT Set-Response-Last-Datablock,
    set-response-last-datablock-with-list [4] IMPLICIT Set-Response-Last-Datablock-With-List,
    set-response-with-list                [5] IMPLICIT Set-Response-With-List
}

Set-Response-Normal ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    result                                Data-Access-Result
}

Set-Response-Datablock ::= SEQUENCE
{
    invoke-id-and-priority                Invoke-Id-And-Priority,
    block-number                          Unsigned32
}

```

```

Set-Response-Last-Datablock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      Data-Access-Result,
    block-number                Unsigned32
}

Set-Response-Last-Datablock-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      SEQUENCE OF Data-Access-Result,
    block-number                Unsigned32
}

Set-Response-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      SEQUENCE OF Data-Access-Result
}

Action-Request ::= CHOICE
{
    action-request-normal      [1] IMPLICIT Action-Request-Normal,
    action-request-next-pblock [2] IMPLICIT Action-Request-Next-Pblock,
    action-request-with-list    [3] IMPLICIT Action-Request-With-List,
    action-request-with-first-pblock [4] IMPLICIT Action-Request-With-First-Pblock,
    action-request-with-list-and-first-pblock [5] IMPLICIT Action-Request-With-List-And-First-Pblock,
    action-request-with-pblock  [6] IMPLICIT Action-Request-With-Pblock
}

Action-Request-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor     Cosem-Method-Descriptor,
    method-invocation-parameters Data OPTIONAL
}

Action-Request-Next-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    block-number                Unsigned32
}

Action-Request-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor-list SEQUENCE OF Cosem-Method-Descriptor,
    method-invocation-parameters SEQUENCE OF Data
}

Action-Request-With-First-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor     Cosem-Method-Descriptor,
    pblock                      DataBlock-SA
}

Action-Request-With-List-And-First-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor-list SEQUENCE OF Cosem-Method-Descriptor,
    pblock                      DataBlock-SA
}

Action-Request-With-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    pblock                      DataBlock-SA
}

Action-Response ::= CHOICE
{
    action-response-normal      [1] IMPLICIT Action-Response-Normal,
    action-response-with-pblock [2] IMPLICIT Action-Response-With-Pblock,
    action-response-with-list    [3] IMPLICIT Action-Response-With-List,
    action-response-next-pblock [4] IMPLICIT Action-Response-Next-Pblock
}

```

```

Action-Response-Normal      ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    single-response             Action-Response-With-Optional-Data
}

Action-Response-With-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    pblock                     DataBlock-SA
}

Action-Response-With-List   ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    list-of-responses           SEQUENCE OF Action-Response-With-Optional-Data
}

Action-Response-Next-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    block-number                Unsigned32
}

EventNotificationRequest    ::= SEQUENCE
{
    time                       OCTET STRING OPTIONAL,
    cosem-attribute-descriptor Cosem-Attribute-Descriptor,
    attribute-value            Data
}

ExceptionResponse           ::= SEQUENCE
{
    state-error                [0] IMPLICIT ENUMERATED
    {
        service-not-allowed    (1),
        service-unknown        (2)
    },
    service-error              [1] IMPLICIT ENUMERATED
    {
        operation-not-possible (1),
        service-not-supported  (2),
        other-reason           (3)
    }
}

-- Data-Notification
Data-Notification ::= SEQUENCE
{
    long-invoke-id-and-priority Long-Invoke-Id-And-Priority,
    date-time                 OCTET STRING,
    notification-body          Notification-Body
}

-- General APDUs
General-Ded-Ciphering ::= SEQUENCE
{
    system-title               OCTET STRING,
    ciphered-content            OCTET STRING
}

General-Glo-Ciphering ::= SEQUENCE
{
    system-title               OCTET STRING,
    ciphered-content            OCTET STRING
}

General-Block-Transfer ::= SEQUENCE
{
    block-control              Block-Control,
    block-number               Unsigned16,
    block-number-ack            Unsigned16,
    block-data                  OCTET STRING
}

```

-- Types used in the xDLMS data transfer services

Variable-Access-Specification ::= CHOICE

```
{
  variable-name                [2] IMPLICIT ObjectName,
  -- detailed-access [3] is not used in DLMS/COSEM
  parameterized-access         [4] IMPLICIT Parameterized-Access,
  block-number-access          [5] IMPLICIT Block-Number-Access,
  read-data-block-access       [6] IMPLICIT Read-Data-Block-Access,
  write-data-block-access      [7] IMPLICIT Write-Data-Block-Access
}
```

Parameterized-Access ::= SEQUENCE

```
{
  variable-name                ObjectName,
  selector                     Unsigned8,
  parameter                    Data
}
```

Block-Number-Access ::= SEQUENCE

```
{
  block-number                 Unsigned16
}
```

Read-Data-Block-Access ::= SEQUENCE

```
{
  last-block                   BOOLEAN,
  block-number                 Unsigned16,
  raw-data                     OCTET STRING
}
```

Write-Data-Block-Access ::= SEQUENCE

```
{
  last-block                   BOOLEAN,
  block-number                 Unsigned16
}
```

Data ::= CHOICE

```
{
  null-data                    [0] IMPLICIT NULL,
  array                        [1] IMPLICIT SEQUENCE OF Data,
  structure                    [2] IMPLICIT SEQUENCE OF Data,
  boolean                      [3] IMPLICIT BOOLEAN,
  bit-string                   [4] IMPLICIT BIT STRING,
  double-long                  [5] IMPLICIT Integer32,
  double-long-unsigned         [6] IMPLICIT Unsigned32,
  -- floating point [7] is not used in DLMS/COSEM. It uses [23] and [24]
  octet-string                 [9] IMPLICIT OCTET STRING,
  visible-string               [10] IMPLICIT VisibleString,
  -- time [11] is not used in DLMS/COSEM. It uses [27]
  utf8-string                  [12] IMPLICIT OCTET STRING UTF8String
  -- An ordered sequence of characters encoded as UTF-8.
  bcd                          [13] IMPLICIT Integer8,
  integer                      [15] IMPLICIT Integer8,
  long                         [16] IMPLICIT Integer16,
  unsigned                     [17] IMPLICIT Unsigned8,
  long-unsigned                [18] IMPLICIT Unsigned16,
  compact-array                [19] IMPLICIT SEQUENCE
  {
    contents-description       [0] TypeDescription,
    array-contents             [1] IMPLICIT OCTET STRING
  },
  long64                       [20] IMPLICIT Integer64,
  long64-unsigned              [21] IMPLICIT Unsigned64,
  enum                         [22] IMPLICIT Unsigned8,
  float32                      [23] IMPLICIT OCTET STRING (SIZE(4)),
  float64                      [24] IMPLICIT OCTET STRING (SIZE(8)),
  date_time                    [25] IMPLICIT OCTET STRING (SIZE(12)),
  date                         [26] IMPLICIT OCTET STRING (SIZE(5)),
  time                         [27] IMPLICIT OCTET STRING (SIZE(4)),
  dont-care                    [255] IMPLICIT NULL
}
```

-- The following TypeDescription relates to the compact-array data Type

TypeDescription ::= CHOICE


```

{
    NULL-data [0] IMPLICIT NULL,
    array [1] IMPLICIT SEQUENCE
    {
        number-of-elements Unsigned16,
        type-description TypeDescription
    },
    structure [2] IMPLICIT SEQUENCE OF TypeDescription,
    boolean [3] IMPLICIT NULL,
    bit-string [4] IMPLICIT NULL,
    double-long [5] IMPLICIT NULL,
    double-long-unsigned [6] IMPLICIT NULL,
    octet-string [9] IMPLICIT NULL,
    visible-string [10] IMPLICIT NULL,
    utf8-string [12] IMPLICIT NULL,
    bcd [13] IMPLICIT NULL,
    integer [15] IMPLICIT NULL,
    long [16] IMPLICIT NULL,
    unsigned [17] IMPLICIT NULL,
    long-unsigned [18] IMPLICIT NULL,
    long64 [20] IMPLICIT NULL,
    long64-unsigned [21] IMPLICIT NULL,
    enum [22] IMPLICIT NULL,
    float32 [23] IMPLICIT NULL,
    float64 [24] IMPLICIT NULL,
    date_time [25] IMPLICIT NULL,
    date [26] IMPLICIT NULL,
    time [27] IMPLICIT NULL,
    dont-care [255] IMPLICIT NULL
}

```

Data-Access-Result ::= **ENUMERATED**

```

{
    success (0),
    hardware-fault (1),
    temporary-failure (2),
    read-write-denied (3),
    object-undefined (4),
    object-class-inconsistent (9),
    object-unavailable (11),
    type-unmatched (12),
    scope-of-access-violated (13),
    data-block-unavailable (14),
    long-get-aborted (15),
    no-long-get-in-progress (16),
    long-set-aborted (17),
    no-long-set-in-progress (18),
    data-block-number-invalid (19),
    other-reason (250)
}

```

Action-Result ::= **ENUMERATED**

```

{
    success (0),
    hardware-fault (1),
    temporary-failure (2),
    read-write-denied (3),
    object-undefined (4),
    object-class-inconsistent (9),
    object-unavailable (11),
    type-unmatched (12),
    scope-of-access-violated (13),
    data-block-unavailable (14),
    long-action-aborted (15),
    no-long-action-in-progress (16),
    other-reason (250)
}

```

-- IEC 61334-6:2000, Clause 5 specifies that bits of any byte are numbered from 1 to 8,
-- where bit 8 is the most significant.
-- In IEC 62056-5-3 bits are numbered from 0 to 7.

-- Use of Invoke-Id-And-Priority

```

-- invoke-id bits 0-3 invoke-id, 0x0..0xF
-- reserved bits 4-5 shall be set to 0,
-- service-class bit 6 0 = Unconfirmed, 1 = Confirmed
-- priority bit 7 0 = Normal, 1 = High

```

~~Examples for the Invoke-Id-And-Priority byte:~~

~~Priority = High, Service-class = unconfirmed, Invoke-id = 1: value = 0x81~~

~~Priority = High, Service-class = confirmed, Invoke-id = 1: value = 0xC1~~
~~Priority = Normal, Service-class = confirmed, Invoke-id = 1: value = 0x41~~

```
Invoke-Id-And-Priority ::= Unsigned8
-- Use of Long-Invoke-Id-And-Priority
--   invoke-id           bits 0-23
--   reserved            bits 24-27
--   self-descriptive    bit 28      0 = Not-Self-Descriptive,
--                                   1 = Self-Descriptive
--   processing-option    bit 29      0 = Continue on Error, 1 = Break on Error
--   service-class        bit 30      0 = Unconfirmed, 1 = Confirmed
--   priority             bit 31      0 = Normal, 1 = High
```

```
Long-Invoke-Id-And-Priority ::= Unsigned32
```

```
Cosem-Attribute-Descriptor ::= SEQUENCE
```

```
{
  class-id           Cosem-Class-Id,
  instance-id        Cosem-Object-Instance-Id,
  attribute-id        Cosem-Object-Attribute-Id
}
```

```
Cosem-Method-Descriptor ::= SEQUENCE
```

```
{
  class-id           Cosem-Class-Id,
  instance-id        Cosem-Object-Instance-Id,
  method-id          Cosem-Object-Method-Id
}
```

```
Cosem-Class-Id ::= Unsigned16
```

```
Cosem-Object-Instance-Id ::= OCTET STRING(SIZE(6))
```

```
Cosem-Object-Attribute-Id ::= Integer8
```

```
Cosem-Object-Method-Id ::= Integer8
```

```
Selective-Access-Descriptor ::= SEQUENCE
```

```
{
  access-selector    Unsigned8,
  access-parameters  Data
}
```

```
Cosem-Attribute-Descriptor-With-Selection ::= SEQUENCE
```

```
{
  cosem-attribute-descriptor Cosem-Attribute-Descriptor,
  access-selection           Selective-Access-Descriptor OPTIONAL
}
```

```
Get-Data-Result ::= CHOICE
```

```
{
  data                [0] Data,
  data-access-result  [1] IMPLICIT Data-Access-Result
}
```

```
Data-Block-Result ::= SEQUENCE -- Used in ReadResponse with block transfer
```

```
{
  last-block          BOOLEAN,
  block-number        Unsigned16,
  raw-data            OCTET STRING
}
```

```
DataBlock-G ::= SEQUENCE -- G == DataBlock for the GET-response
```

```
{
  last-block          BOOLEAN,
  block-number        Unsigned32,
  result              CHOICE
  {
    raw-data          [0] IMPLICIT OCTET STRING,
    data-access-result [1] IMPLICIT Data-Access-Result
  }
}
```

```
DataBlock-SA ::= SEQUENCE -- SA == DataBlock for the SET-request, ACTION-request and
-- ACTION-response
```

```
{
  last-block          BOOLEAN,
  block-number        Unsigned32,
}
```

```

raw-data                                OCTET STRING
}

Action-Response-With-Optional-Data ::= SEQUENCE
{
    result                                Action-Result,
    return-parameters                    Get-Data-Result OPTIONAL
}
Notification-Body ::= SEQUENCE
{
    data-value                            Data
}

-- Use of Block-Control
--   window                               bits 0-5       window advertise
--   streaming                             bit  6         0 = No Streaming active,
--                                     1 = Streaming active
--   last-block                            bit  7         0 = Not Last Block, 1 = Last Block
Block-Control ::=
                                Unsigned8
END

```

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Annex A (normative)

Using the COSEM application layer in various communications profiles

A.1 General

As specified in IEC 62056-1-0¹⁸ the COSEM interface model for energy metering equipment, specified in IEC 62056-6-2:2016 has been designed for use with a variety of communication profiles for exchanging data over various communication media. ~~As it will be shown in IEC 62056-1-0,~~ In each such profile, the application layer is the COSEM AL, providing the xDLMS services to access attributes and methods of COSEM objects. For each communication profile, the following elements shall be specified:

- the targeted communication environments;
- the structure of the profile (the set of protocol layers);
- the identification / addressing scheme;
- mapping of the COSEM AL services to the service set provided and used by the supporting layer;
- communication profile specific parameters of the COSEM AL services;
- other specific considerations / constraints for using certain services within a given profile.

A.2 Targeted communication environments

This part identifies the communication environments, for which the given communication profile is specified.

A.3 The structure of the profile

This part specifies the protocol layers included in the given profile.

A.4 Identification and addressing schemes

This part describes the identification and addressing schemes specific for the profile.

As described in IEC 62056-6-2:2016, 4.7, metering equipment are modelled in COSEM as physical devices, containing one or more logical devices. In the COSEM client/server type model, data exchange takes place within application associations, between a COSEM client AP and a COSEM Logical Device, playing the role of a server AP.

To be able to establish the required AA and then to exchange data with the help of the supporting lower layer protocols, the client- and server APs shall be identified and addressed, according to the rules of a communication profile. At least the following elements need to be identified / addressed:

- physical devices hosting clients and servers;
- client- and server APs;

The client- and server APs also identify the AAs.

¹⁸ ~~Under consideration.~~

A.5 Supporting layer services and service mapping

This part specifies the service mapping between the services requested by the COSEM AL and the services provided by its supporting layer.

In each communication profile, the COSEM AL provides the same set of services to the client- and server APs. However, the supporting protocol layer in the various profiles provides a different set of services to the service user AL.

The service mapping specifies how the AL is using the services of its supporting layer to provide ACSE and xDLMS services to its service user. For this purpose, MSCs are generally used, showing the sequence of the events following a service invocation by the COSEM AP.

A.6 Communication profile specific parameters of the COSEM AL services

In COSEM, only the COSEM-OPEN service has communication profile specific parameters (the Protocol_Connection_Parameters). Their values and use are defined as part of the communication profile specification.

A.7 Specific considerations / constraints using certain services within a given profile

The availability and the protocol of some of the services may depend on the communication profile. These elements are specified as part of the communication profile specification.

A.8 The 3-layer, connection-oriented, HDLC based communication profile

This profile is specified in IEC 62056-7-6.

A.9 The TCP-UDP/IP based communication profiles (COSEM_on_IP)

This profile is specified in IEC 62056-9-7.

A.10 The S-FSK PLC profile

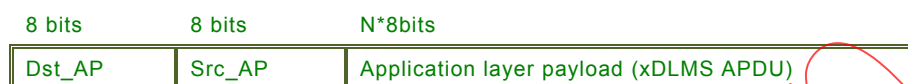
This profile is specified in IEC 62056-8-3.

Annex B (normative)

SMS short wrapper

This Annex specifies the transport of xDLMS APDUs in an SMS.

The payload of an SMS message is the xDLMS APDU prepended with the identifier of the Destination_AP and the Source_AP as shown in Figure B.1:



Where:

- Dst_AP = Destination AP identifies the destination Application Process;
- Src_AP = Source AP identifies the source Application Process.

Figure B.1 – Short wrapper

Table B.1 specifies the identifiers of reserved Application Processes.

Table B.1 – Reserved Application Processes

Client side reserved AP	
No-station	0x00
Client Management Process	0x01
Public client	0x10
Server side reserved AP	
No-station	0x00
Management Logical device	0x01
Reserved	0x02..0xF
All-station (Broadcast)	0x7F

Annex C (informative)

AARQ and AARE encoding examples

C.1 General

This annex contains examples of encoding of the AARQ and AARE APDUs, in cases of using various levels of authentication and in cases of success and failure.

In ~~DLMS/COSEM~~, The AARQ, AARE, RLRQ and RLRE APDUs – see 7.2 – shall be encoded in BER (ISO/IEC 8825-1). The user-information field of the AARQ and AARE APDUs contains the xDLMS InitiateRequest / InitiateResponse or ConfirmedServiceError APDUs, respectively, encoded in A-XDR as OCTET STRING.

C.2 Encoding of the xDLMS InitiateRequest / InitiateResponse APDUs

The xDLMS InitiateRequest / InitiateResponse APDUs are specified as follows:

```
InitiateRequest ::= SEQUENCE
{
  -- shall not be encoded in DLMS without ciphering
  dedicated-key          OCTET STRING OPTIONAL,
  response-allowed       BOOLEAN DEFAULT TRUE,
  proposed-quality-of-service IMPLICIT Integer8 OPTIONAL,
  proposed-dlms-version-number Unsigned8,
  proposed-conformance    Conformance,
  client-max-receive-pdu-size Unsigned16
}

InitiateResponse ::= SEQUENCE
{
  negotiated-quality-of-service IMPLICIT Integer8 OPTIONAL,
  negotiated-dlms-version-number Unsigned8,
  negotiated-conformance        Conformance,
  server-max-receive-pdu-size   Unsigned16,
  vaa-name                      ObjectName
}
```

The xDLMS InitiateRequest and InitiateResponse APDUs are encoded in A-XDR and they are inserted in the user-information field of the AARQ / AARE APDUs respectively.

In the examples below, the following values are used:

- dedicated key: not present; no ciphering is used;
- response-allowed: TRUE (default value);
- proposed-quality-of-service and negotiated-quality-of-service: not present (not used in DLMS/COSEM);
- proposed-conformance and negotiated-conformance: see below;
- proposed-dlms-version-number and negotiated-dlms-version-number = 6;
- client-max-receive-pdu-size: 1200_D = 0x04B0;
- server-max-receive-pdu-size: 500_D = 0x01F4;
- vaa-name in the case of LN referencing: the dummy value 0x0007;
- vaa-name in the case of SN referencing: the base_name of the current “Association SN” object, 0xFA00.
- the proposed-conformance and the negotiated-conformance elements carry the proposed conformance block and the negotiated conformance block respectively. The values of

these examples, for LN referencing and SN referencing respectively, are shown in Table C.1.

Table C.1 – Conformance block

Conformance::= [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24))		LN referencing		SN referencing	
-- the bit is set when the corresponding service or functionality is available	Used with	Proposed/ Negotiated		Proposed / Negotiated	
reserved-zero (0),		0	0	0	0
reserved-one (1),		0	0	0	0
reserved-two (2),		0	0	0	0
read (3),	SN	0	0	1	1
write (4),	SN	0	0	1	1
unconfirmed-write (5),	SN	0	0	1	1
reserved-six (6),		0	0	0	0
reserved-seven (7),		0	0	0	0
attribute0-supported-with-set (8),	LN	0	0	0	0
priority-mgmt-supported (9),	LN	1	1	0	0
attribute0-supported-with-get (10),	LN	1	0	0	0
block-transfer-with-get-or-read (11),	LN	1	1	0	0
block-transfer-with-set-or-write (12),	LN	1	0	0	0
block-transfer-with-action (13),	LN	1	0	0	0
multiple-references (14),	LN/SN	1	0	1	1
information-report (15),	SN	0	0	1	1
reserved-sixteen (16),		0	0	0	0
reserved-seventeen (17),		0	0	0	0
parameterized-access (18),	SN	0	0	1	1
get (19),	LN	1	1	0	0
set (20),	LN	1	1	0	0
selective-access (21),	LN	1	1	0	0
event-notification (22),	LN	1	1	0	0
action (23),	LN	1	1	0	0
Value of the bit string		00 7E 1F	00 50 1F	1C 03 20	1C 03 20

With these parameters, the A-XDR encoding of the xDLMS InitiateRequest APDU is the following, see Table C.2:

Table C.2 – A-XDR encoding of the xDLMS InitiateRequest APDU

-- A-XDR encoding of the xDLMS InitiateRequest APDU	LN referencing	SN referencing
// encoding of the tag of the DLMS APDU CHOICE (InitiateRequest)	01	01
-- encoding of the dedicated-key component (OCTET STRING OPTIONAL)		
// usage flag(FALSE , not present)	00	00
-- encoding of the response-allowed component (BOOLEAN DEFAULT TRUE)		
// usage flag(FALSE , default value TRUE conveyed)	00	00
-- encoding of the proposed-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)		
// usage flag(FALSE , not present)	00	00
-- encoding of the proposed-dlms-version-number component (Unsigned8)		
// value= 6, the encoding of an Unsigned8 is its value	06	06
-- encoding of the proposed-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)) ¹)		
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag) ²	5F 1F	5F 1F
// encoding of the length of the 'contents' field in octet (4)	04	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00	00
// encoding of the fixed length BIT STRING value	00 7E 1F	1C 03 20
-- encoding of the client-max-receive-pdu-size component (Unsigned16)		
// value = 0x04B0, the encoding of an Unsigned16 is its value	04 B0	04 B0
-- resulting octet-string, to be inserted in the user-information field of the AARQ APDU	01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0	01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0
¹ As specified in IEC 61334-6:2000, Annex C, Examples 1 and 2, the proposed-conformance element of the xDLMS InitiateRequest APDU and the negotiated-conformance element of the xDLMS InitiateResponse APDU are encoded in BER. That's why the length of the bit-string and the number of the unused bits are encoded. ² For encoding of identifier octets see ISO/IEC 8825-1:2008, 8.1.2. For compliance with existing implementations, encoding of the [Application 31] tag on one byte (5F) instead of two bytes (5F 1F) is accepted when the 3-layer, connection-oriented, HDLC-based profile is used.		

The A-XDR encoding of the xDLMS InitiateResponse APDU is the following, see Table C.3:

Table C.3 – A-XDR encoding of the xDLMS InitiateResponse APDU

-- A-XDR encoding of the xDLMS InitiateResponse APDU	LN referencing	SN referencing
// encoding of the tag of the DLMS APDU CHOICE (InitiateResponse)	08	08
-- encoding of the negotiated-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)		
// usage flag(FALSE , not present)	00	00
-- encoding of the negotiated-dlms-version-number component (Unsigned8)		
// value = 6, the encoding of an Unsigned8 is its value	06	06
-- encoding of the negotiated-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)))		
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag)	5F 1F	5F 1F
// encoding of the length of the 'contents' field in octet (4)	04	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00	00
// encoding of the fixed length BIT STRING value	00 50 1F	1C 03 20
-- encoding of the server-max-receive-pdu-size component (Unsigned16)		
// value = 0x01F4, the encoding of an Unsigned16 is its value	01 F4	01 F4
-- encoding of the VAA-Name component (ObjectName, Integer16)		
// value=0x0007 for LN and 0xFA00 for SN referencing; the encoding of a value constrained Integer16 is its value	00 07	FA 00
-- resulting octet-string, to be inserted in the user-information field of the AARE APDU	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00

C.3 Specification of the AARQ and AARE APDUs

AARQ-apdu ::= [APPLICATION 0] IMPLICIT SEQUENCE

{

-- [APPLICATION 0] == [60H] = [96]

protocol-version	[0] IMPLICIT	BIT STRING {version1 (0)} DEFAULT {version1},
application-context-name	[1]	Application-context-name,
called-AP-title	[2]	AP-title OPTIONAL,
called-AE-qualifier	[3]	AE-qualifier OPTIONAL,
called-AP-invocation-id	[4]	AP-invocation-identifier OPTIONAL,
called-AE-invocation-id	[5]	AE-invocation-identifier OPTIONAL,
calling-AP-title	[6]	AP-title OPTIONAL,
calling-AE-qualifier	[7]	AE-qualifier OPTIONAL,
calling-AP-invocation-id	[8]	AP-invocation-identifier OPTIONAL,
calling-AE-invocation-id	[9]	AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
sender-acse-requirements [10] IMPLICIT ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is selected.
mechanism-name [11] IMPLICIT Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is selected.
calling-authentication-value [12] EXPLICIT Authentication-value OPTIONAL,
implementation-information [29] IMPLICIT Implementation-data OPTIONAL,

```

    user-information          [30] EXPLICIT  Association-information OPTIONAL
}

-- The user-information field shall carry an xDLMS InitiateRequest APDU encoded in
-- A-XDR. The resulting OCTET STRING shall be encoded in BER.

AARE-apdu ::= [APPLICATION 1] IMPLICIT SEQUENCE
{
-- [APPLICATION 1] == [ 61H ] = [ 97 ]

    protocol-version          [0] IMPLICIT  BIT STRING {version1 (0)}
                                DEFAULT {version1},
    application-context-name   [1]          Application-context-name,
    result                     [2]          Association-result,
    result-source-diagnostic   [3]          Associate-source-diagnostic,
    responding-AP-title        [4]          AP-title OPTIONAL,
    responding-AE-qualifier    [5]          AE-qualifier OPTIONAL,
    responding-AP-invocation-id [6]          AP-invocation-identifier OPTIONAL,
    responding-AE-invocation-id [7]          AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
    responder-acse-requirements [8] IMPLICIT ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    mechanism-name            [9] IMPLICIT  Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    responding-authentication-value [10] EXPLICIT Authentication-value OPTIONAL,
    implementation-information      [29] IMPLICIT Implementation-data OPTIONAL,
    user-information              [30] EXPLICIT Association-information OPTIONAL
}

-- The user-information field shall carry either an InitiateResponse (or, when the
-- proposed xDLMS context is not accepted by the server, a ConfirmedServiceError) APDU
-- encoded in A-XDR. The resulting OCTET STRING shall be encoded in BER.

```

C.4 Data for the examples

In these examples:

- the protocol-version is the default ACSE version;
- the value of the application-context-name:
 - in the case of LN referencing, with no ciphering: 2, 16, 756, 5, 8, 1, 1;
 - in the case of SN referencing, with no ciphering: 2, 16, 756, 5, 8, 1, 2;
- the optional called-AP-title, called-AE-qualifier, called-AP-invocation-id, called-AE-invocation-id, calling-AP-title, calling-AE-qualifier, calling-AP-invocation-id, calling-AE-invocation-id fields of the AARQ, and the optional responding-AP-title, responding-AE-qualifier, responding-AP-invocation-id, responding-AE-invocation-id fields of the AARE are not present;
- the value of the mechanism-name:
 - in the case of low-level-security: 2, 16, 756, 5, 8, 2, 1;
 - in the case of high-level-security (5): 2, 16, 756, 5, 8, 2, 5;
- the calling-authentication-value:
 - in the case of low-level-security is 12345678 (encoded as 31 32 33 34 35 36 37 38);
 - in the case of high-level security, (challenge CtoS) is K56iVagY (encoded as 4B 35 36 69 56 61 67 59);
- the responding authentication-value (challenge StoC) is P6wRJ21F (encoded as 50 36 77 52 4A 32 31 46);
- the optional implementation-information field in the AARQ and AARE APDUs is not present;

- the user-information field carries the xDLMS InitiateRequest / InitiateResponse APDUs as shown above.

The application-context-name and the (authentication) mechanism-name OBJECT IDENTIFIERS are encoded as follows:

- BER Encoding for OBJECT IDENTIFIER is a packed sequence of numbers representing the arc labels. Each number – except the first two, which are combined into one – is represented as a series of octets, with 7 bits being used from each octet and the most significant bit is set to 1 in all but the last octet. The fewest possible number of octets shall be used;
- in the case of the application context name LN referencing with no ciphering, the arc labels of the object identifier are (2, 16, 756, 5, 8, 1, 1);
 - the first octet of the encoding is the combination of the first two numbers into a single number, following the rule of $40 \times \text{First} + \text{Second} \rightarrow 40 \times 2 + 16 = 96 = 0x60$;
 - the third number of the Object Identifier (756) requires two octets: its hexadecimal value is 0x02F4, which is 00000010 11110100, but following the above rule, the MSB of the first octet shall be set to 1 and the MSB of the second (last) octet shall be set to 0, thus this bit shall be shifted into the LSB of the first octet. This gives binary 10000101 01110100, which is 0x8574;
 - each remaining number of the Object Identifier required to be encoded on one octet;
 - this results in the encoding 60 85 74 05 08 01 01.
- similarly, in the case of application context name SN referencing with no ciphering the BER encoding is 60 85 74 05 08 01 02;
- in the case of mechanism name low-level-security, the BER encoding is 60 85 74 05 08 02 01;
- in the case of mechanism name high-level-security (5), the BER encoding is 60 85 74 05 08 02 05.

C.5 Encoding of the AARQ APDU

Here, six different cases are shown:

- LN referencing with no ciphering, no security, LLS and HLS;
- SN referencing with no ciphering, no security, LLS and HLS;

The encoding is shown in Table C.4. See also Table C.5.

Table C.4 – BER encoding of the AARQ APDU

-- BER encoding of the AARQ APDU	LN referencing			SN referencing		
	no sec.	LLS	HLS	no sec.	LLS	HLS
// encoding of the tag of the AARQ APDU ([APPLICATION 0], Application)	60					
// encoding of the length of the AARQ's content's field	1D	36	36	1D	36	36
-- protocol-version field ([0], IMPLICIT BIT STRING { version1 (0) } DEFAULT { version1 })						
// no encoding, thus it is considered with its DEFAULT value						
-- encoding of the fields of the Kernel						
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)						
// encoding of the tag ([1], Context-specific)	A1			A1		
// encoding of the length of the tagged component's value field	09			09		
// encoding of the choice for application-context-name (OBJECT IDENTIFIER , Universal)	06			06		
// encoding of the length of the Object Identifier's value field	07			07		
// encoding of the value of the Object Identifier	60 85 74 05 08 01 01			60 85 74 05 08 01 02		
-- encoding of the fields of the authentication functional unit						
--sender-acse-requirements field ([10], ACSE-requirements, BIT STRING { authentication (0) })						
// encoding of the tag of the acse-requirements field ([10], IMPLICIT , Context-specific)	-	8A	8A	-	8A	8A
// encoding of the length of the tagged component's value field	-	02	02	-	02	02
// encoding of the number of unused bits in the last byte of the BIT STRING	-	07	07	-	07	07
// encoding of the authentication functional unit (0)						
The number of bits coded may vary from client to client, but within the COSEM environment, only bit 0 set to 1 (indicating the requirement of the authentication functional unit) is to be respected.	-	80	80	-	80	80
-- mechanism-name field ([11], IMPLICIT Mechanism-name OBJECT IDENTIFIER)						
// encoding of the tag ([11], IMPLICIT , Context-specific)	-	8B	8B	-	8B	8B

-- BER encoding of the AARQ APDU		LN referencing			SN referencing		
		no sec.	LLS	HLS	no sec.	LLS	HLS
// encoding of the length of the tagged component's value field		-	07	07	-	07	07
// encoding of the value of the OBJECT IDENTIFIER :			60 85 74 05 08 02 01	60 85 74 05 08 02 05		60 85 74 05 08 02 01	60 85 74 05 08 02 05
- low-level-security-mechanism-name (1)		-			-		
- high-level-security-mechanism-name (5)							
-- calling-authentication-value field ([12], Authentication-value CHOICE)							
// encoding of the tag ([12], EXPLICIT , Context-specific)		-	AC	AC	-	AC	AC
// encoding of the length of the tagged component's value field		-	0A	0A	-	0A	0A
// encoding of the choice for Authentication-value (characteristic IMPLICIT GraphicString)		-	80	80	-	80	80
// encoding of the length of the Authentication-value's value field (8 octets)			08	08	-	08	08
// encoding of the calling-authentication-value:			31 32 33 34 35 36 37 38	4B 35 36 69 56 61 67 59		31 32 33 34 35 36 37 38	4B 35 36 69 56 61 67 59
- in the case of LLS, the value of the Password "12345678"					-		
- in the case of HLS, the value of challenge CtoS "K56iVagY"							
-- encoding of the user-information field component (Association-information, OCTET STRING)							
// encoding of the tag ([30], Context-specific, Constructed)		BE	BE	BE	BE	BE	BE
// encoding of the length of the tagged component's value field		10	10	10	10	10	10
// encoding of the choice for user-information (OCTET STRING , Universal)		04	04	04	04	04	04
// encoding of the length of the OCTET STRING 's value field (14 octets)		0E	0E	0E	0E	0E	0E
// user-information: xDLMS InitiateRequest APDU		01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0	06 5F 1F 04 B0	06 5F 1F 04 B0	01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0	06 5F 1F 04 B0	06 5F 1F 04 B0

Table C.5 – Complete AARQ APDU

LN referencing with no ciphering, lowest level security;	60 1D A1 09 06 07 60 85 74 05 08 01 01 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0
LN referencing with no ciphering, low level security;	60 36 A1 09 06 07 60 85 74 05 08 01 01 8A 02 07 80 8B 07 60 85 74 05 08 02 01 AC 0A 80 08 31 32 33 34 35 36 37 38 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0
LN referencing with no ciphering, high level security;	60 36 A1 09 06 07 60 85 74 05 08 01 01 8A 02 07 80 8B 07 60 85 74 05 08 02 05 AC 0A 80 08 4B 35 36 69 56 61 67 59 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0
SN referencing with no ciphering, lowest level security;	60 1D A1 09 06 07 60 85 74 05 08 01 02 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0
SN referencing with no ciphering, low level security;	60 36 A1 09 06 07 60 85 74 05 08 01 02 8A 02 07 80 8B 07 60 85 74 05 08 02 01 AC 0A 80 08 31 32 33 34 35 36 37 38 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0
SN referencing with no ciphering, high level security	60 36 A1 09 06 07 60 85 74 05 08 01 02 8A 02 07 80 8B 07 60 85 74 05 08 02 05 AC 0A 80 08 4B 35 36 69 56 61 67 59 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0

C.6 Encoding of the AARE APDU

Here, six different cases are shown:

- LN referencing with no ciphering, no security or LLS, successful establishment of the AA;
- LN referencing with no ciphering, no security or LLS, failure because the proposed application-context-name does not fit the application-context-name supported by the server (failure case 1):
 - when the meter uses LN referencing, SN referencing is proposed;
 - when the meter uses SN referencing, LN referencing is proposed;
- LN referencing with no ciphering, no security or LLS, failure because the proposed-dlms-version-number is too low; (failure case 2)
- LN referencing with no ciphering, HLS, successful establishment of the AA;
- SN referencing with no ciphering, no security or LLS, successful establishment of the AA;
- SN referencing with no ciphering, HLS, successful establishment of the AA.

The encoding is shown in Table C.6. See also Table C.7.

Table C.6 – BER encoding of the AARE APDU

-- BER encoding of the AARE APDU	LN referencing					SN referencing		
	No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success		
// encoding of the tag for the AARE APDU ([APPLICATION 1], Application)	61				61			
// encoding of the length of the AARE's contents field	29	29	1F	42	29			42
-- protocol-version field ([0], IMPLICIT BIT STRING { version1 (0) } DEFAULT { version1 })								
// no encoding, thus it is considered with its DEFAULT value								
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)								
// encoding of the tag ([1], Context-specific)	A1				A1			
// encoding of the length of the tagged component's value field	09				09			
// encoding of the choice for application-context-name (OBJECT IDENTIFIER, Universal)	06				06			
// encoding of the length of the Object Identifier's value field	07				07			
// encoding of the value of the Object Identifier: NOTE when the proposed application-context does not fit the application-context supported by the server, the server responds either with the application-context name proposed or the application-context-name supported.	60 85 74 05 08 01 01	60 85 74 05 08 01 01	60 85 74 05 08 01 01	60 85 74 05 08 01 01	60 85 74 05 08 01 02	60 85 74 05 08 01 02	60 85 74 05 08 01 02	
-- result field ([2], Association-result, INTEGER)								
// encoding of the tag ([2], Context-specific)	A2				A2			
// encoding of the length of the tagged component's value field	03						03	
// encoding of the choice for the result (INTEGER, Universal)	02						02	
// encoding of the length of the result's value field	01						01	

-- BER encoding of the AARE APDU		LN referencing				SN referencing	
		No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success
// encoding of the value of the Result:							
// success: 0, accepted		00	01	01	00	00	00
// failure case 1 and 2: 1, rejected-permanent							
-- result-source-diagnostic field ([3], Associate-source-diagnostic, CHOICE)							
// encoding of the tag ([3], Context-specific)		A3				A3	
// encoding of the length of the tagged component's value field		05				05	
// encoding of the tag for the acse-service-user CHOICE (1)		A1				A1	
// encoding of the length of the tagged component's value field		03				03	
// encoding of the choice for associate-source-diagnostics (INTEGER, Universal)		02				02	
// encoding of the length of the value field		01				01	
// encoding of the value:							
- success, no security and LLS: 0, no diagnostics provided;							
- failure 1: 2, application-context-name not supported;		00	02	01	0E	00	0E
- failure 2: 1, no-reason-given.							
- success, HLS security (5): 14, authentication required;							
-- encoding of the fields of the authentication functional unit							
-- responder-acse-requirements field ([8], IMPLICIT, ACSE-requirements, BIT STRING { authentication (0) })							
// encoding of the tag of the acse-requirements field ([8], IMPLICIT, Context-specific)		-			88	-	88
// encoding of the length of the tagged component's value field.		-			02	-	02

-- BER encoding of the AARE APDU		LN referencing				SN referencing		
		No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success	
// encoding of the number of unused bits in the last byte of the BIT STRING		-			07	-	07	
// encoding of the authentication functional unit (0)		-			80	-	80	
-- mechanism-name field ([9], IMPLICIT , Mechanism-name OBJECT IDENTIFIER)								
// encoding of the tag ([9], IMPLICIT , Context-specific)		-			89	-	89	
// encoding of the length of the tagged component's value field		-			07	-	07	
// encoding of the value of the object identifier: high-level-security-mechanism-name (5)		-			60 85 74 05 08 02 05	-	60 85 74 05 08 02 05	
-- responding-authentication-value field ([10], EXPLICIT , Authentication-value CHOICE)								
// encoding of the tag ([10], Context-specific)		-			AA	-	AA	
// encoding of the length of the tagged component's value field		-			0A	-	0A	
// encoding of the choice for Authentication-value (charstring [0] IMPLICIT GraphicString)		-			80	-	80	
// encoding of the length of the Authentication-information's value field (8 octets)		-			08	-	08	
// encoding of the value of the challenge Stoc "P6wRJ21F"					50 36 77 52 4A 32 31 46	-	50 36 77 52 4A 32 31 46	
-- encoding of the user-information field component (Association-information, OCTET STRING)								
// encoding of the tag for the user-information field component ([30], Context-specific, Constructed)		BE	BE	BE	BE	BE	BE	
// encoding of the length of the tagged component's value field		10	10	06	10	10	10	
// encoding of the choice for user-information (OCTET STRING, Universal)								
// encoding of the length of the OCTET STRING's value field		0E	0E	04	0E	0E	0E	

-- BER encoding of the AARE APDU	LN referencing				SN referencing	
	No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success
// failure case 1: xDLMS-InitiateResponse; // failure case 2: ConfirmedServiceError (14), InitiateError [1], ServiceError, initiate [6], dlms- version-too-low (1)	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	0E 01 06 01	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00	08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00

Table C.7 – The complete AARE APDU

LN referencing with no ciphering, no security or LLS, successful establishment of the AA	61 29 A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 00 A3 05 A1 03 02 01 00 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07
LN referencing with no ciphering, no security or LLS, failure because the proposed application-context- name does not fit the application- context-name supported by the server (failure case 1):	61 29 A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 01 A3 05 A1 03 02 01 02 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07 or 61 29 A1 09 06 07 60 85 74 05 08 01 02 A2 03 02 01 01 A3 05 A1 03 02 01 02 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07
LN referencing with no ciphering, no security or LLS, failure because the proposed-dlms-version-number is too low; (failure case 2)	61 1F A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 01 A3 05 A1 03 02 01 01 BE 06 04 04 0E 01 06 01
LN referencing with no ciphering, high level security;	61 42 A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 00 A3 05 A1 03 02 01 0E 88 02 07 80 89 07 60 85 74 05 08 02 05 AA 0A 80 08 50 36 77 52 4A 32 31 46 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07
SN referencing with no ciphering, lowest level security;	61 29 A1 09 06 07 60 85 74 05 08 01 02 A2 03 02 01 00 A3 05 A1 03 02 01 00 BE 10 04 0E 08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00
SN referencing with no ciphering, high level security	61 42 A1 09 06 07 60 85 74 05 08 01 02 A2 03 02 01 00 A3 05 A1 03 02 01 0E 88 02 07 80 89 07 60 85 74 05 08 02 05 AA 0A 80 08 50 36 77 52 4A 32 31 46 BE 10 04 0E 08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00

Annex D (informative)

Encoding examples: AARQ and AARE APDUs using a ciphered application context

D.1 A-XDR encoding of the xDLMS InitiateRequest APDU, carrying a dedicated key

NOTE The System Title is the same in each example. In reality, the System Title in the request and in the response APDUs are different, as they are originated by different systems.

In this example:

- the value of the dedicated key is 00112233445566778899AABBCCDDEEFF;
- the value of the Conformance block is 007E1F;
- the value of the client-max-receive-pdu-size is 1 200 bytes (0x04B0).

The A-XDR encoding of the xDLMS InitiateRequest APDU carrying a dedicated key is shown in Table D.1.

Table D.1 – A-XDR encoding of the xDLMS InitiateRequest APDU

// encoding of the tag of the DLMS ARDU CHOICE (<i>InitiateRequest</i>)	01
-- encoding of the dedicated-key component (OCTET STRING OPTIONAL)	
// usage flag (TRUE , present)	01
// length of the OCTET STRING	10
// contents of the OCTET STRING	0011223344556677 8899AABBCCDDEEFF
-- encoding of the response-allowed component (BOOLEAN DEFAULT TRUE)	
// usage flag (FALSE , default value TRUE conveyed)	00
-- encoding of the proposed-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)	
// usage flag (FALSE , not present)	00
-- encoding of the proposed-dlms-version-number component (<i>Unsigned8</i>)	
// value = 6, the A-XDR encoding of an Unsigned8 is its value	06
-- encoding of the proposed-conformance component (<i>Conformance</i> , [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)) ¹)	
// encoding of the [APPLICATION 31] tag (<i>ASN.1 explicit tag</i>) ²	5F1F
// encoding of the length of the 'contents' field in octet (4)	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00
// encoding of the fixed length BIT STRING value	007E1F
-- encoding of the client-max-receive-pdu-size component (<i>Unsigned16</i>)	
// value = 0x04B0, the encoding of an Unsigned16 is its value	04B0
-- resulting octet-string	0101100011223344 5566778899AABBCC DDEEFF0000065F1F 0400007E1F04B0

- ¹ As specified in IEC 61334-6:2000, Annex C, Examples 1 and 2, the proposed-conformance element of the xDLMS InitiateRequest APDU and the negotiated-conformance element of the xDLMS InitiateResponse APDU are encoded in BER. That is why the length of the bit-string and the number of the unused bits are encoded.
- ² For encoding of identifier octets see ISO/IEC 8825-1:2008, 8.1.2. For compliance with existing implementations, encoding of the [Application 31] tag on one byte (5F) instead of two bytes (5F 1F) is accepted when the 3-layer, connection-oriented, HDLC-based profile is used.

D.2 Authenticated encryption of the xDLMS InitiateRequest APDU

Table D.2 shows the encoding of an xDLMS InitiateRequest APDU which is also authenticated and encrypted.

Table D.2 – Authenticated encryption of the xDLMS InitiateRequest APDU

	<i>X</i>	Contents	LEN(X) bytes	len(X) bits
Security material				
Security suite		GCM-AES-128		
System Title	<i>Sys-T</i>	4D4D4D 0000BC614E (here, the five last octets contain the manufacturing number in hexadecimal form)	8	64
Frame Counter	<i>FC</i>	01234567	4	32
Initialization Vector	<i>IV</i>	<i>Sys-T</i> <i>FC</i> 4D4D4D0000BC614E01234567	12	96
Block cipher key (global)	<i>EK</i>	000102030405060708090A0B0C0D0E0F	16	128
Authentication Key	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Security applied		Authenticated encryption		
Security control byte (with unicast key)	<i>SC</i>	<i>SC</i> = <i>AE</i> 30	1	8
Security header	<i>SH</i>	<i>SH</i> = <i>SC</i> - <i>AE</i> <i>FC</i> 3001234567	5	40
Inputs				
xDLMS APDU to be protected	<i>APDU</i>	01011000112233445566778899AABBCC DDEEFF0000065F1F0400007E1F04B0	31	188
Plaintext	<i>P</i>	01011000112233445566778899AABBCC DDEEFF0000065F1F0400007E1F04B0	31	188
Associated data	<i>A</i>	<i>SC</i> <i>AK</i> 30D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	17	136
Outputs				
Ciphertext	<i>C</i>	801302FF8A7874133D414CED25B42534 D28DB0047720606B175BD52211BE68	31	188
Authentication tag	<i>T</i>	41DB204D39EE6FDB8E356855	12	96
The complete ciphered APDU		<i>TAG</i> <i>LEN</i> <i>SH</i> <i>C</i> <i>T</i> 21303001234567801302FF8A7874133D 414CED25B42534D28DB0047720606B17 5BD52211BE6841DB204D39EE6FDB8E35 6855	50	400

D.3 The AARQ APDU

In this example, the following values are used:

- Application-Context-Name: Logical_Name_Referencing_With_Ciphering;
- Calling-AP-Title (carries the System title): 4D4D4D0000BC614E;
- Mechanism-Name: COSEM_Low_Level_Security;
- Calling-Authentication-Value: 12345678

The BER encoding of the AARQ APDU is shown in Table D.3.

Table D.3 – BER encoding of the AARQ APDU

// encoding of the tag of the AARQ APDU ([APPLICATION 0], Application)	60
// encoding of the length of the AARQ's contents field (102 octets)	66
-- protocol-version field ([0], IMPLICIT BIT STRING { version 1 (0) } DEFAULT { version1 })	
// no encoding, thus it is considered with its DEFAULT value	
-- encoding of the fields of the Kernel	
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)	
// encoding of the tag ([1], Context-specific)	A1
// encoding of the length of the tagged component's value field	09
// encoding of the choice for application-context-name (OBJECT IDENTIFIER , Universal)	06
// encoding of the length of the Object Identifier's value field	07
// encoding of the value of the Object Identifier	60857405080103
-- encoding of the calling-AP-title field	
// encoding of the tag ([6], Context-specific)	A6
// encoding of the length of the tagged component's value field	0A
// encoding of the type ([4], Universal, Octetstring type)	04
// encoding of the length of the calling-AP-title-field	08
// encoding of the value	4D4D4D0000BC614E
-- encoding of the fields of the authentication functional unit	
--sender-acse-requirements field ([10], ACSE-requirements, BIT STRING { authentication (0) })	
// encoding of the tag of the acse-requirements field ([10], IMPLICIT , Context-specific)	8A
// encoding of the length of the tagged component's value field	02
// encoding of the number of unused bits in the last byte of the BIT STRING	07
// encoding of the authentication functional unit (0)	
The number of bits coded may vary from client to client, but within the COSEM environment, only bit 0 set to 1 (indicating the requirement of the authentication functional unit) is to be respected.	80

-- mechanism-name field ([11], IMPLICIT Mechanism-name OBJECT IDENTIFIER)	
// encoding of the tag ([11], IMPLICIT , Context-specific)	8B
// encoding of the length of the tagged component's value field	07
// encoding of the value of the OBJECT IDENTIFIER : - low-level-security-mechanism-name,	60857405080201
-- calling-authentication-value field ([12], Authentication-value CHOICE)	
// encoding of the tag ([12], EXPLICIT , Context-specific)	AC
// encoding of the length of the tagged component's value field	0A
// encoding of the choice for Authentication-value (charstring [0] IMPLICIT GraphicString)	80
// encoding of the length of the Authentication-value's value field (8 octets)	08
// encoding of the calling-authentication-value (12345678)	3132333435363738
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	34
// encoding of the choice for user-information (OCTET STRING , Universal)	04
// encoding of the length of the OCTET STRING 's value field (32 octets)	32
-- ciphered xDLMS InitiateRequest APDU	2130300123456780 1302FF8A7874133D 414CED25B42534D2 8DB0047720606B17 5BD52211BE6841DB 204D39EE6FDB8E35 6855

D.4 A-XDR encoding of the xDLMS InitiateResponse APDU

In this example:

- the value of the Conformance block is 007C1F;
- the value of the server-max-receive-pdu-size is 1 024 bytes (0x0400).

The A-XDR encoding of the xDLMS InitiateResponse APDU is shown in Table D.4.

Table D.4 – A-XDR encoding of the xDLMS InitiateResponse APDU

// encoding of the tag of the DLMS APDU CHOICE (InitiateResponse)	08
-- encoding of the negotiated-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)	
// usage flag (FALSE , not present)	00
-- encoding of the negotiated-dlms-version-number component (Unsigned8)	
// value = 6, the A-XDR encoding of an Unsigned8 is its value	06
-- encoding of the negotiated-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)))	
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag)	5F1F
// encoding of the length of the 'contents' field in octet (4)	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00
// encoding of the fixed length BIT STRING value	007C1F
-- encoding of the server-max-receive-pdu-size component (Unsigned16)	
// value = 0x0400, the encoding of an Unsigned16 is its value	0400
-- encoding of the VAA-Name component (ObjectName, Integer16)	
// value=0x0007; the encoding of a value constrained Integer16 is its value	0007
-- resulting octet-string, to be inserted in the user-information field of the AARE APDU	0800065F1F040000 7C1F04000007

D.5 Authenticated encryption of the xDLMS InitiateResponse APDU

Table D.5 shows the encoding of the xDLMS InitiateResponse APDU which is also authenticated and encrypted.

Table D.5 – Authenticated encryption of the xDLMS InitiateResponse APDU

	<i>X</i>	Contents	LEN(X) bytes	len(X) bits
Security material				
Security suite		GCM-AES-128		
System Title	<i>Sys-T</i>	4D4D4D0000BC614E (here, the five last octets contain the manufacturing number in hexadecimal form)	8	64
Frame Counter	<i>FC</i>	01234567	4	32
Initialization Vector	<i>IV</i>	<i>Sys-T</i> <i>FC</i> 4D4D4D0000BC614E01234567	12	96
Block cipher key (global)	<i>EK</i>	000102030405060708090A0B0C0D0E0F	16	128
Authentication Key	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Security applied		Authenticated encryption		
Security control byte (with unicast key)	<i>SC</i>	<i>SC-AE</i> 30	1	8
Security header	<i>SH</i>	<i>SH</i> = <i>SC-AE</i> <i>FC</i> 3001234567	5	40
Inputs				

	<i>X</i>	Contents	LEN(X) bytes	len(X) bits
xDLMS APDU to be protected	<i>APDU</i>	0800065F1F0400007C1F04000007	14	112
Plaintext	<i>P</i>	0800065F1F0400007C1F04000007	14	112
Associated data	<i>A</i>	SC II AK 30D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	17	136
Outputs				
Ciphertext	<i>C</i>	891214A0845E475714383F65BC19	14	112
Authentication tag	<i>T</i>	745CA235906525E4F3E1C893	12	96
The complete Ciphertext APDU		TAG II LEN II SH II C II T 281F3001234567891214A0845E475714 383F65BC19745CA235906525E4F3E1C8 93	33	264

D.6 The AARE APDU

The BER encoding of the AARE APDU is shown in Table D.6.

Table D.6 – BER encoding of the AARE APDU

-- BER encoding of the AARE APDU	
// encoding of the tag for the AARE APDU ([APPLICATION 1], Application)	61
// encoding of the length of the AARE's contents field (72 octets)	48
-- protocol-version field ([0], IMPLICIT BIT STRING { version1 (0) } DEFAULT { version1 })	
// no encoding, thus it is considered with its DEFAULT value	
-- encoding of the fields of the Kernel	
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)	
// encoding of the tag ([1], Context-specific)	A1
// encoding of the length of the tagged component's value field	09
// encoding of the choice for application-context-name (OBJECT IDENTIFIER, Universal)	06
// encoding of the length of the Object Identifier's value field	07
// encoding of the value of the Object Identifier: NOTE When the proposed application-context does not fit the application-context supported by the server, the server responds either with the application-context name proposed or the application-context-name supported.	60857405080103
-- result field ([2], Association-result, INTEGER)	
// encoding of the tag ([2], Context-specific)	A2
// encoding of the length of the tagged component's value field	03
// encoding of the choice for the result (INTEGER, Universal)	02
// encoding of the length of the result's value field	01
// encoding of the value of the Result: 0, accepted	00
-- result-source-diagnostic field ([3], Associate-source-diagnostic, CHOICE)	

-- BER encoding of the AARE APDU	
// encoding of the tag ([3], Context-specific)	A3
// encoding of the length of the tagged component's value field	05
// encoding of the tag for the acse-service-user CHOICE (1)	A1
// encoding of the length of the tagged component's value field	03
// encoding of the choice for associate-source-diagnostics (INTEGER, Universal)	02
// encoding of the length of the value field	01
// encoding of the value (0, no diagnostics provided)	00
-- encoding of the responding-AP-title field	
// encoding of the tag ([4], Context-specific)	A4
// encoding of the length of the tagged component's value field	0A
// encoding of the type ([4], Universal, Octetstring type)	04
// encoding of the length of the responding-AP-title-field	08
// encoding of the value	4D4D4D0000BC614E
-- encoding of the fields of the authentication functional unit	
-- In this example the Authentication functional unit is not present; it is not necessary in the case of ILS, but if it is present it is also acceptable.	
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	23
// encoding of the choice for user-information (OCTET STRING, Universal)	04
// encoding of the length of the OCTET STRING's value field	21
-- ciphered xDLMS InitiateResponse APDU	281F300123456789 1214A0845E475714 383F65BC19745CA2 35906525E4F3E1C8 93

D.7 The RLRQ APDU (carrying a ciphered xDLMS InitiateRequest APDU)

The BER encoding of the RLRQ APDU is shown in Table D.7.

Table D.7 – BER encoding of the RLRQ APDU

-- BER encoding of the RLRQ APDU	
// encoding of the tag of the RLRQ APDU ([APPLICATION 2], Application)	62
// encoding of the length of the RLRQ's contents field	39
-- reason field	
// encoding of the tag ([0], IMPLICIT)	80
// encoding of the length of the tagged component's value field	01
// encoding of the value (0, normal)	00
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	34
// encoding of the choice for user-information (OCTET STRING, Universal)	04
// encoding of the length of the OCTET STRING's value field (14 octets)	32
// user-information: xDLMS InitiateRequest APDU	2130300123456780 1302FF8A7874133D 414CED25B42534D2 8DB0047720606B17 5BD52211BE6841DB 204D39EE6FDB8E35 6855

D.8 The RLRE APDU (carrying a ciphered xDLMS InitiateResponse APDU)

The BER encoding of the RLRQ APDU is shown in Table D.8.

Table D.8 – BER encoding of the RLRE APDU

-- BER encoding of the RLRE APDU	
// encoding of the tag of the RLRE APDU ([APPLICATION 3], Application)	63
// encoding of the length of the RLRE's contents field	28
-- reason field	
// encoding of the tag ([0], IMPLICIT)	80
// encoding of the length of the tagged component's value field	01
// encoding of the value (0, normal)	00
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	23
// encoding of the choice for user-information (OCTET STRING, Universal)	04
// encoding of the length of the OCTET STRING's value field (14 octets)	21
// user-information: xDLMS InitiateResponse APDU	281F300123456789 1214A0845E475714 383F65BC19745CA2 35906525E4F3E1C8 93

Annex E (informative)

Data transfer service examples

Table E.2 to Table E.9 show examples for data exchange using xDLMS services with LN referencing (left column) and SN referencing (right column). Table E.1 shows the objects used in the examples.

Table E.1 – Objects used in the examples

Object 1: - Class: Data - Logical name: 0000800000FF - Short name of value attribute: 0100 - Value: octet string of 50 elements - 01020304050607080910111213141516 - 17181920212223242526272829303132 - 33343536373839404142434445464748 - 4950 Object 2: - Class: Data - Logical name: 0000800100FF - Short name of value attribute: 0110 - Value: visible string of 3 elements 303030

In the case of block transfer, the negotiated APDU size is 40 bytes.

NOTE What is negotiated is the APDU size, not the block size. Therefore, the block size is smaller than the APDU size.

Table E.2 – Example: Reading the value of a single attribute without block transfer

C001C1 00010000800000FF0200 <GetRequest> <GetRequestNormal> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </GetRequestNormal> </GetRequest>	0501 020100 <ReadRequest Qty="0001" > <VariableName Value="0100" /> </ReadRequest>
C401C1 00 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <GetResponse> <GetResponseNormal> <InvokeIdAndPriority Value="C1" /> <Result> <Data> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Data> </Result> </GetResponseNormal> </GetResponse>	0C01 60 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <ReadResponse Qty="0001" > <Data> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Data> </ReadResponse>

Table E.3 – Example: Reading the value of a list of attributes without block transfer

<pre>C003C1 02 00010000800000FF0200 00010000800100FF0200 <GetRequestWithList> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="000800100FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> </AttributeDescriptorList> </GetRequestWithList> </GetRequest></pre>	<pre>0502 020100 020110 <ReadRequest Qty="0002" > <VariableName Value="0100" /> <VariableName Value="0110" /> </ReadRequest></pre>

C403C1 02 00 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 00 0A03 303030	0C02 00 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 00 0A03 303030 <ReadResponse Qty="0002" > <Data> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Data> </ReadResponse>

Table E.4 – Example: Reading the value of a single attribute with block transfer

<pre> C001C1 00010000800000FF0200 <GetRequest> <GetRequestNormal> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </GetRequestNormal> </GetRequest> </pre>	<pre> 0501 020100 <ReadRequest Qty="0001" > <VariableName Value="0100" /> </ReadRequest> </pre>
<pre> C402C1 00 00 00000001 00 1E 093201020304050607080910111213 141516171819202122232425262728 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> <Result> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <Result> <RawData Value="09320102030405060708091011121314 1516171819202122232425262728" /> </Result> </Result> </GetResponseWithDataBlock> </GetResponse> // 30 bytes of raw-data contains data type, length and 28 bytes // of data. Note that Data is encoded, not Get-Data-result. </pre>	<pre> 0C01 02 00 00 0001 21 01000932010203040506070809101112 13141516171819202122232425262728 29 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="00" /> <BlockNumber Value="0001" /> <RawData Value="01000932010203040506070809101112 13141516171819202122232425262728 29" /> </DataBlockResult> </ReadResponse> // 33 bytes of raw-data contains number of data, success, data // type, length and 29 bytes of data. // As the raw-data contains the data encoded exactly as without // block transfer, the number of results is encoded because the // ReadResponse is a SEQUENCE OF CHOICE. </pre>

<pre> C402C1 00000001 <GetRequest> <GetRequestForNextDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </GetRequestForNextDataBlock> </GetRequest> </pre>	<pre> 0501 050001 <ReadRequest Qty="0001" > <BlockNumberAccess> <BlockNumber Value="0001" /> </BlockNumberAccess> </ReadRequest> </pre>
<pre> C402C1 01 00000002 00 16 29303132333435363738394041424344 454647484950 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> <Result> <LastBlock Value="01" /> <BlockNumber Value="00000002" /> <Result> <RawData Value="29303132333435363738394041424344 454647484950" /> </Result> </Result> </GetResponseWithDataBlock> </GetResponse> // APDU length 32 bytes, 22 bytes of raw-data carries the // remaining part of data requested. </pre>	<pre> 0C01 02 01 0002 15 30313233343536373839404142434445 4647484950 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="01" /> <BlockNumber Value="0002" /> <RawData Value="30313233343536373839404142434445 4647484950" /> </DataBlockResult> </ReadResponse> // APDU length 28 bytes, 21 bytes of raw-data carries the // remaining part of data requested. </pre>

Table E.5 – Example: Reading the value of a list of attributes with block transfer

<pre>C003C1 02 00010000800000FF0200 000100008000100FF0200 <GetRequestWithList> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="000800100FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> </AttributeDescriptorList> </GetRequestWithList> </GetRequest></pre>	<pre>0502 020100 020110 <ReadRequest Qty="0002" > <VariableName Value="0100" /> <VariableName Value="0110" /> </ReadRequest></pre>

<pre> C402C1 00 00 00000001 00 00 1E 02000932010203040506070809101112 1314151617181920212223242526 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> </Result> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <Result> <RawData Value="02000932010203040506070809101112 1314151617181920212223242526" /> </Result> </Result> </GetResponseWithDataBlock> </GetResponse> // 30 bytes of raw-data contains the number of results and part // of the data. The first one is success, octet-string of 32 // elements; the first 26 bytes fit in. </pre>	<pre> 0C01 00 02 00 0001 21 02000932010203040506070809101112 13141516171819202122232425262728 29 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="00" /> <BlockNumber Value="0001" /> <RawData Value="02000932010203040506070809101112 13141516171819202122232425262728 29" /> </DataBlockResult> </ReadResponse> // 33 bytes of raw-data contains the number of results and part // of the data. The first one is success, octet-string of 32 // elements; the first 29 bytes fit in. </pre>
<pre> C002C1 00000001 <GetRequest> <GetRequestForNextDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </GetRequestForNextDataBlock> </GetRequest> </pre>	<pre> 0501 05 0001 <ReadRequest Qty="0001" > <BlockNumberAccess> <BlockNumber Value="0001" /> </BlockNumberAccess> </ReadRequest> </pre>

<pre> C402C1 01 00000002 00 1E 27282930313233343536373839404142 4344454647484950000A03303030 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> </Result> <LastBlock Value="01" /> <BlockNumber Value="00000002" /> </Result> <RawData Value="27282930313233343536373839404142 4344454647484950000A03303030" /> </Result> </GetResponseWithDataBlock> </GetResponse> // 30 bytes of raw-data contains the remaining 24 bytes of the // first result and it also contains the six bytes of the second // result: success, visible string of 3 elements. </pre>	<pre> 0C01 02 01 0002 1B 30313233343536373839404142434445 4647484950000A03303030 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="01" /> <BlockNumber Value="0002" /> <RawData Value="30313233343536373839404142434445 4647484950000A03303030" /> </DataBlockResult> </ReadResponse> // The APDU is 34 bytes. It contains the second and last block. // 27 bytes of raw-data contains the remaining 21 bytes of the // first result and the six bytes of the second result: success, // visible string of 3 elements </pre>

Table E.6 – Example: Writing the value of a single attribute without block transfer

C101C1 00010000800000FF0200 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <SetRequest> <SetRequestNormal> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <Value> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Value> </SetRequestNormal> </SetRequest>	06 01 020100 01 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <VariableName Value="0100" /> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </ListOfData> </WriteRequest>
C501C1 00 00 <SetResponse> <SetResponseNormal> <InvokeIdAndPriority Value="C1" /> <Result Value="Success" /> </SetResponseNormal> </SetResponse>	0501 00 00 <WriteResponse Qty="0001" > <Success /> </WriteResponse>

Table E.7 – Example: Writing the value of a list of attributes without block transfer

<pre> C104C1 02 00010000800000FF0200 00010000800100FF0200 02 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 0A03 303030 <SetRequest> <SetRequestNormalWithList> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> </AttributeDescriptorList> </SetRequestNormalWithList> </SetRequest> </pre>	<pre> 0602 020100 020110 02 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 0A03 303030 <WriteRequest> <ListOfVariableAccessSpecification Qty="0002" > <VariableName Value="0100" /> <VariableName Value="0110" /> </ListOfVariableAccessSpecification> <ListOfData Qty="0002" > <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> <VisibleString Value="303030" /> </ListOfData> </WriteRequest> </pre>

C505C1 02 00 00 00	0D02 00 00 00 <WriteResponse Qty="0002" > <Success /> <Success /> </WriteResponse>
<SetResponse> <SetResponseWithList> <InvokeIdAndPriority Value="C1" /> <Result Qty="0002" > <DataAccessResult Value="Success" /> <DataAccessResult Value="Success" /> </Result> </SetResponseWithList> </SetResponse>	

Table E.8 – Example: Writing the value of a single attribute with block transfer

C102C1 00 00 00000001 15 09320102030405060708091011121314 1516171819	0601 07 00 0001 01 091F 01020100010932010203040506070809 161112131415161718192021222324 <SetRequest> <SetRequestWithFirstDataBlock> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </DataBlock> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <RawData Value="09320102030405060708091011121314 1516171819" /> </DataBlock> </SetRequestWithFirstDataBlock> </SetRequest> // 21 bytes of raw-data contain the type length and the first 19 // bytes of data to be written.
<WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="00" /> <BlockNumber Value="0001" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="01020100010932010203040506070809 101112131415161718192021222324" /> </ListOfData> </WriteRequest> // 31 bytes of octet-string contains raw-data: the sequence of // Variable-Access-Specification, the sequence of data, the type, // length and the first 24 bytes to be written.	

C502C1 00000001 <SetResponse> <SetResponseForDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </SetResponseForDataBlock> </SetResponse>	0D01 02 0001 <WriteResponse Qty="0001" > <BlockNumber Value="0001" /> </WriteResponse>
C103C1 01 00000002 1F 20212223242526272829303132333435 363738394041424344454647484950 <SetRequest> <SetRequestWithDataBlock> <DataBlock> <LastBlock Value="01" /> <BlockNumber Value="00000002" /> <RawData Value="20212223242526272829303132333435 363738394041424344454647484950" /> </DataBlock> </SetRequestWithDataBlock> </SetRequest> // 31 bytes of raw-data contains the remaining 21 bytes of the // data to be written.	0601 07 01 0002 01 091A 25262728293031323334353637383940 41424344454647484950 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="01" /> <BlockNumber Value="0002" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="25262728293031323334353637383940 41424344454647484950" /> </ListOfData> </WriteRequest> // The APDU is 35 bytes. 26 bytes of octet-string contains raw- // data: the remaining 26 bytes of data to be written.
C503C10000000002 <SetResponse> <SetResponseForLastDataBlock> <InvokeIdAndPriority Value="C1" /> <Result Value="Success" /> <BlockNumber Value="00000002" /> </SetResponseForLastDataBlock> </SetResponse>	0D0100 <WriteResponse Qty="0001" > <Success /> </WriteResponse>

Table E.9 – Example: Writing the value of a list of attributes with block transfer

<pre> C105C1 02 00010000800000FF0200 00010000800100FF0200 00 00 00000001 0A 02093201020304050607 <SetRequest> <SetRequestWithListAndWithFirstDatablock> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800100FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <_AttributeDescriptorWithSelection> <AttributeDescriptorList> <DataBlock> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <RawData Value="02093201020304050607" /> </DataBlock> </SetRequestWithListAndWithFirstDatablock> </SetRequest> // The APDU is 40 bytes. It contains the two attribute // descriptors and 10 bytes of raw-data containing the type and // length of the first data and the first 7 bytes to be written. </pre>	<pre> 0601 07 00 0001 01 091F 02020100020110020932010203040506 070809101112131415161718192021 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="00" /> <BlockNumber Value="0001" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfDataQty="0001" > <OctetString Value="02020100020110020932010203040506 070809101112131415161718192021" /> </ListOfData> </WriteRequest> // The APDU is 40 bytes. 31 bytes of octet-string contains raw- // data: the number and the name of objects to be written, the // number of data to be written and the first 21 bytes of the // first data to be written. </pre>

C502C1 00000001 <SetResponse> <SetResponseForDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </SetResponseForDataBlock> </SetResponse>	0D01 02 0001 <WriteResponse Qty="0001" > <BlockNumber Value="0001" /> </WriteResponse>
C103C1 00 00000002 1F 08091011121314151617181920212223 242526272829303132333435363738 <SetRequest> <SetRequestWithDataBlock> <InvokeIdAndPriority Value="C1" /> <DataBlock> <LastBlock Value="00" /> <BlockNumber Value="00000002" /> <RawData Value="08091011121314151617181920212223 242526272829303132333435363738" /> </DataBlock> </SetRequestWithDataBlock> </SetRequest> // The APDU is 40 bytes. 31 bytes of raw-data contain the second // part of data to be written.	0601 07 00 0002 01 091F 22232425262728293031323334353637 383940414243444546474849500A03 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="00" /> <BlockNumber Value="0002" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="22232425262728293031323334353637 383940414243444546474849500A03" /> </ListOfData> </WriteRequest> // The APDU is 40 bytes. 31 bytes of octet-string contains raw- // data: the second 29 bytes of the first data to be written and // the data type and length of the second data to be written. The // value follows in the next block.
C502C100000002 <SetResponse> <SetResponseForDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000002" /> </SetResponseForDataBlock> </SetResponse>	0D01 02 0002 <WriteResponse Qty="0001" > <BlockNumber Value="0002" /> </WriteResponse>

<pre> C103C1 01 00000003 11 3940414243444546474849500A033030 30 <SetRequest> <SetRequestWithDataBlock> <InvokeIdAndPriority Value="C1" /> <DataBlock> <LastBlock Value="01" /> <BlockNumber Value="00000003" /> <RawData Value="3940414243444546474849500A033030 30" /> </DataBlock> </SetRequestWithDataBlock> </SetRequest> // The APDU is 26 bytes. 17 bytes of raw-data contain the third // part of the first data and the second data to be written. </pre>	<pre> 0601 07 01 0003 01 0903 303030 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="01" /> <BlockNumber Value="0003" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="303030" /> </ListOfData> </WriteRequest> // The APDU is 12 bytes. 3 bytes of octet-string contains // raw-data: the value of the second attribute. </pre>
<pre> C504C1 02 00 00 00 00000003 <SetResponse> <SetResponseForLastDataBlockWithList> <InvokeIdAndPriority Value="C1" /> <Result Qty="0002" > <DataAccessResult Value="Success" /> <_DataAccessResult Value="Success" /> </Result> <BlockNumber Value="00000003" /> </SetResponseForLastDataBlockWithList> </SetResponse> </pre>	<pre> 0D02 00 00 00 <WriteResponse Qty="0002" > <Success /> <Success /> </WriteResponse> </pre>

Annex F (informative)

Overview of cryptography

F.1 General

NOTE 1 Annex F is provided as a brief introduction to the cryptography tools selected. More information can be found in the documents referenced.

NOTE 2 The following text is quoted from NIST SP 800-21:2005, 3.1.

Cryptography is a branch of mathematics that is based on the transformation of data and can be used to provide several security services: confidentiality, data integrity, authentication, authorization and non-repudiation. Cryptography relies upon two basic components: an *algorithm* (or cryptographic methodology) and a *key*. The algorithm is a mathematical function, and the key is a parameter used in the transformation.

A cryptographic algorithm and a key are used to apply cryptographic protection to data (e.g., encrypt the data or generate a digital signature) and to remove or check the protection (e.g., decrypt the encrypted data or verify the digital signature). There are three basic types of approved cryptographic algorithms: cryptographic hash functions, symmetric key algorithms and asymmetric key algorithms:

- cryptographic hash functions do not require keys (although they can be used in a mode in which keys are used). A hash function is often used as a component of an algorithm to provide a security service. See Clause F.2;
- symmetric algorithms (often called secret key algorithms) use a single key to both apply the protection and to remove or check the protection. See Clause F.3;
- asymmetric algorithms (often called public key algorithms) use two keys (i.e., a key pair): a public key and a private key that are mathematically related to each other. See Clause F.4.

In order to use cryptography, cryptographic keys shall be “in place”, i.e., keys shall be established for parties using cryptography.

F.2 Hash functions

NOTE The following text is quoted from NIST SP 800-21:2005, 3.2.

A hash function produces a short representation of a longer message. A good hash function is a one-way function: it is easy to compute the hash value from a particular input; however, backing up the process from the hash value back to the input is extremely difficult. With a good hash function, it is also extremely difficult to find two specific inputs that produce the same hash value. Because of these characteristics, hash functions are often used to determine whether or not data has changed.

A hash function takes an input of arbitrary length and outputs a fixed length value. Common names for the output of a hash function include *hash value* and *message digest*. Figure F.1 depicts the use of a hash function.

A hash value (H1) is computed on data (M1). M1 and H1 are then saved or transmitted. At a later time, the correctness of the retrieved or received data is checked by labelling the received data as M2 (rather than M1) and computing a new hash value (H2) on the received value. If the newly computed hash value (H2) is equal to the retrieved or received hash value (H1), then it can be assumed that the retrieved or received data (M2) is the same as the original data (M1) (i.e. $M1 = M2$).

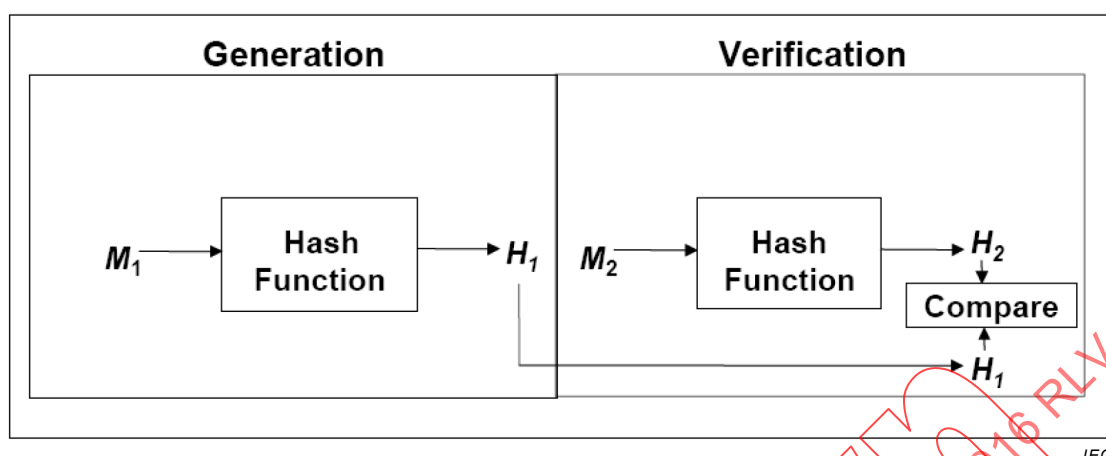


Figure F.1 – Hash function

F.3 Symmetric key algorithms

F.3.1 General

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.

Symmetric key algorithms (often called secret key algorithms) use a single key to both apply the protection and to remove or check the protection. For example, the key used to encrypt data is also used to decrypt the encrypted data. This key shall be kept secret if the data is to retain its cryptographic protection. Symmetric algorithms are used to provide confidentiality via encryption, or an assurance of authenticity or integrity via authentication, or are used during key establishment.

Keys used for one purpose shall not be used for other purposes. (See NIST SP 800-57:2006).

F.3.2 Encryption and decryption

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.1. In this context, “for Federal Government use” means “for the purposes of this standard”.

Encryption is used to provide confidentiality for data. The data to be protected is called *plaintext*. Encryption transforms the data into *ciphertext*. Ciphertext can be transformed back into plaintext using decryption. The approved algorithms for encryption and decryption algorithms are: the Advanced Encryption Standard (AES) and the Triple Data Encryption Algorithm (TDEA). TDEA is based on the Data Encryption Standard (DES), which is no longer approved for Federal Government use except as a component of TDEA. Each of these algorithms operates on blocks (chunks) of data during an encryption or decryption operation. For this reason, these algorithms are commonly referred to as block cipher algorithms.

Plaintext data can be recovered from ciphertext only by using the same key that was used to encrypt the data. Unauthorized recipients of the ciphertext who know the cryptographic algorithm but do not have the correct key should not be able to decrypt the ciphertext. However, anyone who has the key and the cryptographic algorithm can easily decrypt the ciphertext and obtain the original plaintext data.

Figure F.2 depicts the encryption and decryption processes. The plaintext (P) and a key (K) are used by the encryption process to produce the ciphertext (C). To decrypt, the ciphertext (C) and the same key (K) are used by the decryption process to recover the plaintext (P).

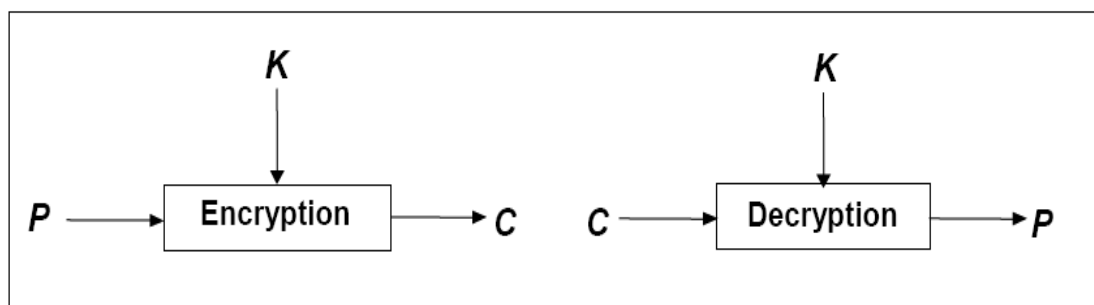


Figure F.2 – Encryption and decryption

With symmetric key block cipher algorithms, the same plaintext block and key will always produce the same ciphertext block. This property does not provide acceptable security. Therefore, cryptographic modes of operation have been defined to address this problem (see F.3.4).

F.3.3 Advanced Encryption Standard (AES)

NOTE 1 The following text is quoted from NIST SP 800-21:2005, 3.3.1.3.

The Advanced Encryption Standard (AES) was developed as a replacement for DES and is the preferred algorithm for new products. AES is specified in FIPS PUB 197. AES encrypts and decrypts data in 128-bit blocks, using 128, 192 or 256 bit keys. All three key sizes are adequate.

NOTE 2 The following text is quoted from RFC 5084.

AES offers a combination of security, performance, efficiency, ease of implementation, and flexibility. Specifically, the algorithm performs well in both hardware and software across a wide range of computing environments. Also, the very low memory requirements of the algorithm make it very well suited for restricted-space environments.

F.3.4 Encryption Modes of Operation

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.1.4.

With a symmetric key block cipher algorithm, the same plaintext block will always encrypt to the same ciphertext block when the same symmetric key is used. If the multiple blocks in a typical message (data stream) are encrypted separately, an adversary could easily substitute individual blocks, possibly without detection. Furthermore, certain kinds of data patterns in the plaintext, such as repeated blocks, would be apparent in the ciphertext.

Cryptographic modes of operation have been defined to address this problem by combining the basic cryptographic algorithm with variable initialization values (commonly known as initialization vectors) and feedback rules for the information derived from the cryptographic operation.

NIST SP 800-38D:2007 specifies the Galois/Counter Mode (GCM), an algorithm for authenticated encryption with associated data, and its specialization, GMAC, for generating a message authentication code (MAC) on data that is not encrypted. GCM and GMAC are modes of operation for an underlying approved symmetric key block cipher. See 5.4.8.

F.3.5 Message Authentication Code

F.3.5.1 General

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.2. In this context, “for Federal Government use” means “for the purposes of this standard”.

Message Authentication Codes (MACs) provide an assurance of authenticity and integrity. A MAC is a cryptographic checksum on the data that is used to provide assurance that the data has not changed or been altered and that the MAC was computed by the expected party (the sender). Typically, MACs are used between two parties that share a secret key to authenticate information exchanged between those parties.

Figure F.3 depicts the use of message authentication codes (MACs).

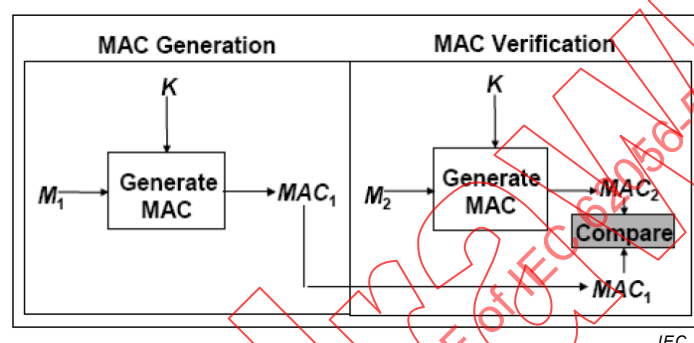


Figure F.3 – Message Authentication Codes (MACs)

A MAC (MAC1) is computed on data (M1) using a key (K). M1 and MAC1 are then saved or transmitted. At a later time, the authenticity of the retrieved or received data is checked by labelling the retrieved or received data as M2 and computing a MAC (MAC2) on it using the same key (K). If the retrieved or received MAC (MAC1) is the same as the newly computed MAC (MAC2), then it can be assumed that the retrieved or received data (M2) is the same as the original data (M1) (i.e. $M1 = M2$). The verifying party also knows who the sending party is because no one else knows the key.

Typically, MACs are used to detect data modifications that occur between the initial generation of the MAC and the verification of the received MAC. They do not detect errors that occur before the MAC is originally generated.

Message integrity is frequently provided using non-cryptographic techniques known as error detection codes. However, these codes can be altered by an adversary to the adversary's benefit. The use of an approved cryptographic mechanism, such as a MAC, addresses this problem. That is, the integrity provided by a MAC is based on the assumption that it is not possible to generate a MAC without knowing the cryptographic key. An adversary without knowledge of the key will be unable to modify data and then generate an authentic MAC on the modified data. It is therefore crucial that MAC keys be kept secret.

Two types of algorithms for computing a MAC have been approved for Federal government use: MAC algorithms that are based on block cipher algorithms, and MAC algorithms that are based on hash functions.

F.3.5.2 The Keyed-Hash Message Authentication Code (HMAC)

NOTE The following text is quoted from FIPS PUB 198.

The Keyed-Hash Message Authentication Code (HMAC) uses a cryptographic hash function in conjunction with a secret key. HMAC shall be used in combination with an approved

cryptographic hash function. HMAC uses a secret key for the calculation and verification of the MACs. For details, see FIPS PUB 198.

F.3.6 Key establishment

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.3.

Symmetric key algorithms may be used to wrap (i.e. encrypt) keying material using a key-wrapping key (also known as a key encrypting key). The wrapped keying material can then be stored or transmitted securely. Unwrapping the keying material requires the use of the same key-wrapping key that was used during the original wrapping process.

Key wrapping differs from simple encryption in that the wrapping process includes an integrity feature. During the unwrapping process, this integrity feature detects accidental or intentional modifications to the wrapped keying material.

F.4 Asymmetric key algorithms

F.4.1 General

The use of asymmetric key algorithms for DLMS/COSEM is under consideration.

NOTE 1 The following text is quoted from NIST SP 800-21:2005, 3.4.

Asymmetric algorithms (often called public key algorithms) use two keys: a public key and a private key, which are mathematically related to each other. The public key may be made public; the private key shall remain secret if the data is to retain its cryptographic protection. Even though there is a relationship between the two keys, the private key cannot be determined from the public key. Which key to be used to apply versus remove or check the protection depends on the service to be provided. For example, a digital signature is computed using a private key, and the signature is verified using the public key; for those algorithms also capable of encryption⁴⁹, the encryption is performed using the public key, and the decryption is performed using the private key.

NOTE 2 Not all public key algorithms are capable of multiple functions, e.g., generating digital signatures and encryption.

Asymmetric algorithms are used primarily as data integrity, authentication, and non-repudiation mechanisms (i.e., digital signatures), and for key establishment.

Some asymmetric algorithms use domain parameters, which are additional values necessary for the operation of the cryptographic algorithm. These values are mathematically related to each other. Domain parameters are usually public and are used by a community of users for a substantial period of time.

The secure use of asymmetric algorithms requires that users obtain certain assurances:

- assurance of domain parameter validity provides confidence that the domain parameters are mathematically correct;
- assurance of public key validity provides confidence that the public key appears to be a suitable key; and
- assurance of private key possession provides confidence that the party that is supposedly the owner of the private key really has the key.

Some asymmetric algorithms may be used for multiple purposes (e.g., for both digital signatures and key establishment). Keys used for one purpose shall not be used for other purposes.

F.4.2 Digital signatures

NOTE The following text is quoted from NIST SP 800-21:2005, 3.4.1.

A digital signature is an electronic analogue of a written signature that can be used in proving to the recipient or a third party that the message was signed by the originator (a property known as non-repudiation). Digital signatures may also be generated for stored data and programs so that the integrity of the data and programs may be verified at a later time.

Digital signatures authenticate the integrity of the signed data and the identity of the signatory. A digital signature is represented in a computer as a string of bits and is computed using a digital signature algorithm that provides the capability to generate and verify signatures. Signature generation uses a private key to generate a digital signature. Signature verification uses the public key that corresponds to, but is not the same as, the private key to verify the signature. Each signatory possesses a private and public key pair. Signature generation can be performed only by the possessor of the signatory's private key. However, anyone can verify the signature by employing the signatory's public key. The security of a digital signature system is dependent on maintaining the secrecy of a signatory's private key. Therefore, users shall guard against the unauthorized acquisition of their private keys.

F.4.3 Key establishment

NOTE 1 The following text is quoted from NIST SP 800-21:2005, 3.4.2.

Two types of asymmetric key (i.e., public key) establishment are defined: *key transport* and *key agreement*. Approved key establishment schemes are specified in NIST SP 800-56, *Recommendation on Key Establishment Schemes*.

Key transport is the distribution of a key (and other keying material) from one party to another party. The transported key is created by the sending party. The keying material is encrypted by the sending party and decrypted by the receiving party. The sending party encrypts the keying material using the receiving party's public key; the receiving party decrypts the received keying material using the associated private key.

Key agreement is the participation by both parties (i.e., the sending and receiving parties) in the creation of shared keying material. Each party has either one or two key pairs²⁰, and the public keys are made known to the other party. The key pairs are used to compute a shared secret²⁴ value, which is then used with other information to derive keying material using a key derivation function. Typically, a hash function (see Clause F.2) is used during the key derivation process.

NOTE 2 A key pair consists of a private key and its associated public key.

NOTE 3 The shared secret is never transmitted from one party to the other.

²⁰

²⁴

Annex G (informative)

Significant technical changes with respect to IEC ~~62056-53~~ 62056-5-3 Ed.1.0:2013

This part of IEC 62056 series includes the following significant technical changes with respect to IEC ~~62056-53~~ 62056-5-3 Ed.1.0:2013:

- ~~The title of this part has changed from “COSEM Application layer” to “DLMS/COSEM application layer”;~~
- ~~Clause 2 includes a number of new references, mainly concerning data security;~~
- ~~Clause 3 includes a number of new abbreviations, mainly concerning data security;~~
- ~~Clause 4 of the previous edition, *The COSEM communications framework*, has been removed and will make the basis of the new Part IEC 62056-1-0;~~
- ~~subclause 4.2.3 has been re-organised. Each specific feature is now described in a separate subclause (derived from 7.4 of the previous edition);~~
- ~~Subclause 4.2.3.1 *The xDLMS application service element* now contains Annex A of the previous edition, with necessary amendments;~~
- ~~Clause 5 now specifies all elements concerning information security in DLMS/COSEM, including data access security — derived from IEC 62056-62:2006, 4.7 — and data transport security using ciphered xDLMS APDUs;~~
- ~~Clause 6 has been reorganized: the four service primitives — request, indication, response, confirm as appropriate — of each service are described together. The service parameters are presented in a tabular form and they follow the order of the fields of the respective APDUs. In the description of the Use of the services, reference is made to the time sequence diagrams specified in 6.1;~~
- ~~Subclause 6.1 now provides a general description of the service primitives and the notation used;~~
- ~~Subclause 6.2, *The COSEM_OPEN service*: the Calling_AP_Title and the Responding_AP_Title parameters are now used in application contexts using ciphering;~~
- ~~Subclause 6.3, *The COSEM_Release service*: the description has been amended for a better alignment with the ACSE A Release service and to allow the user information field of the RLRQ / RLRE to carry a ciphered xDLMS InitiateRequest / InitiateResponse APDU, to secure the COSEM_RELEASE service;~~
- ~~Subclause 6.5, *Security parameters* contains the general specification of the security parameters used by data access services in ciphered application contexts;~~
- ~~Subclauses 6.6 *The GET service*, 6.7 *The SET service* and 6.8 *The ACTION service*: the specification of the services using LN referencing has been amended for a coherent presentation with that of the services using SN referencing. The request and response primitive types are also presented in a table. These changes do not affect the protocol of the services or the encoding of the APDUs;~~
- ~~Subclause 6.11 now includes the variable access specification parameter of the Read, Write and UnconfirmedWrite services used with SN referencing. New variants have been added to support block transfer;~~
- ~~Subclause 0 now contains the detailed specification of the Read service. Block transfer is also available now. The use of the Variable_Access_Specification variants is presented in a table;~~
- ~~Subclause 6.13 now contains the detailed specification of the Write service. Block transfer is also available now. The use of the Variable_Access_Specification variants is presented in a table;~~

- ~~Subclause 6.14 now contains the detailed specification of the UnconfirmedWrite service. The use of the Variable_Access_Specification variants is presented in a table;~~
- ~~Subclause 6.15 now contains the detailed specification of the InformationReport service;~~
- ~~In 7.1.1, and 7.1.2, the state definitions are presented in a tabular form;~~
- ~~Subclause 7.2.1 now includes the specification of the ACSE services. The description of the service parameters / fields and of the AARQ / AARE APDUs has been amended;~~
- ~~Subclause 7.2.2.3, *The COSEM authentication mechanism name*: a new mechanism name (5) has been added for HLS with GMAC;~~
- ~~subclause 7.2.4.3 *Establishment of unconfirmed application associations* has been amended;~~
- ~~subclause 7.2.4.4 *Pre-established application associations* has been amended;~~
- ~~subclause 7.2.5 *Protocol for application association release* has been amended and now allows the use of a ciphered InitiateRequest APDUs in the user information field;~~
- ~~subclause 7.3.1 now provides the description of the negotiation of services and options using the conformance block;~~
- ~~Subclause 7.3.2 now summarizes all the rules concerning confirmed and unconfirmed service invocations;~~
- ~~Subclause 7.3.3, *Protocol for the GET service*: the protocol specification and the figures have been amended. Transferring long data are also specified here. A new figure has been added. Table 36 shows the APDUs to be used with each request and response type. It is clarified, that:

 - ~~if the value of a single attribute was requested, only the type and value shall be encoded (Data);~~
 - ~~if the value of a list of attributes was requested, then the list of results shall be encoded: for each attribute, either Data or Data_Access_Result.~~~~A new error case d) has been added: the block number sent by the server is not equal to the next in sequence;~~~~
- ~~Subclause 7.3.4, *Protocol for the SET service*: the protocol specification and the figures have been amended in a similar way;~~
- ~~Subclause 7.3.5, *Protocol for the ACTION service*, the protocol specification and the figures have been amended in a similar way;~~
- ~~Subclause 7.3.6, *Protocol for the EventNotification service*: the specification has been amended;~~
- ~~subclause 7.3.7, *Protocol of the Read service*: the protocol specification has been amended to include block transfer. The mapping between the GET and ACTION services to the Read service has been brought and it is described in more detail;~~
- ~~Subclause 7.3.8, *Protocol for the Write service*, the protocol specification has been amended to include block transfer. The mapping between the SET and ACTION services to the Write service has been brought and it is described in more detail;~~
- ~~Subclause 7.3.9, *Protocol for the UnconfirmedWrite service*: the protocol of the UnconfirmedWrite service has been amended to cover block transfer. The mapping between the SET and ACTION services to the UnconfirmedWrite service has been brought and it is described in more detail;~~
- ~~Subclause 7.3.10, *Protocol for the InformationReport service*: the protocol of the InformationReport service has been amended. The mapping between the EventNotification and the InformationReport service has been brought;~~
- ~~Clause 8 *Abstract syntax*: The ASN.1 specification has been amended to include the changes for data security and SN block transfer. The elements have been re-arranged. The encoding of the user information field tag [30] has been changed from IMPLICIT to EXPLICIT, to lead to constructed encoding, in line with the practice.~~

- ~~Clause 8 Abstract syntax: The list of Data types has been modified. Added: time [11] // Tag of the "time" type in IEC 61334-4-41:1996, not usable in DLMS/COSEM. DLMS/COSEM uses [27]; UTF8-string [12] IMPLICIT OCTET STRING // An ordered sequence of characters encoded as UTF-8. Deleted: floating point [7] IMPLICIT OCTET STRING (SIZE(4)) // DLMS/COSEM uses types [23] and [24].~~
- Annex A includes now the former Clause B.1 of IEC 62056-53:2006;
- ~~Clause B.2, The 3-layer, connection-oriented, HDLC based communication profile and Clause B.3 The TCP-UDP/IP based communication profiles (COSEM_on_IP) of IEC 62056-53:2006 have been removed and will appear in other parts of the IEC 62056 series;~~
- ~~Annex B AARQ and AARE encoding examples includes the former Annex C of IEC 62056-53:2006. The examples have been amended. All examples are complete now and they are presented in a tabular form for easy comparison between the various cases;~~
- ~~Annex C provides encoding examples of AARQ and AARE APDUs using a ciphered application context;~~
- ~~Annex D includes data transfer service examples;~~
- ~~Annex E provides an overview of cryptography.~~
- an Introduction explaining the relationship to the DLMS UA Green Book Editions has been added;
- subclause 4.2.3.1: the DataNotification service has been added;
- subclause 4.2.3.6: the DataNotification service has been added;
- subclause 4.2.3.7: the Long-Invoke-Id parameter has been added;
- subclause 4.2.3.12 has been re-formulated to introduce the general block transfer (GBT) mechanism;
- subclause 4.2.3.13 describes the GBT mechanism;
- subclause 4.2.5, Figure 2 showing the summary of DLMS/COSEM AL services has been amended and includes now the DataNotification service;
- subclause 5.3: the specification of the authentication mechanisms and Figure 3 have been amended;
- subclause 5.4.1 Applying, removing or checking the protection: ciphering and deciphering has been amended;
- subclause 5.4.6: the specification of the ciphered xDLMS APDUs has been amended. The new general global ciphering and dedicated ciphering APDUs have been added;
- subclause 5.4.8.3.2.3 Figure 6 – Cryptographic protection of xDLMS APDUs using GCM has been amended;
- subclause 5.4.8.3.3 specifies now the security header with GCM;
- subclause 5.4.8.4: the specification of the High Level Security authentication with GMAC (authentication_mechanism_id(5) has been amended (editorial changes only);
- subclause 6.2: the specification of the COSEM-OPEN service has been amended: the AARQ APDU may carry now the identifier of the client-side user;
- subclause 6.2, Table 11: and in the text that follows, the missing Response_Allowed field has been added;
- subclause 6.2: a Note 2 has been added on the User_Information parameter;
- subclause 6.5: the specification of the additional service parameter has been amended;
- subclause 6.6 the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 6.7: the alternative of using the service specific or the general block transfer mechanism has been added;

- subclause 6.8: a clarification on the Method_Invocation_Parameter has been added and the alternative of using the service specific or the general block transfer mechanism have been added;
- subclause 6.9 specifies the DataNotification service;
- subclause 6.10: the possibility of using the general block transfer mechanism has been added;
- subclause 6.13: the alternatives of using the service specific or the general block transfer mechanism has been added;
- subclause 6.14: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 6.15: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 6.18: the DataNotification service has been added to the summary of xDLMS services;
- subclause 7.1.1, Figure 10: the DataNotification service has been added;
- subclause 7.1.2, Figure 11: the DataNotification service has been added;
- subclause 7.2.3.2 Encoding of the xDLMS APDUs has been added;
- subclause 7.2.4.1 Protocol for the establishment of confirmed application associations has been amended to specify the use of Calling_AE_Invocation_Identifier. The missing description of the fields of the AARE authentication functional unit has been added;
- subclause 7.3.1: new elements have been added to the conformance block: general-protection, general-block-transfer, data-notification;
- subclause 7.3.3: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.4: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.5: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.6 specifies the protocol of the DataNotification service;
- subclause 7.3.8: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.9: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.10: the possibility of using the general block transfer mechanism has been added;
- subclause 7.3.12 specifies the protocol of general block transfer mechanism;
- Clause 8 Abstract syntax of ACSE and COSEM APDUs of ACSE and COSEM APDUs has been amended to include the new APDUs and types;
- Clauses A.8, A.9 and A.10 reference other parts of the IEC 62056 series specifying media specific communication profiles,
- Annex B specifies the SMS short wrapper.

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Index

- AA, confirmed, 16
- AA, pre-established, 17
- AA, unconfirmed, 17
- ~~AARQ and AARE encoding examples, 131~~
- A-ASSOCIATE service, 16, 45
- Abstract syntax, 23
- Abstract syntax, COSEM APDUs, 128, 190
- Access right, 24
- Access_Selection_Parameters, 58, 61
- ACSE functional units, 82
- ACSE procedures, 22
- ACSE protocol version, 47, 91
- ACSE requirements, 84
- ACSE services and APDUs, 82
- ACTION service, 19, 62, 104
- ACTION.confirm, 66
- ACTION.indication, 66
- ACTION.request, 65
- ACTION.response, 66
- Action-Request, 65
- ACTION-REQUEST-FIRST-BLOCK, 64, 104, 108, 112
- ACTION-REQUEST-LAST-BLOCK, 64, 104, 108, 112
- ACTION-REQUEST-NEXT, 64, 104, 107
- Action-Request-Next-Pblock, 104
- Action-Request-Normal, 104
- ACTION-REQUEST-NORMAL, 64, 104, 107, 112, 115
- ACTION-REQUEST-ONE-BLOCK, 64, 104, 108, 112
- Action-Request-With-First-Pblock, 104
- Action-Request-With-List, 104
- ACTION-REQUEST-WITH-LIST, 64, 104, 108, 112, 115
- ACTION-REQUEST-WITH-LIST-AND-FIRST-BLOCK, 64, 104, 108, 113
- Action-Request-With-List-And-With-Frist-Pblock, 104
- Action-Request-With-Pblock, 104
- Action-Response, 66
- ACTION-RESPONSE-LAST-BLOCK, 64, 104, 108
- ACTION-RESPONSE-NEXT, 64, 104, 108, 113
- Action-Response-Next-Pblock, 104
- Action-Response-Normal, 104
- ACTION-RESPONSE-NORMAL, 64, 104, 108, 113
- ACTION-RESPONSE-ONE-BLOCK, 64, 104
- ACTION-RESPONSE-ONE-ONE-BLOCK, 108
- Action-Response-With-List, 104
- ACTION-RESPONSE-WITH-LIST, 64, 104, 109, 113
- Action-Response-With-Pblock, 104
- Additional authenticated data, 36, 37, 38
- Additional data, 34
- Advanced Encryption Standard, 34, 184, 185
- AES-128 key wrap algorithm, 29, 33
- ~~AL service, non-client/server type, 16~~
- AL services, AA establishment and release, 16
- AL services, client/server type, 18
- AL services, data transfer, 17
- AL, management services, 78
- Application association, 15, 50
- Application association, confirmed, 87
- Application association, establishment, 87
- Application association, graceful release, 92
- Application association, non-graceful release, 95
- Application association, pre-established, 91
- Application association, release, 92
- Application association, unconfirmed, 91
- Application context, 23
- Application context name, 16, 47, 84, 85, 89
- Application Control Service Element, 15
- Application Programming Interface, 18
- Application_Addresses parameter, 67
- A-RELEASE, 50
- A-RELEASE service, 17
- ASN.1, 85
- Association LN, 24
- Association SN, 24
- Attribute_0 referencing, 20
- Authenticated decryption, 36, 37
- Authenticated encryption, 34, 36
- Authentication, 22, 28, 183, 187
- ~~Authentication context, 20~~
- Authentication key, 29, 35, 36, 38, 39, 41
- Authentication mechanism, 23
- Authentication mechanism name, 16, 86
- Authentication tag, 35, 36, 37, 38
- Authentication value, 84
- authentication_mechanism_id(5), 41
- Authenticity, 184
- Authorization, 183
- A-XDR encoding, 16
- BER encoding, 16
- Bi-directional block transfer, 21
- Block cipher, 35
- Block cipher algorithm, 184
- Block cipher key, 29, 36, 38
- Block_Number, 59, 62, 65, 72, 75, 99, 103
- Block_Number_Access, 69, 71, 72
- Broadcast, 32, 40
- Calling authentication value, 24, 26, 48
- Central DCS, 32
- Challenge, 25
- Ciphered APDUs, 23
- Ciphered xDLMS APDU, 29
- Ciphertext, 31, 35, 36, 37, 184
- Client side layer management services, 78

- Client SN_MAPPER, 19
- Client system title, 89
- Client_Max_Receive_PDU_Size, 48
- client_system_title, 40
- client-max-receive-pdu-size, 89
- Communication environment, 142
- Communication profile, 11
- Communication profile specific parameters, 143
- Communication profile structure, 142
- Concentrator, 32
- Confidentiality, 23, 32, 183, 184
- ConfirmedServiceError, 28, 72, 75, 97
- Conformance block, 19, 96
- Control function, 15, 80
- COSEM AL, ASO services, 16
- COSEM AL, layer management services, 22
- COSEM AL, protocol specification, 22
- COSEM AL, service specification, 43
- COSEM AL, services, 16
- COSEM application context, 19
- COSEM application context name, 85
- COSEM application layer, protocol specification, 80
- COSEM client/server type services, 19
- COSEM interface object, 16, 18
- COSEM_Application_Context_Name, 85
- COSEM_Attribute_Descriptor, 58, 61
- COSEM_Authentication_Mechanism_Name, 86
- COSEM_Class_Id, 58, 61, 64
- COSEM_Method_Descriptor, 64
- COSEM_Method_Id, 64
- COSEM_Object_Attribute_Id, 58, 61
- COSEM_Object_Instance_Id, 58, 61, 64
- COSEM-ABORT service, 17, 53
- COSEM-OPEN service, 16, 25, 45
- COSEM-OPEN service invocations, repeated, 91
- COSEM-RELEASE service, 17, 50
- Counter mode, 34
- Cryptographic keys, 31
- Cryptography, 183
- Data access security, 23
- Data integrity, 183, 187
- Data transfer services, protocol, 96
- Data transport security, 23
- Data_Access_Error, 72, 75
- Data_Access_Result, 62
- DataBlock_G, 59, 99, 100
- DataBlock_SA, 103
- DataNotification service, 66
- Decryption, 184
- Dedicated key, 32, 33, 48
- Definitions, 13
- Denial-of-service attack, 51
- Deterministic construction, 39
- Digital signature, 187, 188
- DLMS conformance, 48
- DLMS version number, 48
- Eavesdropping, 24
- Encryption, 28, 184
- Event notification, 19
- EventNotification service, 19, 67
- ExceptionResponse, 28, 97
- Failure_type, 47
- Fixed field, 39
- Forward cipher function, 36
- Frame counter, 27
- Galois/Counter Mode, 29, 34, 185
- General block transfer mechanism, 21
- GET service, 19, 57, 98
- GET.confirm, 59
- GET.indication, 59
- GET.request, 59
- GET.response, 59
- Get_Data_Result, 58
- Get-Request, 59
- Get-Request-Next, 98
- GET-REQUEST-NEXT, 58, 98, 100, 107
- Get-Request-Normal, 98
- GET-REQUEST-NORMAL, 58, 98, 107
- Get-Request-With-List, 98
- GET-REQUEST-WITH-LIST, 58, 98, 107
- Get-Response, 59
- GET-RESPONSE-LAST-BLOCK, 58, 98, 107
- Get-Response-Normal, 98
- GET-RESPONSE-NORMAL, 58, 98, 107
- GET-RESPONSE-ONE-BLOCK, 58, 98, 99, 107
- Get-Response-With-Datablock, 98
- Get-Response-With-List, 98
- GET-RESPONSE-WITH-LIST, 58, 98, 107
- Global key, 32, 33
- Global unicast encryption key, 41
- global_key_transfer, 33
- Hash value, 183
- High level security, 25, 41
- HLS secret, 41
- Identification and addressing scheme, 142
- Identifying service invocations, 20
- Implementation information, 48, 84
- InformationReport service, 19, 77, 115
- InformationReport.request, 116
- InformationReportRequest, 116
- Initialization vector, 29, 35, 36, 37, 39, 185
- Integrity, 23, 184
- Intrinsic security, 25
- Invocation field, 35, 39, 40
- Invoke_Id, 58, 60, 63, 100, 103, 105
- Invoke_Id parameter, 20
- Key agreement, 188
- Key encrypting keys, 32
- Key establishment, 187, 188
- Key management, 32
- Key transport, 188
- Key wrapping key, 32, 187
- Key_set, 27, 35
- Keyed-Hash Message Authentication Code, 186

Last_Block, 59, 62, 65, 72, 75, 99, 103
 LN referencing, 18
 LN/SN data transfer service mapping, 79
 Local_or_Remote, 47, 51
 Logical Name, 16
 Long service parameters, 21
Lost block recovery, 21
 Low level security, 24
 Lowest level security, 24
 Manufacturer ID, 39
 Manufacturing number, 39
 Master key, 32
~~MD5 algorithm, 22~~
 Mechanism name, 84
 Message Authentication Code, 186
 Message digest, 183
 Message integrity, 32, 186
 Message replay, 24
 Message source, 32
 Mode of Operation, 185
 Multiple references, 20
~~NIST, 20~~
 Nonce, 35, 36
 Non-repudiation, 183, 187
 Parameterized_Access, 69, 71, 74, 75, 77
 Plaintext, 31, 35, 36, 37, 38, 184
 Pre-established application association, 49
 Presentation layer, 16
 Priority, 58, 60, 63, 100, 103, 105
 Priority parameter, 20
 Private key, 31, 187
 proposed-conformance, 89
 proposed-dlms-version-number, 89
 Protocol connection parameters, 47
 Protocol version, 84
 Public key, 31, 187
 Raw_Data, 59, 62, 65, 72, 103
 Read service, 19, 69, 106
 Read.confirm, 73
 Read.indication, 73
 Read.request, 73
 Read.response, 73
 Read_Data_Block_Access, 69, 71
 ReadRequest, 73, 107
 ReadResponse, 72, 73, 107, 108
 Reason, 85
 Referencing method, 16
 Registered COSEM names, 85
~~reply_to_HLS_authentication, 23~~
 Request_Type, 58, 60, 63
 Responding-AP-title, 90
 Response_Type, 58, 60
 response-allowed, 87, 89, 91
 Result, 47, 84, 99
 Result (–), 72, 75
 Result (+), 72, 75
 Result Source-Diagnostic, 84
 RLRE APDU, 50
 RLRQ APDU, 50
 Secret, 24
 Secret key, 25
 Security attributes, 28
 Security context, 28
 Security control, 38
 Security header, 38
~~Security material, 24~~
 Security mechanism name, 26, 48
 Security policy, 28
 Security setup, 33
 Security suite, 29
~~Security_Options, 24, 51~~
~~Security_Status, 24, 51~~
 Selective access, 20
 Sender ACSE requirements, 89
 Server system title, 90
 Server_Max_Receive_PDU_Size, 49
 server_system_title, 40
 Service_Class, 58, 60, 63
 Service_Class == Unconfirmed, 50
 Service_Class parameter, 49
 SET service, 19, 60, 101
 SET.confirm, 62
 SET.indication, 62
 SET.request, 62
 SET.response, 62
 SetMapperTables.request, 78
 Set-Request, 62
 SET-REQUEST-FIRST-BLOCK, 61, 101, 111
 SET-REQUEST-FIRST-BLOCK-WITH-LIST, 61, 101, 111
 SET-REQUEST-LAST-BLOCK, 61, 101, 111
 Set-Request-Normal, 101
 SET-REQUEST-NORMAL, 61, 101, 111, 115
 SET-REQUEST-ONE-BLOCK, 61, 101, 111
 Set-Request-With-Datablock, 101
 SET-REQUEST-WITH-FIRST-BLOCK, 61
 Set-Request-With-First-Datablock, 101
 Set-Request-With-List, 101
 SET-REQUEST-WITH-LIST, 61, 101, 111, 115
 Set-Request-With-List-And-With-First-Datablock, 101
 Set-Response, 62
 SET-RESPONSE-ACK-BLOCK, 61, 101, 111
 Set-Response-Datablock, 101
 SET-RESPONSE-LAST-BLOCK, 61, 101, 112
 SET-RESPONSE-LAST-BLOCK-WITH-LIST, 61, 101, 112
 Set-Response-Last-Datablock, 101
 Set-Response-Normal, 101
 SET-RESPONSE-NORMAL, 61, 101, 111
 Set-Response-With-List, 101
 SET-RESPONSE-WITH-LIST, 61, 101, 112
 S-FSK PLC environment, 40
 SHA-1 algorithm, 25
 Short Name, 16
 SN referencing, 18
 SN_MAPPER ASE, 73, 76, 77
Streaming, 21

Supporting layer services and service mapping, 143
 Symmetric key, 31
 Symmetric key algorithm, 184
 Symmetric key block cipher, 34
 System title, 39
 TriggerEventNotificationSending service, 68
 UnconfirmedWrite service, 19, 76, 114
 UnconfirmedWrite.indication, 77
 UnconfirmedWrite.request, 77
 UnconfirmedWriteRequest, 77
 Unicast, 32
 Uni-directional block transfer, 21
 User information, 49, 85
 Variable Access Specification, 69

Variable_Access_Specification, 71
 Variable_Name, 69, 71, 74, 75, 77
 Variable-Access-Specification, 70, 74, 77
 Write service, 19, 73, 110
 Write.confirm, 76
 Write.indication, 76
 Write.request, 76
 Write.response, 76
 Write_Data_Block_Access, 69, 74
 WriteRequest, 76, 111
 WriteResponse, 75, 76, 111
 xDLMS context, 16
 xDLMS InitiateRequest, 33
 xDLMS InitiateResponse, 33
 xDLMS procedures, 22
 xDLMS_ASE, 15

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INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Electricity metering data exchange – The DLMS/COSEM suite –
Part 5-3: DLMS/COSEM application layer**

**Échange des données de comptage de l'électricité – La suite DLMS/COSEM –
Partie 5-3: Couche application DLMS/COSEM**

CONTENTS

FOREWORD.....	8
INTRODUCTION.....	10
1 Scope.....	11
2 Normative references	11
3 Terms, definitions and abbreviations	13
3.1 Terms and definitions	13
3.2 Abbreviations	13
4 Overview	15
4.1 DLMS/COSEM application layer structure	15
4.2 DLMS/COSEM application layer services	16
4.2.1 ASO services	16
4.2.2 Services provided for application association establishment and release	16
4.2.3 Services provided for data transfer	17
4.2.4 Layer management services	22
4.2.5 Summary of DLMS/COSEM application layer services	22
4.3 DLMS/COSEM application layer protocols	22
5 Information security in DLMS/COSEM	23
5.1 Definitions	23
5.2 General	23
5.3 Data access security	24
5.3.1 Overview	24
5.3.2 No security (lowest level security) authentication	24
5.3.3 Low Level Security (LLS) authentication	24
5.3.4 High Level Security (HLS) authentication	25
5.4 Data transport security	27
5.4.1 Applying, removing or checking the protection: ciphering and deciphering	27
5.4.2 Security context	28
5.4.3 Security policy	28
5.4.4 Security suite	29
5.4.5 Security material	29
5.4.6 Ciphered xDLMS APDUs	29
5.4.7 Cryptographic keys	31
5.4.8 The Galois/Counter Mode of Operation (GCM)	34
6 DLMS/COSEM application layer service specification	43
6.1 Service primitives and parameters	43
6.2 The COSEM-OPEN service	45
6.3 The COSEM-RELEASE service	50
6.4 COSEM-ABORT service	52
6.5 Protection and general block transfer parameters	53
6.6 The GET service	57
6.7 The SET service	59
6.8 The ACTION service	62
6.9 The DataNotification service	66
6.10 The EventNotification service	67
6.11 The TriggerEventNotificationSending service	68

6.12	Variable access specification.....	69
6.13	The Read service.....	69
6.14	The Write service.....	73
6.15	The UnconfirmedWrite service.....	76
6.16	The InformationReport service.....	77
6.17	Client side layer management services: the SetMapperTable.request.....	78
6.18	Summary of services and LN/SN data transfer service mapping	78
7	DLMS/COSEM application layer protocol specification.....	79
7.1	The control function	79
7.1.1	State definitions of the client side control function.....	79
7.1.2	State definitions of the server side control function	81
7.2	The ACSE services and APDUs.....	82
7.2.1	ACSE functional units, services and service parameters.....	82
7.2.2	Registered COSEM names.....	85
7.2.3	APDU encoding rules	87
7.2.4	Protocol for application association establishment.....	87
7.2.5	Protocol for application association release.....	92
7.3	Protocol for the data transfer services	95
7.3.1	Negotiation of services and options – the conformance block.....	95
7.3.2	Confirmed and unconfirmed service invocations.....	96
7.3.3	Protocol for the GET service.....	98
7.3.4	Protocol for the SET service.....	101
7.3.5	Protocol for the ACTION service.....	104
7.3.6	Protocol of the DataNotification service.....	106
7.3.7	Protocol for the EventNotification service.....	106
7.3.8	Protocol for the Read service.....	106
7.3.9	Protocol for the Write service.....	110
7.3.10	Protocol for the UnconfirmedWrite service.....	114
7.3.11	Protocol for the InformationReport service.....	115
7.3.12	Protocol of general block transfer mechanism.....	116
8	Abstract syntax of ACSE and COSEM APDUs	127
Annex A (normative)	Using the COSEM application layer in various communications profiles.....	142
A.1	General.....	142
A.2	Targeted communication environments.....	142
A.3	The structure of the profile	142
A.4	Identification and addressing schemes	142
A.5	Supporting layer services and service mapping.....	143
A.6	Communication profile specific parameters of the COSEM AL services.....	143
A.7	Specific considerations / constraints using certain services within a given profile	143
A.8	The 3-layer, connection-oriented, HDLC based communication profile.....	143
A.9	The TCP-UDP/IP based communication profiles (COSEM_on_IP)	143
A.10	The S-FSK PLC profile	143
Annex B (normative)	SMS short wrapper	144
Annex C (informative)	AARQ and AARE encoding examples.....	145
C.1	General.....	145
C.2	Encoding of the xDLMS InitiateRequest / InitiateResponse APDUs.....	145
C.3	Specification of the AARQ and AARE APDUs	148

C.4	Data for the examples	149
C.5	Encoding of the AARQ APDU	150
C.6	Encoding of the AARE APDU.....	153
Annex D (informative) Encoding examples: AARQ and AARE APDUs using a ciphered application context.....		159
D.1	A-XDR encoding of the xDLMS InitiateRequest APDU, carrying a dedicated key	159
D.2	Authenticated encryption of the xDLMS InitiateRequest APDU	160
D.3	The AARQ APDU	161
D.4	A-XDR encoding of the xDLMS InitiateResponse APDU	162
D.5	Authenticated encryption of the xDLMS InitiateResponse APDU	163
D.6	The AARE APDU.....	164
D.7	The RLRQ APDU (carrying a ciphered xDLMS InitiateRequest APDU).....	165
D.8	The RLRE APDU (carrying a ciphered xDLMS InitiateResponse APDU).....	166
Annex E (informative) Data transfer service examples		167
Annex F (informative) Overview of cryptography		183
F.1	General.....	183
F.2	Hash functions	183
F.3	Symmetric key algorithms.....	184
F.3.1	General	184
F.3.2	Encryption and decryption	184
F.3.3	Advanced Encryption Standard (AES).....	185
F.3.4	Encryption Modes of Operation	185
F.3.5	Message Authentication Code	186
F.3.6	Key establishment.....	187
F.4	Asymmetric key algorithms.....	187
F.4.1	General	187
F.4.2	Digital signatures	188
F.4.3	Key establishment.....	188
Annex G (informative) Significant technical changes with respect to IEC 62056-5-3 Ed.1.0:2013.....		189
Bibliography.....		191
Index.....		194
Figure 1 – Structure of the COSEM Application layers		15
Figure 2 – Summary of DLMS/COSEM AL services.....		22
Figure 3 – Authentication mechanisms during AA establishment		27
Figure 4 – Structure of service specific global ciphering and dedicated ciphering APDUs		30
Figure 5 – Structure of general global ciphering and dedicated ciphering APDUs		30
Figure 6 – Cryptographic protection of xDLMS APDUs using GCM		37
Figure 7 – Service primitives		43
Figure 8 – Time sequence diagrams.....		44
Figure 9 – Additional service parameters to control cryptographic protection and general block transfer		54
Figure 10 – Partial state machine for the client side control function		80
Figure 11 – Partial state machine for the server side control function		81

Figure 12 – MSC for successful AA establishment preceded by a successful lower layer connection establishment	88
Figure 13 – Graceful AA release using the A-RELEASE service	93
Figure 14 – Graceful AA release by disconnecting the supporting layer	94
Figure 15 – Aborting an AA following a PH-ABORT indication	95
Figure 16 – MSC of the GET service	98
Figure 17 – MSC of the GET service with block transfer	99
Figure 18 – MSC of the GET service with block transfer, long GET aborted	101
Figure 19 – MSC of the SET service	102
Figure 20 – MSC of the SET service with block transfer	102
Figure 21 – MSC of the ACTION service	104
Figure 22 – MSC of the ACTION service with block transfer	105
Figure 23 – MSC of the Read service used for reading an attribute	109
Figure 24 – MSC of the Read service used for invoking a method	109
Figure 25 – MSC of the Read Service used for reading an attribute, with block transfer	110
Figure 26 – MSC of the Write service used for writing an attribute	113
Figure 27 – MSC of the Write service used for invoking a method	113
Figure 28 – MSC of the Write service used for writing an attribute, with block transfer	114
Figure 29 – MSC of the Unconfirmed Write service used for writing an attribute	115
Figure 30 – Partial service invocations and GBT APDUs	118
Figure 31 – GET service with GBT, switching to streaming	120
Figure 32 – GET service with partial invocations, GBT and streaming, recovery of 4 th block sent in the 2nd stream	121
Figure 33 – GET service with partial invocations, GBT and streaming, recovery of 4 th and 5 th blocks	122
Figure 34 – GET service with partial invocations, GBT and streaming, recovery of last block	123
Figure 35 – SET service with GBT, with server not supporting streaming, recovery of 3rd block	124
Figure 36 – ACTION-WITH-LIST service with bi-directional GBT and block recovery	125
Figure 37 – DataNotification service with GBT with partial invocation	126
Figure B.1 – Short wrapper	144
Figure F.1 – Hash function	184
Figure F.2 – Encryption and decryption	185
Figure F.3 – Message Authentication Codes (MACs)	186
Table 1 – Clarification of the meaning of PDU Size for DLMS/COSEM	18
Table 2 – Security suites	29
Table 3 – Ciphered xDLMS APDUs	29
Table 4 – Use of the fields of the ciphered APDUs	31
Table 5 – Cryptographic keys and their management	34
Table 6 – Security control byte	38
Table 7 – Plaintext and additional authenticated data	38
Table 8 – Example for ciphered APDUs	40
Table 9 – HLS example with GMAC	42

Table 10 – Codes for AL service parameters	45
Table 11 – Service parameters of the COSEM-OPEN service primitives	46
Table 12 – Service parameters of the COSEM-RELEASE service primitives	50
Table 13 – Service parameters of the COSEM-ABORT service primitives	53
Table 14 – Additional service parameters	55
Table 15 – Security parameters	56
Table 16 – Service parameters of the GET service	57
Table 17 – GET service request and response types	58
Table 18 – Service parameters of the SET service	60
Table 19 – SET service request and response types	61
Table 20 – Service parameters of the ACTION service	63
Table 21 – ACTION service request and response types	64
Table 22 – Service parameters of the DataNotification service primitives	66
Table 23 – Service parameters of the EventNotification service primitives	67
Table 24 – Service parameters of the TriggerEventNotificationSending request service primitive	68
Table 25 – Variable Access Specification	69
Table 26 – Service parameters of the Read service	70
Table 27 – Use of the Variable_Access_Specification variants and the Read.response choices	71
Table 28 – Service parameters of the Write service	74
Table 29 – Use of the Variable_Access_Specification variants and the Write.response choices	74
Table 30 – Service parameters of the UnconfirmedWrite service	76
Table 31 – Use of the Variable_Access_Specification variants	77
Table 32 – Service parameters of the InformationReport service	78
Table 33 – Service parameters of the SetMapperTable.request service primitives	78
Table 34 – Summary of ACSE services	79
Table 35 – Summary of xDLMS services for LN referencing	79
Table 36 – Summary of xDLMS services for SN referencing	79
Table 37 – ACSE functional units, services and service parameters	83
Table 38 – Use of ciphered / unciphered APDUs	86
Table 39 – xDLMS Conformance block	96
Table 40 – GET service types and APDUs	98
Table 41 – SET service types and APDUs	101
Table 42 – ACTION service types and APDUs	104
Table 43 – Mapping between the GET and the Read services	107
Table 44 – Mapping between the ACTION and the Read services	108
Table 45 – Mapping between the SET and the Write services	111
Table 46 – Mapping between the ACTION and the Write service	112
Table 47 – Mapping between the SET and the UnconfirmedWrite services	115
Table 48 – Mapping between the ACTION and the UnconfirmedWrite services	115
Table 49 – Mapping between the EventNotification and InformationReport services	116
Table B.1 – Reserved Application Processes	144

Table C.1 – Conformance block	146
Table C.2 – A-XDR encoding of the xDLMS InitiateRequest APDU	147
Table C.3 – A-XDR encoding of the xDLMS InitiateResponse APDU	148
Table C.4 – BER encoding of the AARQ APDU	151
Table C.5 – Complete AARQ APDU	153
Table C.6 – BER encoding of the AARE APDU	154
Table C.7 – The complete AARE APDU	158
Table D.1 – A-XDR encoding of the xDLMS InitiateRequest APDU	159
Table D.2 – Authenticated encryption of the xDLMS InitiateRequest APDU	160
Table D.3 – BER encoding of the AARQ APDU	161
Table D.4 – A-XDR encoding of the xDLMS InitiateResponse APDU	163
Table D.5 – Authenticated encryption of the xDLMS InitiateResponse APDU	163
Table D.6 – BER encoding of the AARE APDU	164
Table D.7 – BER encoding of the RLRQ APDU	166
Table D.8 – BER encoding of the RLRE APDU	166
Table E.1 – Objects used in the examples	167
Table E.2 – Example: Reading the value of a single attribute without block transfer	168
Table E.3 – Example: Reading the value of a list of attributes without block transfer	169
Table E.4 – Example: Reading the value of a single attribute with block transfer	171
Table E.5 – Example: Reading the value of a list of attributes with block transfer	173
Table E.6 – Example: Writing the value of a single attribute without block transfer	176
Table E.7 – Example: Writing the value of a list of attributes without block transfer	177
Table E.8 – Example: Writing the value of a single attribute with block transfer	178
Table E.9 – Example: Writing the value of a list of attributes with block transfer	180

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ELECTRICITY METERING DATA EXCHANGE – THE DLMS/COSEM SUITE –

Part 5-3: DLMS/COSEM application layer

FOREWORD

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DLMS¹ User Association
Zug/Switzerland
www.dlms.com

¹ Device Language Message Specification.

International Standard IEC 62056-5-3 has been prepared by IEC technical committee 13: Electrical energy measurement and control.

This second edition cancels and replaces the first edition of IEC 62056-5-3 published in 2013. It constitutes a technical revision.

The significant technical changes with respect to the previous edition are listed in Annex G (informative).

The text of this standard is based on the following documents:

FDIS	Report on voting
13/1648/FDIS	13/1657/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all the parts in the IEC 62056 series, published under the general title *Electricity metering data exchange– The DLMS/COSEM suite*, can be found on the IEC website.

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

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

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

INTRODUCTION

This second edition of IEC 62056-5-3 has been prepared by IEC TC13 WG14 with a significant contribution of the DLMS User Association, its D-type liaison partner.

This edition is in line with the DLMS UA Green Book Edition 7.0 Amendment 3. The main new features are the DataNotification service, the general protection and the general block transfer mechanisms and the SMS short wrapper.

In 2014, the DLMS UA has published Green Book Edition 8.0 adding several new features regarding functionality, efficiency and security while keeping full backwards compatibility.

The intention of the DLMS UA is to bring also these latest developments to international standardization. Therefore, IEC TC13 WG14 launched a project to bring these new elements also to the IEC 62056 series that will lead to Edition 3.0 of the standard.

Clause 5 and Annex F are based on parts of NIST documents. Reprinted courtesy of the National Institute of Standards and Technology, Technology Administration, U.S. Department of Commerce.

ELECTRICITY METERING DATA EXCHANGE – THE DLMS/COSEM SUITE –

Part 5-3: DLMS/COSEM application layer

1 Scope

This part of IEC 62056 specifies the DLMS/COSEM application layer in terms of structure, services and protocols for COSEM clients and servers, and defines how to use the DLMS/COSEM application layer in various communication profiles.

It defines services for establishing and releasing application associations, and data communication services for accessing the methods and attributes of COSEM interface objects, defined in IEC 62056-6-2:2016, using either logical name (LN) or short name (SN) referencing.

Annex A (normative) defines how to use the COSEM application layer in various communication profiles. It specifies how various communication profiles can be constructed for exchanging data with metering equipment using the COSEM interface model, and what are the necessary elements to specify in each communication profile. The actual, media-specific communication profiles are specified in separate parts of the IEC 62056 series.

Annex B (normative) specifies the SMS short wrapper.

Annex C, Annex D and Annex E (informative) include encoding examples for APDUs.

Annex F (informative) provides an overview of cryptography.

Annex G (informative) lists the main technical changes in this edition of the standard.

2 Normative references

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

IEC 61334-4-41:1996, *Distribution automation using distribution line carrier systems – Part 4: Data communication protocols – Section 41: Application protocols – Distribution line message specification*

IEC 61334-6:2000, *Distribution automation using distribution line carrier systems – Part 6: A-XDR encoding rule*

IEC TR 62051:1999, *Electricity metering – Glossary of terms*

IEC TR 62051-1:2004, *Electricity metering – Data exchange for meter reading, tariff and load control – Glossary of terms – Part 1: Terms related to data exchange with metering equipment using DLMS/COSEM*

IEC 62056-1-0, *Electricity metering data exchange – The DLMS/COSEM suite – Part 1-0: Smart metering standardisation framework*

IEC 62056-6-1:2015, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-1: Object Identification System (OBIS)*

IEC 62056-6-2:2016, *Electricity metering data exchange – The DLMS/COSEM suite – Part 6-2: COSEM interface classes*

IEC 62056-8-3:2013, *Electricity metering data exchange – The DLMS/COSEM suite – Part 8-3: Communication profile for PLC S-FSK neighbourhood networks*

ISO/IEC 8824-1:2008, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation*

ISO/IEC 8825-1:2008, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 15953:1999, *Information technology – Open Systems Interconnection – Service definition for the Application Service Object Association Control Service Element*

NOTE This standard cancels and replaces ISO/IEC 8649-1:1999 and its Amd. 1:1997 and Amd. 2:1998, of which it constitutes a technical revision.

ISO/IEC 15954:1999, *Information technology – Open Systems Interconnection – Connection-mode protocol for the Application Service Object Association Control Service Element*

NOTE This standard cancels and replaces ISO/IEC 8650-1:1999 and its Amd. 1:1997 and Amd. 2:1998, of which it constitutes a technical revision.

FIPS PUB 180-4:2012, *Secure hash standard*

FIPS PUB 197:2001, *Advanced Encryption Standard (AES)*

NIST SP 800-38D:2007, *Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC*

NIST SP 800-57:2006, *Recommendation for Key Management – Part 1: General (Revised)*

The following RFCs are available online from the Internet Engineering Task Force (IETF):
<http://www.ietf.org/rfc/std-index.txt>, <http://www.ietf.org/rfc/>

RFC 1321, *The MD5 Message-Digest Algorithm*. Edited by R. Rivest (MIT Laboratory for Computer Science and RSA Data Security, Inc.) April 1992

RFC 3394, *Advanced Encryption Standard (AES) Key Wrap Algorithm*. Edited by J. Schaad (Soaring Hawk Consulting) and R. Housley (RSA Laboratories) September 2002

RFC 4106, *The Use of Galois/Counter Mode (GCM) in IPsec Encapsulating Security Payload (ESP)*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC TR 62051:1999, in IEC TR 62051-1 and in RFC 4106 apply.

3.2 Abbreviations

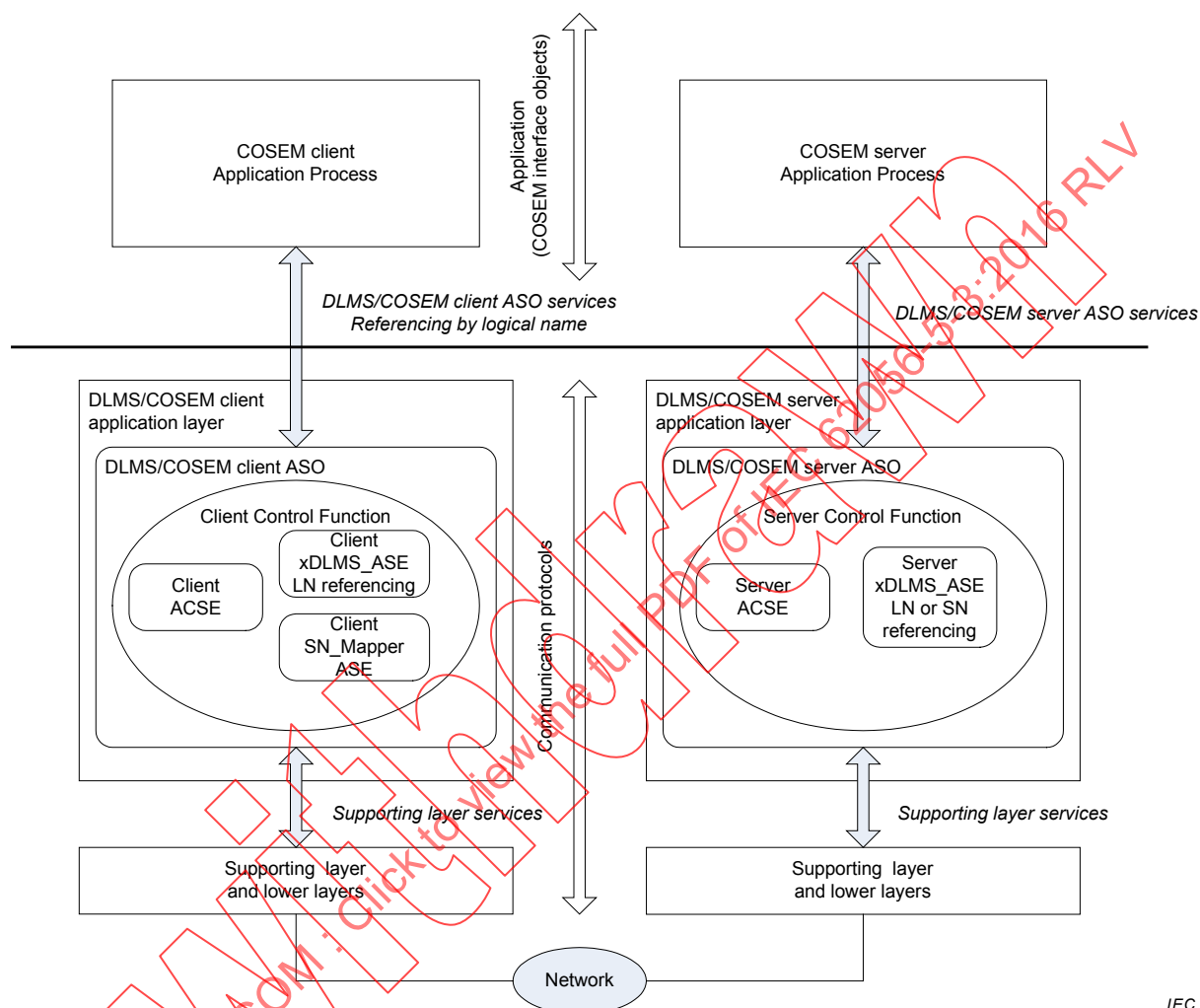
AA	Application Association
AAD	Additional Authenticated Data (used with ciphering of APDUs)
AARE	A-Associate Response – an APDU of the ACSE
AARQ	A-Associate Request – an APDU of the ACSE
ACPM	Association Control Protocol Machine
ACSE	Association Control Service Element
AE	Application Entity
AES	Advanced Encryption Standard
AL	Application Layer
AP	Application Process
APDU	Application Layer Protocol Data Unit
API	Application Programming Interface
ASE	Application Service Element
ASO	Application Service Object
A-XDR	Adapted Extended Data Representation
base_name	The short_name corresponding to the first attribute (“logical_name”) of a COSEM object
BER	Basic Encoding Rules
CF	Control Function
CL	Connectionless
Client	A station, asking for services. In the case of the 3-layer, CO HDLC based profile it is the master station
.cnf	:confirm service primitive
CO	Connection-oriented
COSEM	Companion Specification for Energy Metering
COSEM_class_id	COSEM interface class identifier
COSEM object	An instance of a COSEM interface class
DCS	Data Collection System
DLMS	Device Language Message Specification
DLMS UA	DLMS User Association
FIPS	Federal Information Processing Standard
GBT	General Block Transfer
GCM	Galois/Counter Mode, an algorithm for authenticated encryption with associated data
GMAC	A specialization of GCM for generating a message authentication code (MAC) on data that is not encrypted
HDLC	High-level Data Link Control

HLS	High Level Security
HMAC	Keyed-Hash Message Authentication Code
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
.ind	.indication service primitive
IP	Internet Protocol
ISO	International Organization for Standardization
IV	Initialization Vector
LDN	Logical Device Name
LLC	Logical Link Control (Sublayer)
LLS	Low Level Security
LSB	Least Significant Bit
MAC	Medium Access Control (sublayer)
MAC	Message Authentication Code (cryptography)
master	Central station – station which takes the initiative and controls the data flow
MSB	Most Significant Bit
MSC	Message Sequence Chart
NIST	National Institute of Standards and Technology
OBIS	OBject Identification System
OSI	Open System Interconnection
PDU	Protocol Data Unit
PHSDU	PH SDU
PLC	Power line carrier
PPP	Point-to-Point Protocol
.req	.request service primitive
.res	.response service primitive
RLRE	A-Release Response – an APDU of the ACSE
RLRQ	A-Release Request – an APDU of the ACSE
SAP	Service Access Point
Server	A station, delivering services. The tariff device (meter) is normally the server, delivering the requested values or executing the requested tasks.
TCP	Transmission Control Protocol
TDEA	Triple Data Encryption Algorithm
UDP	User Datagram Protocol
VAA	Virtual Application Association
xDLMS_ASE	Extended DLMS Application Service Element

4 Overview

4.1 DLMS/COSEM application layer structure

The structure of the client and server COSEM application layers is shown in Figure 1.



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Figure 1 – Structure of the COSEM Application layers

The main component of the COSEM AL is the COSEM Application Service Object. It provides services to its service user, the COSEM Application Process, and uses services provided by the supporting lower layer. It contains three mandatory components both on the client and on the server side:

- the Association Control Service Element, ACSE;
- the extended DLMS Application Service Element, xDLMS_ASE;
- the Control Function, CF.

On the client side, there is a fourth, optional element, called the Client SN_MAPPER ASE.

The task of the ACSE is to establish, maintain, and release application associations. For the purposes of DLMS/COSEM connection oriented (CO) communication profiles, the CO ACSE, specified in ISO/IEC 15953:1999 and ISO/IEC 15954:1999 is used.

The task of the xDLMS_ASE is to provide data transfer services between COSEM APs. It is based on the DLMS standard, IEC 61334-4-41:1996. It has been extended for DLMS/COSEM; see 4.2.3.1. The main objective of DLMS/COSEM is to provide a business domain oriented interface object model for metering devices and systems while keeping backward compatibility with the DLMS standard. To meet these objectives, DLMS/COSEM includes an evolution of DLMS. Remaining fully compliant to the DLMS standard, DLMS/COSEM provides a more metering specific view of the meter through the COSEM interface objects.

IEC 62056-6-2:2016, 4.2 specifies two referencing methods to attributes and methods of COSEM interface objects for use in COSEM servers: LN and SN referencing. When LN referencing is used, the Logical Name of the COSEM objects shall be as specified in IEC 62056-6-1. Therefore, on the server side, two distinct xDLMS service sets are specified: one exclusively for LN referencing and the other exclusively for SN referencing. It can be considered that there are two different xDLMS_ASEs: one providing services for LN referencing and the other for SN referencing. The server AL may include one, the other or both xDLMS_ASEs.

The CF element specifies how the ASO services invoke the appropriate service primitives of the ACSE, the xDLMS_ASE and the services of the supporting layer.

NOTE Both the client and the server COSEM ASO can contain other, optional application protocol components.

The optional Client SN_MAPPER ASE is present in the client side AL ASO, when the server uses SN referencing. It provides mapping between services using LN and SN referencing. See also 6.18.

The COSEM AL also performs some functions of the OSI presentation layer:

- encoding the ACSE APDUs in BER (ISO/IEC 8825-1). See also 7.2.3;
- encoding the xDLMS APDUs carrying the data transfer services in A-XDR (IEC 61334-6).

4.2 DLMS/COSEM application layer services

4.2.1 ASO services

The services required by, or provided for the COSEM client and server APs at the logical interfaces with the respective COSEM AL, using CO procedures, fall into three categories:

- application association establishment and release;
- data transfer;
- layer management.

4.2.2 Services provided for application association establishment and release

The services provided for the establishment and release of AAs are the following:

- COSEM-OPEN;
- COSEM-RELEASE;
- COSEM-ABORT.

The COSEM-OPEN service is used to establish AAs. It is based on the ACSE A-ASSOCIATE service. It causes the start of use of an AA by those ASE procedures identified by the value of the Application_Context_Name, Security_Mechanism_Name and xDLMS context parameters. AAs may be established in different ways:

- confirmed AAs are established via a message exchange – using the COSEM-OPEN service – between the client and the server to negotiate the contexts. Confirmed AAs can be established between a single client and a single server;

- unconfirmed AAs are established via a message sent – using the COSEM-OPEN service – from the client to the server, using the parameters of the contexts supposed to be used by the server. Unconfirmed AAs can be established between a client and one or multiple servers;
- pre-established AAs may pre-exist. In this case, the COSEM-OPEN service is not used. A pre-established AA can be confirmed or unconfirmed.

The COSEM-RELEASE service is used to release AAs. If successful, it causes the completion of the use of the AA without loss of information in transit (graceful release). In some communication profiles – for example in the TCP-UDP/IP based profile – the COSEM-RELEASE service is based on the ACSE A-RELEASE service. In some other communication profiles – for example in the 3-layer, CO, HDLC-based profile – there is a one-to-one relationship between a confirmed AA and the supporting protocol layer connection. Therefore, AAs can be released simply by disconnecting the corresponding supporting layer connection. Pre-established AAs cannot be released.

The COSEM-ABORT service causes the abnormal release of an AA with the possible loss of information in transit. It does not rely on the ACSE A-ABORT service.

The COSEM-OPEN service is specified in 6.2, the COSEM-RELEASE service in 6.3 and the COSEM-ABORT service in 6.4.

4.2.3 Services provided for data transfer

4.2.3.1 The xDLMS application service element

As mentioned in 4.1, xDLMS includes some extensions to the DLMS standard, IEC 61334-4-41:1996. These extensions define added functionality; existing functionality is not modified. They are made in such a way, that there is no conflict with the existing DLMS standard and comprise the following:

- additional services;
- additional data types;
- new DLMS version number;
- new conformance block;
- clarification of the meaning of the PDU Size.

The additional services are:

- the GET, SET services available to access COSEM object attributes and the ACTION service available to access COSEM object methods using LN referencing, see 4.2.3.5;
- the DataNotification service used by the server to push data to the client; see 4.2.3.6.
- the EventNotification service used by the server to notify the client about events that occur in the server, see 4.2.3.6;

The additional data types are specified in Clause 8.

The new DLMS version number, corresponding to the first version of the xDLMS ASE is 6.

The new xDLMS conformance block enables optimised DLMS/COSEM server implementations with extended functionality. It can be distinguished from the DLMS conformance block by its tag "Application 31". See 7.3.1 and Clause 8.

For services using SN referencing, new variants of the Variable_Access_Specification service parameter, the Read.response and the Write.response services have been added to support selective access and block transfer.

To clarify the meaning of the maximum PDU size usable by the client and the server, the modifications shown in Table 1 have been made. The xDLMS-Initiate service uses these names for PDU Sizes.

Table 1 – Clarification of the meaning of PDU Size for DLMS/COSEM

was:	new:
Page 61, Table 3, IEC 61334-4-41:1996	
Proposed Max PDU Size	Client Max Receive PDU Size
Negotiated Max PDU Size	Server Max Receive PDU Size
Page 63, 5th paragraph, IEC 61334-4-41:1996	
The Proposed Max PDU Size parameter, of type Unsigned16, proposes a maximum length expressed in bytes for the exchanged DLMS PDUs. The value proposed in an Initiate request shall be large enough to always permit the Initiate Error PDU transmission.	The Client Max Receive PDU Size parameter, of type Unsigned16, contains the maximum length expressed in bytes for a DLMS PDU that the server may send. The client will discard any received PDUs that are longer than this maximum length. The value shall be large enough to always permit the AARE APDU transmission. Values below 12 are reserved. The value 0 indicates that there is no limit on the PDU size.
Page 63, last paragraph, IEC 61334-4-41:1996	
The Negotiated Max PDU Size parameter, of type Unsigned16, contains a maximum length expressed in bytes for the exchanged DLMS PDUs. A PDU that is longer than this maximum length will be discarded. This maximum length is computed as the minimum of the Proposed Max PDU Size and the maximum PDU size than the VDE-handler may support.	The Server Max Receive PDU Size parameter, of type Unsigned16, contains the maximum length expressed in bytes for a DLMS PDU that the client may send. The server will discard any received PDUs that are longer than this maximum length. Values below 12 are reserved. The value 0 indicates that there is no limit on the PDU size.

4.2.3.2 Client/server and non-client/server type services

xDLMS data transfer services are related to attributes and methods of COSEM interface objects, specified in IEC 62056-6-2:2016 and provide the interface between the COSEM application model and the communication protocols.

When the server uses SN referencing, attributes and methods of COSEM interface objects are mapped to DLMS named variables. The mapping is held by the Association SN interface object(s).

For accessing attributes and methods, client/server type services are used: the client requests services and the server provides them.

There are also unsolicited, unconfirmed services. These are requested by the server, on pre-defined conditions, e.g. schedules, triggers or events, to inform the client of the value of one or more attributes, as though they had been requested by the client.

4.2.3.3 Referencing methods and service mapping

As specified in 4.1, there are two distinct service sets available, one for LN and one for SN referencing.

On the client side, in order to handle the different referencing methods transparently for the AP, the AL provides only one service set, using LN referencing. Using a unique, standardized service set between COSEM client APs and the communication protocol – hiding the particularities of COSEM servers using different referencing methods – allows specifying an Application Programming Interface, API. This is an explicitly specified interface corresponding to this service set for applications running in a given computing environment (for example Windows, UNIX, etc.). Using this – public – API specification, client applications can be developed without knowledge about particularities of a given server.

On the server side, services using LN referencing and/or SN referencing can be provided.

In the case of confirmed AAs, the referencing method and the service set to be used are negotiated during the AA establishment phase via the COSEM application context; see 7.2.2.2, and the conformance block; see 7.3.1. It shall not change during the lifetime of the AA established. Using LN or SN services within a given AA is exclusive.

In the case of unconfirmed and pre-established AAs, the client AL is expected to know the referencing method and the service set supported by the server.

When the server uses LN referencing, the services are the same on both side. When the server does not use LN referencing, a mapping between client side and server side services takes place. As explained in 4.1, if the server uses SN referencing this mapping is performed by the Client SN_MAPPER ASE. See also 6.18.

4.2.3.4 Confirmed and unconfirmed services

Within confirmed AAs, client/server type data transfer services can be invoked in a confirmed or unconfirmed manner. Within unconfirmed AA-s, client/server type data transfer services may be invoked in an unconfirmed manner only. See also 7.3.2.

4.2.3.5 DLMS/COSEM client/server type services

COSEM client/server type data transfer services for LN referencing are the following:

- the GET service, used to read the value of one or more attributes of COSEM interface objects. See 6.6;
- the SET service, used to write the value of one or more attributes of COSEM interface objects. See 6.7;
- the ACTION service, used to invoke one or more methods of COSEM interface objects. Invoking methods may imply sending service parameters and returning data. See 6.8.

COSEM client/server type data transfer services for SN referencing are the following:

- the Read service, used to read the value of one or more attributes or to invoke one or more methods of COSEM interface objects when return parameters are expected. It is a confirmed service. See 6.13;
- the Write service, used to write the value of one or more attributes or to invoke one or more methods of COSEM interface objects when no return parameters are expected. It is a confirmed service. See 6.14;
- the UnconfirmedWrite service, used to write the value of one or more attributes or to invoke one or more methods of COSEM interface objects. It is an unconfirmed service. See 6.15.

4.2.3.6 Services for data and event notification

To support push operation, the DataNotification service is available, see 6.9. It can be used both in application contexts using SN referencing and LN referencing.

NOTE The DataNotification service is used in conjunction with "Push setup" COSEM interface objects see IEC 62056-6-2:2016, 5.3.8.

To support event notification, COSEM also provides non client/server type, unsolicited services:

- with LN referencing the EventNotification service. See 6.10;
- with SN referencing, the InformationReport service. See 6.16.

4.2.3.7 Identifying service invocations: the Invoke_Id parameter

In the client/server model, requests are sent by the client and responses are sent by the server. The client is allowed to send several requests before receiving the response to the previous ones. Therefore – to be able to identify which response corresponds to each request – it is necessary to include a reference in the request.

The Invoke_Id parameter is used for this purpose. The value of this parameter is assigned by the client so that each request carries a different Invoke_Id. The server shall copy the Invoke_Id into the corresponding response.

This feature is available only with LN referencing.

In the DataNotification service – see 6.9 – the Long-Invoke-Id parameter is used instead of the Invoke_Id parameter.

The EventNotification service – being a non-client/server type service – does not contain the Invoke_Id parameter.

4.2.3.8 Priority of service invocations: the Priority parameter

For data transfer services using LN referencing, two priority levels are available: normal (FALSE) and high (TRUE). This feature allows receiving a response to a new request before the response to a previous request is completed.

Normally, the server serves incoming service requests in the order of reception (FIFS, First In, First Served). However, a request with the priority parameter set to HIGH shall be served before the previous requests with priority NORMAL. The response shall carry the same priority flag as that of the corresponding request. Managing priority is a negotiable feature; see 7.3.1.

NOTE 1 As service invocations are identified with an Invoke_Id, services with the same priority can be served in any order.

NOTE 2 If the feature is not supported, requests with HIGH priority are served with NORMAL priority.

This feature is not available with services using SN referencing. The server treats the services on a FIFS basis.

4.2.3.9 Selective access

In the case of some COSEM interface classes, selective access to attributes is available, meaning that either the whole attribute or a selected portion of it can be accessed. For this purpose, access selectors and parameters are specified as part of the specification of the relevant attributes.

To use this possibility, attribute-related services can be invoked with these access selection parameters. In the case of LN referencing, this feature is called Selective access; see 6.6 and 6.7. It is a negotiable feature; see 7.3.1. In the case of SN referencing, this feature is called Parameterized access; see 6.13, 6.14 and 6.15. It is a negotiable feature; see 7.3.1.

4.2.3.10 Multiple references

In a COSEM object related service invocation, it is possible to reference one or several attributes respectively methods. Using multiple references is a negotiable feature. See 7.3.1.

4.2.3.11 Attribute_0 referencing

With the GET and SET services, a special feature, Attribute_0 referencing, is available. By convention, attributes of COSEM interface objects are numbered from 1 to n, where

Attribute_1 is the logical name of the COSEM interface object. Attribute_0 has a special meaning: it references all attributes with positive index (public attributes). The use of Attribute_0 referencing with the GET service is explained in 6.6 and with the SET service in 6.7.

NOTE As specified in IEC 62056-6-2:2016, 4.1 and 4.2, manufacturers can add proprietary methods and/or attributes to any object, using negative numbers.

Attribute_0 referencing is a negotiable feature; see 7.3.1.

4.2.3.12 Transferring long service parameters

The xDLMS service primitives are carried in an encoded form by xDLMS APDUs. This encoded form may be longer than the Client / Server Max Receive PDU Size negotiated. To transfer such 'long' messages, there are two mechanisms available:

- a) service specific block transfer mechanism: in this case, the service primitive invocations contain only one part – one block – of the data (e.g. attribute values), so that the encoded form fits in a single APDU. Using block transfer with the GET / SET / ACTION (LN referencing) and Read / Write (SN referencing) is a negotiable feature, see 7.3.1;

NOTE 1 Block transfer is not available with the unsolicited InformationReport and EventNotification services.

NOTE 2 There is no block-recovery mechanism available with these services.

- b) the general block transfer mechanism specified in 4.2.3.13.

The two mechanisms can co-exist.

An APDU that fits in the Client / Server Max Receive PDU Size negotiated may be too long to fit in a single frame / packet of the supporting layer. Such APDUs may be transported if the supporting layer provide(s) segmentation; see Annex A.

4.2.3.13 General block transfer mechanism

The general block transfer (GBT) mechanism – supporting also streaming of blocks – can be used with any xDLMS service.

NOTE The DataNotification service does not have its own service specific block transfer mechanism. Therefore, to transport long DataNotification APDUs the GBT mechanism is available.

With this mechanism, long application layer level messages are carried by General-Block-Transfer APDUs instead of service specific "with-datablock" APDUs.

The GBT mechanism supports uni-directional and bi-directional block transfer, streaming and lost block recovery:

- uni-directional block transfer means that while one party is sending blocks the other party only confirms the blocks received. If it has blocks to send, it can start sending them when the other party has finished;
- bi-directional block transfer means that while one party is sending blocks, the other party not only confirms the blocks received but if it has blocks to send it can send them as well while it is still receiving blocks;

Bi-directional block transfer is useful when long service parameters need to be transported in both directions.

- streaming means that several blocks may be sent – streamed – by one party without an acknowledgement of each block from the other party;
- lost block recovery means that if the reception of a block is not confirmed, it can be sent again. If streaming is used, lost block recovery takes place at the end of the streaming window.

Using the GBT mechanism is a negotiable feature, see 7.3.1.

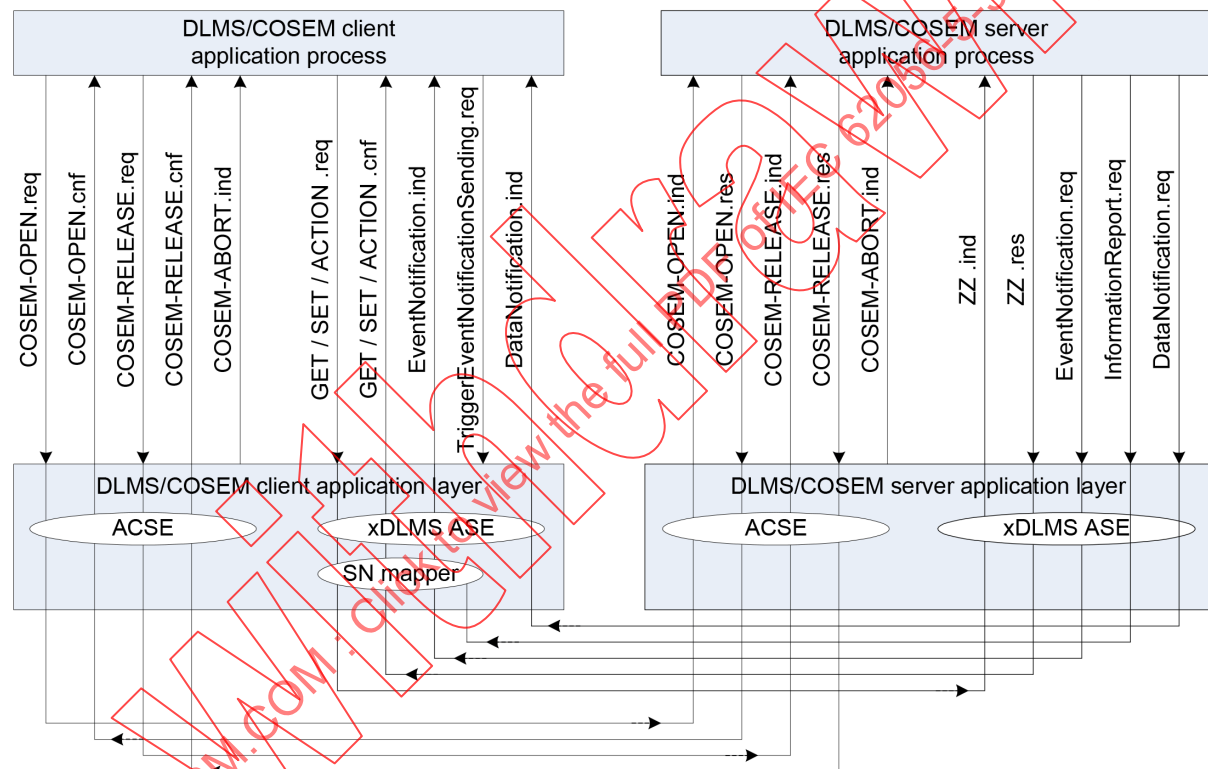
The protocol of the GBT mechanism is specified in 7.3.12.

4.2.4 Layer management services

Layer management services have local importance only. Therefore, specification of these services is not within the scope of this international standard. The specific SetMapperTable service is defined in 6.17.

4.2.5 Summary of DLMS/COSEM application layer services

A summary of the services available at the top of the COSEM AL is shown in Figure 2. Layer management services are not shown. Although the service primitives are different on the client and server side, the APDUs are the same. The DLMS/COSEM Application layer services are specified in Clause 6. The DLMS/COSEM Application layer protocol is specified in Clause 7. The abstract syntax of the ACSE and xDLMS APDUs is specified in Clause 8. Encoding examples are provided in Annex C, Annex D and Annex E.



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NOTE The client AP always uses LN referencing. If the server uses SN referencing then a mapping is performed by the SN mapper entity of the client AL. Consequently, the service primitives ZZ.ind and ZZ.res may be LN or SN service primitives. LN/SN service mapping is specified in 6.18.

Figure 2 – Summary of DLMS/COSEM AL services

4.3 DLMS/COSEM application layer protocols

The DLMS/COSEM AL protocols specify the procedures for information transfer for AA control and authentication using connection-oriented ACSE procedures, and for data transfer between DLMS/COSEM clients and servers using xDLMS procedures. Therefore, the AL protocol is based on the ACSE and the DLMS protocols, as specified in ISO/IEC 15954:1999 and in IEC 61334-4-41:1996 – with the extensions for DLMS/COSEM – respectively. The procedures are defined in terms of:

- the interactions between peer ACSE and xDLMS protocol machines through the use of services of the supporting protocol layer;

- the interactions between the ACSE and xDLMS protocol machines and their service user;
- the abstract syntax of the APDUs using ASN.1 as specified in ISO/IEC 8824-1.

The DLMS/COSEM AL protocols are specified in Clause 7.

5 Information security in DLMS/COSEM

5.1 Definitions

5.1.1

confidentiality

preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information. A loss of confidentiality is the unauthorized disclosure of information

[SOURCE: FIPS PUB 199:2002]

5.1.2

integrity

guarding against improper information modification or destruction, and includes ensuring information non-repudiation and authenticity. A loss of integrity is the unauthorized modification or destruction of information

[SOURCE: FIPS PUB 199:2002]

5.2 General

Confidentiality and integrity are among the key requirements when open systems connect to public media. With the increase of computational power, the requirements for strong cryptographic methods also increase. DLMS/COSEM provides two main information security features for accessing and transporting data:

- *data access security* controls access to the data held by a DLMS/COSEM server. See 5.3;
- *data transport security* allows the sending party to apply cryptographic protection to the xDLMS APDUs sent to ensure confidentiality and integrity. This requires ciphered APDUs. The receiving party can remove or check this protection. See 5.4.

These information security features are provided partly by the COSEM AL, partly by COSEM objects:

- upon AA establishment, the client and the server negotiate the *application context* and the *authentication mechanism* using the ACSE services. The application context determines whether ciphered APDUs can be used or not. The authentication mechanism determines the protocol to be used by the communication entities to authenticate themselves. The ACSE APDUs are not cryptographically protected;

The user-information field of the ACSE APDUs shall be cryptographically protected as determined by the application-context and the security policy.

- once an AA is successfully established, COSEM services can be used to access attributes and methods of COSEM objects, depending on the access rights valid in the given association. These services are carried by xDLMS APDUs, which may be cryptographically protected: authenticated, encrypted, or both, depending on the security policy in force. The cryptographic protection is applied, removed or checked by the COSEM AL. The COSEM AP of the sending party informs, via service parameters, the COSEM AL about the protection to be applied to the APDU to be sent. The COSEM AL of the receiving party informs the COSEM AP about the protection that has been applied to the APDU received.

The message security methods described in this part of IEC 62056 have been selected from the standards specified by NIST and the IETF.

For an overview of cryptography; see Annex F.

5.3 Data access security

5.3.1 Overview

Data access security concerns role based access to data in a DLMS/COSEM device.

It is managed by the “Association LN” / “Association SN” objects. Each COSEM server i.e. a logical device may support AAs with various clients, each having a different role, and with this, different access rights. Each AA is identified with a pair of lower layer addresses. Each Association object provides a list of objects visible in that particular AA and the access rights to their attributes and methods.

To be able to access data, the client shall be properly authenticated. Upon AA establishment, an authentication mechanism is negotiated between the client and the server. This specifies the required authentication of the peers, and, where needed, the security algorithm to verify the authentication. Three data access security levels are provided:

- Lowest Level Security (no security);
- Low Level Security (LLS);
- High Level Security (HLS).

5.3.2 No security (lowest level security) authentication

The purpose of No security (lowest level security) authentication is to allow the client to retrieve some basic information from the server. This authentication mechanism does not require any authentication; it allows direct access to the data in the server, within the access rights available in the given AA. The No security authentication mechanism is shown in Figure 3.

5.3.3 Low Level Security (LLS) authentication

The purpose of Low Level Security is to allow the authentication of clients by verifying the password supplied. The server is not authenticated. This authentication mechanism is typically used when the communication channel offers adequate security to avoid eavesdropping and message (password) replay.

The client has to supply the correct password during the process of AA establishment. If the password is OK, the AA is established and the client can access data within the access rights available in the given AA. Otherwise, the AA is not established.

The LLS authentication process is supported by the COSEM-OPEN service of the COSEM AL – see 6.2 – and it is as follows:

- the client transmits a “secret” (for example a password) to the server, by using the “Calling_Authentication_Value” parameter of the COSEM-OPEN.request service primitive;
- the server checks if the “secret” received corresponds to the client identification;
- if yes, the client is authenticated and the AA can be established. If no, the AA is rejected;
- the result with diagnostic information is sent back by the server using the COSEM-OPEN.response service primitive.

The association objects provide a method/attribute to change the “secret”; see IEC 62056-6-2:2016, 5.3.3 and 5.3.4.

The LLS authentication mechanism is shown in Figure 3.

5.3.4 High Level Security (HLS) authentication

The purpose of High Level Security is to allow mutual authentication of the client and the server participating in an association. This authentication mechanism is typically used when the communication channel offers no intrinsic security and precautions have to be taken against eavesdroppers and against message (password) replay.

HLS requires that both the client and the server mutually authenticate each other. This is a 4-pass process, involving the exchange of challenges during AA establishment, which is followed by exchanging the results of processing these challenges, using cryptographic methods. If the authentication takes place, the client can proceed to access data within the access rights available in the given AA, and it accepts data coming from the server. Otherwise, the AA is not established.

The HLS authentication process is supported by the COSEM-OPEN service – see 6.2 – and by the Association LN / SN objects as follows:

Pass 1: The client transmits a “challenge” CtoS – for example, a random string – to the server;

Pass 2: The server transmits a “challenge” StoC – for example, a random string – to the client.

The length of the challenges shall be 8 octets to 64 octets.

If StoC is the same as CtoS, the client shall reject it.

Pass 3: The client processes a “challenge” StoC according to the rules of the HLS authentication mechanism negotiated:

- in the case of HLS_authentication_mechanism_id(2), the method of processing the challenge is secret – for example encrypting with a secret key – which is the HLS secret known by both the client and the server;
- in the case of HLS_authentication_mechanism_id(3), the client processes StoC concatenating StoC and the shared HLS secret and calculating a digest using the MD5 algorithm (RFC 1321):

$$f(\text{StoC}) = \mathbf{MD5}(\text{StoC} \parallel \text{HLS secret})$$

- in the case of HLS_authentication_mechanism_id(4), the process is the same, but the client generates a digest using the SHA-1 algorithm. FIPS PUB 180-4 applies in this respect;
- in the case of HLS_authentication_mechanism_id(5), the client processes StoC calculating a hash value T using the GMAC algorithm:

$$f(\text{StoC}) = \text{SC} \parallel \text{FC} \parallel \text{T} = \text{SC} \parallel \text{FC} \parallel \mathbf{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{StoC})$$

See also 5.4.8.4.

The result – $f(\text{StoC})$ – is sent back to the server. The server checks if $f(\text{StoC})$ is the result of correct processing and – if so – it accepts the authentication of the client.

Pass 4: If the client is authenticated, the server processes the “challenge” CtoS in the same way as described in Pass3. The result – $f(\text{CtoS})$ – is sent back to the client. The client checks if $f(\text{CtoS})$ is the result of correct processing and – if so – it accepts the authentication of the server.

The HLS authentication mechanism is shown in Figure 3.

It is important to note that the security of the message exchange phase is independent of the security of the authentication mechanism. Even in the case where the parties are not authenticated the security of message exchanged can be ensured using cryptographically protected APDUs.

Pass 1 is supported by the COSEM-OPEN.request service primitive of the client AL. The parameter "Security_Mechanism_Name" carries the identifier of the HLS mechanism, and the parameter "Calling_Authentication_Value" carries the challenge CtoS.

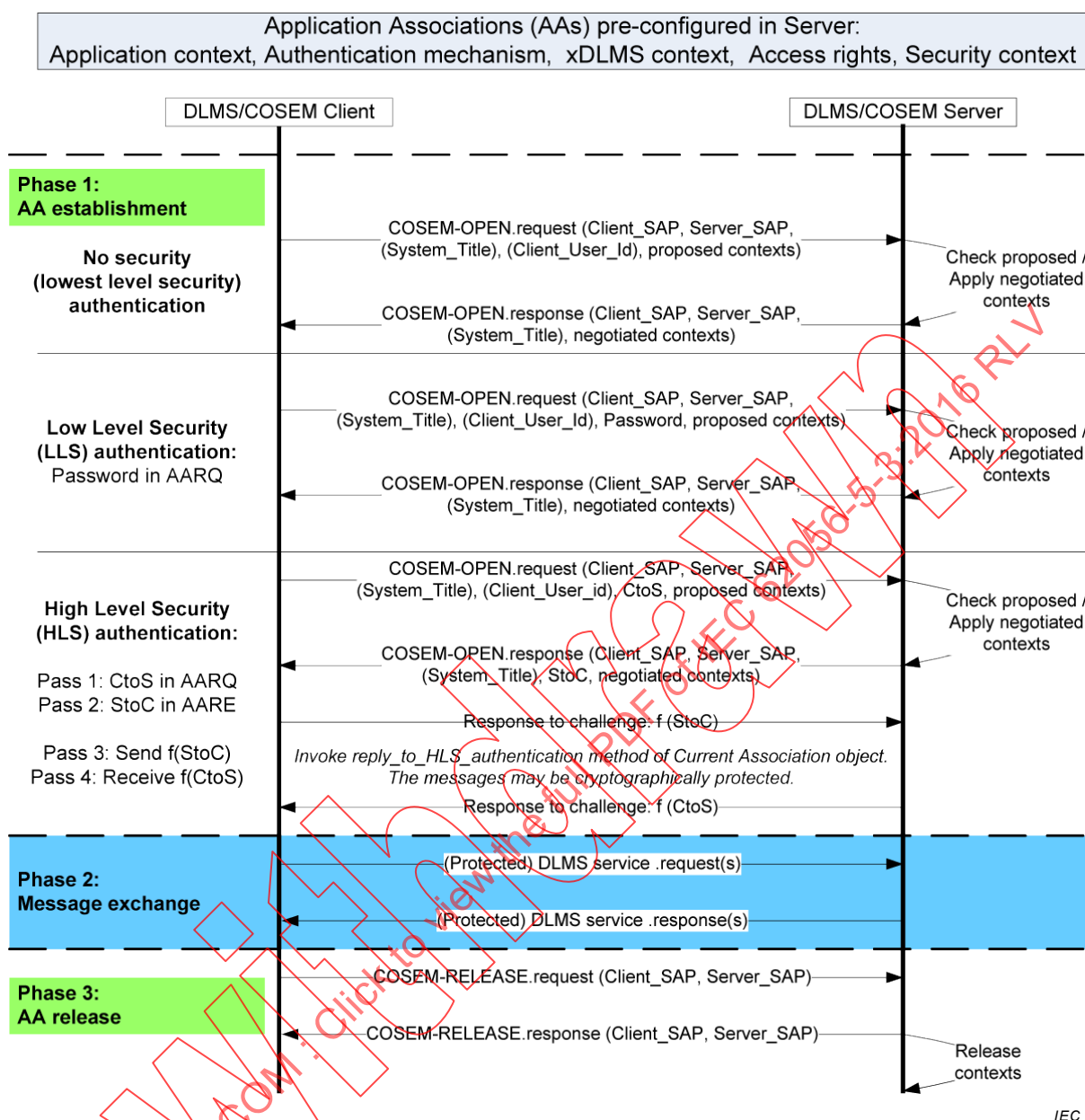
Pass 2 is supported by the COSEM-OPEN.response service primitive of the server AL. The parameter "Security_Mechanism_Name" carries the identifier of the HLS mechanism, and the parameter "Responding_Authentication_Value" carries the challenge Stoc.

After Pass 2 – provided that the proposed application context and xDLMS context are acceptable – the server grants access to the method reply_to_HLS_authentication of the current "Association SN / LN" object using the application context negotiated.

Pass 3 and Pass 4 are supported by the method reply_to_HLS_authentication of the "Association SN / LN" object(s). If both passes 3 and 4 are successfully executed, then the AA is established with the application context and xDLMS context negotiated.

NOTE The dedicated-key, if transferred, can be used from this moment.

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NOTE 1 The elements System_Title and Client user (shown in brackets) are optional.

NOTE 2 In pre-established AAs no authentication takes place.

Figure 3 – Authentication mechanisms during AA establishment

In addition, the Association SN / LN object provides the method to change the HLS “secret”: change_HLS_secret.

REMARK After the client has issued the change_HLS_secret () – or change_LLS_secret () – method, it expects a response from the server acknowledging that the secret has been changed. It is possible that the server transmits the acknowledgement, but due to communication problems, the acknowledgement is not received at the client side. Therefore, the client does not know if the secret has been changed or not. For simplicity reasons, the server does not offer any special support for this case; i.e. it is left to the client to cope with this situation.

5.4 Data transport security

5.4.1 Applying, removing or checking the protection: ciphering and deciphering

xDLMS APDUs – the messages – transported between the client and the server can be protected using cryptographic methods.

NOTE This also applies to the xDLMS Initiate APDUs carried by the AARQ / AARE APDUs.

When a COSEM object attribute or method related xDLMS service primitive is invoked by the AP, the service parameters include the Security_Options parameter. This parameter informs the AL on the kind of ciphered APDU to be used, on the protection to be applied, and includes the necessary security material. The AL builds first the APDU corresponding to the service primitive then it builds the ciphered APDU.

When the AL receives a ciphered APDU, it decipheres it, verifying and removing the protection, restoring the original, unciphered APDU. When this is successfully done, it invokes the appropriate service primitive. The service parameters include the Security_Status parameter, that informs the AP about the kind of ciphered APDU used, on the protection that has been verified and removed, and may include security material. They also include the Protection_Element parameter.

The Security_Options, Security_Status and Protection_Element parameters are specified in 6.5.

5.4.2 Security context

The security context defines security attributes relevant for the ciphering / deciphering process:

- the security policy in force, determining the kind of protection to be applied. See 5.4.3;
- the security suite, specifying the security algorithm(s). See 5.4.4;
- the security material relevant for the given security suite, including elements like block cipher keys, authentication keys, initialization vectors etc. See 5.4.5.

5.4.3 Security policy

The following security policies are specified:

- security is not imposed;
- all messages are authenticated;
- all messages are encrypted;
- all messages are authenticated and encrypted.

The security policy is held by the security_policy attribute of the "Security setup" object; see IEC 62056-6-2:2016, 5.3.7.

Authenticated access may be required selectively: certain attributes and methods may be accessible only by using authenticated messages. This is indicated by the access mode to each attribute and method; see IEC 62056-6-2:2016, 5.3.3 and 5.3.4 respectively. Therefore, authenticated xDLMS APDUs may be used – within a ciphered application context – even when the security policy in effect does not require that all messages be authenticated.

Note that if authenticated access is required, but the application context is not a ciphered one, the attributes and methods requiring authentication cannot be accessed. If the client attempts to send a ciphered APDU in an unciphered application context, then the server application layer shall reject it. In the case of SN referencing, the response shall be ConfirmedServiceError APDU, carrying the tag of the rejected APDU. In the case of LN referencing, the response shall be an ExceptionResponse APDU.

On the other hand, encryption applies generally for all messages within a given AA: if the security policy requires that all messages shall be encrypted, then all APDUs shall be encrypted – and additionally they may be authenticated.

When the security policy requires that all messages shall be authenticated and encrypted, then only APDUs that are both encrypted and authenticated can be used.

Messages protected by higher security than what the security policy requires are always allowed (provided that the application context negotiated allows them).

5.4.4 Security suite

A security suite determines the cryptographic algorithm(s) used for message security. A security suite is identified with a Security Suite ID; see Table 2. Currently, one security suite is specified, the Galois/Counter Mode (GCM) with AES-128. In this security suite, global keys – see 5.4.7.3.3 – are protected during transportation using the AES-128 key wrap algorithm.

Table 2 – Security suites

Security Suite Id	Authentication algorithm	Encryption algorithm	Key transport method
0	AES-GCM-128	AES-GCM-128	Key wrapping using AES-128 key wrap
All other reserved	–	–	–

5.4.5 Security material

The elements of the security material are the following:

- a block cipher key, denoted *EK*;
- an authentication key, denoted *AK*;
- an initialization vector, denoted *IV*.

The elements depend on the security suite. For AES-GCM-128, they are defined in 5.4.8.

5.4.6 Ciphered xDLMS APDUs

Ciphered xDLMS APDUs can be used in a ciphered application context only. In a ciphered application context, unciphered APDUs may also be used.

The different kind of ciphered APDUs are shown in Table 3. Their structure is shown in Figure 4 and Figure 5.

Table 3 – Ciphered xDLMS APDUs

APDU type	Parties	Type of crypto	Security services	Key used
Service specific global / dedicated ciphering	Client – Server	Symmetric	Authentication Encryption	Shared global / dedicated key
general-glo-ciphering				
general-ded-ciphering				

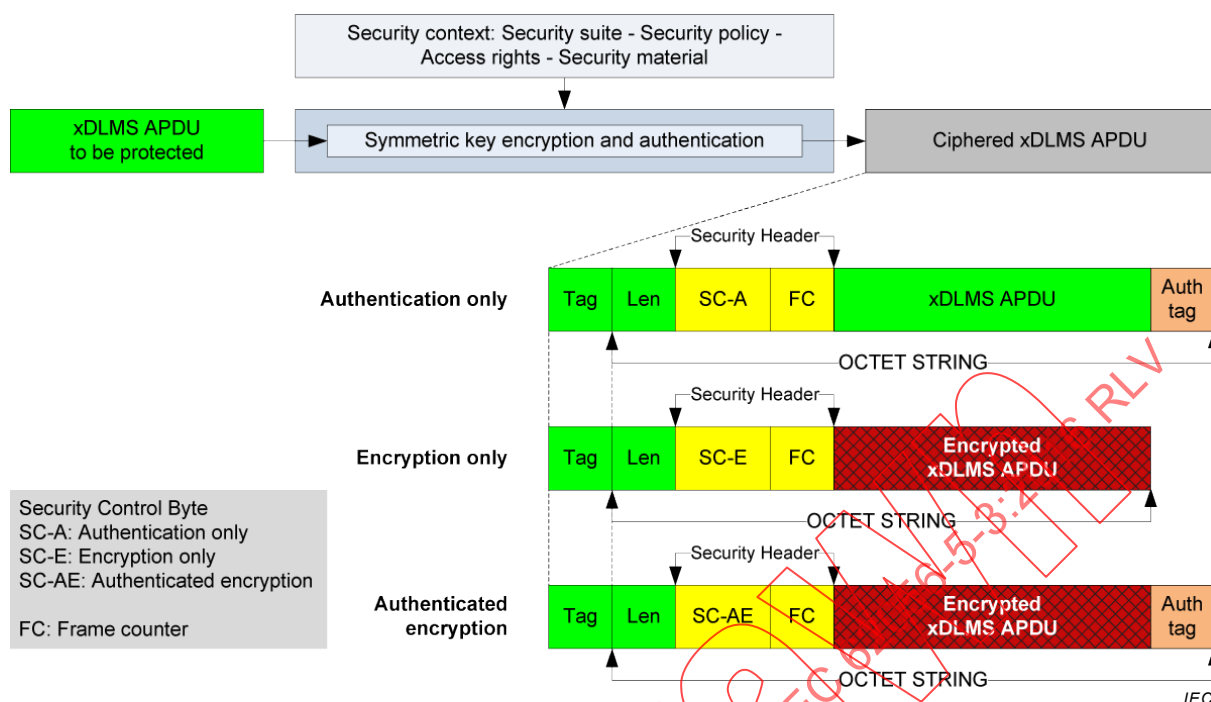
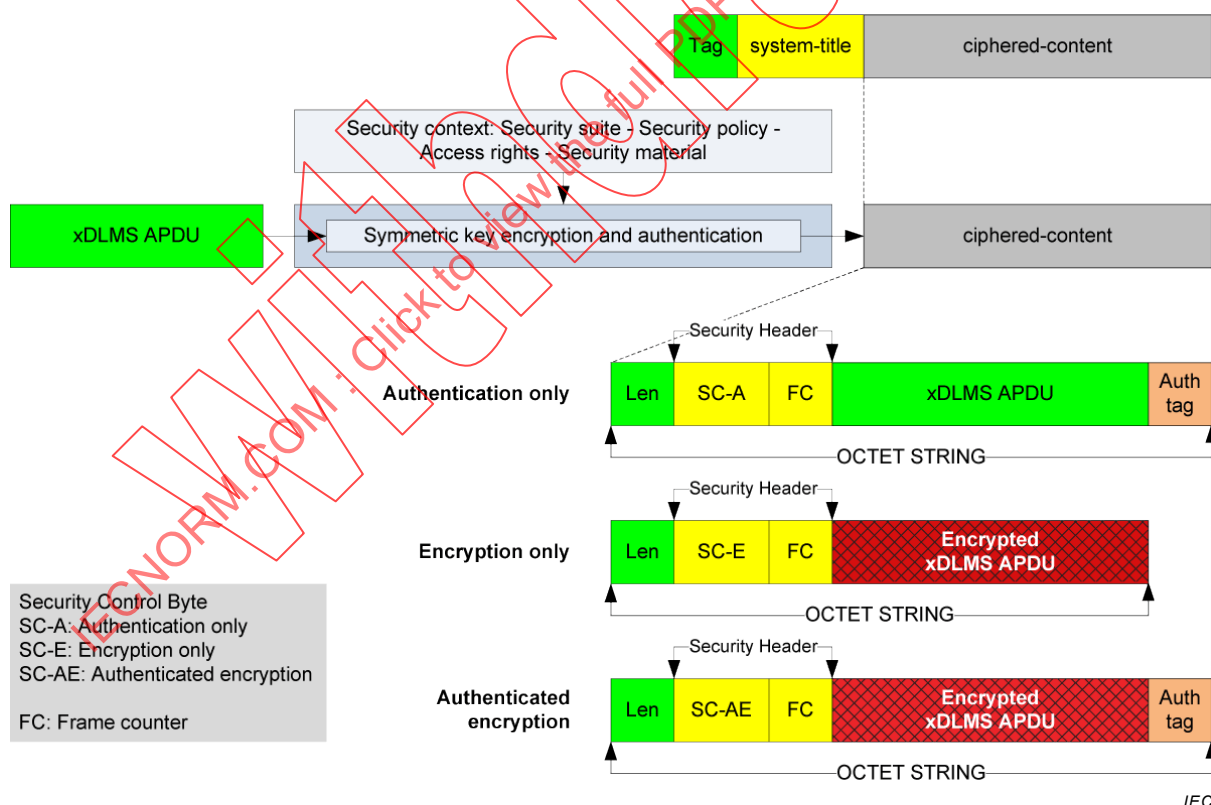


Figure 4 – Structure of service specific global ciphering and dedicated ciphering APDUs



NOTE The purpose to include system-title of the sender is to allow the other party to build the initialization vector where the system-title has not been exchanged in another way; see 5.4.8.3.4.6.

Figure 5 – Structure of general global ciphering and dedicated ciphering APDUs

The use of the fields of the ciphered APDUs is summarized in Table 4.

Table 4 – Use of the fields of the ciphered APDUs

APDU field	Service specific global / dedicated ciphering	general-glo- / general-ded-ciphering	Meaning
tag	Service specific	[219] [220]	The tag of the ciphered APDU; see Clause 8.
system-title	–	0	System title of the sender. NOTE It is octet-string, which may be of length zero when transmitting the system-title is not required.
length	+	+	Length of the octet-string that contains the ciphered xDLMS APDU / ciphered-content.
security control byte	+	+	Provides information on the protection applied, the key-set and the security suite used. See Table 6.
Frame counter	+	+	The invocation field of the initialization vector. It is an integer counter which increments upon each invocation of the authenticated encryption function using the same key. When a new key is established the related frame counter shall be reset to 0.
unprotected xDLMS APDU	(+)	(+)	The APDU that is protected.
encrypted xDLMS APDU	(+)	(+)	The encrypted APDU i.e. the ciphertext.
authentication tag	(+)	(+)	Calculated by the AES-GCM algorithm, see 5.4.8.

5.4.7 Cryptographic keys

5.4.7.1 General

A cryptographic key is a parameter used in conjunction with a cryptographic algorithm that determines its operation in such a way that an entity with knowledge of the key can reproduce or reverse the operation, while an entity without knowledge of the key cannot. For the purposes of DLMS/COSEM, examples of operations include:

- the transformation of plaintext data into ciphertext data;
- the transformation of ciphertext data into plaintext data;
- the computation of an authentication code from data;
- the verification of an authentication code from data and a received authentication code.

5.4.7.2 Key types

Various key types are defined. They are identified according to their classification, their cryptographic function, their use and their scope.

By their classification, a distinction is made between:

- *symmetric* keys. A symmetric key is a single cryptographic key that is used with a secret (symmetric) key algorithm. For an overview of symmetric key algorithms; see Clause F.3;
- *public* and *private* keys, used with public key cryptographic algorithms. For an overview of asymmetric key algorithms; see Clause F.4.

For symmetric keys, a distinction is made between:

- *Symmetric authentication keys*, used with symmetric key algorithms to provide assurance of the integrity and source of messages;
- *Symmetric data encryption keys*, used with symmetric key algorithms to apply confidentiality protection to information; and
- *Symmetric key wrapping keys*, used to encrypt other keys using symmetric key algorithms. Key wrapping keys are also known as key encrypting keys (KEK).

By their use, a distinction is made between:

- *unicast keys*, used to secure unicast communication between two peers;
- *broadcast keys*, used to secure broadcast communication between a DLMS/COSEM client and several DLMS/COSEM servers. In DLMS/COSEM, broadcast can be initiated by the client only.

By their scope, a distinction is made between *dedicated keys* and *global keys*. These terms are DLMS/COSEM specific:

- a *dedicated key* is a ciphering key that may be used to cipher xDLMS APDUs from the establishment of an AA between a client and a server until the AA is released. Therefore, its lifetime is the same as the lifetime of the AA. It is delivered during AA establishment and used in subsequent transmissions within the same AA.

When the AA is released, the dedicated key should be destroyed by the server as well as by the client.

- a *global key* is a ciphering key that may be (re-)used to cipher xDLMS APDUs, exchanged between the same client and server, in more than one instance of the AA.

The following (symmetric) encryption keys may be available: global unicast key, global broadcast key, dedicated unicast key.

A (symmetric) authentication key is always a global key that can be used in unicast and broadcast messages.

In addition, security suite specific rules may apply. See also Table 5.

5.4.7.3 Key management

5.4.7.3.1 System architectures

NOTE Subclause 5.4.7.3 provides general guidelines for secure implementation. The management of the security system, including the security keys is the responsibility of the system operator.

For the purposes of 5.4.7.3, two general system architectures are considered:

- the client is the central DCS, exchanging data directly with servers;
- the client is a concentrator, exchanging data on the one hand with servers, and on the other hand with the central DCS. In this case, the concentrator may or may not be a server at the same time. The central DCS may or may not be a client.

For generation and distribution of symmetric keys, NIST SP 800-57:2006, 8.1.5.2 applies.

5.4.7.3.2 Master key

A master key shall be present in each server logical device configured in the system. This key is used for wrapping global keys; see 5.4.7.3.3.

NOTE 1 The way of generating and installing the master key is out of the scope of this international standard.

A secure mechanism shall be in place to ensure that the central data DCS knows the master key of each server logical device participating in the system.

NOTE 2 The specification of such a mechanism is out of the scope of this international standard.

The concentrators, if they are present in the system, shall not know the master keys.

For security reasons, the lifetime of the master key should be limited. The way to replace the master keys is out of the scope of this standard. For guidance, see NIST SP 800-57:2006, 8.2.3, Key change function.

5.4.7.3.3 Global keys

Before ciphering can be used, global keys have to be generated and delivered to the COSEM logical devices participating in the system.

Global keys shall be generated by the central DCS.

The way to generate the global keys is outside the scope of this international standard. For security reasons, their lifetime should be limited.

For delivery, global keys shall be wrapped using the AES-128 key wrap algorithm as specified in RFC 3394, and using the master key as the Key Encryption Key (KEK).

When the system works without (a) concentrator(s), the global keys shall be delivered by the central DCS invoking the `global_key_transfer` method of the “Security setup” interface object in the server with the wrapped global key as a parameter; see IEC 62056-6-2:2016, 5.3.7.

When the system works with (a) concentrator(s), the global keys shall be delivered – wrapped by the master key – to the concentrator. The `global_key_transfer` method of the “Security setup” interface object in the server shall be invoked then by the concentrator with the wrapped global key as a parameter. For details, see IEC 62056-6-2:2016, 5.3.7.

In any case, the global key is wrapped by the master key.

The concentrator should not know the master keys, therefore it should not be able to wrap / unwrap global keys.

The global keys shall also be made available by the central DCS to the concentrator(s), if present, in a secure way.

NOTE The specification of such a process is out of the scope of this part of IEC 62056.

5.4.7.3.4 Dedicated keys

When the system works without (a) concentrator(s), dedicated keys shall be generated by the central DCS. When the system works with (a) concentrator(s), dedicated keys shall be generated by the concentrators.

For delivery, they shall be included in the dedicated-key field of the xDLMS InitiateRequest APDU, carried by the user-information field of the AARQ APDU. The xDLMS InitiateRequest APDU shall be authenticated and encrypted using the AES-GCM-128 algorithm, the global unicast encryption key and – if in use, see 5.4.8.3.4.4 – the authentication key. Likewise, the xDLMS InitiateResponse APDU, carried by the user-information field of the AARE APDU shall be also encrypted and authenticated the same way. See also 5.2.

5.4.7.3.5 Summary

The various cryptographic key types, together with their use and their management are summarized in Table 5.

Table 5 – Cryptographic keys and their management

Key type	Use	Generation	Delivery	Location
Symmetric keys				
Master key	Key Encryption Key (KEK) for global keys	Not specified	Not specified	Central DCS and DLMS/COSEM server
Global unicast encryption key	Global ciphering of unicast xDLMS APDUs	Central DCS	Wrapped with master key, invocation of global_key_transfer method by the central DCS or the concentrator	Central DCS (and Concentrator) and COSEM server
Global broadcast encryption key	Global ciphering of broadcast xDLMS APDUs	Central DCS	Wrapped with master key, invocation of global_key_transfer method by the central DCS or the concentrator	Central DCS (and Concentrator) and DLMS/COSEM server
Authentication key (Global)	Authentication of xDLMS APDUs	Central DCS	Wrapped with master key, invocation of global_key_transfer method by the central DCS or the concentrator	Central DCS (and Concentrator) and DLMS/COSEM server
Dedicated (unicast) encryption key	Dedicated ciphering of unicast xDLMS APDUs	Central DCS or Concentrator	Transported as part of the xDLMS InitiateRequest APDU, which is encrypted and authenticated using the AES-GCM-128 algorithm, the global unicast encryption key and the authentication key	Central DCS (or Concentrator) and DLMS/COSEM server (during the lifetime of the AA)
NOTE If alternatives are given, the first alternative is valid for systems not using concentrators and the second alternative for systems using concentrators.				

5.4.8 The Galois/Counter Mode of Operation (GCM)

5.4.8.1 General

NOTE The following text is taken from NIST SP 800-38D:2007, Clause 3.

Galois/Counter Mode (GCM) is an algorithm for authenticated encryption with associated data. GCM is constructed from an approved symmetric key block cipher with a block size of 128 bits, such as the Advanced Encryption Standard (AES) algorithm; see FIPS PUB 197. Thus, GCM is a mode of operation of the AES algorithm.

GCM provides assurance of the confidentiality of data using a variation of the Counter mode of operation for encryption.

GCM provides assurance of the authenticity of the confidential data (up to about 64 gigabytes per invocation) using a universal hash function that is defined over a binary Galois (i.e., finite) field. GCM can also provide authentication assurance for additional data (of practically unlimited length per invocation) that is not encrypted.

If the GCM input is restricted to data that is not to be encrypted, the resulting specialization of GCM, called GMAC, is simply an authentication mode on the input data.

GCM provides stronger authentication assurance than a (non-cryptographic) checksum or error detecting code; in particular, GCM can detect both accidental modifications of the data and intentional, unauthorized modifications.

In DLMS/COSEM, it is also possible to use GCM to provide confidentiality only: in this case, the authentication tags are simply not computed and checked.

For more information, see NIST SP 800-38D:2007.

5.4.8.2 Definitions, abbreviations, symbols and notation relevant for the Galois/Counter mode

Term / Abbreviation	Symbol	Meaning
Additional authenticated data (AAD)	A	Input data to the authenticated encryption function that is authenticated but not encrypted. It is also known as Associated Data.
Authenticated decryption		Function of GCM in which the ciphertext is decrypted into the plaintext, and the authenticity of the ciphertext and the AAD are verified.
Authenticated encryption		Function of GCM in which the plaintext is encrypted into the ciphertext, and an authentication tag is generated on the AAD and the ciphertext.
Authentication key	AK	Part of the AAD
Block cipher		Parameterized family of permutations on bit strings of a fixed length; the parameter that determines the permutation is a bit string called the key.
Ciphertext	C	Encrypted form of the plaintext
	EK	Block cipher key
Fixed field		In the deterministic construction of IVs, field that identifies the device or context for the instance of the authenticated encryption function.
	FC	Frame counter.
Fresh		For a newly generated key, property of being unequal to any previously used key.
GCM		Galois/Counter Mode
Initialization vector	IV	Nonce that is associated with an invocation of authenticated encryption on a particular plaintext and AAD.
Invocation field		In the deterministic construction of IVs, field that identifies the sets of inputs to the authenticated encryption function in a particular device or context. For the purposes of this international standard, the invocation field is the frame counter.
Key		Parameter of the block cipher that determines the selection of the forward cipher function from the family of permutations.
	KEK	Key encryption key
	$len(X)$	Bit length of the bit string X
	$LEN(X)$	Octet length of the octet string X
Nonce		Value that is used only once within a specified context.
Plaintext	P	Input data to the authenticated encryption function that is both authenticated and encrypted.
	SC	Security control byte
	SH	Security header; concatenation of the security control byte SC and the frame counter FC : $SH = SC \parallel FC$.
System title	$_{Sys-T}$	A unique identifier of the system.
Authentication tag	T	Cryptographic checksum on data that is designed to reveal both the accidental errors and the intentional modification of the data.
	t	Bit length of the authentication tag NOTE This is the same as $len(T)$.
	$X \parallel Y$	Concatenation of two strings, X and Y .

5.4.8.3 Elements of GCM

5.4.8.3.1 Block cipher and keys

For the purposes of this international standard, the AES encryption standard has been selected. GCM uses the forward cipher function; it does not employ the inverse cipher function.

GCM uses a single key, the block cipher key (the key, for short). Its size shall be 128 bits. In DLMS/COSEM, for additional security, an authentication key is also specified. It is part of the additional authenticated data, AAD. The block cipher key is denoted *EK* and the authentication key is denoted *AK*.

5.4.8.3.2 GCM functions

5.4.8.3.2.1 General

NOTE The following is based on NIST SP 800-38D:2007, 5.2.

The two functions that comprise GCM are called authenticated encryption and authenticated decryption. The authenticated encryption function encrypts the confidential data and computes an authentication tag on both the confidential data and any additional, non-confidential data. The authenticated decryption function decrypts the confidential data, contingent on the verification of the tag.

When the input is restricted to non-confidential data, the resulting variant of GCM is called GMAC. For GMAC, the authenticated encryption and decryption functions become the functions for generating and verifying an authentication tag on the non-confidential data.

Finally, if authentication is not required, the authenticated encryption function encrypts the confidential data, but the authentication tag is not computed. The authenticated decryption function decrypts the confidential data, but no authentication tag is computed and verified.

5.4.8.3.2.2 Authenticated encryption – input and output data

NOTE The following text is based on NIST SP 800-38D:2007, 5.2.1.1 and RFC 4106:2005, 2.1.

The authenticated encryption operation has four inputs, each of which shall be an octet string:

- a plaintext, denoted *P*;
- additional authenticated data (AAD), denoted *A*. It shall include – together with other elements – the authentication key, denoted *AK*.
- a secret block cipher key denoted *EK*;
- an initialization vector denoted *IV*.

The plaintext and the AAD are the two categories of data that GCM protects. GCM protects the authenticity of the plaintext and the AAD; GCM also protects the confidentiality of the plaintext, while the AAD is left in the clear.

The IV is essentially a nonce, i.e. a value that is unique within the specified (security) context, which determines an invocation of the authenticated encryption function on the input data to be protected. See 5.4.8.3.4.5.

There are two outputs:

- a ciphertext, denoted *C* whose length is exactly that of the plaintext *P*;
- an authentication tag, denoted *T*.

5.4.8.3.2.3 Authenticated decryption – input and output data

The authenticated encryption and authenticated decryption functions, their inputs and outputs, as well as the structure of the ciphered xDLMS APDU / ciphered-content are shown in Figure 6 below. The authenticated decryption operation has five inputs:

- the secret block cipher key, denoted EK ;
- the initialization vector, denoted IV ;
- the ciphertext, denoted C ;
- the additional authenticated data (AAD), denoted A ;
- the authentication tag, denoted T .

The output is one of the following:

- the plaintext P that corresponds to the ciphertext C , or
- a special error code, denoted *FAIL* in this standard.

The output P indicates that T is the correct authentication tag for IV , A , and C ; otherwise, the output is *FAIL*.

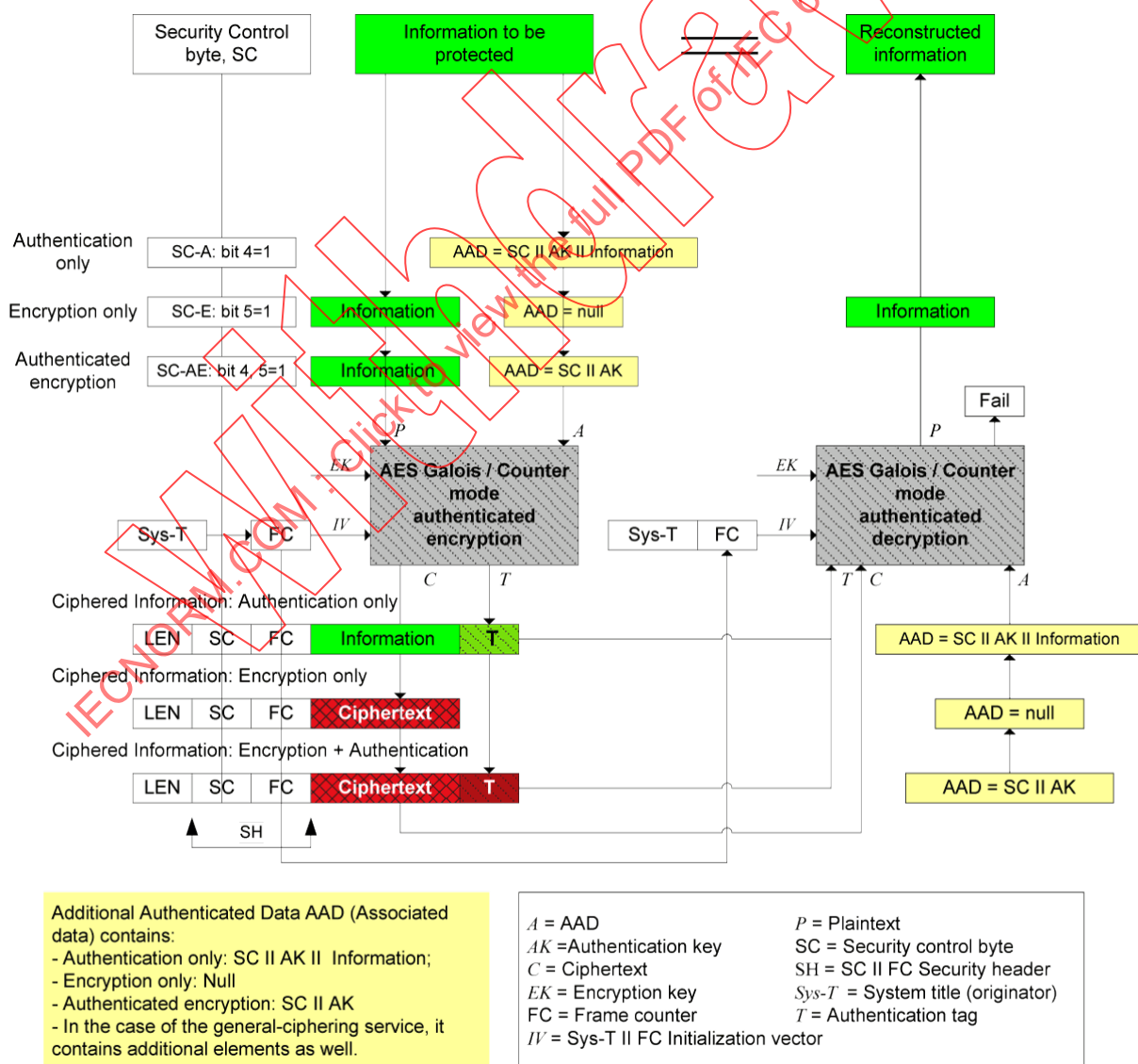


Figure 6 – Cryptographic protection of xDLMS APDUs using GCM

5.4.8.3.3 Security header with GCM

The security header SH includes the security control byte concatenated with the invocation counter: SH = SC || FC. The security control byte is shown in Table 6, where:

- Bit 3...0: Security_Suite_Id, see 5.4.4;
- Bit 4: “A” subfield: indicates that authentication is applied;
- Bit 5: “E” subfield: indicates that encryption is applied;
- Bit 6: Key_Set subfield 0 = Unicast;
1 = Broadcast
- Bit 7: Reserved, shall be set to 0.

Table 6 – Security control byte

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3..0
Reserved	Key_Set	E	A	Security_Suite_Id

The Frame Counter is an internal counter maintained by the sending and receiving parties.

5.4.8.3.4 GCM parameters and data elements

5.4.8.3.4.1 Length of the authentication tag

The bit length of the authentication tag, denoted t , is a security parameter. Its value shall be 96 bits.

5.4.8.3.4.2 Plaintext and additional authenticated data

The plaintext, denoted P and the additional authenticated data, denoted A depend on the kind of protection. They are shown in Table 7, where SC is the security control byte, AK is the authentication key and M is the message, i.e. the xDLMS APDU to be protected.

The bit lengths of P and A shall meet the following requirements:

- $\text{len}(P) < 2^{39}-256$;
- $\text{len}(A) < 2^{64}-1$;
- the bit lengths of P and A shall all be multiples of 8, so that these values are octet strings.

Table 7 – Plaintext and additional authenticated data

Security control, SC		Security	P	A
E field	A field			
0	0	None	–	–
0	1	Authenticated only	–	$SC AK M$
1	0	Encrypted only	M	–
1	1	Encrypted and authenticated	M	$SC AK$

5.4.8.3.4.3 Block cipher key, EK

The size of the block cipher key, denoted EK shall be 128 bits (16 octets): $\text{len}(EK) = 128$.

The key shall be generated uniformly at random or close to uniformly at random i.e., so that each possible key is (nearly) equally likely to be generated. Consequently, the key will be fresh, i.e., unequal to any previous key, with high probability. The key shall be secret and

shall be used exclusively for GCM with the chosen block cipher AES. Additional requirements on the establishment and management of keys are discussed in NIST SP 800-38D:2007, 8.1.

5.4.8.3.4.4 Authentication key, AK

Although not required by GCM, an authentication key denoted AK is specified for additional security in DLMS/COSEM. For its length and its generation, the same rules apply as for the encryption key. The authentication key shall be part of the additional authenticated data AAD. If an authentication key has been transferred, it shall be used, until a null authentication key is transferred.

5.4.8.3.4.5 Initialization vector, IV

For the construction of the initialization vector, IV , deterministic construction as specified in NIST SP 800-38D:2007, 8.2.1 shall be used.

In the deterministic construction, the IV is the concatenation of two fields, called the fixed field and the invocation field. The fixed field shall identify the physical device, or, more generally, the (security) context for the instance of the authenticated encryption function. The invocation field shall identify the sets of inputs to the authenticated encryption function in that particular device.

For any given key, two distinct physical devices shall not share the same fixed field, and two distinct sets of inputs to any single device shall not share the same invocation field.

The length of the IV shall be 96 bits (12 octets): $len(IV) = 96$. Within this:

- the leading (i.e. the leftmost) 64 bits (8 octets) shall hold the fixed field. It shall contain the system title; see 5.4.8.3.4.6;
- the trailing (i.e. the rightmost) 32 bits shall hold the invocation field; see 5.4.8.3.4.7.

The bit length of the fixed field limits the number of distinct physical devices that can implement the authenticated encryption function for the given key to 2^{64} . The bit length of the invocation field limits the number of invocations of the authenticated encryption function to 2^{32} with any given input sets without violating the uniqueness requirement.

5.4.8.3.4.6 System title

Each physical device in the system, including the meters, the concentrators when used, and the DCS shall be uniquely identified with its system title. The system title denoted as $Sys-T$ shall be constructed as follows:

- its length shall be 8 octets;
- the leading (i.e., the 3 leftmost) octets shall hold the three-letter manufacturer ID². This is the same as used in the leading octets of the Logical Device Name of server logical devices;

The three-letter manufacturer ID shall be used to identify all client and server systems.

NOTE 1 It can be obtained from the DLMS UA.

- the trailing (i.e. the 5 rightmost) octets, together with the manufacturer ID, shall ensure the uniqueness of the system title.

NOTE 2 These 5 octets can be derived for example from the last twelve digits of the manufacturing number, up to 999 999 999 999. This value converts to 0xE8D4A50FFF. Values above this, up to 0xFFFFFFFF (decimal value 1 099 511 627 775) can also be used, but these values cannot be mapped to the last 12 digits of the manufacturing number.

² Administered by the DLMS UA acting as a registration authority; the same as the one used in the LDN.

Project specific companion specifications may specify a different structure for the system title, but in any case, the system title shall be 8 octets long – if necessary, right padded to 8 octets – and shall be unique. The details shall be specified by the naming authority designated as such for the project.

Before the message security algorithms can be used – this requires a ciphered application context – the peers have to exchange system titles. The following possibilities are available:

- when the S-FSK PLC profile is used, system titles are exchanged during the registration process using the CIASE protocol. See IEC 62056-8-3;
- in all communication profiles, system titles are exchanged during AA establishment with a ciphered context using the COSEM-OPEN service – see 6.2 – carried the AARQ / AARE APDUs;

If the system titles sent / received during AA establishment are not the same as the ones exchanged during the CIASE registration process, the AA shall be rejected.

- by writing the client_system_title attribute and by reading the server_system_title attribute of “Security setup” objects; see IEC 62056-6-2:2016, 5.3.7.

NOTE 3 For broadcast communication, only the COSEM client sends it to the COSEM server.

5.4.8.3.4.7 Invocation field

The invocation field shall be an integer counter (frame counter).

5.4.8.3.5 Example

The following example – see Table 8 – illustrates the process of creating ciphered xDLMS APDUs when applying authentication only, encryption only and authenticated encryption.

Table 8 – Example for ciphered APDUs

	<i>X</i>	Contents			<i>LEN</i> (<i>X</i>) bytes	<i>Len</i> (<i>X</i>) bits
Security material						
Security suite		GCM-AES-128				
System Title	<i>Sys-T</i>	4D4D4D0000BC614E (here, the five last octets contain the manufacturing number in hexadecimal form)			8	64
Frame Counter	<i>FC</i>	01234567			4	32
Initialization Vector	<i>IV</i>	<i>Sys-T</i> <i>FC</i> 4D4D4D0000BC614E01234567			12	96
Block cipher key (global)	<i>EK</i>	000102030405060708090A0B0C0D0E0F			16	128
Authentication Key	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF			16	128
Security applied		Authentication	Encryption	Authenticated encryption		
Security control byte (with unicast key)	<i>SC</i>	<i>SC-A</i>	<i>SC-E</i>	<i>SC-AE</i>	1	8
		10	20	30		
Security header	<i>SH</i>	<i>SH</i> = <i>SC-A</i> <i>FC</i>	<i>SH</i> = <i>SC-E</i> <i>FC</i>	<i>SH</i> = <i>SC-AE</i> <i>FC</i>		
		1001234567	2001234567	3001234567	5	40
Inputs		Authentication	Encryption	Authenticated encryption		
xDLMS APDU to be protected	<i>APDU</i>	C0010000080000010000FF0200 (Get-request, attribute 2 of the Clock object)			13	104

	<i>X</i>	Contents			<i>LEN</i> (<i>X</i>) bytes	<i>Len</i> (<i>X</i>) bits
Plaintext	<i>P</i>	Null	C00100000800000 10000FF0200	C00100000800000 10000FF0200	13	104
Associated data	<i>A</i>	<i>SC II AK II APDU</i>	–	<i>SC II AK</i>		
Associated Data – Authentication	<i>A-A</i>	10D0D1D2D3D4D5D 6D7D8D9DADBDCDD DEDFC0010000080 000010000FF0200	–	–	30	240
Associated Data – Encryption	<i>A-E</i>	–	–	–	0	0
Associated Data – Authenticated encryption	<i>A-AE</i>	–	–	30D0D1D2D3D4D5D 6D7D8D9DADBDCDD DEDF	17	136
Outputs		Authentication	Encryption	Authenticated encryption		
Ciphertext	<i>C</i>	NULL	411312FF935A475 66827C467BC	411312FF935A475 66827C467BC	13	104
Authentication tag	<i>T</i>	06725D910F9221D 263877516	–	7D825C3BE4A77C3 FCC056B6B	12	96
The complete Ciphertext APDU		<i>TAG II LEN II SH II APDU II T</i>	<i>TAG II LEN II SH II C</i>	<i>TAG II LEN II SH II C II T</i>	–	–
Authenticated APDU		C81E1001234567C 001000008000001 0000FF020006725 D910F9221D26387 7516	–	–	32	256
Encrypted APDU		–	C81220012345674 11312FF935A4756 66827C467BC	–	20	160
Authenticated and encrypted APDU		–	–	C81E30012345674 11312FF935A4756 6827C467BC7D825 C3BE4A77C3FCC05 6B6B	32	256

NOTE In this example the value of the invocation field is 01234567. In real life, the value shall be incremented with each invocation of the GCM algorithm.

5.4.8.4 High Level Security peer authentication with GMAC (authentication_mechanism_id(5))

NOTE See also 5.3.4.

In the case of authentication_mechanism_id(5), the process is the following:

- Pass 1 and Pass 2 shall be the same as described in 5.3.4;
- in Pass 3 and 4, instead of the HLS secret (held by the “Association LN” / “Association SN” objects), the global unicast encryption key, and the authentication key (if in use) are used. These are transferred to the server using the global_key_transfer method of the “Security setup” interface class. See IEC 62056-6-2:2016, 5.3.7;
- in Pass 3, the client processes StoC calculating a hash value T using the GMAC algorithm:

$$f(\text{StoC}) = \text{SC II FC II T} = \text{SC II FC II GMAC}(\text{SC II AK II StoC})$$

The result f(StoC) is sent back to the server. The server checks if f(StoC) is the result of the correct processing and – if correct – accepts the authentication of the client.

- in Pass 4, the server processes CtoS calculating a hash value T using the GMAC algorithm:

$$f(\text{CtoS}) = \text{SC} \parallel \text{FC} \parallel \text{T} = \text{SC} \parallel \text{FC} \parallel \mathbf{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{CtoS})$$

The result $f(\text{CtoS})$ is sent back to the client. The client checks if $f(\text{CtoS})$ is the result of the correct processing and – if correct – accepts the authentication of the server.

To exchange $f(\text{StoC})$ and $f(\text{CtoS})$, the client invokes the *reply_to_HLS_authentication* method of Current Association object. The messages may be cryptographically protected.

An example is shown in Table 9 below.

Table 9 – HLS example with GMAC

Security material	X	Contents	LEN(X) bytes	len(X) bits
Security suite		GCM-AES-128		
System Title	Sys-T	Client		
		4D4D4D0000000001		
		(here, the five last octets contain the manufacturing number in hexa)	8	64
Frame Counter	FC	00000001	4	32
Initialization Vector	IV	Sys-T FC		
		Client		
		4D4D4D0000000001 00000001	12	96
Block cipher key (global)	EK	000102030405060708090A0B0C0D0E0F	16	128
Authentication Key	AK	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Security control	SC	10	1	8
Pass 1: Client sends challenge to server				
CtoS		4B35366956616759 "K56iVagY"	8	64
Pass 2: Server sends challenge to client				
StoC		503677524A323146 "P6wRJ21F"	8	64
Pass 3: Client processes StoC				
SC AK StoC		10D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF503677 524A323146		
T = GMAC (SC AK StoC)		1A52FE7DD3E72748973C1E28	12	96
f(StoC) = SC FC T		10000000011A52FE7DD3E72748973C1E28	17	136
Pass 4: Server processes CtoS				
SC AK CtoS		10D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF4B3536 6956616759		
T = GMAC (SC AK CtoS)		FE1466AFB3DBCD4F9389E2B7	12	96
f(CtoS) = SC FC T		1001234567FE1466AFB3DBCD4F9389E2B7	17	136
NOTE In this example the value of the invocation field is 01234567. In real life, the value shall be incremented with each invocation of the GCM algorithm.				

6 DLMS/COSEM application layer service specification

6.1 Service primitives and parameters

In general, the services of a layer (or sublayer) are the capabilities it offers to a user in the next higher layer (or sublayer). In order to provide its service, a layer builds its functions on the services it requires from the next lower layer. Figure 7 illustrates this notion of service hierarchy and shows the relationship of the two correspondent N-users and their associated N-layer peer protocol entities.

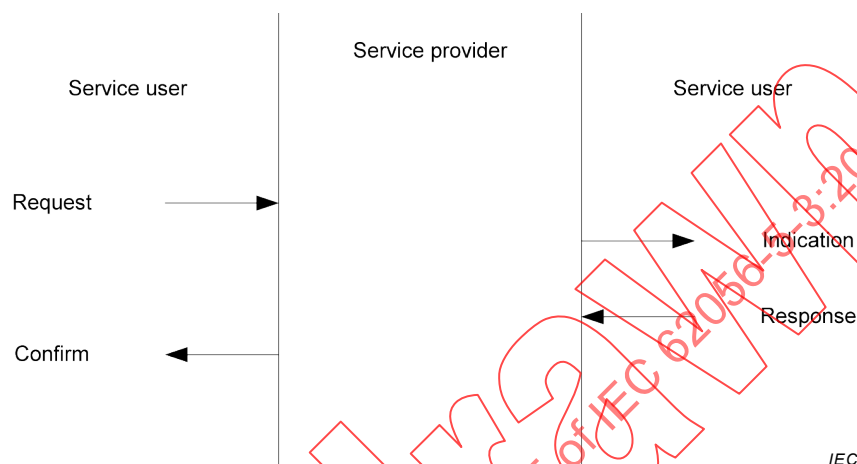


Figure 7 – Service primitives

Services are specified by describing the information flow between the N-user and the N-layer. This information flow is modelled by discrete, instantaneous events, which characterize the provision of a service. Each event consists of passing a service primitive from one layer to the other through an N-layer service access point associated with an N-user. Service primitives convey the information required in providing a particular service. These service primitives are an abstraction in that they specify only the service provided rather than the means by which the service is provided. This definition of service is independent of any particular interface implementation.

Services are specified by describing the service primitives and parameters that characterize each service. A service may have one or more related primitives that constitute the activity that is related to the particular service. Each service primitive may have zero or more parameters that convey the information required to provide the service. Primitives are of four generic types:

- **REQUEST:** The request primitive is passed from the N-user to the N-layer to request that a service be initiated;
- **INDICATION:** The indication primitive is passed from the N-layer to the N-user to indicate an internal N-layer event that is significant to the N-user. This event may be logically related to a remote service request, or may be caused by an event internal to the N-layer;
- **RESPONSE:** The response primitive is passed from the N-user to the N-layer to complete a procedure previously invoked by an indication primitive;
- **CONFIRM:** The confirm primitive is passed from the N-layer to the N-user to convey the results of one or more associated previous service request(s).

Possible relationships among primitive types are illustrated by the time-sequence diagrams shown in Figure 8. The figure also indicates the logical relationship of the primitive types. Primitive types that occur earlier in time and are connected by dotted lines in the diagrams are the logical antecedents of subsequent primitive types.

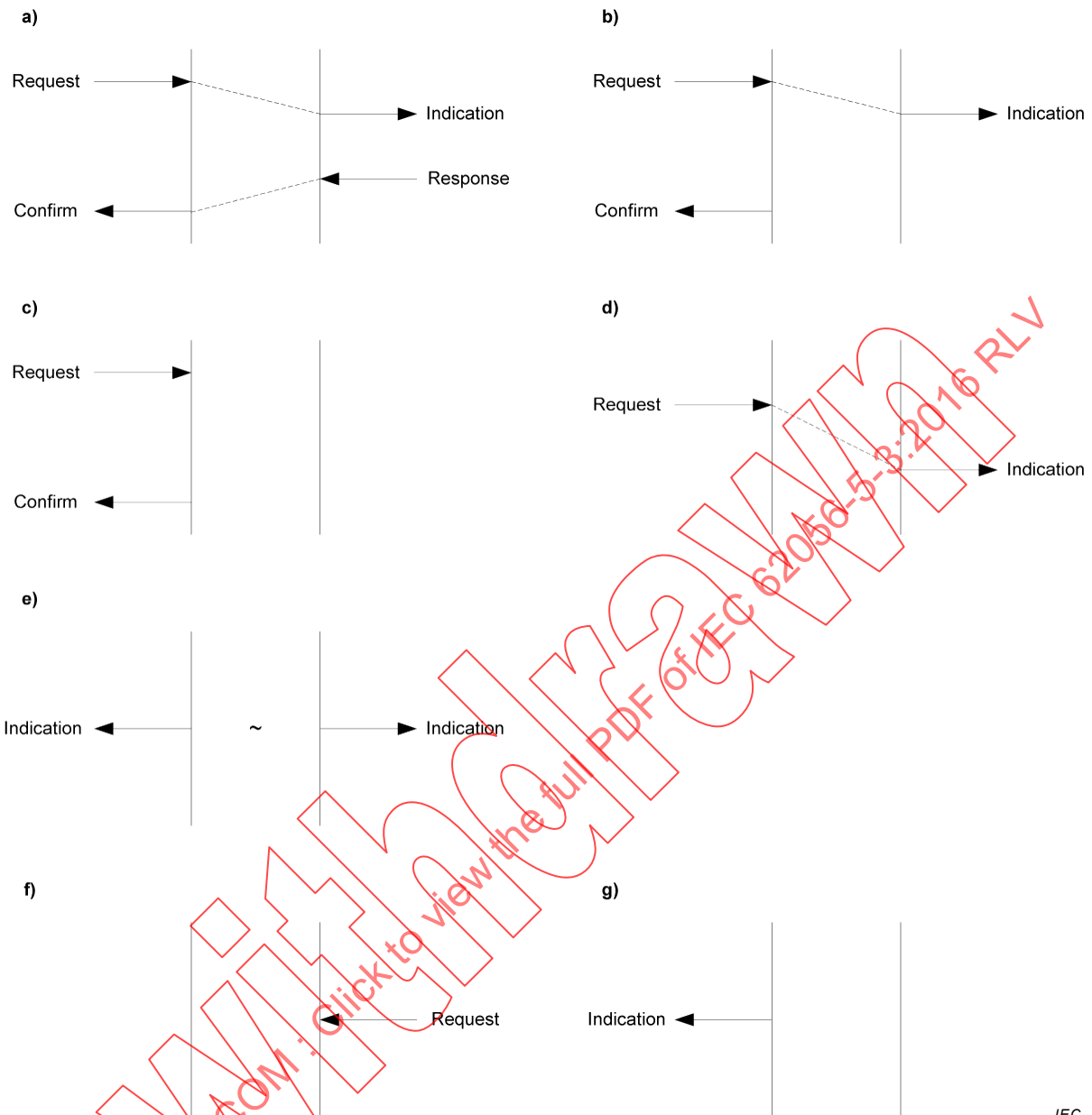


Figure 8 – Time sequence diagrams

The service parameters of the COSEM AL service primitives are presented in a tabular format. Each table consists of two to five columns describing the service primitives and their parameters. In each table, one parameter – or a part of it – is listed on each line. In the appropriate service primitive columns, a code is used to specify the type of usage of the parameter. The codes used are listed in Table 10.

Some parameters may contain sub-parameters. These are indicated by labelling of the parameters as M, U, S or C, and indenting all sub-parameters under the parameter. Presence of the sub-parameters is always dependent on the presence of the parameter that they appear under. For example, an optional parameter may have sub-parameters; if the parameter is not supplied, then no sub-parameters may be supplied.

Table 10 – Codes for AL service parameters

M	The parameter is mandatory for the primitive.
U	The parameter is a user option, and may or may not be provided depending on dynamic usage by the ASE user.
S	The parameter is selected among other S-parameters as internal response of the server ASE environment.
C	The parameter is conditional upon other parameters or the environment of the ASE user.
(–)	The parameter is never present.
=	The " (=) " code following one of the M, U, S or C codes indicates that the parameter is semantically equivalent to the parameter in the service primitive to its immediate left in the table. For instance, an " M (=) " code in the .indication service primitive column and an "M" in the .request service primitive column means that the parameter in the .indication primitive is semantically equivalent to the one in the .request primitive.

Throughout this standard, the following rules are observed regarding the naming of terms:

- the name of ACSE services and the data transfer services using LN referencing is written in uppercase. Examples are: COSEM-OPEN, GET;
- the name of the data transfer services using SN referencing is written in title case. Examples are: Read, Write;
- camel notation is used in the following cases: DataNotification, EventNotification, TriggerEventNotificationSending, UnconfirmedWrite, InformationReport;
- the types of the LN service primitives may be mentioned in two alternative forms. Examples: "GET.request service primitive of Request_Type == NORMAL" or "GET-REQUEST-NORMAL service primitive";
- service parameter name elements are capitalized and joined with an underscore to signify a single entity. Examples are Protocol_Connection_Parameters and COSEM_Attribute_Descriptor;
- when the same parameter may occur several times, this is indicated by repeating the parameter in curly brackets. Example: Data { Data };
- in the data transfer service specifications, parameters used with block transfer only are shown in bold. Example: **DataBlock_G**;
- direct reference to a service parameter uses the capitalized form, while indirect (non-specific) reference uses the normal text without underscore joining. A direct reference example is: "The COSEM_Attribute_Descriptor parameter references a COSEM object attribute." An indirect (non-specific) reference example is: "A GET-REQUEST-NORMAL service primitive contains a single COSEM attribute descriptor";
- the names of COSEM data transfer APDUs using LN referencing are capitalized and joined with a dash to signify a single entity. Example: Get-Request-Normal;
- the names of COSEM data transfer APDUs using SN referencing use the camel notation. Example: ReadRequest.

6.2 The COSEM-OPEN service

Function

The function of the COSEM-OPEN service is to establish an AA between peer COSEM APs. It uses the A-ASSOCIATE service of the ACSE. The COSEM-OPEN service provides only the framework for *transporting* this information. To provide and verify that information is the job of the appropriate COSEM AP.

Semantics of the service primitives

The COSEM-OPEN service primitives shall provide parameters as shown in Table 11.

Table 11 – Service parameters of the COSEM-OPEN service primitives

	.request	.indication	.response	.confirm
Protocol_Connection_Parameters	M	M (=)	M	M (=)
ACSE_Protocol_Version	U	U (=)	U	U (=)
Application_Context_Name	M	M (=)	M	M (=)
Called_AP_Title	U	U (=)	–	–
Called_AE_Qualifier	U	U(=)	–	–
Called_AP_Invocation_Identifier	U	U (=)	–	–
Called_AE_Invocation_Identifier	U	U (=)	–	–
Calling_AP_Title	C	C (=)	–	–
Calling_AE_Qualifier	U	U (=)	–	–
Calling_AP_Invocation_Identifier	U	U (=)	–	–
Calling_AE_Invocation_Identifier	U	U (=)	–	–
Local_Or_Remote	–	–	–	M
Result	–	–	M	M
Failure_Type	–	–	M	M
Responding_AP_Title	–	–	C	C (=)
Responding_AE_Qualifier	–	–	U	U (=)
Responding_AP_Invocation_Identifier	–	–	U	U (=)
Responding_AE_Invocation_Identifier	–	–	U	U (=)
ACSE_Requirements	U	U (=)	U	U (=)
Security_Mechanism_Name	C	C (=)	C	C (=)
Calling_Authentication_Value	C	C (=)	–	–
Responding_Authentication_Value	–	–	C	C (=)
Implementation_Information	U	U (=)	U	U (=)
Proposed_xDLMS_Context	M	M (=)	–	–
Dedicated_Key	C	C (=)	–	–
Response_Allowed	C	C (=)		
Proposed_DLMS_Version_Number	M	M (=)	–	–
Proposed_DLMS_Conformance	M	M (=)	–	–
Client_Max_Receive_PDU_Size	M	M (=)	–	–
Negotiated_xDLMS_Context	–	–	S	S (=)
Negotiated_DLMS_Version_Number	–	–	M	M (=)
Negotiated_DLMS_Conformance	–	–	M	M (=)
Server_Max_Receive_PDU_Size	–	–	M	M (=)
VAA_Name			M	M (=)
XLMS_Initiate_Error			S	S (=)
User_Information	U	C (=)	–	–
Service_Class	M	M (=)	–	–

The service parameters of the COSEM-OPEN.request service primitive, except the Protocol_Connection_Parameters, the User_Information parameter and – depending on the communication profile – the Service_Class parameter are carried by the fields of the AARQ APDU sent by the client.

The service parameters of the COSEM-OPEN.response service primitive, except the Protocol_Connection_Parameters is carried by the fields of the AARE APDU sent by the server.

The A-ASSOCIATE service and the AARQ and AARE APDUs are specified in 7.2. Encoding examples are given in Annex C and Annex D.

The Protocol_Connection_Parameters parameter is mandatory. It contains all information necessary to use the layers of the communication profile, including the communication profile (protocol) identifier and the addresses required. It identifies the participants of the AA. The elements of this parameter are passed to the entities managing lower layer connections and to the lower layers as appropriate.

The ACSE_Protocol_Version parameter is optional. If present, the default value shall be used.

The Application_Context_Name parameter is mandatory. In the request primitive, it holds the value proposed by the client. In the response primitive, it holds the same value or the value supported by the server.

The Calling_AP_Title parameter is conditional. When the Application_Context_Name indicates an application context using ciphering, it may carry the client system title specified in 5.4.8.3.4.6.

The use of the Called_AP_Title, Called_AE_Qualifier, Called_AP_Invocation_Identifier, Called_AE_Invocation_Identifier, Calling_AE_Qualifier, Calling_AP_Invocation_Identifier and Calling_AE_Invocation_Identifier parameters is optional. The Calling_AE_Invocation_Identifier parameter carries the identifier of the client-side user of the AA. The use of the other parameters is not specified in this international standard.

NOTE 1 The client user identification mechanism is specified in IEC 62056-6-2:2016, 5.3.2.

The Local_or_Remote parameter is mandatory. It indicates the origin of the COSEM-OPEN.confirm primitive. It is set to Remote if the primitive has been generated following the reception of an AARE APDU from the server. It is set to Local if the primitive has been locally generated.

The Result parameter is mandatory. In the case of remote confirmation, it indicates whether the Server accepted the proposed AA or not. In the case of local confirmation, it indicates whether the client side protocol stack accepted the request or not.

The Failure_type parameter is mandatory. In the case of remote confirmation, it carries the information provided by the server. In the case of local and negative confirmation, it indicates the reason for the failure.

The use of the Responding_AP_Title parameter is conditional. When the Application_Context_Name parameter indicates an application context using ciphering, it may carry the server system title specified in 5.4.8.3.4.6.

The use of the Responding_AE_Qualifier, Responding_AP_Invocation_Identifier and Responding_AE_Invocation_Identifier parameters is optional. Their use is not specified in this international standard.

The ACSE_Requirements parameter is optional. It is used to select the optional authentication functional unit of the A-Associate service for the association; see 7.2.1.

The presence of the ACSE_Requirements parameter depends on the security mechanism used:

- in the case of Lowest Level Security, it shall not be present; only the Kernel functional unit will be used;
- in the case of Low Level Security (LLS) it shall be present in the .request primitive and it may be present in the .response service primitive and it shall indicate authentication;
- in the case of High Level Security (HLS), it shall be present both in the .request and the .response service primitives and it shall indicate authentication.

The `Security_Mechanism_Name` parameter is conditional. It is present only if the authentication functional unit has been selected. If present, the .request primitive holds the value proposed by the client and the .response primitive holds the value required by the server, i.e. the one to be used by the client.

The `Calling_Authentication_Value` parameter and the `Responding_Authentication_Value` parameters are conditional. They are present only if the authentication functional unit has been selected. They hold the client authentication value / server authentication value respectively, appropriate for the `Security_Mechanism_Name`.

The `Implementation_Information` parameter is optional. Its use is not specified in this international standard.

The `Proposed_xDLMS_Context` parameter holds the elements of the proposed xDLMS context carried by the xDLMS InitiateRequest APDU, placed in the user-information field of the AARQ APDU.

The `Dedicated_Key` element is conditional. It may be present only, when the `Application_Context_Name` parameter indicates an application context using ciphering. The dedicated key is used for dedicated ciphering of xDLMS APDUs exchanged within the AA established.

When the dedicated key is present, the xDLMS InitiateRequest APDU shall be authenticated and encrypted using the AES-GCM-128 algorithm, the global unicast encryption key and the authentication key (if in use). The xDLMS InitiateRequest APDU shall be ciphered the same way when the dedicated key is not present but it is necessary to protect the RLRQ APDU by including the ciphered xDLMS InitiateRequest in its user-information field; see 6.3.

The use of `Response_Allowed` element is conditional. It indicates if the server is allowed to respond with an AARE APDU, i.e. if the AA to be established is confirmed (`Response_Allowed == TRUE`) or not confirmed (`Response_Allowed == FALSE`).

The `Proposed_DLMS_Version_Number` element holds the proposed DLMS version number; see 4.2.3.1.

The `Proposed_DLMS_Conformance` element holds the proposed conformance block; see 7.3.1.

The `Client_Max_Receive_PDU_Size` element holds the maximum length of the xDLMS APDUs the client can receive; see Table 1.

If the xDLMS context proposed by the client is acceptable for the server, then the response service primitive shall contain the `Negotiated_xDLMS_Context` parameter. It holds the elements of the negotiated xDLMS context, carried by the xDLMS InitiateResponse APDU, placed in the user-information field of the AARE APDU. If the xDLMS InitiateRequest APDU has been ciphered, the xDLMS InitiateResponse APDU shall be also ciphered the same way.

The `Negotiated_DLMS_Version_Number` element holds the negotiated DLMS version number. See 4.2.3.1.

The `Negotiated_DLMS_Conformance` element holds the negotiated conformance block. See 7.3.1.

The `Server_Max_Receive_PDU_Size` element carries the maximum length of the xDLMS APDUs the server can receive; see Table 1.

The `VAA_name` element carries the dummy value of 0x0007 in the case of LN referencing, and the `base_name` of the current Association object, 0xFA00, in the case of SN referencing.

If the xDLMS context proposed by the client is not acceptable for the server, then the response service primitive shall carry the `xDLMS_Initiate_Error` parameter. It is carried by the `ConfirmedServiceError` APDU, with appropriate diagnostic elements, placed in the user-information field of the AARE APDU.

The `User_Information` parameter is optional. If present, it shall be passed on to the supporting layer, provided it is capable to carry it. The indication primitive shall then contain the user-specific information carried by the supporting lower protocol layer(s); see Annex A.

NOTE 2 The `User_Information` parameter of the COSEM-OPEN service is not to be confused with the user-information field of the AARQ / AARE APDUs.

The `Service_Class` parameter is mandatory. It indicates whether the service shall be invoked in a confirmed or in an unconfirmed manner. The handling of this parameter may depend on the communication profile; see Annex A.

Use

Possible logical sequences of the COSEM-OPEN service primitives are illustrated in Figure 8:

- for confirmed AA – successful or unsuccessful – establishment, item a);
- for unconfirmed AA establishment, item b);
- in the case of a pre-established AA or an unsuccessful attempt due to a local error, item c).

The `.request` primitive is invoked by the client AP to request the establishment of a confirmed or an unconfirmed AA with a server AP.

NOTE 3 Before the invocation of the COSEM-OPEN.request primitive, the physical layers shall be connected. Depending on the communication profile, the invocation of this primitive may also imply the connection of other lower layers.

Upon reception of the request invocation, the AL constructs and sends an AARQ APDU to the server.

The indication primitive is generated by the server AL when a correctly formatted AARQ APDU is received.

The `.response` primitive is invoked by the server AP to indicate to the AL whether the proposed AA is accepted or not. It is invoked only if the proposed AA is confirmed. The AL constructs then an AARE APDU and sends it to its peer, containing the service parameters received from the AP.

The `.confirm` primitive is generated by the client AL to indicate to the client AP whether the AA previously requested is accepted or not:

- remotely, when an AARE APDU is received;
- locally, if the requested AA already exists; this includes pre-established AAs;

- locally, if the corresponding .request primitive has been invoked with Service_Class == Unconfirmed;
- locally, if the requested AA is not allowed;
- locally, if an error is detected: missing or not correct parameters, failure during the establishment of the requested lower layer connections, missing physical connection, etc.

The protocol for establishing an AA is specified in 7.2.4. Communication profile specific rules are specified in Annex A.

6.3 The COSEM-RELEASE service

Function

The function of the COSEM-RELEASE service is to gracefully release an existing AA. Depending on the way it is invoked, it uses the A-RELEASE service of the ACSE or not.

Semantics of the service primitives

The COSEM-RELEASE service primitives shall provide parameters as shown in Table 12.

Table 12 – Service parameters of the COSEM-RELEASE service primitives

	.request	.indication	.response	.confirm
Use_RLRQ_RLRE	U	C(=)	C(=)	-
Reason	U	U(=)	U	U(=)
Proposed_xDLMS_Context	C	C(=)	-	-
Negotiated_xDLMS_Context	-	-	C	C(=)
Local_Or_Remote	-	-	-	M
Result	-	-	M	M
Failure_Type	-	-	-	C
User_Information	U	C(=)	U	C(=)

The Use_RLRQ_RLRE parameter in the .request primitive is optional. If present, its value may be FALSE (default) or TRUE. It indicates whether the ACSE A-RELEASE service – involving an RLRQ / RLRE APDU exchange – should be used or not. The A-RELEASE service and the RLRQ / RLRE APDUs are specified in 7.2. The Use_RLRQ_RLRE parameter in the .response primitive is conditional. If it was present in the .indication primitive and if its value was TRUE, it shall also be present and its value shall be TRUE. Otherwise, it shall not be present or its value shall be FALSE.

If the value of the Use_RLRQ_RLRE parameter is FALSE, then the AA can be released by disconnecting the supporting layer of the AL.

The Reason parameter is optional. It may be present only if the value of the Use_RLRQ_RLRE is TRUE. It is carried by the reason field of the RLRQ / RLRE APDU respectively.

When used on the .request primitive, this parameter identifies the general level of urgency of the request. It takes one of the following symbolic values:

- normal;
- urgent (not available in DLMS/COSEM); or
- user defined.

When used on the .response primitive, this parameter identifies information about why the acceptor accepted or rejected the release request. Note that in DLMS/COSEM, the server cannot reject the release request. It takes one of the following symbolic values:

- normal;
- not finished; or
- user defined.

NOTE The value "not finished" is used in the .response primitive when the acceptor is forced to release the association but wishes to give a warning that it has additional information to send or receive.

The Proposed_xDLMS_Context parameter is conditional. It is present only if the value of the Use_RLRQ_RLRE is TRUE and the AA to be released has been established with an application context using ciphering. This option allows securing the COSEM-RELEASE service, and avoiding thereby a denial-of-service attack that may be carried out by unauthorized releasing of the AA.

In the .request primitive, the Proposed_xDLMS_Context parameter shall be the same as in the COSEM-OPEN.request service primitive, having established the AA to be released. It is carried by the xDLMS InitiateRequest APDU, authenticated and encrypted the same way as in the AARQ and placed in the user-information field of the RLRQ APDU.

If the xDLMS InitiateRequest APDU can be successfully deciphered, then the .response primitive shall carry the same Negotiated_xDLMS_Context parameter as in the COSEM-OPEN.response primitive. It is carried by the xDLMS InitiateResponse APDU, authenticated and encrypted the same way as in the AARE and placed in the user-information field of the RLRE APDU.

Otherwise, the RLRQ APDU is silently discarded.

The Local_or_Remote parameter is mandatory. It indicates the origin of the COSEM-RELEASE.confirm primitive.

It is set to Remote if either:

- a RLRE APDU has been received from the server; or
- a disconnect confirmation service primitive has been received.

It is set to Local if the primitive has been locally generated.

The Result parameter is mandatory. In the .response primitive, it indicates whether the server AP can accept the request to release the AA or not. As servers cannot refuse such requests, its value should normally be SUCCESS unless the AA referenced does not exist.

The Failure_Type parameter is conditional. It is present if Result == ERROR. In this case, it indicates the reason for the failure. It is a locally generated parameter on the client side.

The User_Information parameter in the .request primitive is optional. If present, it is passed to the supporting layer, provided it is able to carry it. The .indication primitive contains then the user-specific information carried by the supporting lower protocol layer(s). Similarly, it is optional in the .response primitive. If present, it is passed to the supporting layer. In the .confirm primitive, it may be present only when the service is remotely confirmed. It contains then the user-specific information carried by the supporting lower protocol layer(s).

The specification of the content of the User_Information parameter is not within the scope of this international standard. See also Annex A.

Use

Possible logical sequences of the COSEM-RELEASE service primitives are illustrated in Figure 8:

- for successful release of a confirmed AA , item a);
- for release of an unconfirmed AA , item b); and
- for an unsuccessful attempt due to a local error, item c).

The use of the COSEM-RELEASE service depends on the value of the Use_RLRQ_RLRE parameter. When it is invoked with Use_RLRQ_RLRE == TRUE, the service is based on the ACSE A-RELEASE service. Otherwise, the invocation of the service leads to the disconnection of the supporting layer.

The .request primitive is invoked by the client AP to request the release of a confirmed or an unconfirmed AA with a server AP. Upon reception of the request invocation with Use_RLRQ_RLRE == TRUE, the AL constructs and sends an RLRQ APDU to the server. Otherwise, it sends an XX-DISCONNECT.request primitive (where XX is the supporting lower protocol layer).

The .indication primitive is generated by the server AL if:

- a RLRQ APDU is received. If a deciphering error occurs, the RLRQ APDU is silently discarded (no .indication primitive is generated); or
- an XX-DISCONNECT.request is received.

The .response primitive is invoked by the server AP, but only if the AA to be released is confirmed. Note, that the server AP cannot refuse this request. Upon reception of the .response service primitive, the server AL:

- sends a RLRE APDU, if the Use_RLRQ_RLRE parameter is TRUE; or
- sends an XX-DISCONNECT.response otherwise.

The .confirm primitive is generated by the client AL to indicate to the client AP whether the requested release of the AA is accepted or not:

- remotely, when an XX-DISCONNECT.cnf primitive is received. The supporting layer is disconnected; or
- remotely, when a RLRE APDU is received. The supporting layer is not disconnected; or
- locally, upon the expiry of a time-out on waiting for an RLRE APDU; or
- locally, when an RLRQ APDU to release an unconfirmed AA is sent out; or
- locally, when a local error is detected: missing or incorrect parameters, or communication failure at lower protocol layer level, etc.

If the RLRE APDU received contains a ciphered xDLMS InitiateResponse APDU but it cannot be deciphered, then the RLRE APDU shall be discarded. It is left to the client to cope with the situation.

The protocol for releasing an AA is specified in 7.2.5. Communication profile specific rules are specified in Annex A. See also 7.2.1.

6.4 COSEM-ABORT service

Function

The function of the COSEM-ABORT service is to indicate an unsolicited disconnection of the supporting layer.

Semantics

The COSEM-ABORT service primitives shall provide parameters as shown in Table 13.

Table 13 – Service parameters of the COSEM-ABORT service primitives

	.indication
Diagnostics	U

The Diagnostics parameter is optional. It shall indicate the possible reason for the disconnection, and may carry lower protocol layer dependent information as well. Specification of the contents of this parameter is not within the scope of this international standard.

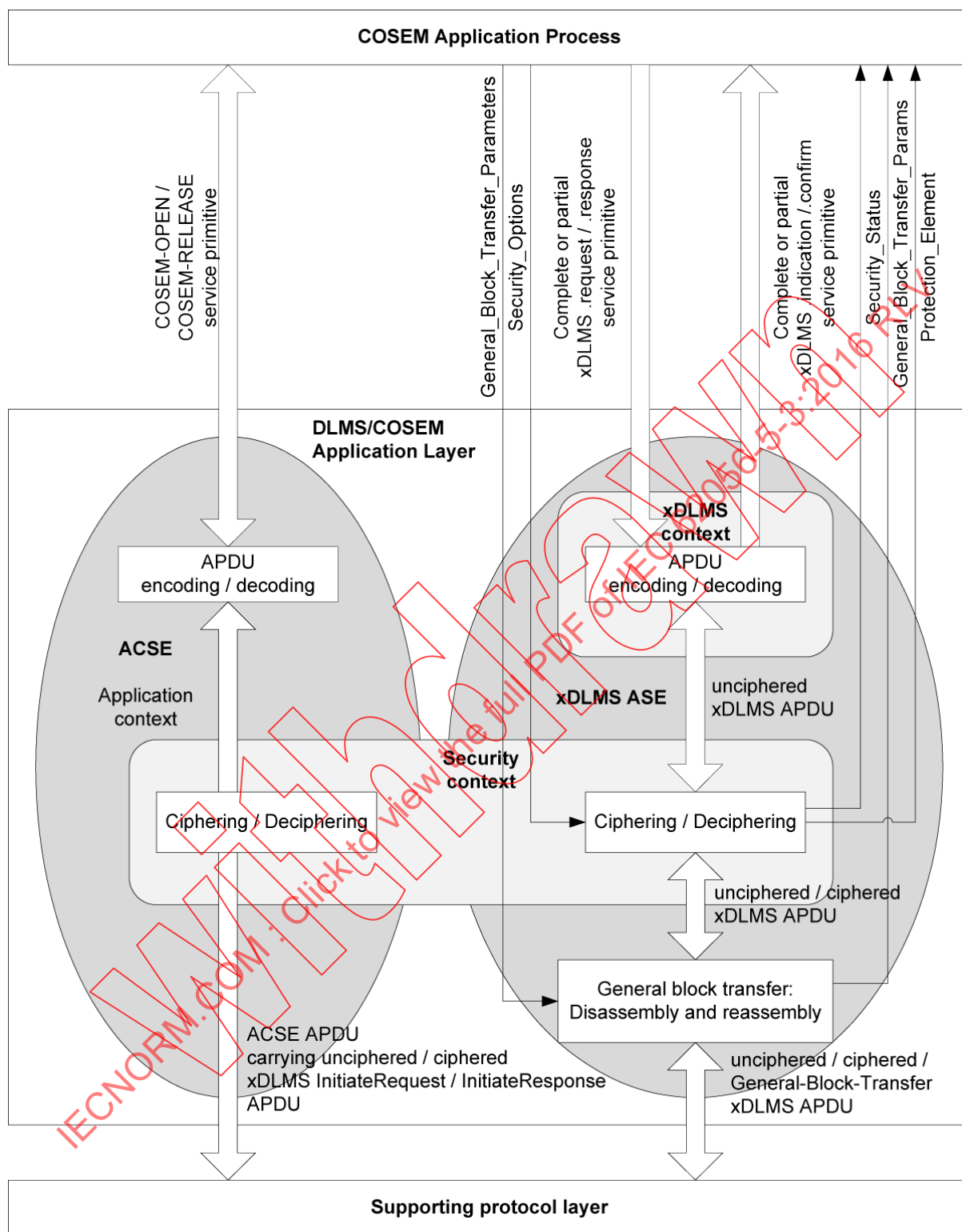
Use

The COSEM-ABORT.indication primitive is locally generated both on the client and on the server side to indicate to the COSEM AP that a lower layer connection closed in an unsolicited manner. The origin of such an event can be an external event (for example the physical line is broken), or an action of a supporting layer connection manager AP, present in some profiles, when the supporting layer connection is not managed by the COSEM AL. This shall cause the COSEM APs to abort any existing AAs, except the pre-established ones on the server side.

The protocol for the COSEM-ABORT service is specified in 7.2.5.3.

6.5 Protection and general block transfer parameters

To control cryptographic protection of xDLMS APDUs and the GBT mechanism, additional service parameters are passed between the AL and the AP as shown in Figure 9 and Table 14.



NOTE For services initiated by the client, the service primitives are .request, .indication, .response and .confirm. For unsolicited services – initiated by the server – the service primitives are .request and .indication.

Figure 9 – Additional service parameters to control cryptographic protection and general block transfer

Table 14 – Additional service parameters

	.request	.indication	.response	.confirm
Additional_Service_Parameters	U	–	U (=)	
Invocation_Type	M	–	M (=)	–
Security_Options	C	–	C (=)	–
General_Block_Transfer_Parameters	C	–	C (=)	–
Block_Transfer_Streaming	M	–	M (=)	–
Block_Transfer_Window	M	–	M (=)	–
Service_Parameters	M	–	M (=)	–
Additional_Service_Parameters	–	U	–	U (=)
Invocation_Type	–	U	–	U (=)
Security_Status	–	C	–	C (=)
General_Block_Transfer_Parameters	–	C	–	C (=)
Block_Transfer_Window	–	M	–	M (=)
Service_Parameters	–	M	–	M (=)
Protection_Element	–	C	–	C (=)
NOTE The service primitives available depend on the kind of the service.				

The Additional_Service_Parameters are present only if ciphering or GBT is used.

The Invocation_Type parameter indicates if the service invocation is complete or partial. Possible values: COMPLETE, FIRST-PART, ONE-PART and LAST-PART.

NOTE 1 Partial service invocations may be useful when the service parameters are long. However, there is no direct relationship between the partial service invocations and the General-Block-Transfer APDUs.

The Security_Options parameter holds information on the protection to be applied by the AL. See Table 15. It is present only if Invocation_Type = COMPLETE or FIRST-PART.

The General_Block_Transfer_Parameters parameter provides information on the GBT streaming capabilities:

- the Block_Transfer_Streaming parameter is present only in .request and .response service primitives. It is passed by the AP to the AL to indicate that the AL is allowed to send General-Block-Transfer APDUs using streaming (TRUE) or not (FALSE);
- the Block_Transfer_Window parameter indicates the window size supported, i.e. the maximum number of blocks that can be received in a window.

The General_Block_Transfer_Parameters parameter is present only if Invocation_Type = COMPLETE or FIRST-PART.

The streaming process itself is managed by the AL. See 7.3.12.

The Service_Parameters are mandatory: they include the parameters of the COSEM object attribute or method related xDLMS service invocation. If Invocation_Type != COMPLETE, then it includes a part of the service parameters.

The Security_Status parameter is conditional: it is present only if cryptographic protection has been applied. It carries information on the protection that has been verified / removed by the AL. It may be present in all type of service invocations. See Table 15.

The Protection_Element parameter is conditional: it is present only if the APDU has been authenticated. See Table 15.

Table 15 – Security parameters

	.request	.indication	.response	.confirm
Security_Options	C	–	C (=)	–
Security_Options_Element	M		M (=)	
Security_Protection_Type	M	–	M (=)	–
Glo_Ciphering	S	–	S (=)	–
Ded_Ciphering	S	–	S (=)	–
General_Glo_Ciphering	S	–	S (=)	–
General_Ded_Ciphering	S	–	S (=)	–
System_Title	C	–	C (=)	–
Security_Control	M	–	M (=)	–
Security_Status	–	C	–	C (=)
Security_Status_Element	–	M	–	M (=)
Security_Protection_Type		M		M (=)
Glo_Ciphering	–	S	–	S (=)
Ded_Ciphering	–	S	–	S (=)
General_Glo_Ciphering	–	S	–	S (=)
General_Ded_Ciphering	–	S	–	S (=)
System_Title	–	C	–	C (=)
Security_Control	–	M	–	M (=)
Protection_Element	–	C	–	C (=)
Frame_Counter	–	M	–	M (=)
Authentication_Tag		M		M (=)
NOTE The service primitives available depend on the kind of the service.				

The Security_Options parameter is present only if the application context is a ciphered one and the .request / .response service primitive has to be ciphered. It contains the Security_Options_Element sub-parameter. It is present only if Invocation_Type = COMPLETE or FIRST-PART.

The Security_Status parameter is present only if the application context is a ciphered one and if the .indication / .confirm service primitive has been ciphered. It contains the Security_Status_Element sub-parameter. It may be present in all type of service invocations.

The Security_Options_Element and Security_Status_Element include:

- Security_Protection_Type, identifies the ciphered APDU that shall be / has been used:
 - Glo_Ciphering: the service specific glo-ciphering APDU shall be / has been used (e.g. glo-get-response);
 - Ded_Ciphering: the service specific ded-ciphering APDU shall be / has been used (e.g. ded-get-response);
 - General_Glo_Ciphering: the general-glo-ciphering APDU shall be / has been used;
 - General_Ded_Ciphering: the general-ded-ciphering APDU shall be / has been used.
- The System_Title parameter is present only with General_Glo_Ciphering and General_Ded_Ciphering. It holds the system title of the sender.

NOTE 2 The purpose to include system-title of the sender is to allow the other party to build the initialization vector where the system-title has not been exchanged in another way; see 5.4.8.3.4.6.

- The Security_Control field contains the Security Control byte, see Table 6.

The Protection_Element parameter is present only if the APDU has been authenticated. It may be present in all type of service invocations, but it may be empty if it is no yet available. It contains:

- the Frame_Counter, holding the invocation field of the initialization vector, see 5.4.8.3.4.5.
- the Authentication tag.

6.6 The GET service

Function

The GET service is used with LN referencing. It can be invoked in a confirmed or unconfirmed manner. Its function is to read the value of one or more COSEM interface object attributes. The result can be delivered in a single response or – if it is too long to fit in a single response – in multiple responses, with block transfer.

Semantics

The GET service primitives shall provide parameters as shown in Table 16.

Table 16 – Service parameters of the GET service

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	M (=)	M (=)
Request_Type	M	M (=)	–	–
COSEM_Attribute_Descriptor { COSEM_Attribute_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Attribute_Id	M	M (=)		
Access_Selection_Parameters	U	U (=)		
Access_Selector	M	M (=)		
Access_Parameters	M	M (=)		
Block_Number	C	C (=)	–	–
Response_Type	–	–	M	M (=)
Result	–	–	M	M (=)
Get_Data_Result { Get_Data_Result }	–	–	S	S (=)
Data			S	S (=)
Data_Access_Result			S	S (=)
DataBlock_G	–	–	S	S (=)
Last_Block			M	M (=)
Block_Number			M	M (=)
Result			M	M (=)
Raw_Data			S	S (=)
Data_Access_Result			S	S (=)
NOTE For security parameters see Table 15.				

The Invoke_Id parameter identifies the instance of the service invocation.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Service_Class parameter indicates whether the service is confirmed or unconfirmed. The handling of this parameter depends on the communication profile; see Annex A.

The use of the Request_Type and Response_Type parameters is shown in Table 17.

Table 17 – GET service request and response types

Request type		Response type	
NORMAL	The value of a single attribute is requested.	NORMAL	The complete result is delivered.
		ONE-BLOCK	One block of the result is delivered.
NEXT	The next data block is requested.	ONE-BLOCK	As above.
		LAST-BLOCK	The last block of the result is delivered.
WITH-LIST	The value of a list of attributes is requested.	WITH-LIST	The complete result is delivered.
		ONE-BLOCK	As above.
NOTE The same Response_Type can be present more than once, to show the possible responses to each kind of request.			

The COSEM_Attribute_Descriptor parameter references a COSEM object attribute. It is present when Request_Type == NORMAL or WITH-LIST. It is a composite parameter:

- the (COSEM_Class_Id, COSEM_Object_Instance_Id) doublet non-ambiguously references one and only one COSEM object instance;
- the COSEM_Object_Attribute_Id element identifies the attribute(s) of the object instance. COSEM_Object_Attribute_Id == 0 references all public attributes of the object (Attribute_0 feature; see 4.2.3.11);
- the Access_Selection_Parameters is present only when COSEM_Object_Attribute_Id != 0 and if selective access to the given attribute is available; see 4.2.3.9. The Access_Selector and Access_Parameters sub-parameters are defined in the COSEM interface object definitions; see IEC 62056-6-2:2016.

A GET-REQUEST-NORMAL service primitive contains a single COSEM attribute descriptor. A GET-REQUEST-WITH-LIST service primitive contains a list of COSEM attribute descriptors; their number is limited by the server-max-receive-pdu-size: a GET.request service primitive shall always fit in a single APDU.

The Block_Number parameter is used in the GET-REQUEST-NEXT service primitive. It carries the number of the latest data block received correctly.

If the encoded form of the response fits in a single APDU, the Result is of type Get_Data_Result:

- the Data choice carries the value of the attribute at the time of access; or
- the Data_Access_Result choice carries the reason for the read to fail for this attribute.

A GET-RESPONSE-NORMAL service primitive carries a single Get_Data_Result parameter. A GET-RESPONSE-WITH-LIST service primitive carries a list of Get_Data_Result parameters; their number and order shall be the same as that of the COSEM_Attribute_Descriptor parameters in the request.

If COSEM_Object_Attribute_Id == 0 (Attribute_0), the Data shall be a structure containing the value of all public attributes in the order of their appearance in the given object specification. For attributes to which no access right is granted within the given AA, or which cannot be accessed for any other reason, null-data shall be returned.

If the encoded form of the response does not fit in a single APDU, it can be transported in data blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used, the Result is of type DataBlock_G. It carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the (inner) Result element carries either Raw_Data or Data_Access_Result. Within this:
 - if the value of a single attribute was requested, Raw_Data carries a part of the value of the attribute (Data). If the Data cannot be delivered, the response shall be GET-RESPONSE-NORMAL with Data_Access_Result;
 - if the value of a list of attributes was requested, Raw_Data carries a part of the list of Get_Data_Results, either Data or Data_Access_Result for each attribute;
 - if the raw data cannot be delivered, Data_Access_Result shall carry the reason. For error cases, see 7.3.3.

Use

Possible logical sequences of the GET service primitives are illustrated in Figure 8:

- for a successful confirmed GET, item a);
- for an unconfirmed GET, item d); and
- for an unsuccessful attempt due to a local error, item c).

The GET.request primitive is invoked by the client AP to read the value of one or all attributes of one or more COSEM objects of the server AP. The first request shall always be of Request_Type == NORMAL or WITH-LIST. A GET-REQUEST-NEXT service primitive is invoked only when the server could not deliver the complete data in a single response, i.e. following the reception of a .confirm primitive of Response_Type == ONE-BLOCK. Upon reception of the .request primitive, the client AL builds the Get-Request APDU appropriate for the request type and sends it to the server.

The GET.indication primitive is generated by the server AL upon reception of a Get-Request APDU.

The GET.response primitive is invoked by the server AP, if Service_Class == Confirmed, to send a response to an .indication primitive received. If the complete data requested fits in a single APDU, the .response primitive is invoked with Response_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it is invoked with Response_Type == ONE-BLOCK and finally with LAST-BLOCK.

The GET.confirm primitive is generated by the client AL to indicate the reception of a Get-Response APDU.

The protocol for the GET service is specified in 7.3.3.

6.7 The SET service

Function

The SET service is used with LN referencing. It can be invoked in a confirmed or unconfirmed manner. Its function is to write the value of one or more COSEM interface object attributes. The data to be written can be sent in a single request or – if it is too long to fit in a single request – in multiple requests, with block transfer.

Semantics

The SET service primitives shall provide parameters as shown in Table 18.

Table 18 – Service parameters of the SET service

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	M (=)	M (=)
Request_Type	M	M (=)	–	–
COSEM_Attribute_Descriptor { COSEM_Attribute_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Attribute_Id	M	M (=)		
Access_Selection_Parameters	U	U (=)		
Access_Selector	M	M (=)		
Access_Parameters	M	M (=)		
Data {Data }	C	C (=)	–	–
DataBlock_SA	C	C (=)	–	–
Last_Block	M	M (=)		
Block_Number	M	M (=)		
Raw_Data	M	M (=)		
Response_Type	–	–	M	M (=)
Result { Result }	–	–	C	C (=)
Block_Number	–	–	C	C (=)
NOTE For security parameters, see Table 15.				

The Invoke_Id parameter identifies the instance of the service invocation.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Service_Class parameter indicates whether the service is confirmed or unconfirmed. The handling of this parameter depends on the communication profile; see Annex A.

The use of the Request_Type and Response_Type parameters is shown in Table 19.

Table 19 – SET service request and response types

Request type		Response type	
NORMAL	The reference of a single attribute and the complete data to be written is sent.	NORMAL	The result is delivered.
FIRST-BLOCK	The reference of a single attribute and the first block of the data to be written is sent.	ACK-BLOCK	The correct reception of the block is acknowledged.
ONE-BLOCK	One block of the data to be written is sent.		
LAST-BLOCK	The last block of the data to be written is sent.	LAST-BLOCK	The correct reception of the last block is acknowledged and the result is delivered.
		LAST-BLOCK-WITH-LIST	The correct reception of the last block is acknowledged and the list of results is delivered.
WITH-LIST	The reference of a list of attributes and the complete data to be written is sent.	WITH-LIST	The list of results is delivered.
FIRST-BLOCK-WITH-LIST	The reference of a list of attributes and the first block of data to be written is sent.	ACK-BLOCK	The correct reception of the block is acknowledged.
NOTE The same Response_Type can be present more than once, to show the possible responses to each request.			

The COSEM_Attribute_Descriptor parameter references a COSEM object attribute. It is present when Request_Type == NORMAL, FIRST-BLOCK, WITH-LIST and FIRST-BLOCK-WITH-LIST. It is a composite parameter:

- the (COSEM_Class_Id, COSEM_Object_Instance_Id) doublet non-ambiguously references one and only one COSEM object instance;
- the COSEM_Object_Attribute_Id identifies the attribute(s) of the object instance. COSEM_Object_Attribute_Id == 0 references all public attributes of the object (Attribute_0 feature; see 4.2.3.11),
- the Access_Selection_Parameters is present only when COSEM_Object_Attribute_Id != 0 and if selective access to the given attribute is available; see 4.2.3.9. The Access_Selector and the Access_Parameters sub-parameters are defined in the COSEM interface object definitions; see IEC 62056-6-2:2016.

A SET-REQUEST-NORMAL or SET-REQUEST-WITH-FIRST-BLOCK service primitive contains a single COSEM attribute descriptor. A SET-REQUEST-WITH-LIST or a SET-REQUEST-FIRST-BLOCK-WITH-LIST service primitive contains a list of COSEM attribute descriptors; their number is limited by the server-max-receive-pdu-size: all COSEM attribute descriptors – together with (a part of) the data to be written – shall fit in a single APDU.

The Data parameter contains the data necessary to write the value of the referenced attributes. The number and the order of the Data parameters shall be the same as that of the COSEM_Attribute_Descriptor parameters.

If COSEM_Object_Attribute_Id == 0 (Attribute_0), the Data sent shall be a structure, containing, for each public attribute, in the order of their appearance in the given object specification, either a value or null-data, meaning that the given attribute needs not be set.

If the encoded form of the Data parameter does not fit in a single APDU, it can be transported in blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used, the DataBlock_SA parameter carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the data to be written.

The Result parameters are present in the .response primitive when Response_Type != ACK-BLOCK. Their number and order shall be the same as that of the COSEM_Attribute_Descriptor parameters in the request. Each Result shall contain either the information "success" or a reason for failing to write the attribute referenced (Data_Access_Result). When in the .request primitive COSEM_Object_Attribute_Id == 0 (Attribute_0), the Result shall carry a list of results, either the information "success" or a reason for failing to write the attribute (Data_Access_Result), for each public attribute, in the order of their appearance in the given object specification.

The Block_Number parameter shall be present when Response_Type == ACK-BLOCK, LAST-BLOCK, or LAST-BLOCK-WITH-LIST. It carries the number of the latest data block received correctly.

Use

Possible logical sequences of the SET service primitives are illustrated in Figure 8:

- for a successful confirmed SET, item a);
- for an unconfirmed SET, item d); and
- for an unsuccessful attempt due to a local error, item c).

The SET.request primitive is invoked by the client AP to write the value of one or all attributes of one or more COSEM objects of the server AP. If the complete data to be sent fits in a single APDU, the .request primitive shall be invoked with Request_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it shall be invoked with Request_Type == FIRST-BLOCK or FIRST-BLOCK-WITH-LIST, then with Request_Type == ONE-BLOCK and finally with LAST-BLOCK as appropriate. Upon reception of the .request primitive, the client AL builds the Set-Request APDU appropriate for the Request_Type and sends it to the server.

The SET.indication primitive is generated by the server AL upon reception of a Set-Request APDU.

The SET.response primitive is invoked by the server AP, if Service_Class == Confirmed, to send a response to an .indication primitive received. If the data were sent in a single APDU, the .response primitive is invoked with Response_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it is invoked with Response_Type == ACK-BLOCK, and finally with LAST-BLOCK or LAST-BLOCK-WITH-LIST as appropriate.

The SET.confirm primitive is generated by the client AL to indicate the reception of a Set-Response APDU.

The protocol for the SET service is specified in 7.3.4.

6.8 The ACTION service

Function

The ACTION service is used with LN referencing. It can be invoked in a confirmed or unconfirmed manner. Its function is to invoke one or more COSEM interface objects methods. It comprises two phases:

- in the first phase, the client sends the reference(s) of the method(s) to be invoked, with the method invocation parameters necessary;
- in the second phase, after invoking the methods, the server sends back the result and the return parameters generated by the invocation of the method(s), if any.

If the method invocation parameters are too long to fit in a single request, they are sent in multiple requests (block transfer from the client to the server). If the result and the return parameters are too long to fit in a single response, they are returned in multiple responses (block transfer from the server to the client.)

Semantics

The ACTION service primitives shall provide parameters as shown in Table 20.

Table 20 – Service parameters of the ACTION service

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	M (=)	M (=)
Request_Type	M	M (=)	–	–
COSEM_Method_Descriptor { COSEM_Method_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Method_Id	M	M (=)		
Method_Invocation_Parameters { Method_Invocation_Parameters }	U	U (=)	–	–
Response_Type	–	–	M	M (=)
Action_Response { Action_Response }	–	–	M	M (=)
Result			M	M (=)
Response_Parameters			U	U (=)
Data			S	S (=)
Data_Access_Result			S	S (=)
DataBlock_SA	C	C (=)	C	C (=)
Last_Block	M	M (=)	M	M (=)
Block_Number	M	M (=)	M	M (=)
Raw_Data	M	M (=)	M	M (=)
Block_Number	C	C (=)	C	C (=)
NOTE For security parameters, see Table 15.				

The Invoke_Id parameter identifies the instance of the service invocation.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Service_Class parameter indicates whether the service is confirmed or unconfirmed. The handling of this parameter depends on the communication profile; see Annex A.

The use of the Request_Type and Response_Type parameters is shown in Table 21.

Table 21 – ACTION service request and response types

Request type		Response type	
NORMAL	The reference of a single method and the complete method invocation parameter is sent.	NORMAL	The result and the complete return parameter are sent.
		ONE-BLOCK	One block of the result and of the return parameter is sent.
NEXT	The next data block is requested.	ONE-BLOCK	As above.
		LAST-BLOCK	The last block of the result(s) and of the return parameter(s) is sent.
FIRST-BLOCK	The reference of a single method and the first block of the method invocation parameters is sent.	NEXT	Correct reception of the block is acknowledged.
ONE-BLOCK	One block of the method invocation parameters is sent.		
LAST-BLOCK	The last block of the method invocation parameters is sent.	NORMAL	As above.
		ONE-BLOCK	As above.
WITH-LIST	The reference of a list of methods and the complete list of method invocation parameters is sent.	WITH-LIST	The complete list of results and return parameters is sent.
		ONE-BLOCK	See above.
WITH-LIST-AND-FIRST-BLOCK	The reference of a list of methods and the first block of the method invocation parameters is sent.	NEXT	The correct reception of the block is acknowledged.
NOTE The same Response_Type can be present more than once, to show the possible responses to each request.			

The COSEM_Method_Descriptor parameter references a COSEM object method. It is present if Request_Type == NORMAL, FIRST-BLOCK, WITH-LIST and WITH-LIST-AND-FIRST-BLOCK. It is a composite parameter:

- the (COSEM_Class_Id, COSEM_Object_Instance_Id) doublet non-ambiguously references one and only one COSEM object instance;
- the COSEM_Method_Id identifies one method of the COSEM object referenced.

An ACTION-REQUEST-NORMAL or ACTION-REQUEST-FIRST-BLOCK service primitive shall contain a single COSEM method descriptor. An ACTION-REQUEST-WITH-LIST or ACTION-REQUEST-WITH-LIST-AND-FIRST-BLOCK service primitive shall contain a list of COSEM method descriptors: their number is limited by the server-max-receive-pdu-size: all COSEM method references – together with (a part of) the method invocation parameters – shall fit in a single APDU.

The Method_Invocation_Parameter parameter carries the parameter(s) necessary for the invocation of the method(s) referenced.

- if Request_Type == NORMAL, the Method_Invocation_Parameter parameter is optional;
- if Request_Type == WITH-LIST, the service primitive shall contain a list of Method_Invocation_Parameters. The number and the order of the method invocation parameters shall be the same as that of the COSEM_Method_Descriptor-s. If the invocation of any of the methods does not require additional parameters, it shall be nevertheless present, but it shall be null data.

If the encoded form of the COSEM method descriptor(s) and method invocation parameter(s) does not fit in a single APDU, it can be transported in blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used the DataBlock_SA parameter carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the method invocation parameters.

The Action_Response parameters are present in the .response primitive when Response_Type == NORMAL, or WITH-LIST. Their number and the order shall be the same as that of the of COSEM method descriptors. It consists of two elements:

- the Result parameter. It contains either the information “success” or a reason for failing to invoke the method referenced (Action-Result);
- the Response_Parameter(s). Each response parameter shall contain either the Data returned as a result of invoking the method, or a reason for returning the parameters to fail (Data-Access-Result). If the invocation of any of the methods does not return parameters, null data shall be returned.

If the response does not fit in a single APDU, it can be transported in blocks using either the service-specific or the general block transfer mechanism.

If the service-specific block transfer mechanism is used, the DataBlock_SA parameter carries block transfer control information and raw-data:

- the Last_Block element indicates whether the current block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the response:
 - if a single method was invoked, Raw Data carries the result and the Response_Parameters if any. If no Response_Parameters are returned, the response shall be of type ACTION-RESPONSE-NORMAL;
 - if a list of methods was invoked, Raw_Data carries a part of the list of Action_Responses and optional data.

The Block_Number parameter in an ACTION-REQUEST-NEXT service primitive shall carry the number of the latest data block received from the server correctly.

The Block_Number parameter in an ACTION-RESPONSE-NEXT service primitive shall carry the number of the latest data block received from the client correctly.

Use

Possible logical sequences of the ACTION service primitives are illustrated in Figure 8:

- for a successful confirmed ACTION, item a);
- for an unconfirmed ACTION, item d); and
- for an unsuccessful attempt due to a local error, item c).

In the first phase, the ACTION.request primitive is invoked by the client AP to invoke one or more methods of one or more COSEM interface objects of the server AP. If the complete list of COSEM method descriptors and method invocation parameters fits in a single APDU, the .request primitive is invoked with Request_Type == NORMAL or WITH-LIST as appropriate. Otherwise, it is invoked with Request_Type == FIRST-BLOCK or WITH-LIST-AND-FIRST-BLOCK as appropriate, then with Request_Type == ONE-BLOCK and finally with LAST-BLOCK. Upon reception of the .request primitive, the client AL builds the Action-Request APDU appropriate for the Request_Type and sends it to the server.

The ACTION.indication primitive is generated by the server AL upon reception of an Action-Request APDU.

During the block transfer of the method invocation parameters, the server AP invokes the ACTION.response primitive with Request_Type == NEXT until the last block is received.

The ACTION.confirm primitive is generated by the client AL upon reception of an Action-Response APDU.

Once all method invocation parameters are transferred, the server invokes the methods of COSEM interface objects referenced, and the second phase commences.

If the complete response fits in a single APDU, the ACTION.response primitive is invoked by the server AP with Response_Type == NORMAL or WITH-LIST, as appropriate. Otherwise, it is invoked with Response_Type == ONE-BLOCK and finally with LAST-BLOCK. Upon reception of the .response primitive, the server AL builds the Action-Response APDU appropriate for the Response_Type and sends it to the client.

The ACTION.confirm primitive is generated by the client AL to indicate the reception of an Action-Response APDU.

During the block transfer of the return parameters, the client AP invokes the .request primitive with Request_Type == NEXT until the last block is received.

The protocol for the ACTION service is specified in 7.3.5.

6.9 The DataNotification service

Function

The DataNotification service is an unsolicited, unconfirmed service. It is used by the server to push data to the client. It is an unconfirmed service. The push process is configured by “Push setup” objects; see IEC 62056-6-2:2016, 5.3.8.

Semantics

The DataNotification service primitives shall provide parameters as shown in Table 22.

Table 22 – Service parameters of the DataNotification service primitives

	.request	.indication
Long_Invoke_Id	M	M (=)
Self_Descriptive	–	–
Processing_Option	–	–
Service_Class	–	–
Priority	M	M (=)
Date_Time	U	U (=)
Notification_Body	M	M (=)

The Long_Invoke_Id parameter identifies the instance of the service invocation.

The Self_Descriptive, Processing_Option and Service_Class parameters are not used in the case of this service.

The Priority parameter indicates the priority level associated to the instance of the service invocation: normal (FALSE) or high (TRUE).

The Date_Time parameter indicates the time at which the DataNotification.request service primitive is invoked. It is octet-string, which may be of length zero when transmitting the Date_Time is not required.

The Notification_Body parameter contains the push data.

Use

A possible logical sequence of the DataNotification service primitives is illustrated in Figure 8 f) and g).

The .request primitive is invoked by the server AP to push data to the remote client AP. Upon reception of the .request primitive, the server AL builds the DataNotification APDU.

The .indication primitive is generated by the client AL upon reception of a DataNotification APDU.

The protocol for the DataNotification service is specified in 7.3.6.

6.10 The EventNotification service

Function

The EventNotification service is an unsolicited, non-client/server type service. It is requested by the server, upon occurrence of an event, in order to inform the client of the value of an attribute, as though it had been requested by the COSEM. It is an unconfirmed service.

Semantics

The EventNotification service primitives shall provide parameters as shown in Table 23.

Table 23 – Service parameters of the EventNotification service primitives

	.request	.indication
Time	U	U (=)
Application_Addresses	U	U (=)
COSEM_Attribute_Descriptor	M	M (=)
COSEM_Class_Id	M	M (=)
COSEM_Object_Instance_Id	M	M (=)
COSEM_Object_Attribute_Id	M	M (=)
Attribute_Value	M	M (=)

The optional Time parameter indicates the time at which the EventNotification.request service primitive was issued.

The Application_Addresses parameter is optional. It is present only when the EventNotification service is invoked outside of an established AA. In this case, it contains all protocol specific parameters required to identify the sender and destination APs.

When the .request primitive does not contain the optional Application_Addresses parameter, default addresses shall be used, those of the server management logical device and the client

management AP. Both APs are always present and in any protocol profile, they are bound to known, pre-defined addresses.

The (COSEM_Class_Id, COSEM_Object_Instance_Id, COSEM_Object_Attribute_Id) triplet references non-ambiguously one and only one attribute of a COSEM interface object instance.

The Attribute_Value parameter carries the value of this attribute. More information about the notified event may be obtained by interrogating this COSEM interface object.

If the encoded form of the request does not fit in a single APDU, it can be transported in data blocks using the general block transfer mechanism.

Use

A possible logical sequence of the EventNotification service primitives is illustrated in Figure 8 f) and g).

The .request primitive is invoked by the server AP to send the value of a COSEM interface object attribute to the remote client AP. Upon reception of the .request primitive, the Server AL builds the EventNotificationRequest APDU.

In some cases, the supporting lower layer protocol(s) do (does) not allow sending a protocol data unit in a real, unsolicited manner. In these cases, the client has to explicitly solicit sending an EventNotification frame, by invoking the Trigger_EventNotification_Sending service primitive.

The EventNotification.indication primitive is generated by the client AL upon reception of an EventNotificationRequest APDU.

The protocol for the EventNotification service is specified in 7.3.7.

6.11 The TriggerEventNotificationSending service

Function

The function of the TriggerEventNotificationSending service is to trigger the server by the client to send the frame carrying the EventNotification.request APDU.

This service is necessary in the case of protocols, when the server is not able to send a real non-solicited EventNotification.request APDU.

Semantics

The TriggerEventNotificationSending.request service primitive shall provide parameters as shown in Table 24.

Table 24 – Service parameters of the TriggerEventNotificationSending.request service primitive

	.request
Protocol_Parameters	M

The Protocol_Parameters parameter contains all lower protocol layer dependent information, which is required for triggering the server to send out an eventually pending frame containing an EventNotification.request APDU. This information includes the protocol identifier, and all the required lower layer parameters.

Use

Upon reception of a TriggerEventNotificationSending.request service invocation from the client AP, the client AL shall invoke the corresponding supporting layer service to send a trigger message to the server.

6.12 Variable access specification

Variable_Access_Specification is a parameter of the xDLMS Read / Write / UnconfirmedWrite InformationReport .request / .indication service primitives. Its variants are shown in Table 25:

- Variable_Name identifies a DLMS named variable;
- Parameterized_Access provides the capability to transport additional parameters;
- Block_Number_Access transports a block number;
- Read_Data_Block_Access transports block transfer control information and raw data;
- Write_Data_Block_Access transports block transfer control information.

The use of the different variants depends on the service and it is described in the respective SN service specifications.

Table 25 – Variable Access Specification

Variable_Access_Specification	Read .request	Write .request	Unconfirmed Write.request	Information Report
Kind_Of_Access	M	M	M	M
Variable_Name	S	S	S	M
Detailed_Access	Not used in DLMS/COSEM			
Parameterized_Access	S	S	S	–
Variable_Name	M	M	M	
Selector	U	U	U	
Parameter	U	U	U	
Block_Number_Access	S	–	–	–
Block_Number	M			
Read_Data_Block_Access	S	–	–	–
Last_Block	M			
Block_Number	M			
Raw_Data	M			
Write_Data_Block_Access	–	S	–	–
Last_Block		M		
Block_Number		M		

6.13 The Read service

Function

The Read service is used with SN referencing. It is a confirmed service. Its functions are:

- to read the value of one or more COSEM interface object attributes. In this case, the encoded form of the .request service primitive shall fit in a single APDU. The result can be delivered in a single response, or – if it is too long to fit in a single response – in multiple responses, with block transfer;

- to invoke one or more COSEM interface object methods, when return parameters are expected. In this case, if either the .request (including the method references and the method invocation parameters) or the .response service primitive (including the results and return parameters) is too long to fit in a single APDU, then block transfer with multiple requests and/or responses can be used.

The Read service is specified in IEC 61334-4-41:1996, 10.4 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The Read service primitives shall provide service parameters as shown in Table 26.

Table 26 – Service parameters of the Read service

	.request	.indication	.response	.confirm
Variable_Access_Specification { Variable_Access_Specification }	M	M (=)		
Variable_Name	S	S (=)		
Parameterized_Access	S	S (=)	–	–
Variable_Name	M	M (=)		
Selector	U	U (=)		
Parameter	U	U (=)		
Read_Data_Block_Access	S	S (=)		
Last_Block	M	M (=)		
Block_Number	M	M (=)		
Raw_Data	M	M (=)		
Block_Number_Access	S	S (=)		
Block_Number	M	M (=)		
Result (+)			S	S (=)
Read_Result { Read_Result }	–	–	M	M (=)
Data			S	S (=)
Data_Access_Error			S	S (=)
Data_Block_Result			S	S (=)
Last_Block			M	M (=)
Block_Number			M	M (=)
Raw_Data			M	M (=)
Block_Number			S	S (=)
Result (–)	–	–	S	S (=)
Error_Type			M	M (=)
NOTE For security parameters, see Table 15.				

The use of the different variants of the Variable-Access-Specification service parameter of the Read.request service primitive and the different choices of the Read.response primitive are shown in Table 27.

If the encoded form of the response does not fit in a single APDU, it can be transported in data blocks using the general block transfer mechanism.

Table 27 – Use of the Variable_Access_Specification variants and the Read.response choices

Read.request Variable_Access_Specification		Read.response CHOICE	
Variable_Name (Variable_Name)	References a list ¹ of COSEM object attributes.	Data {Data}	Delivers the value of the attribute(s) referenced.
		Data_Access_Error {Data_Access_Error}	Provides the reason for the read to fail.
		Data_Block_Result	Delivers block transfer control information and one block of raw data.
Parameterized_Access {Parameterized_Access}	References a list ¹ of COSEM object attributes to be read selectively.	Data {Data}	As above.
		Data_Access_Error {Data_Access_Error}	
		Data_Block_Result	
	References a list ¹ of COSEM object methods, with method invocation parameters.	Data {Data}	Delivers the method invocation return parameters. NOTE If parameters are returned, this implies that the method invocation succeeded.
		Data_Access_Error {Data_Access_Error}	Provides the reason for the method invocation to fail.
Read_Data_Block_Access	Carries block transfer control information and one part of encoded form of the COSEM method references and method invocation parameters.	Data_Block_Result	As above.
		Block_Number	Carries the number of the latest data block received.
Block_Number_Access	Carries the number of the latest data block received.	Data_Block_Result	As above.
NOTE The same Read.response choice can be present more than once, to show the possible responses to each request.			
¹ A list may have one or more elements.			

The Read.request service primitive may have one or more Variable_Access_Specification parameters.

- the Variable_Name variant is used to reference a complete COSEM object attribute to be read. The request may include one or more variable names;
- the Parameterized_Access variant is used either:
 - to reference a COSEM object attribute to be read selectively. In this case, the Variable_Name element references the COSEM object attribute, the Selector and the Parameter elements carry the access selector and the access parameters respectively as specified in the attribute specification; or
 - to reference a COSEM object method to be invoked. In this case, the Variable_Name element references the method, the Selector element is zero and the Parameter element carries the method invocation parameters (if any) or null data;
 - the request may include one or more parameterized access parameters;

NOTE 1 With this, the Read service can transport information in both directions, just like the ACTION service used with LN referencing: method invocation parameters from the client to the server and return parameters from the server to the client.

- the Read_Data_Block_Access variant is used when one or more COSEM object methods are invoked and the encoded form of the request does not fit in a single APDU. The request may include a single Read_Data_Block_Access parameter. It carries block transfer control information and raw data:

- the Last_Block element indicates if the given block is the last one (TRUE) or not (FALSE);
- the Block_Number element carries the number of the actual block sent;
- the Raw_Data element carries a part of the encoded form of the list of Variable_Access_Specification parameters (as it would be used without block transfer) including the method references and the method invocation parameters. Here, only the variants Variable_Name and Parameterized_Access are allowed.
- the Block_Number_Access variant is used when the server uses block transfer to send a long response, to confirm the reception of a data block and to request the next data block. The request may include a single Block_Number_Access parameter. It carries the number of the latest data block received correctly.

The Result (+) parameter indicates that the requested service has succeeded.

Without block transfer, the .response / .confirm service primitives contain one or more Read_Result parameters. Their number and order shall be the same as that of the Variable_Name / Parameterized_Access parameters in the .request / .indication primitives.

If the Read service is used to read attribute(s), then:

- the Data choice is taken to carry the value of the attribute at the time of access;
- the Data_Access_Error is taken to carry the reason for the read to fail for this attribute.

If the Read service is used to invoke method(s), then:

- the Data choice is taken to carry the return parameters (if data are returned, this implies that the method invocation succeeded). If there are no return parameters, Data shall be null data;
- NOTE 2 However, if no return data are expected, the Write service is used to invoke methods.
- the Data_Access_Error choice is taken to carry the reason for the method invocation to fail for this method.

In the case of block transfer, the .response / .confirm primitive contains a single Read_Result parameter. The Data_Block_Result choice is taken to carry one block of the response:

- the Last_Block element indicates whether the given block is the last one (TRUE) or not (FALSE);
- the Block_Number element shall carry the number of the block sent;
- the Raw_Data element contains a part of the encoded form of the list of Read_Results.

If the data block cannot be provided, then the .response primitive shall carry a single Result parameter using the Data_Access_Error choice, carrying an appropriate error message, for example (14) data-block-unavailable.

If the block number in the request is not the one expected, or if the next block cannot be delivered, then the Read.response service primitive shall be returned with a single Read_Result parameter, with the choice Data_Access_Error, carrying an appropriate code, for example (19) data-block-number-invalid.

The Block_Number choice is taken when the Read service is used to invoke one or more methods and the request is sent in several blocks, to confirm the correct reception of a data block and to ask for the next block. It carries the number of the latest block received.

The Result (–) parameter indicates that the service previously requested failed. The Error_Type parameter provides the reason for failure. In this case, the server shall send back a ConfirmedServiceError APDU instead of a ReadResponse APDU.

Use

A possible logical sequence of the Read service primitives is illustrated in Figure 8 item a).

The Read.request primitive is invoked following the invocation of a GET or ACTION .request primitive by the client AP and mapping this to a Read.request primitive by the SN_MAPPER ASE. The client AL builds then the ReadRequest APDU and sends it to the server. For LN / SN service mapping, see 6.18.

The Read.indication primitive is generated by the server AL upon reception of a ReadRequest APDU.

The Read.response primitive is invoked by the server AP in order to send a response to a previously received Read.indication primitive. The server AL builds then the ReadResponse APDU and sends it to the client.

The Read.confirm primitive is generated by the client AL following the reception of a ReadResponse APDU. It is then mapped back to a GET or ACTION .confirm primitive by the SN_MAPPER ASE and the GET or ACTION .confirm primitive is generated.

The protocol of the Read service is specified in 7.3.8.

6.14 The Write service

Function

The Write service is used with SN referencing. It is a confirmed service. Its functions are:

- to write the value of one or more COSEM interface object attributes;
- to invoke one or more COSEM interface object methods when no return parameters are expected.

In both cases, if the encoded form of the .request service primitive does not fit in a single APDU, then it can be sent in several requests with block transfer. The .response service primitive shall always fit in a single APDU.

The Write service is specified in IEC 61334-4-41:1996, 10.5 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The Write service primitives shall provide service parameters as shown in Table 28.

Table 28 – Service parameters of the Write service

	.request	.indication	.response	.confirm
Variable_Access_Specification { Variable_Access_Specification }	M	M(=)		
Variable_Name	S	S (=)		
Parameterized_Access	S	S (=)	–	–
Variable_Name	M	M (=)		
Selector	M	M (=)		
Parameter	M	M (=)		
Write_Data_Block_Access	S	S (=)		
Last_Block	M	M (=)	–	–
Block_Number	M	M (=)		
Data { Data }	M	M (=)	–	–
Result (+)	–	–	S	S (=)
Write_Result { Write_Result }	–	–	S	S (=)
Success			S	S (=)
Data_Access_Error			S	S (=)
Block_Number			S	S (=)
Result (–)			S	S (=)
Error_Type			M	M (=)
NOTE For security parameters, see Table 15.				

The use of the different variants of the Variable-Access-Specification service parameter of the Write.request service primitive and the different choices of the Write.response primitive are shown in Table 29. The use of the Data service parameter is also explained.

If the encoded form of the request does not fit in a single APDU, it can be transported in data blocks using either the service-specific or the general block transfer mechanism.

Table 29 – Use of the Variable_Access_Specification variants and the Write.response choices

Write.request Variable_Access_Specification		Write.response CHOICE	
Variable_Name {Variable_Name}	References a list ¹ of COSEM object attributes.	Success {Success}	Indicates that the attribute referenced could be successfully written.
	The Data service parameter carries the data to be written or the method invocation parameter(s).	Data_Access_Error {Data_Access_Error}	Provides the reason for the write to fail.
Parameterized_Access {Parameterized_Access}	References a list ¹ of COSEM object attributes to be written selectively.	Success {Success}	As above.
	The Data service parameter carries the data to be written.	Data_Access_Error {Data_Access_Error}	
Write_Data_Block_Access	Carries block transfer control information. The Data service parameter carries raw-data, including the encoded form of the list ¹ of COSEM object attribute or method references, and the list of data to be written or the list of method invocation parameters.	Block_Number	Carries the number of the latest data block received.

NOTE The same Write.response choice can be present more than once, to show the possible responses to each request.

¹ A list may have one or more elements.

The Write.request service primitive may have one or more Variable_Access_Specification parameters:

- the Variable_Name variant is used to reference a complete COSEM object attribute to be written or COSEM object method to be invoked. The request may include one or more variable names;
- the Parameterized_Access variant is used to reference a COSEM object attribute to be written selectively. In this case, the Variable_Name element references the COSEM object attribute, the Selector and the Parameter elements carry the access selector and the access parameters respectively as specified in the attribute specification. The request may include one or more Parameterized_Access parameters;

The Data service parameter carries the value(s) to be written to the attribute(s), or the method invocation parameter(s) of the method(s) to be invoked. The number and the order of the Data parameters shall be the same as that of the Variable_Access_Specification parameters.

If the Write.request service primitive does not fit into a single APDU, block transfer may be used. In this case:

- the Write_Data_Block_Access variant of the Variable_Access_Specification carries block transfer control information:
 - the Last_Block element indicates whether the given block is the last one (TRUE) or not (FALSE);
 - the Block_Number element carries the number of the actual block sent;
- the Data parameter carries one part of the list of the attribute references and the list of data to be written, or one part of the list of method references and the list of method invocation parameters.
- The request includes a single Write_Data_Block_Access and a single Data parameter.

The Result (+) parameter indicates that the service requested has succeeded.

The .response / .confirm service primitives contain a list of Write_Result parameters. Their number and order shall be the same as that of the Variable_Name / Parameterized_Access parameters in the .request / .indication service primitives.

Without block transfer, and with block transfer after receiving the last block:

- when the Write service is used to write attribute(s), each element carries either the success of the write access (Success) or a reason for the write to fail for this variable (Data_Access_Error);
- when the Write service is used to invoke method(s), each element carries either the success of the method invocation access (Success) or a reason for the method invocation to fail for this variable (Data_Access_Error).

The Block_Number choice is used during block transfer to confirm the correct reception of a data block and to ask for the next block. It carries the number of the latest block received.

If the block-number in the request is not the one expected, or if the block could not be received correctly, then the Write.response service primitive shall be returned with a single Write_Result parameter, with the choice Data_Access_Error, carrying an appropriate code, for example (19) data-block-number-invalid.

The Result (–) parameter indicates that the service requested has failed. The Error_Type parameter provides the reason for failure. In this case, the server shall send back a ConfirmedServiceError APDU instead of a WriteResponse APDU.

Use

A possible logical sequence of the Write service primitives is illustrated in Figure 8 item a).

The Write.request primitive is invoked following the invocation of a SET or ACTION .request primitive by the client AP and mapping this to a Write.request primitive by the SN_MAPPER ASE. The client AL builds then the WriteRequest APDU and sends it to the server. For LN / SN service mapping, see 6.18.

The Write.indication primitive is generated by the server AL upon reception of a WriteRequest APDU.

The Write.response primitive is invoked by the server AP in order to send a response to a previously received Write.indication primitive. The server AL builds then the WriteResponse APDU and sends it to the client.

The Write.confirm primitive is generated by the client AL following the reception of a WriteResponse APDU. It is mapped then back to a SET or ACTION .confirm primitive by the SN_MAPPER ASE and the SET or ACTION .confirm primitive is generated.

The protocol of the Write service is specified in 7.3.9.

6.15 The UnconfirmedWrite service

Function

The UnconfirmedWrite service is used with SN referencing. It is an unconfirmed service. Its functions are:

- to write the value of one or more COSEM object attributes;
- to invoke one or more COSEM interface object method when no return parameters are expected.

The UnconfirmedWrite.request service primitive shall always fit in a single APDU.

The UnconfirmedWrite service is specified in IEC 61334-4-41:1996, 10.6 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The UnconfirmedWrite service primitives shall provide service parameters as shown in Table 30.

Table 30 – Service parameters of the UnconfirmedWrite service

	.request	.indication
Variable_Access_Specification { Variable_Access_Specification }	M	M(=)
Variable_Name	S	S(=)
Parameterized_Access	S	S(=)
Variable_Name	M	M(=)
Selector	M	M(=)
Parameter	M	M(=)
Data { Data }	M	M(=)
NOTE For security parameters see Table 15.		

The use of the different variants of the Variable-Access-Specification service parameter of the UnconfirmedWrite.request service primitive is shown in Table 31. The use of the Data service parameter is also explained.

If the encoded form of the request does not fit in a single APDU, it can be transported in data blocks using the general block transfer mechanism.

Table 31 – Use of the Variable_Access_Specification variants

UnconfirmedWrite.request Variable_Access_Specification	
Variable_Name {Variable_Name}	References a COSEM object attribute. The Data service parameter carries the data to be written or the method invocation parameter(s).
Parameterized_Access {Parameterized_Access}	References a COSEM object attribute with selective access. The Data service parameter carries the data to be written.

The UnconfirmedWrite.request service primitive may have one or more Variable_Access_Specification parameters.

- the Variable_Name variant is used to reference a complete COSEM object attribute to be written or COSEM object method to be invoked;
- the Parameterized_Access variant is used to reference a COSEM object attribute to be written selectively. In this case, the Variable_Name element references the COSEM object attribute, the Selector and the Parameter elements carry the access selector and the access parameters respectively as specified in the attribute specification.

The Data service parameter carries the value(s) to be written to the attribute(s), or the method invocation parameter(s) of the method(s) to be invoked. The number and the order of the Data parameters shall be the same as that of the Variable_Access_Specification parameters.

Use

A possible logical sequence of the Write service primitives is illustrated in Figure 8 item d).

The UnconfirmedWrite.request primitive is invoked following the invocation of a SET or ACTION .request primitive with Service_Class == Unconfirmed by the client AP and mapping this to an UnconfirmedWrite.request primitive by the SN_MAPPER ASE. The client AL builds then the UnconfirmedWriteRequest APDU and sends it to the server.

The UnconfirmedWrite.indication primitive is generated by the server AL upon reception of a WriteRequest APDU.

The protocol of the UnconfirmedWrite service is specified in 7.3.10.

6.16 The InformationReport service

Function

The InformationReport service is an unsolicited, non-client/server type service. It is requested by a server using SN referencing, upon occurrence of an event, in order to inform the client of the value of one or more DLMS named variables – mapped to COSEM interface object attributes – as though they had been requested by the client. It is an unconfirmed service.

The InformationReport service is specified in IEC 61334-4-41:1996, 10.7 and Annex A. For completeness and for consistency with the specification of services using LN referencing, the specification of the InformationReport service is reproduced here, together with the extensions made for DLMS/COSEM.

Semantics

The InformationReport service primitives shall provide parameters as shown in Table 32.

Table 32 – Service parameters of the InformationReport service

	.request	.indication
Current_Time	M	M (=)
Variable_Access_Specification { Variable_Access_Specification }	M	M (=)
Variable_Name	M	M (=)
Data { Data }	M	M(=)

The Current_Time parameter indicates the time at which the InformationReport.request service primitive was issued.

The Variable_Access_Specification parameter of choice Variable_Name specifies one or more DLMS named variables – mapped to COSEM interface object attributes – the value of which is sent by the server.

The Data parameter carries the value of the DLMS named variable(s), in the same order as the order of the Variable_Access_Specification parameter(s).

The protocol for the InformationReport service is specified in 7.3.11.

6.17 Client side layer management services: the SetMapperTable.request

Function

The function of the SetMapperTable service is to manage the client SN_MAPPER ASE.

Semantics

There is only one primitive, the .request primitive. It shall provide parameters as follows (see Table 33):

Table 33 – Service parameters of the SetMapperTable.request service primitives

	.request
Mapping_Table	M

The Mapping_table parameter is mandatory. It contains the contents of the attribute *object_list* for the requested server and AA. The structure of the content is defined in IEC 62056-6-2:2016.

Use

The SetMapperTable.request service is invoked by the client AP to provide mapping information to the client SN_MAPPER ASE. This service does not cause any data transmission between the client and the server. The client AP uses this service primitive, in order to enhance the efficiency of the mapping process if SN referencing is used.

6.18 Summary of services and LN/SN data transfer service mapping

The following Tables 34 to 36 provide a summary of the COSEM application layer services.

Table 34 – Summary of ACSE services

Client side	Server side
COSEM-OPEN.request	COSEM-OPEN.indication
COSEM-OPEN.confirm	COSEM-OPEN.response
COSEM-RELEASE.request	COSEM-RELEASE.indication
COSEM-RELEASE.confirm	COSEM-RELEASE.response
COSEM-ABORT.indication	COSEM-ABORT.indication

Table 35 – Summary of xDLMS services for LN referencing

Client side	Server side
GET.request	GET.indication
GET.confirm	GET.response
SET.request	SET.indication
SET.confirm	SET.response
ACTION.request	ACTION.indication
ACTION.confirm	ACTION.response
DataNotification.indication	DataNotification.request
EventNotification.indication	EventNotification.request
Trigger_EventNotification_Sending.request	–
NOTE The DataNotification service can be used both in application contexts using SN referencing and LN referencing.	

Table 36 – Summary of xDLMS services for SN referencing

Client side	Server side
Read.request	Read.indication
Read.confirm	Read.response
Write.request	Write.indication
Write.confirm	Write.response
UnconfirmedWrite.request	UnconfirmedWrite.indication
DataNotification.indication	DataNotification.request
InformationReport.indication	InformationReport.request
NOTE The DataNotification service can be used both in application contexts using SN referencing and LN referencing.	

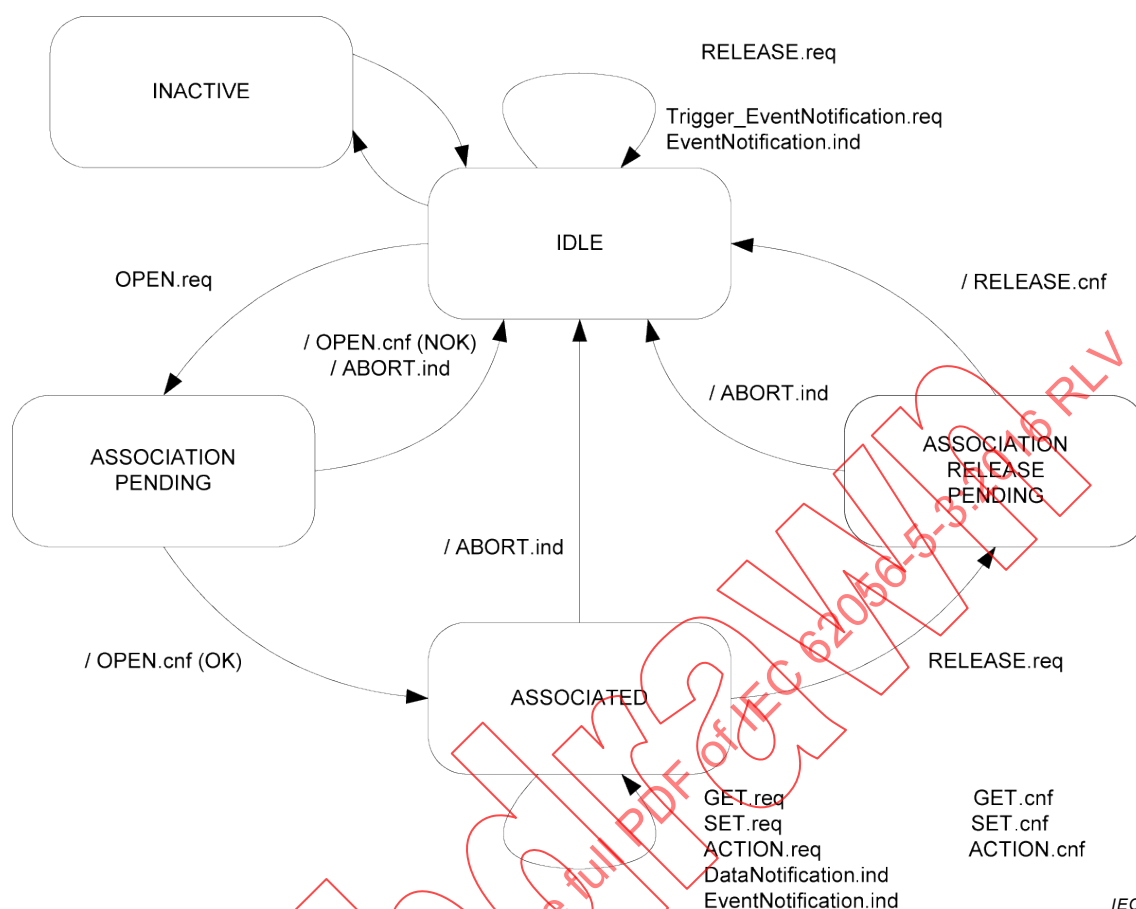
When the server uses SN referencing, a mapping between the service primitives using LN referencing and SN referencing takes place on the client side. This mapping is specified in 7.3.8, 7.3.9, 7.3.10 and 7.3.11.

7 DLMS/COSEM application layer protocol specification

7.1 The control function

7.1.1 State definitions of the client side control function

Figure 10 shows the state machine for the client side CF; see also Figure 1.



NOTE On the state diagrams of the client and server CF, the following conventions are used:

- service primitives with no “/” character as first character are “stimulants”: the invocation of these primitives is the origin of the state transition;
- service primitives with an “/” character as first character are “outputs”: the generation of these primitives is done on the state transition path.

Figure 10 – Partial state machine for the client side control function

The state definitions of the client CF – and of the AL including the CF – are as follows:

INACTIVE	In this state, the CF has no activity at all: it neither provides services to the AP nor uses services of the supporting protocol layer.
IDLE	This is the state of the CF when there is no AA existing, being released, or being established ³ . Nevertheless, some data exchange between the client and server – if the physical channel is already established – is possible. The CF can handle the EventNotification service. NOTE State transitions between the INACTIVE and IDLE states are controlled outside of the protocol. For example, it can be considered that the CF makes the state transition from INACTIVE to IDLE by being instantiated and bound on the top of the supporting protocol layer. The opposite transition happens by deleting the given instance of the CF.
ASSOCIATION PENDING	The CF leaves the IDLE state and enters this state when the AP requests the establishment of an AA by invoking the COSEM-OPEN.request primitive (OPEN.req). The CF may exit this state and enter either the ASSOCIATED state or return to the IDLE state, and generates the COSEM-OPEN.confirm primitive, (/OPEN.cnf(OK)) or (/OPEN.cnf(NOK)), depending on the result of the association request. The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).

³ Note that it is the state machine for the AL: lower layer connections, including the physical connection, are not taken into account. On the other hand, physical connection establishment is done outside of the protocol.

- ASSOCIATED** The CF enters this state when the AA has been successfully established. The client/server type data services are available in this state, and the EventNotification service can be handled. The CF remains in this state until the AP requests the release of the AA by invoking the COSEM-RELEASE.request primitive (RELEASE.req). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).
- ASSOCIATION RELEASE PENDING** The CF leaves the ASSOCIATED state and enters this state when the AP requests the release of the AA by invoking the COSEM-RELEASE.request primitive (RELEASE.req). The CF remains in this state, waiting for the response to this request from the server. As the server is not allowed to refuse a release request, after exiting this state, the CF always enters the IDLE state. The CF may exit this state by generating the COSEM-RELEASE.confirm primitive (/RELEASE.cnf). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).

7.1.2 State definitions of the server side control function

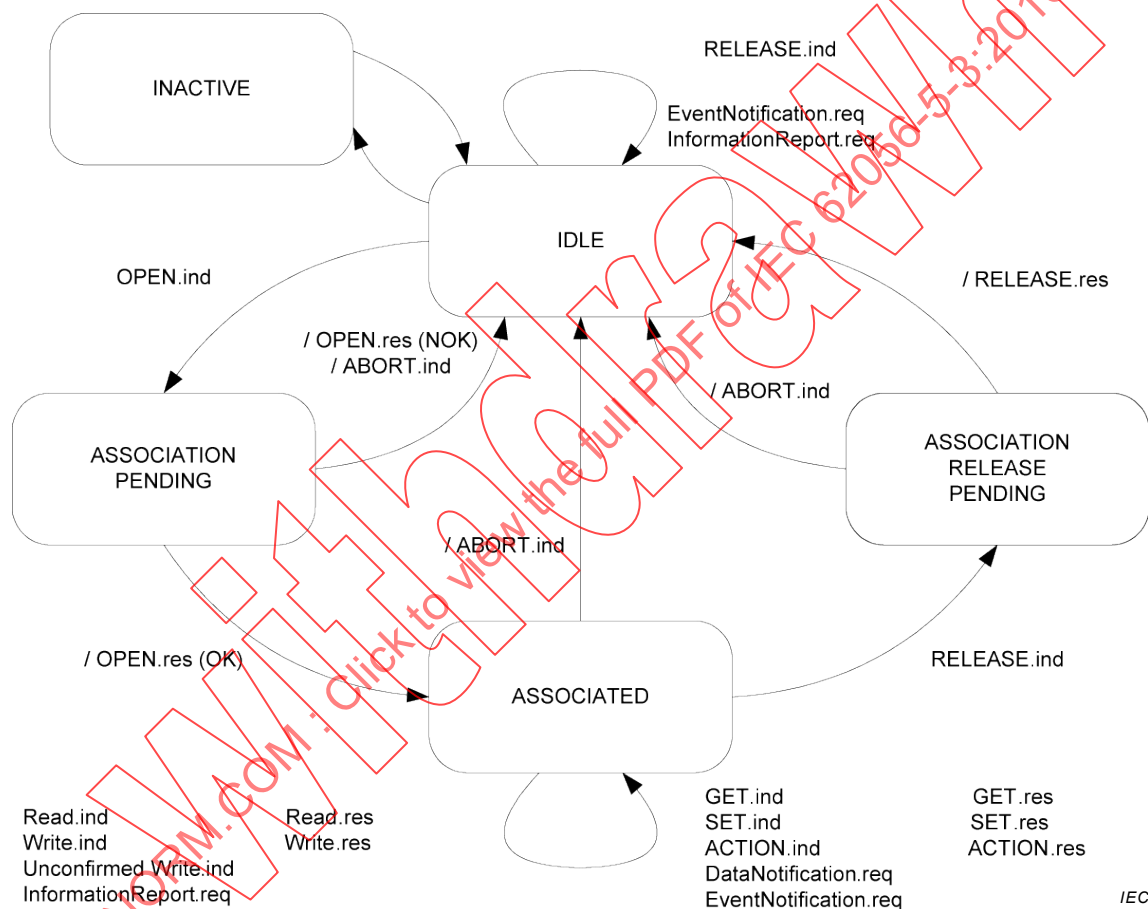


Figure 11 – Partial state machine for the server side control function

Figure 11 shows the state machine for the server side CF; see also Figure 1.

INACTIVE	In this state, the CF has no activity at all: it neither provides services to the AP nor uses services of the supporting protocol layer.
IDLE	This is the state of the CF when there is no AA existing, being released, or being established ⁴ . Nevertheless, some data exchange between the client and server – if the physical channel is already established – is possible. The CF can handle the EventNotification / InformationReport services.
ASSOCIATION PENDING	The CF leaves the IDLE state and enters this state when the client requests the establishment of an AA, and the server AL generates the COSEM-OPEN.indication primitive (/OPEN.ind). The CF may exit this state and enter either the ASSOCIATED state or return to the IDLE state, depending on the result of the association request, and invokes the COSEM-OPEN.response primitive, (/OPEN.res(OK)) or (/OPEN.res(NOK)). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).
ASSOCIATED	The CF enters this state when the AA has been successfully established. The client/server type data services are available in this state, and the EventNotification / InformationReport services can be handled. The CF remains in this state until the client requests the release of the AA, and the server AL generates the COSEM-RELEASE.ind primitive (/RELEASE.ind). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).
ASSOCIATION RELEASE PENDING	The CF leaves the ASSOCIATED state and enters this state when the client requests the release of an AA, and the server AP receives the COSEM-RELEASE.indication primitive (/RELEASE.ind). The CF remains in this state, waiting that the AP accepts the release request. As the server is not allowed to refuse a release request, after exiting this state, the CF always enters the IDLE state. The CF may exit this state when the AP accepts the release of the AA, and invokes the COSEM-RELEASE.response primitive (RELEASE.res). The CF also exits this state and returns to the IDLE state with generating the COSEM-ABORT.indication primitive (/ABORT.ind).

7.2 The ACSE services and APDUS

7.2.1 ACSE functional units, services and service parameters

The DLMS/ COSEM AL ACSE is based on the connection-oriented ACSE, as specified in ISO/IEC 15953:1999 and ISO/IEC 15954:1999.

Functional units are used to negotiate ACSE user requirements during association establishment. Three functional units are defined:

- Kernel functional unit;
- Authentication functional unit; and
- Application Context Negotiation functional unit.

The DLMS/COSEM AL uses only the Kernel and the Authentication functional units.

The acse-requirements parameters of the AARQ and AARE APDUs are used to select the functional units for the association.

The Kernel functional unit is always available. It is the default functional unit.

To be included, the Authentication functional unit shall be explicitly requested on the AARQ APDU and accepted on the AARE APDU. The selection of the Authentication functional unit supports additional parameters on the AARQ and AARE APDUs. The Authentication functional unit does not affect the elements of procedure.

Table 37 shows the services and parameters associated with the ACSE functional units, as used by the DLMS/COSEM AL. The abstract syntax of the ACSE APDUs is specified in Clause 8.

⁴ Note that it is the state machine for the AL: lower layer connections, including the physical connection, are not taken into account. On the other hand, physical connection establishment is done outside of the protocol.

Table 37 – ACSE functional units, services and service parameters

Functional unit	Service	APDU	Parameter	Presence
Kernel	A-ASSOCIATE	AARQ	protocol-version	O ¹
			application-context-name	M
			called-AP-title	U
			called-AE-qualifier	U
			called-AP-invocation-identifier	U
			called-AE-invocation-identifier	U
			calling-AP-title	U
			calling-AE-qualifier	U
			calling-AP-invocation-identifier	U
			calling-AE-invocation-identifier	U
			implementation-information	O
			user-information ²	M
			(carrying an xDLMS InitiateRequest APDU)	
			dedicated-key	U
			response-allowed	U
			proposed-quality-of-service	U
			proposed-dlms-version-number	M
			proposed-conformance	M
			client-max-receive-pdu-size	M
		AARE	protocol-version	O
			application-context-name	M
			result	M
			result-source-diagnostic	M
			responding-AP-title	U
			responding-AE-qualifier	U
			responding-AP-invocation-identifier	U
			responding-AE-invocation-identifier	U
			implementation-information	O
			user-information ²⁾	M
			(carrying an xDLMS InitiateResponse APDU)	S
			negotiated-quality-of-service	U
			negotiated-dlms-version-number	M
			negotiated-conformance	M
			server-max-receive-pdu-size	M
			vaa-name	M
			(or carrying a ConfirmedServiceError APDU)	S
	A-RELEASE	RLRQ	reason	U
			user-information	U
		RLRE	reason	U
			user-information	U
Authentication	A-ASSOCIATE	AARQ	sender-acse-requirements	U
			mechanism-name	U
			calling-authentication-value	U

Functional unit	Service	APDU	Parameter	Presence
		AARE	responder-acse-requirements	U
			mechanism-name	U
			responding-authentication-value	U
¹ O: Presence is an ACPM (COSEM Application layer) option. ² According to ISO/IEC 15953:1999, the user-information parameter is optional. However, in the DLMS/COSEM environment it is mandatory in the AARQ / AARE APDUs.				

In general, the value of each parameter of the AARQ APDU is determined by the parameters of the COSEM-OPEN.request service primitive. Similarly, the value of each parameter of the AARE is determined by the COSEM-OPEN.response primitive. The COSEM-OPEN service is specified in 6.2.

The AARQ and AARE APDU parameters are specified below. Managing these parameters is specified in 7.2.4.1.

- **protocol-version:** the COSEM AL uses the default value. For details, see ISO/IEC 15954:1999;
- **application-context-name:** COSEM application context names are specified in 7.2.2.2;
- **called-, calling- and responding- titles, qualifiers and invocation-identifiers:** these optional fields carry the value of the respective parameters of the COSEM-OPEN service. For details, see ISO/IEC 15954:1999;
- **implementation-information:** this parameter is not used by the COSEM AL. For details, see ISO/IEC 15954:1999;
- **user-information:** in the AARQ APDU, it carries an xDLMS InitiateRequest APDU holding the elements of the Proposed_xDLMS_Context parameter of the COSEM-OPEN.request service primitive. In the AARE APDU, it carries an xDLMS InitiateResponse APDU, holding the elements of the Negotiated_xDLMS_Context parameter, or an xDLMS ConfirmedServiceError APDU, holding the elements of the xDLMS_Initiate_Error parameter of the COSEM-OPEN.response service primitive;
- **sender- and responder-acse-requirements:** this parameter is used to select the optional functional units of the AARQ / AARE. In COSEM, only the Authentication functional unit is used. When present, it carries the value of BIT STRING { authentication (0) }. Bit set: authentication module selected;
- **mechanism-name:** COSEM authentication mechanism names are specified in 7.2.2.3;
- **calling- and responding- authentication-value:** see 5.3;
- **result:** the value of this parameter is determined by the COSEM AP (acceptor) or the COSEM AL (ACPM) as specified below. It is used to determine the value of the Result parameter of the COSEM-OPEN.confirm primitive:
 - if the AARQ APDU is rejected by the ACPM (i.e. the COSEM-OPEN.indication primitive is not issued by the COSEM AL), the value “rejected (permanent)” or “rejected (transient)” is assigned by the ACPM;
 - otherwise, the value is determined by the Result parameter of the COSEM-OPEN.response APDU;
- **result-source-diagnostic:** this parameter contains both the Result source value and the Diagnostic value. It is used to determine the value of the Failure_Type parameter of the COSEM-OPEN.confirm primitive:
 - Result-source value: if the AARQ is rejected by the ACPM, (i.e. the COSEM-OPEN.indication primitive is not issued by the COSEM AL) the ACPM assigns the value “ACSE service-provider”. Otherwise, the ACPM assigns the value “ACSE service-user”;

- Diagnostic value: If the AARQ is rejected by the ACPM, the appropriate value is assigned by the ACPM. Otherwise, the value is determined by the Failure_Type parameter of the COSEM-OPEN.response primitive. If the Diagnostic parameter is not included in the .response primitive, the ACPM assigns the value “null”.

The parameters of the RLRQ / RLRE APDUs – used when the COSEM-RELEASE service (see 6.3) is invoked with the parameter Use_RLRQ_RLRE == TRUE – are specified below.

- **reason:** carries the appropriate value as specified in 6.3;
- **user-information:** if present, it carries an xDLMS InitiateRequest / InitiateResponse APDU, holding the elements of the Proposed_xDLMS_Context / Negotiated_xDLMS_Context parameter of the COSEM-RELEASE.request / .response service primitive respectively; see 6.3.

7.2.2 Registered COSEM names

7.2.2.1 General

Within an OSI environment, many different types of network objects shall be identified with globally unambiguous names. These network objects include abstract syntaxes, transfer syntaxes, application contexts, authentication mechanism names, etc. Names for these objects in most cases are assigned by the committee developing the particular basic ISO standard or by implementers' workshops, and should be registered. For DLMS/COSEM, these object names are assigned by the DLMS User Association, and are specified below.

The decision no. 1999.01846 of OFCOM, Switzerland, attributes the following prefix for object identifiers specified by the DLMS User Association.

{ joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) }

For DLMS/COSEM, object identifiers are specified for naming the following items:

- COSEM application context names;
- COSEM authentication mechanism names.

7.2.2.2 The COSEM application context

In order to effectively exchange information within an AA, the pair of AE-invocations shall be mutually aware of, and follow a common set of rules that govern the exchange. This common set of rules is called the application context of the AA. The application context that applies to an AA is determined during its establishment.

NOTE An AA has only one application context. However, the set of rules that make up the application context of an AA may contain rules for alteration of that set of rules during the lifetime of the AA.

The following methods may be used:

- identifying a pre-existing application context definition;
- transferring an actual description of the application context.

In the COSEM environment, it is intended that an application context pre-exists and it is referenced by its name during the establishment of an AA. The application context name is specified as OBJECT IDENTIFIER ASN.1 type. COSEM identifies the application context name by the following object identifier value:

COSEM_Application_Context_Name::= {joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) application-context(1) context_id(x)}

The meaning of these general COSEM application contexts is:

- there are two ASEs present within the AE invocation, the ACSE and the xDLMS_ASE;
- the xDLMS_ASE shall be as it is specified in IEC 61334-4-41:1996;

NOTE With the COSEM extensions to DLMS; see 4.2.3.1.

- the transfer syntax shall be A-XDR, specified in IEC 61334-6.

The specific context_ids and the use of ciphered and unciphered APDUs are shown in Table 38 below:

Table 38 – Use of ciphered / unciphered APDUs

Application context name	context_id	Unciphered APDUs	Ciphered APDUs
Logical_Name_Referencing_No_Ciphering::=	context_id(1)	Yes	No
Short_Name_Referencing_No_Ciphering::=	context_id(2)	Yes	No
Logical_Name_Referencing_With_Ciphering::=	context_id(3)	Yes	Yes
Short_Name_Referencing_With_Ciphering::=	context_id(4)	Yes	Yes

In order to successfully establish an AA, the application-context-name parameter of the AARQ and AARE APDUs should carry one of the “valid” names. The client proposes an application context name using the Application_Context_Name parameter of the COSEM-OPEN.request primitive. The server may return any value; either the value proposed or the value it supports.

7.2.2.3 The COSEM authentication mechanism name

Authentication of the client, the server or both is one of the security aspects addressed by the DLMS/COSEM specification. Three authentication security levels are specified:

- no authentication (lowest level) security;
- low level, password based authentication security (LLS) identifying only the client;
- high level, four-pass authentication security (HLS) identifying both the client and the server.

COSEM identifies the authentication mechanisms by the following general object identifier value:

```
COSEM_Authentication_Mechanism_Name::=
{joint-iso-coitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8)
authentication_mechanism_name(2) mechanism_id(x)}
```

The value of the mechanism_id element selects one of the security mechanisms specified:

COSEM_lowest_level_security_mechanism_name::=	mechanism_id(0)
COSEM_low_level_security_mechanism_name::=	mechanism_id(1)
COSEM_high_level_security_mechanism_name::=	mechanism_id(2)
COSEM_high_level_security_mechanism_name_using_MD5::=	mechanism_id(3)
COSEM_high_level_security_mechanism_name_using_SHA-1::=	mechanism_id(4)
COSEM_high_level_security_mechanism_name_using_GMAC::=	mechanism_id(5)
NOTE With mechanism_id(2), the method of processing the challenge is secret.	

When the `Authentication_Mechanism_Name` is present in the COSEM-OPEN service, the authentication functional unit of the A-ASSOCIATE service shall be selected. The process of LLS and HLS authentication is described in 5.3 and 5.4.8.4.

7.2.3 APDU encoding rules

7.2.3.1 Encoding of the ACSE APDUs

The ACSE APDUs shall be encoded in BER, in accordance with ISO/IEC 8825-1. The user-information field of these APDUs shall carry the xDLMS InitiateRequest / InitiateResponse / ConfirmedServiceError APDU as appropriate, encoded in A-XDR. The resulting OCTET STRING shall be encoded in BER.

Examples for AARQ/AARE APDU encoding are given in Annex C and in Annex D.

7.2.3.2 Encoding of the xDLMS APDUs

The xDLMS APDUs shall be encoded in A-XDR, as specified in IEC 61334-6.

7.2.4 Protocol for application association establishment

7.2.4.1 Protocol for the establishment of confirmed application associations

AA establishment using the A-Associate service of the ACSE is the key element of COSEM interoperability. The participants of an AA are:

- a client AP, proposing AAs; and
- a server AP, accepting them or not.

NOTE 1 To support multicast and broadcast services, an AA can also be established between a client AP and a group of server APs.

Figure 12 gives the MSC for the case, when:

- the COSEM-OPEN.request primitive requests a confirmed AA;
- the connection of the supporting lower layers is required for the establishment of this AA.

A client AP that desires to establish a confirmed AA, invokes the COSEM-OPEN.request primitive of the ASO with `Service_Class == Confirmed`. The response-allowed parameter of the xDLMS InitiateRequest APDU is set to TRUE. The client AL waits for an AARE APDU, prior to generating the .confirm primitive, with a positive – or negative – result.

The client CF enters the ASSOCIATION PENDING state. It examines then the `Protocol_Connection_Parameters` parameter. If this indicates that the establishment of the supporting layer connection is required, it establishes the connection.

NOTE 2 The PH layer shall be connected before the COSEM-OPEN service is invoked.

The CF assembles then – with the help of the xDLMS ASE and the ACSE – the AARQ APDU containing the parameters of the COSEM-OPEN.request primitive received from the AP and sends it to the server.

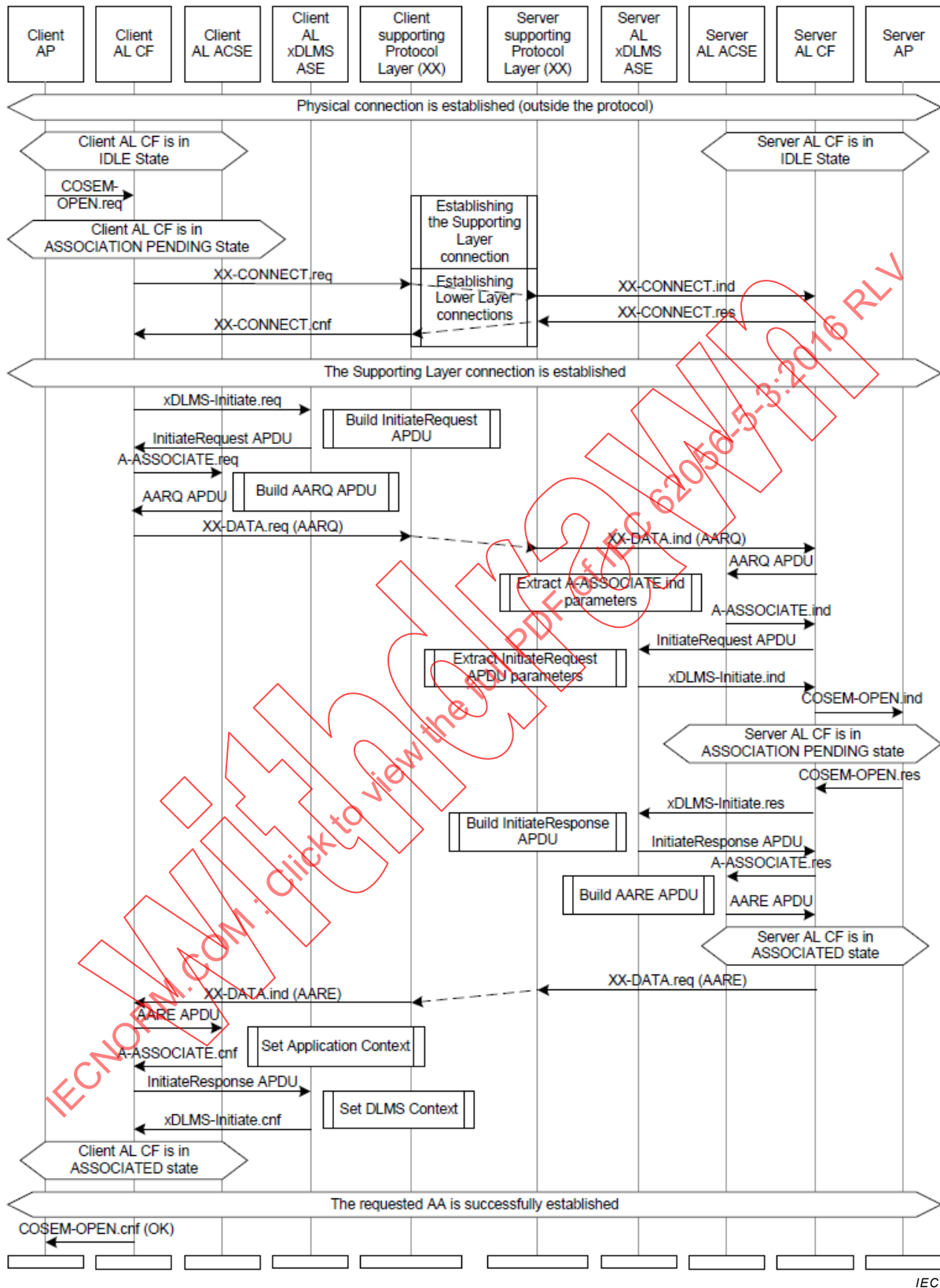


Figure 12 – MSC for successful AA establishment preceded by a successful lower layer connection establishment

The CF of the server AL gives the AARQ APDU received to the ACSE. It extracts the ACSE related parameters then gives back the control to the CF. The CF passes then the contents of the user-information parameter of the AARQ APDU – carrying an xDLMS InitiateRequest APDU – to the xDLMS_ASE. It retrieves the parameters of this APDU, then gives back the control to the CF. The CF generates the COSEM-OPEN.indication to the server AP with the parameters of the APDU received and enters the ASSOCIATION PENDING state.

NOTE 3 Some service parameters of the COSEM-OPEN.indication primitive (address information, User_Information) do not come from the AARQ APDU, but from the supporting layer frame carrying the AARQ APDU. In some communication profiles, the Service_Class parameter of the COSEM-OPEN service is linked to the frame type of the supporting layer. In some other communication profiles, it is linked to the response-allowed field of the xDLMS-Initiate.request APDU. See also Annex A.

NOTE 4 The ASEs only extract the parameters; their interpretation and the decision whether the proposed AA can be accepted or not is the job of the server AP.

The server AP parses the fields of the AARQ APDU as described below.

Fields of the Kernel functional unit:

- application-context-name: it carries the COSEM_Application_Context_Name the client proposes for the association;
- calling-AP-title: when the proposed application context uses ciphering, it shall carry the client system title. If a client system title has already been sent during a registration process, like in the S-FSK PLC profile, the calling-AP-title field shall carry the same system title. Otherwise, the AA shall be rejected and appropriate diagnostic information shall be sent;
- calling-AE-invocation-identifier: this field supports the client user identification process; see IEC 62056-6-2:2016, 5.3.2.

Fields of the authentication functional unit (when present):

- sender-acse-requirements:
- if it is not present or it is present but bit 0 = 0, then the authentication functional unit is not selected. Any following fields of the authentication functional unit may be ignored;
- if present and bit 0 = 1 then the authentication functional unit is selected.
- mechanism-name: it carries the COSEM_Authentication_Mechanism_Name the client proposes for the association;
- calling-authentication-value: it carries the authentication value generated by the client.

If the value of the mechanism-name or the calling-authentication-value fields are not acceptable then the proposed AA shall be refused.

When the parsing of the fields of the Kernel and the authentication functional unit is completed, the server continues with parsing the parameters of the xDLMS InitiateRequest APDU, carried by the user-information field of the AARQ:

- dedicated-key: it carries the dedicated key to be used in the AA being established;
- response-allowed: If the proposed AA is confirmed, the value of this parameter is TRUE (default), and the server shall send back an AARE APDU. Otherwise, the server shall not respond. See also Annex A.
- proposed-dlms-version-number. See 4.2.3.1;
- proposed-conformance. See 7.3.1;
- client-max-receive-pdu-size. See 4.2.3.1.

If all elements of the proposed AA are acceptable, the server AP invokes the COSEM-OPEN.response service primitive with the following parameters:

- Application_Context_Name: the same as the one proposed;
- Result: accepted;
- Failure_Type: Result-source: acse-service-user; Diagnostic: null;
- Responding-AP-title: if the negotiated application context uses ciphering, it shall carry the server system title. If a server system title has already been sent during a registration process, like in the case of the S-FSK PLC profile, the Responding_AP_Title parameter shall carry the same system title. Otherwise, the AA shall be aborted by the client;
- Fields of the AARE authentication functional unit:
 - responder-acse-requirements:
 - a) when no security (Lowest Level Security) authentication or Low Level Security (LLS) authentication is used, this field shall not be present, or if present, bit 0 (authentication) shall be set to 0. Any following fields of the authentication functional unit may be ignored;
 - b) when High Level Security (HLS) authentication is used, this field shall be present and bit 0 (authentication) shall be set to 1;
 - mechanism-name: it shall carry the COSEM_Authentication_Mechanism_Name negotiated;
 - responding-authentication-value: it carries the authentication value generated by the server (StoC).
- User_Information: an xDLMS InitiateResponse APDU carrying the elements of the negotiated xDLMS context.

The CF assembles the AARE APDU – with the help of the xDLMS ASE and the ACSE – and sends it to the client AL via the supporting lower layer protocols, and enters the ASSOCIATED state. The proposed AA is established now, the server is able to receive xDLMS data transfer service request(s) – both confirmed and unconfirmed – and to send responses to confirmed service requests within this AA.

At the client side, the parameters of the AARE APDU received are extracted with the help of the ACSE and the xDLMS ASE, and passed to the client AP via the COSEM-OPEN.confirm service primitive. At the same time, the client AL enters the ASSOCIATED state. The AA is established now with the application context and xDLMS context negotiated.

If the application context proposed by the client is not acceptable or the authentication of the client is not successful, the COSEM-OPEN.response primitive is invoked with the following parameters:

- Application_Context_Name: the same as the one proposed, or the one supported by the server;
- Result: rejected-permanent or rejected-transient;
- Failure_Type: Result-source: acse-service-user; Diagnostic: an appropriate value;
- User_Information: an xDLMS InitiateResponse APDU with the parameters of the xDLMS context supported by the server.

If the application context proposed by the client is acceptable and the authentication of the client is successful but the xDLMS context cannot be accepted, the COSEM-OPEN.response primitive shall be invoked with the following parameters:

- Application_Context_Name: the same as the one proposed;
- Result: rejected-permanent or rejected-transient;
- Failure_Type: Result-source: acse-service-user; Diagnostic: no-reason-given;

- User_Information: an xDLMS ConfirmedServiceError APDU, indicating the reason for not accepting the proposed xDLMS context.

In these two cases, upon invocation of the .response primitive, the CF assembles and sends the AARE APDU to the client via the supporting lower layer protocols. The proposed AA is not established, the server CF returns to the IDLE state.

At the client side, the parameters of the AARE APDU received are extracted with the help of the ACSE and the xDLMS_ASE, and passed to the client AP via the COSEM-OPEN.confirm primitive. The proposed AA is not established, the client CF returns to the IDLE state.

The server ACSE may not be capable of supporting the requested association, for example if the AARQ syntax or the ACSE protocol version are not acceptable. In this situation, it returns a COSEM-OPEN.response primitive to the client with an appropriate Result parameter. The Result Source parameter is appropriately assigned the symbolic value of "ACSE service-provider". The COSEM-OPEN.indication primitive is not issued. The association is not established.

7.2.4.2 Repeated COSEM-OPEN service invocations

If a COSEM-OPEN.request primitive is invoked by the client AP referring to an already established AA, then the AL locally and negatively confirms this request with the reason that the requested AA already exists. Note, that this is always the case for pre-established AAs; see 7.2.4.4.

If, nevertheless, a server AL receives an AARQ APDU referencing to an already existing AA, it simply discards this AARQ, or, if it is implemented, it may also respond with the optional ExceptionResponse APDU.

7.2.4.3 Establishment of unconfirmed application associations

A client AP that desires to establish an unconfirmed AA, invokes the COSEM-OPEN.request primitive of the ASO with Service_Class == Unconfirmed. The response-allowed parameter of the xDLMS InitiateRequest APDU, carried by the user-information parameter of the AARQ is set to FALSE. The client AL does not wait any response from the server: the .confirm primitive is locally generated. Otherwise the procedure is the same as in the case of the establishment of confirmed AAs.

As the establishment of unconfirmed AAs does not require the server AP to respond to the association request coming from the client, in some cases – for example in the case of one-way communications or broadcasting – the establishment of unconfirmed AA is the only possibility.

After the establishment of an unconfirmed AA, xDLMS data transfer services using LN referencing can be invoked only in an unconfirmed manner, until the association is released. With SN referencing, only the UnconfirmedWrite service can be used.

7.2.4.4 Pre-established application associations

The purpose of pre-established AAs is to simplify data exchange. The AA establishment and release phases (phases 1 and 3 on Figure 4), using the COSEM-OPEN and COSEM-RELEASE services are eliminated and only data transfer services are used.

NOTE As for all AAs, the logical devices contain an Association LN / SN interface object for the pre-established associations, too.

This standard does not specify how to establish such AAs: it can be considered, that this has already been done. Pre-established AAs can be considered to exist from the moment the lower layers are able to transmit APDUs between the client and the server.

A pre-established AA can be either confirmed or unconfirmed (depending on the way it has been pre-established).

A pre-established AA cannot be released.

7.2.5 Protocol for application association release

7.2.5.1 Overview

An existing AA can be released gracefully or non-gracefully. Graceful release is initiated by the client AP. Non-graceful release takes place when an event unexpected by the AP occurs, for example a physical disconnection is detected.

7.2.5.2 Graceful release of an application association

DLMS/COSEM provides two mechanisms to release AAs:

- by disconnecting the supporting layer of the AL;
- by using the ACSE A-Release service.

The first mechanism shall be supported in all profiles where the supporting layer of the AL is connection oriented.

EXAMPLE The 3-layer, HDLC based, connection oriented profile.

To release an AA this way, the COSEM-RELEASE service shall be invoked with the Use_RLRQ_RLRE parameter not present or FALSE. Disconnecting the supporting layer shall release all AAs built on that supporting layer connection.

The second mechanism can be used to release an AA without disconnecting the supporting layer. It shall be supported in all profiles when the supporting layer is connectionless. It may be also used when the supporting layer is connection-oriented but the connection is not managed by the AL, or disconnection of the supporting layer is not practical because other applications may use it, or when there is a need to secure the COSEM-RELEASE service. It is the only way to release unconfirmed AAs.

To release an AA in this way, the COSEM-RELEASE service shall be invoked with the Use_RLRQ_RLRE parameter = TRUE. As specified in 6.3, the COSEM-RELEASE service can be secured by including a ciphered xDLMS InitiateRequest / InitiateResponse in the user-information field of the RLRQ / RLRE APDUs respectively, thus preventing a potential denial of service attack.

An example for releasing an AA using the ACSE A-RELEASE service is shown in Figure 13.

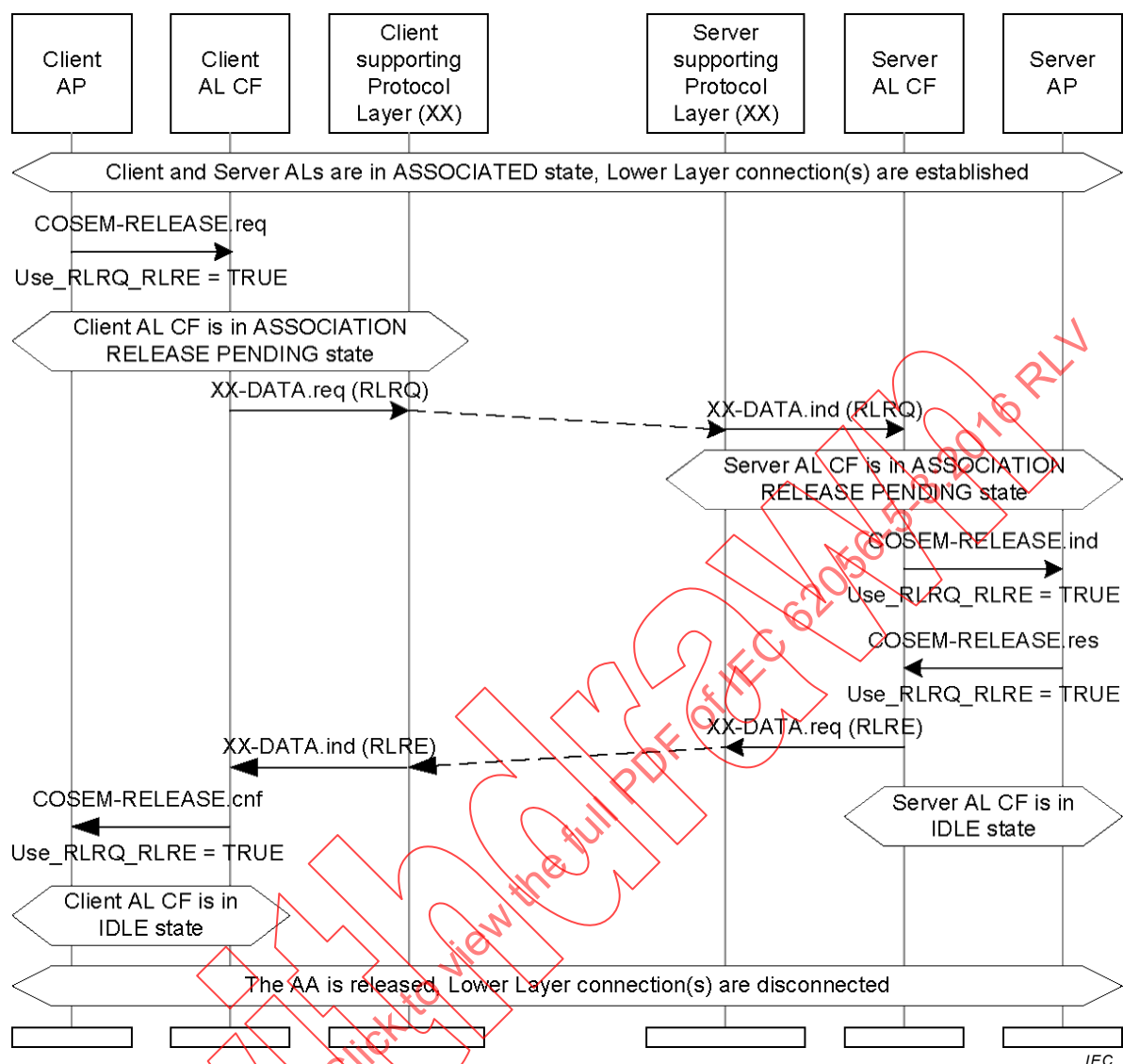


Figure 13 – Graceful AA release using the A-RELEASE service

A client AP that desires to release an AA using the A-RELEASE service, shall invoke the COSEM-RELEASE.request service primitive with Use_RLRQ_RLRE == TRUE. The client CF enters the ASSOCIATION RELEASE PENDING state. It constructs then an RLRQ APDU and sends it to the server. If the AA to be released has been established with a ciphered context, then the user information field of the RLRQ APDU may contain a ciphered xDLMS InitiateRequest APDU, see 6.3.

When the server AL CF receives the RLRQ APDU, it checks first if the user-information field contains a ciphered xDLMS InitiateRequest APDU. If so, it tries to decipher it. If this is successful, it enters the ASSOCIATION RELEASE PENDING state and generates a COSEM-RELEASE.indication primitive with Use_RLRQ_RLRE == TRUE. Otherwise, it silently discards the RLRQ APDU and stays in the ASSOCIATED state.

The .response primitive is invoked by the server AP to indicate if the release of the AA is accepted or not, but only if the AA to be released is confirmed. Note that the server AP cannot refuse a release request. Upon reception of the .response primitive the server AL CF constructs a RLRE APDU and sends it to the client. If the RLRQ APDU contained a ciphered xDLMS InitiateRequest APDU then the RLRE APDU shall contain a ciphered xDLMS InitiateResponse APDU. The server AL CF returns to the IDLE state.

The .confirm primitive is generated by the client AL CF when the RLRE APDU is received. The supporting layer is not disconnected. The client AL CF returns to the IDLE state.

If the RLRE APDU received contains a ciphered xDLMS InitiateResponse APDU but it cannot be deciphered, then the RLRE APDU shall be discarded. It is left to the client to cope with the situation.

Figure 14 gives an example of graceful releasing a confirmed AA by disconnecting the corresponding lower layer connection.

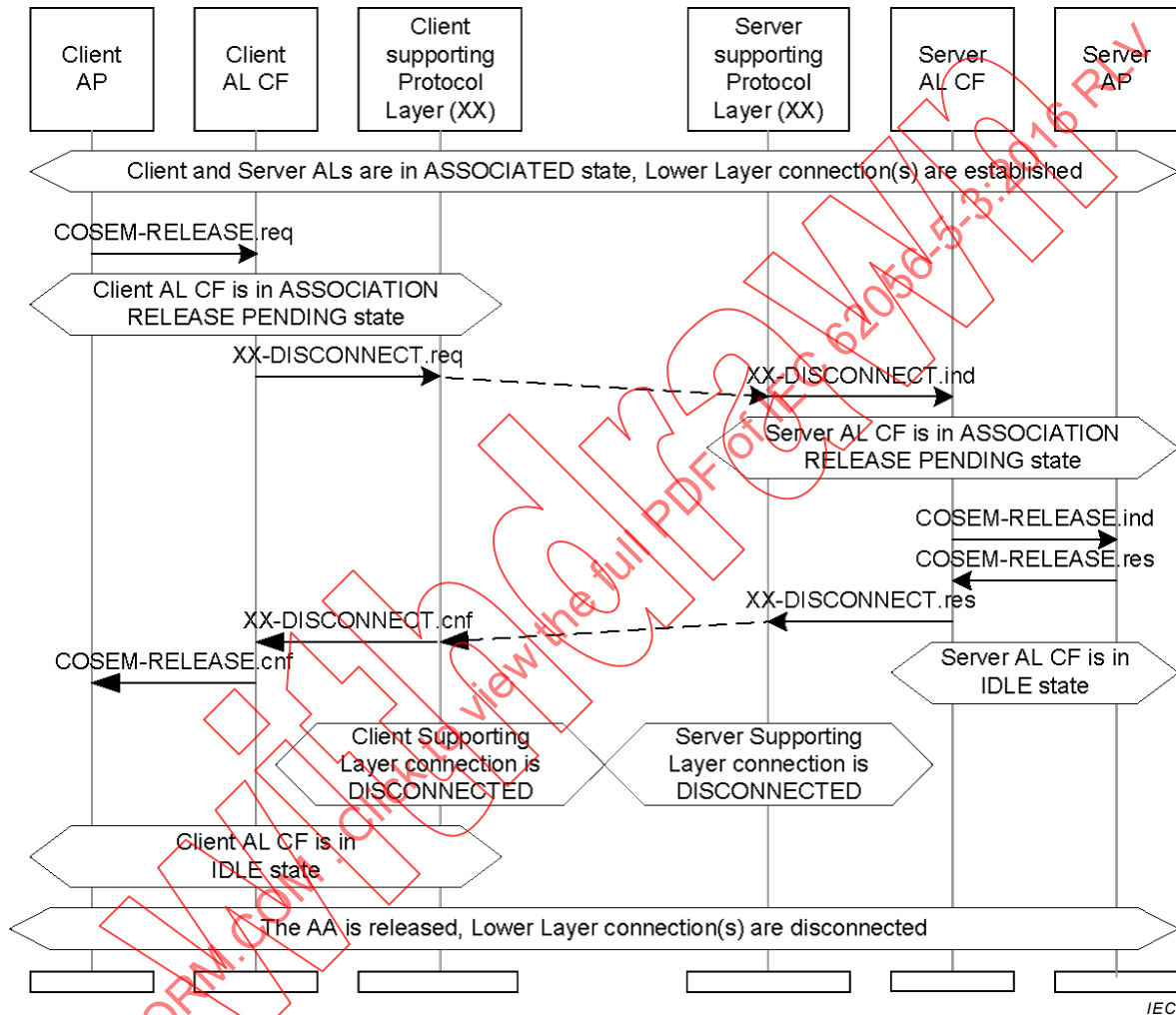


Figure 14 – Graceful AA release by disconnecting the supporting layer

A client AP that desires to release an AA not using the A-RELEASE service, invokes the COSEM-RELEASE.request primitive with Use_RLRQ_RLRE == FALSE or not present. The client AL CF enters the ASSOCIATION RELEASE PENDING state.

In communication profiles where the RLRQ service is mandatory, invoking the .request primitive with no Use_RLRQ_RLRE or with Use_RLRQ_RLRE == FALSE may lead to an error: the .request shall be locally and negatively confirmed. The client AL CF returns to the IDLE state.

When the client AL CF receives the .request primitive, it sends an XX-DISCONNECT.request primitive to the server.

When the server AL CF receives the XX-DISCONNECT.request primitive, the CF enters the ASSOCIATION RELEASE PENDING state. The COSEM-RELEASE.indication primitive is generated by the server AL CF with Use_RLRQ_RLRE == FALSE or not present.

The COSEM-RELEASE.response primitive is invoked by the server AP to indicate if the release of the AA is accepted or not. Note that the server AP cannot refuse a release request. Upon reception of this primitive, the server AL CF sends an XX-DISCONNECT.response primitive to the client and returns to the IDLE state.

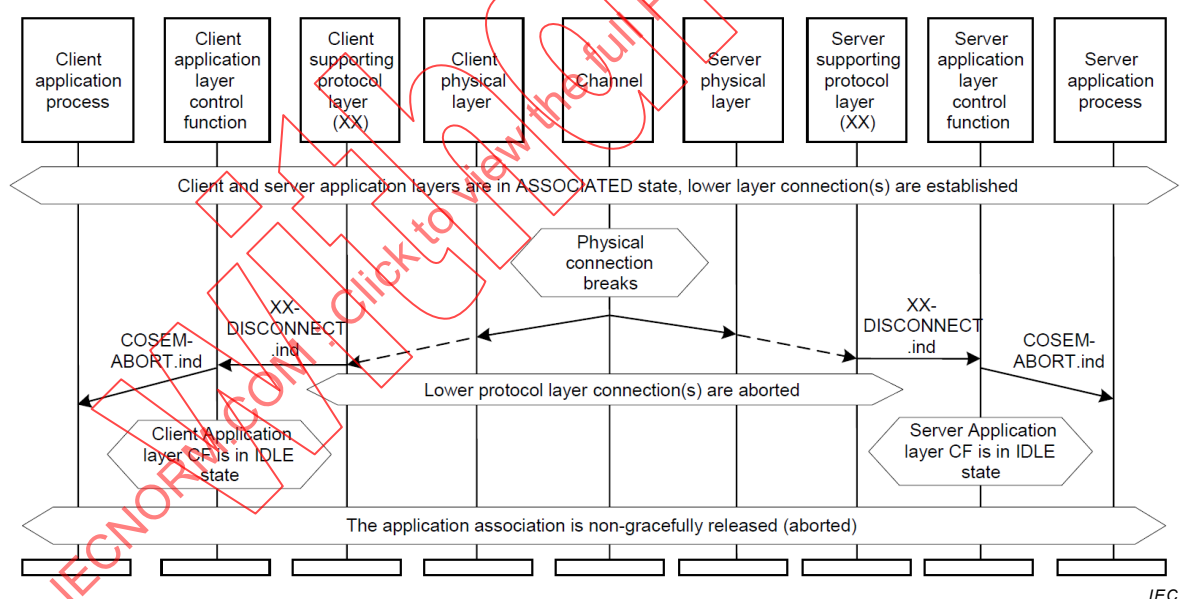
The COSEM-RELEASE.confirm primitive is generated by the client AL when the XX-DISCONNECT.confirm primitive is received. The supporting layer is disconnected. The client AL CF returns to the IDLE state.

7.2.5.3 Non-graceful release of an application association

Various events may result in a non-graceful release of an AA: detection of the disconnection of any lower layer connection (including the physical connection), detecting a local error, etc.

Non-graceful release – abort – of an AA is indicated to the COSEM-AP with the help of the COSEM-ABORT service. The Diagnostics parameter of this service indicates the reason for the non-graceful AA release. The non-graceful release of AA is not selective: if it happens, all the existing association(s) – except the pre-established ones – shall be aborted.

Figure 15 shows the message sequence chart for aborting the AA, due to the detection of a physical disconnection.



NOTE The release of an AA may require internal communication between the ASEs of the CF. These are not shown on the figures.

Figure 15 – Aborting an AA following a PH-ABORT.indication

7.3 Protocol for the data transfer services

7.3.1 Negotiation of services and options – the conformance block

The conformance block allows clients and servers using the same DLMS/COSEM protocol, but supporting different capabilities to negotiate a compatible set of capabilities so that they can communicate. It is carried by the DLMS_Conformance parameter of the COSEM-OPEN service.

In DLMS/COSEM none of the services or options are mandatory: the ones to be used are negotiated via the COSEM-OPEN service (the proposed-conformance parameter of the xDLMS InitiateRequest APDU and the negotiated-conformance parameter of the xDLMS InitiateResponse APDU). An implemented service shall be fully conforming to its specification. If a service or option is not present in the negotiated conformance block, it may not be requested by the client.

The xDLMS conformance block can be distinguished from the DLMS conformance block specified in IEC 61334-4-41:1996 by its tag: APPLICATION 31. It is shown in Table 39.

Table 39 – xDLMS Conformance block

Conformance block bit	Reserved	LN referencing	SN referencing
0	x		
1		general-protection ¹	general-protection ¹
2		general-block-transfer	general-block-transfer
3			read
4			write
5			unconfirmed-write
6	x		
7	x		
8		attribute0-supported-with-set	
9		priority-mgmt-supported	
10		attribute0-supported-with-get	
11		block-transfer-with-get-or-read	block-transfer-with-get-or-read
12		block-transfer-with-set-or-write	block-transfer-with-set-or-write
13		block-transfer-with-action	
14		multiple-references	multiple-references
15			information-report
16		data-notification	data-notification
17	x		
18			parameterized-access
19		get	
20		set	
21		selective-access	
22		event-notification	
23		action	

¹ general-protection includes general-glo-ciphering and general-ded-ciphering.

7.3.2 Confirmed and unconfirmed service invocations

In general, data transfer services may be invoked in a confirmed or an unconfirmed manner. The time sequence of the service primitives corresponds to:

- Figure 8 item a) in case of confirmed service invocations; and
- Figure 8 item d) in case of unconfirmed service invocations.

A client AP that desires to access an attribute or a method of a COSEM interface object invokes the appropriate .request service primitive. The client AL constructs the APDU corresponding to the .request primitive and sends it to the server.

The server AP, upon receipt of the .indication primitive, checks whether the service can be provided or not (validity, client access rights, availability, etc.). If everything is OK, it locally applies the service required on the corresponding “real” object. In the case of confirmed services, the server AP invokes the appropriate .response primitive. The server AL constructs the APDU corresponding to the .response primitive and sends it to the server. The client AL generates the .confirm primitive.

If a confirmed service request cannot be processed by the server AL – for example the request has been received without establishing an AA first, or the request is otherwise erroneous – it is either discarded, or when possible, the server AL responds with a ConfirmedServiceError APDU, or, when implemented, with an ExceptionResponse APDU. These APDUs may contain diagnostic information about the reason of not being able to process the request. They are defined in Clause 8.

Within confirmed AAs, client/server type data transfer services can be invoked in a confirmed or unconfirmed manner.

Within unconfirmed AAs, client/server type data transfer services may be invoked in an unconfirmed manner only. With this, collisions due to potential multiple responses in the case of multicasting and/or broadcasting can be avoided.

In the case of unconfirmed services, three different kinds of destination addresses are possible: individual, group or broadcast. Depending on the destination address type, the receiving station shall handle incoming APDUs differently, as follows:

- XX-APDUs with an individual address of a COSEM logical device. If they are received within an established AA they shall be sent to the COSEM logical device addressed, otherwise they shall be discarded;
- XX-APDUs with a group address of a group of COSEM logical devices. These shall be sent to the group of COSEM logical devices addressed. However, the message received shall be discarded if there is no AA established between a client and the group of COSEM logical devices addressed;
- XX-APDUs with the broadcast address shall be sent to all COSEM logical devices addressed. However, the message received shall be discarded if there is no AA established between a client and the All-station address.

NOTE Unconfirmed AA-s between a client and a group of logical devices are established with a COSEM-OPEN service with Service_Class == Unconfirmed and a group of logical device addresses (for example broadcast address).

7.3.3 Protocol for the GET service

When the client AP desires to read the value of one or more COSEM interface object attributes, it uses the GET service.

As explained in 6.6, the encoded form of the request shall always fit in a single APDU.

On the other hand, the result may be too long to fit in a single APDU. In this case, either the service-specific or the general block transfer mechanism may be used. It is negotiated via bit 2 or bit 11 of the conformance block; see 7.3.1.

NOTE In some DLMS/COSEM communication profiles segmentation is available to transfer long APDUs.

The GET service primitive types and the corresponding APDUs are shown in Table 40.

Table 40 – GET service types and APDUs

GET .req / .ind	Request APDU	Response APDU	GET .res / .cnf
NORMAL	Get-Request-Normal	Get-Response-Normal	NORMAL
		Get-Response-With-Datablock with Last-Block = FALSE	ONE-BLOCK
NEXT	Get-Request-Next	Get-Response-With-Datablock with Last-Block = FALSE	ONE-BLOCK
		Get-Response-With-Datablock with Last-Block = TRUE	LAST-BLOCK
WITH-LIST	Get-Request-With-List	Get-Response-With-List	WITH-LIST
		Get-Response-With-Datablock with Last-Block = FALSE	ONE-BLOCK

Figure 16 shows the MSC for a confirmed GET service in the case of success, without block transfer.

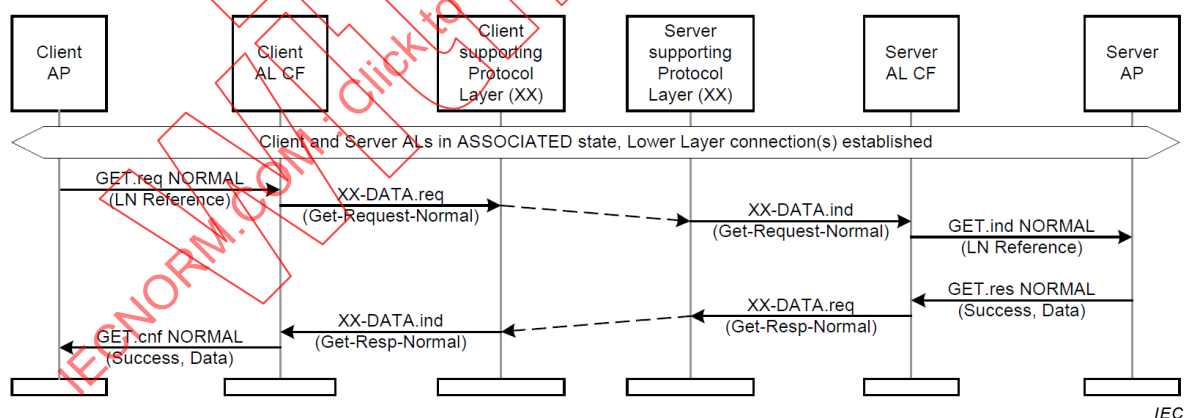


Figure 16 – MSC of the GET service

Figure 17 shows the MSC of a confirmed GET service in the case of success, with the result returned in three blocks.

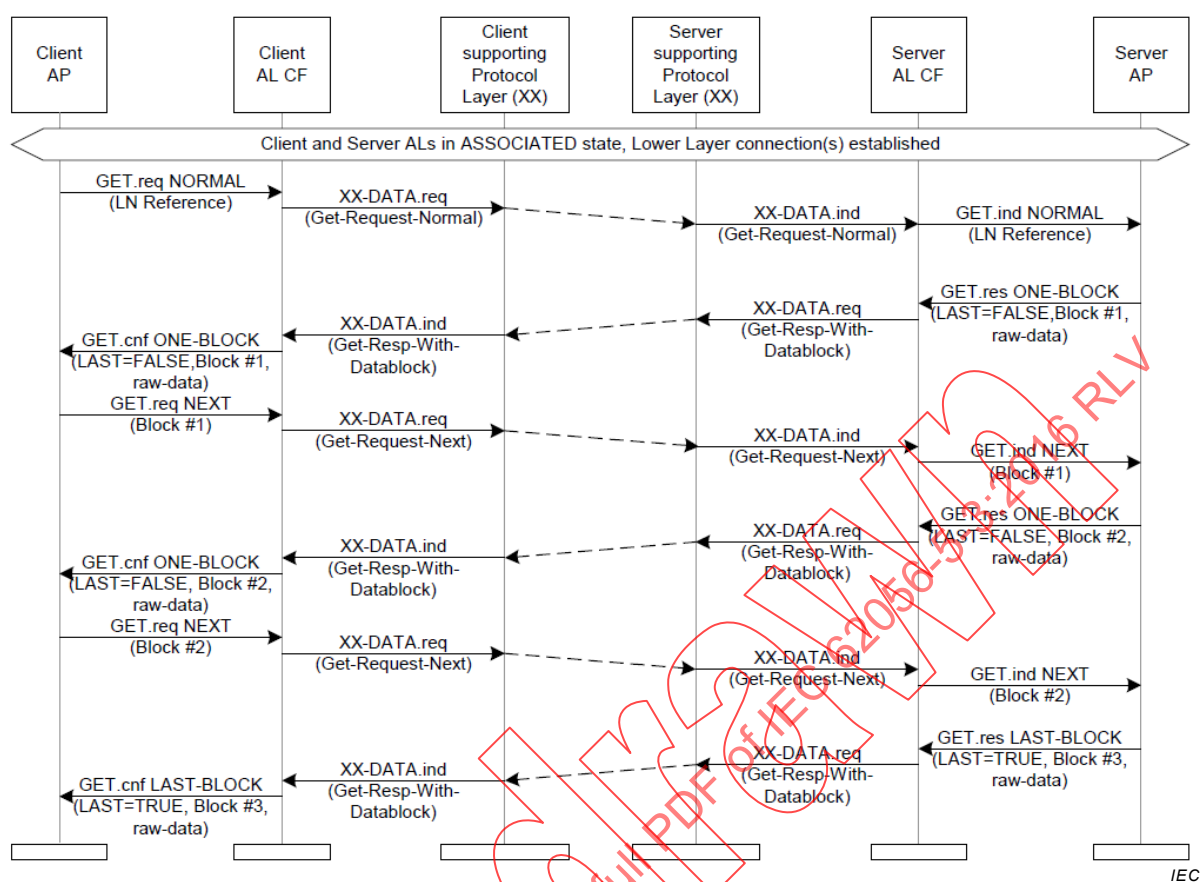


Figure 17 – MSC of the GET service with block transfer

The GET.request primitive is invoked with Request_Type == NORMAL or WITH-LIST as appropriate. As in this case the data to be returned is too long to fit in a single APDU, the server AP sends it in blocks. First, the data is encoded, as if it would fit into a single APDU:

- if the value of a single attribute was requested, only the type and value shall be encoded (Data). If the Data cannot be delivered, the response shall be of type GET-NORMAL with Data_Access_Result;
- if the value of a list of attributes was requested, then the list of results shall be encoded: for each attribute, either Data or Data Access Result.

The result is a series of bytes, $B_1, B_2, B_3, \dots, B_N$.

The server can generate the complete response upon receipt of the first GET.indication primitive or dynamically (on the fly).

The server AP assembles then a DataBlock G structure:

- Last_Block == FALSE;
- Block_Number == 1;
- Result (Raw_Data) == the first K bytes of the encoded data: $B_1, B_2, B_3, \dots, B_K$.

It is recommended to start the numbering of the blocks from 1.

The server AP invokes then the GET-RESPONSE-ONE-BLOCK service primitive with Response Type == ONE-BLOCK carrying this DataBlock-G structure.

Upon reception of the .response primitive, the server AL builds a Get-Response-With-Datablock APDU carrying the parameters of the .response primitive and sends it to the client.

Upon reception of this APDU, the client AL generates a .confirm primitive with Response_Type == ONE-BLOCK. The client AP is informed now that the response is provided in several blocks. It stores the data block received ($B_1, B_2, B_3, \dots, B_K$), then acknowledges its reception and asks for the next one by invoking a GET-REQUEST-NEXT service primitive. The block number shall be the same as the block number of the data block received. The client AL builds a Get-Request-Next APDU and sends it to the server.

When the server AL invokes the GET.indication primitive with Request_Type == NEXT, the server AP prepares and sends the next data block, including $B_{K+1}, B_{K+2}, B_{K+3}, \dots, B_L$ with block-number == 2. This exchange of sending data blocks and acknowledgements continues until the last data block, carrying $B_M, B_{M+1}, B_{M+2}, \dots, B_N$ is sent. The last GET.response primitive is invoked with Response_Type == LAST-BLOCK: in the DataBlock-G structure Last_Block == TRUE. This last data block is not acknowledged by the client.

Throughout the whole procedure, the Invoke_Id and the Priority parameters shall be the same in each primitive.

If during a long data transfer the server receives another service request, it is served according to the priority rules and the priority management settings (Conformance block bit 9).

If any error occurs during the long data transfer, the transfer is aborted. The error cases are:

- a) The server is not able to provide the next block of data for any reason. In this case, the server AP shall invoke a GET-RESPONSE-LAST-BLOCK service primitive. The Result parameter shall contain a DataBlock_G structure with:
 - Last_Block == TRUE;
 - Block_Number == number of the block confirmed by the client + 1;
 - Result == Data_Access_Result, indicating the reason of the failure.
- b) The Block_Number parameter in a GET-REQUEST-NEXT service primitive is not equal to the number of the previous block sent by the server. The server interprets this, as if the client would like to abort the ongoing transfer. In this case, the server AP shall invoke a GET-RESPONSE-LAST-BLOCK service primitive. The Result parameter shall contain a DataBlock_G structure with:
 - Last_Block == TRUE;
 - Block_Number == equal to the block number received from the client;
 - Result == Data-Access-Result, long-get-aborted.
- c) The server may receive a Get-Request-Next APDU when no long data transfer is in progress. In this case, the server AP shall invoke a GET-RESPONSE-LAST-BLOCK service primitive. The Result parameter shall contain a DataBlock_G structure with:
 - Last-block == TRUE;
 - Block-Number == equal to the block number received from the client;
 - Result == Data-Access-Result, no-long-get-in-progress.
- d) The block number sent by the server is not equal to the next in sequence. In this case, the client shall abort the block transfer (see case b).

If, in the error cases above, the server is not able to invoke a GET-RESPONSE-LAST-BLOCK service primitive for any reason, it shall invoke a GET-RESPONSE-NORMAL service primitive, with the Data-Access-Result parameter indicating the reason of the failure. The server shall send a Get-Response-Normal APDU.

The MSC for error case b), long get aborted, is shown in Figure 18:

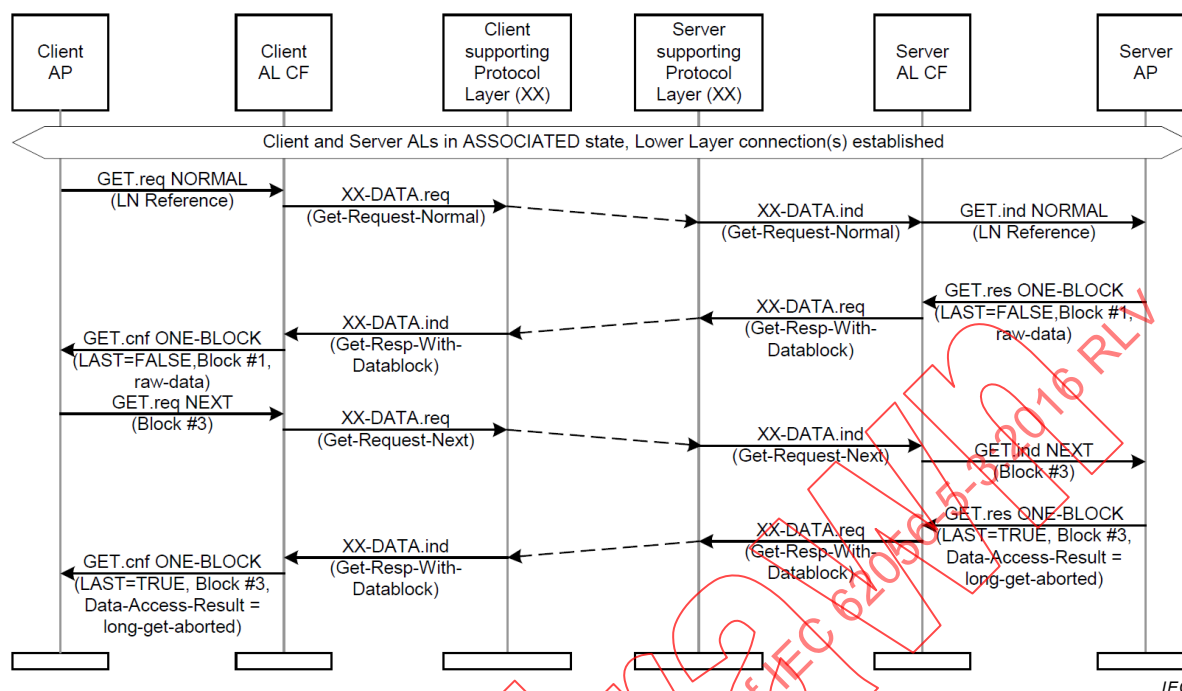


Figure 18 – MSC of the GET service with block transfer, long GET aborted

7.3.4 Protocol for the SET service

When the client AP desires to write the value of one or more COSEM interface object attributes, it uses the SET service.

As explained in 6.7, the encoded form of the request may fit in a single request or not. In this latter case, either the service-specific or the general block transfer mechanism may be used. It is negotiated via bit 2 or bit 12 of the conformance block, see 7.3.1.

NOTE In some DLMS/COSEM communication profiles segmentation is available to transfer long APDUs.

The SET service primitive types and the corresponding APDUs are shown in Table 41.

Table 41 – SET service types and APDUs

SET .req / .ind	Request APDU	Response APDU	SET .res / .cnf
NORMAL	Set-Request-Normal	Set-Response-Normal	NORMAL
FIRST-BLOCK	Set-Request-With-First-Datablock Last-Block = FALSE	Set-Response-Datablock	ACK-BLOCK
ONE-BLOCK	Set-Request-With-Datablock Last-Block = FALSE		
LAST-BLOCK	Set-Request-With-Datablock Last-Block = TRUE	Set-Response-Last-Datablock	LAST-BLOCK
WITH-LIST	Set-Request-With-List	Set-Response-With-List	WITH-LIST
FIRST-BLOCK-WITH-LIST	Set-Request-With-List-And-With-First-Datablock	Set-Response-Datablock	ACK-BLOCK

Figure 19 shows the MSC of a confirmed SET service, in the case of success, without block transfer.

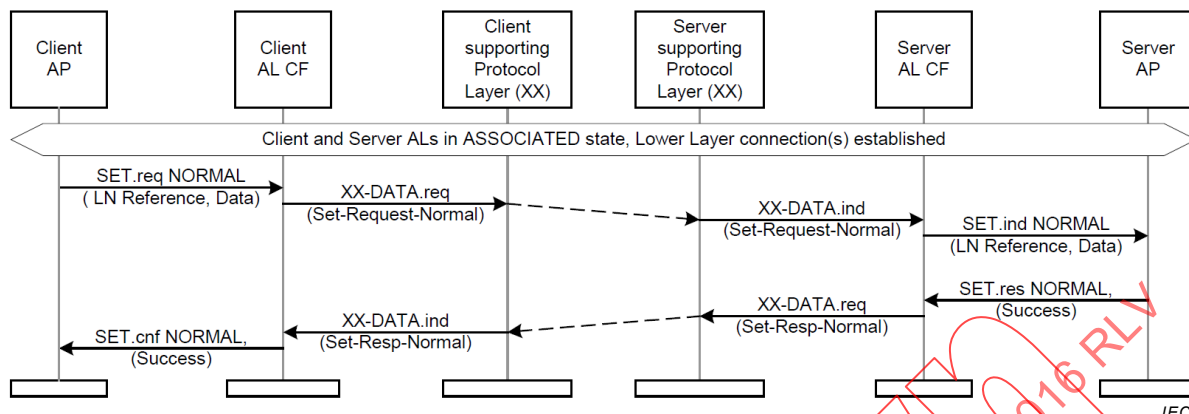


Figure 19 – MSC of the SET service

Figure 20 shows the MSC of a confirmed SET service in the case of success, with the request sent in three blocks.

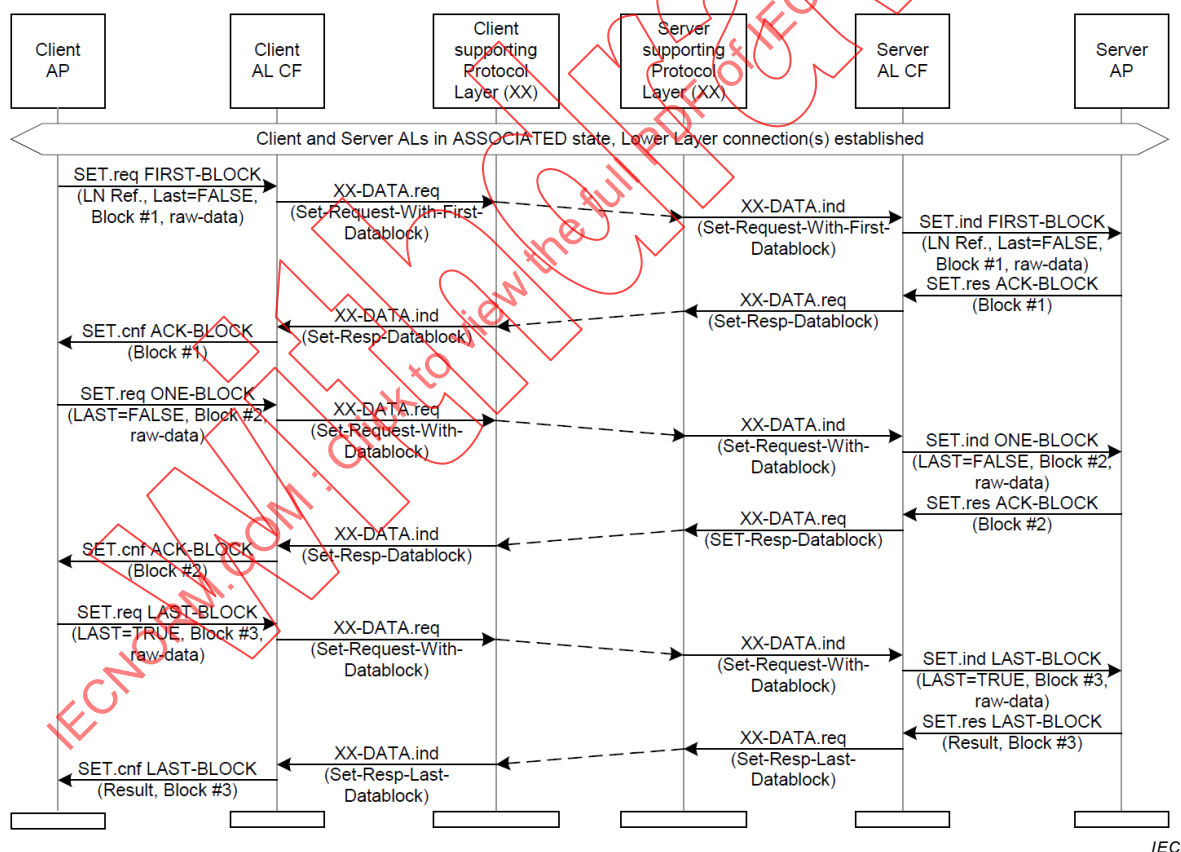


Figure 20 – MSC of the SET service with block transfer

As the data to be sent is too long to fit in a single APDU in this case, the client AP sends it in blocks. First, the data is encoded as if it would fit in a single APDU. The result is a series of bytes, $B_1, B_2, B_3, \dots, B_N$.

The client can generate the complete request ($B_1, B_2, B_3, \dots, B_N$) in one step or dynamically (on the fly).

The client AP assembles then a DataBlock_SA structure:

- Last_Block == FALSE;
- Block_Number == 1;
- Raw_Data == the first K bytes of the encoded data: $B_1, B_2, B_3, \dots, B_K$.

The client AP invokes then the SET-REQUEST-FIRST-BLOCK or SET-REQUEST-FIRST-BLOCK-WITH-LIST service primitive as appropriate, carrying the attribute reference(s) and this DataBlock-SA structure.

Upon reception of the .request primitive, the client AL builds the appropriate Set-Request APDU carrying the parameters of the .request primitive and sends it to the server.

The server stores the data block received, then acknowledges its reception and asks for the next one by invoking a SET.response primitive with Response_Type == ACK-BLOCK and with the same block number as the number of the block received.

To send the next data block carrying $B_{K+1}, B_{K+2}, B_{K+3}, \dots, B_L$, the client AP invokes a SET-REQUEST-ONE-BLOCK service primitive. This exchange of sending data blocks and acknowledgements continues until the last data block carrying $B_M, B_{M+1}, B_{M+2}, \dots, B_N$ is sent, by invoking a SET-REQUEST-LAST-BLOCK service primitive with Last_Block == TRUE.

When these primitives are invoked, the client AL builds a Set-Request-With-Datablock APDU, carrying a DataBlock_SA structure and sends these APDUs to the server.

When the server AP receives the last datablock, it invokes a SET-RESPONSE-LAST-BLOCK or SET-RESPONSE-LAST-BLOCK-WITH-LIST service primitive as appropriate. The Result parameter carries the result of the complete SET service invocation. The Block_Number parameter confirms the reception of the last block.

Throughout the whole procedure, the Invoke_Id and the Priority parameters shall be the same in each primitive.

If during a long data transfer the server receives another service request, it is served according to the priority rules and the priority management settings (Conformance block bit 9).

If any error occurs during the long data transfer, the transfer is aborted. The error cases are:

- a) The server is not able to handle the data block received, for any reason. In this case, the server AP shall invoke a SET-RESPONSE-LAST-BLOCK or SET-RESPONSE-LAST-BLOCK-WITH-LIST service primitive as appropriate. The Result parameter indicates the reason for aborting the transfer;
- b) The Block_Number parameter in a SET-REQUEST-ONE-BLOCK service primitive is not equal to the block number expected by the server (last received + 1). The server interprets this as if the client would like to abort the ongoing transfer. In this case, the server AP shall invoke a SET-RESPONSE-LAST-BLOCK or SET-RESPONSE-LAST-BLOCK-WITH-LIST service primitive as appropriate with the Result parameter Data_Access_Result == long-set-aborted;
- c) The server may receive a Set-Request-With-Datablock APDU when no long data transfer is in progress. In this case, the server AP shall invoke a SET-RESPONSE-LAST-BLOCK service primitive with the Result parameter Data_Access_Result == no-long-set-in-progress.

If, in the error cases above, for any reason the server is not able to invoke a SET-RESPONSE-LAST-BLOCK service primitive, it invokes a SET-RESPONSE-NORMAL service primitive with the Data-Access-Result parameter indicating the reason of the failure.

7.3.5 Protocol for the ACTION service

When the client AP desires to invoke one or more COSEM interface objects methods, it uses the ACTION service. As explained in 6.8, the ACTION service comprises two phases.

If the method references and method invocation parameters or the return parameters do not fit in a single APDU, either the service-specific or the general block transfer mechanism may be used. It is negotiated via bit 2 or bit 13 of the conformance block, see 7.3.1.

NOTE In some DLMS/COSEM communication profiles segmentation is available to transfer long APDUs.

The ACTION service primitive types and the corresponding APDUs are shown in Table 42.

Table 42 – ACTION service types and APDUs

ACTION .req / .ind	Request APDU	Response APDU	SET .res / .cnf
NORMAL	Action-Request-Normal	Action-Response-Normal	NORMAL
		Action-Response-With-Pblock	ONE-BLOCK
NEXT	Action-Request-Next-Pblock	Action-Response-With-Pblock	ONE-BLOCK
		Action-Response-With-Pblock	LAST-BLOCK
FIRST-BLOCK	Action-Request-With-First-Pblock	Action-Response-Next-Pblock	NEXT
ONE-BLOCK	Action-Request-With-Pblock		
LAST-BLOCK	Action-Request-With-Pblock	Action-Response-Normal	NORMAL
		Action-Response-With-Pblock	ONE-BLOCK
WITH-LIST	Action-Request-With-List	Action-Response-With-List	WITH-LIST
		Action-Response-With-Pblock	ONE-BLOCK
WITH-LIST-AND-FIRST-BLOCK	Action-Request-With-List-And-With-First-Pblock	Action-Response-Next-Pblock	NEXT

Figure 21 illustrates the MSC of a confirmed ACTION service in the case of success, without block transfer.

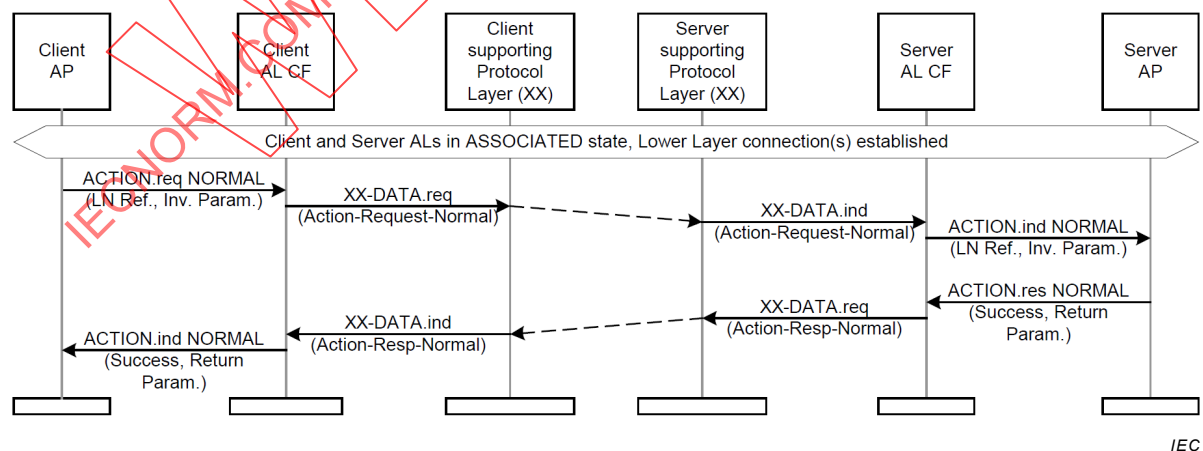


Figure 21 – MSC of the ACTION service

The ACTION service can transport data in both directions:

- in the first phase, the client sends the ACTION.request with the method invocation parameters for the method(s) referenced and the server acknowledges them. The process is essentially the same as in the case of the SET service;
- in the second phase, the server sends the ACTION.response with the result of invoking the method(s) and the return parameters. The process is essentially the same as in the case of the GET service.

Throughout the whole procedure, the Invoke_Id and the Priority parameters shall be the same in each primitive.

If during a long data transfer the server receives another service request, it is served according to the priority rules and the priority management settings (Conformance block bit 9).

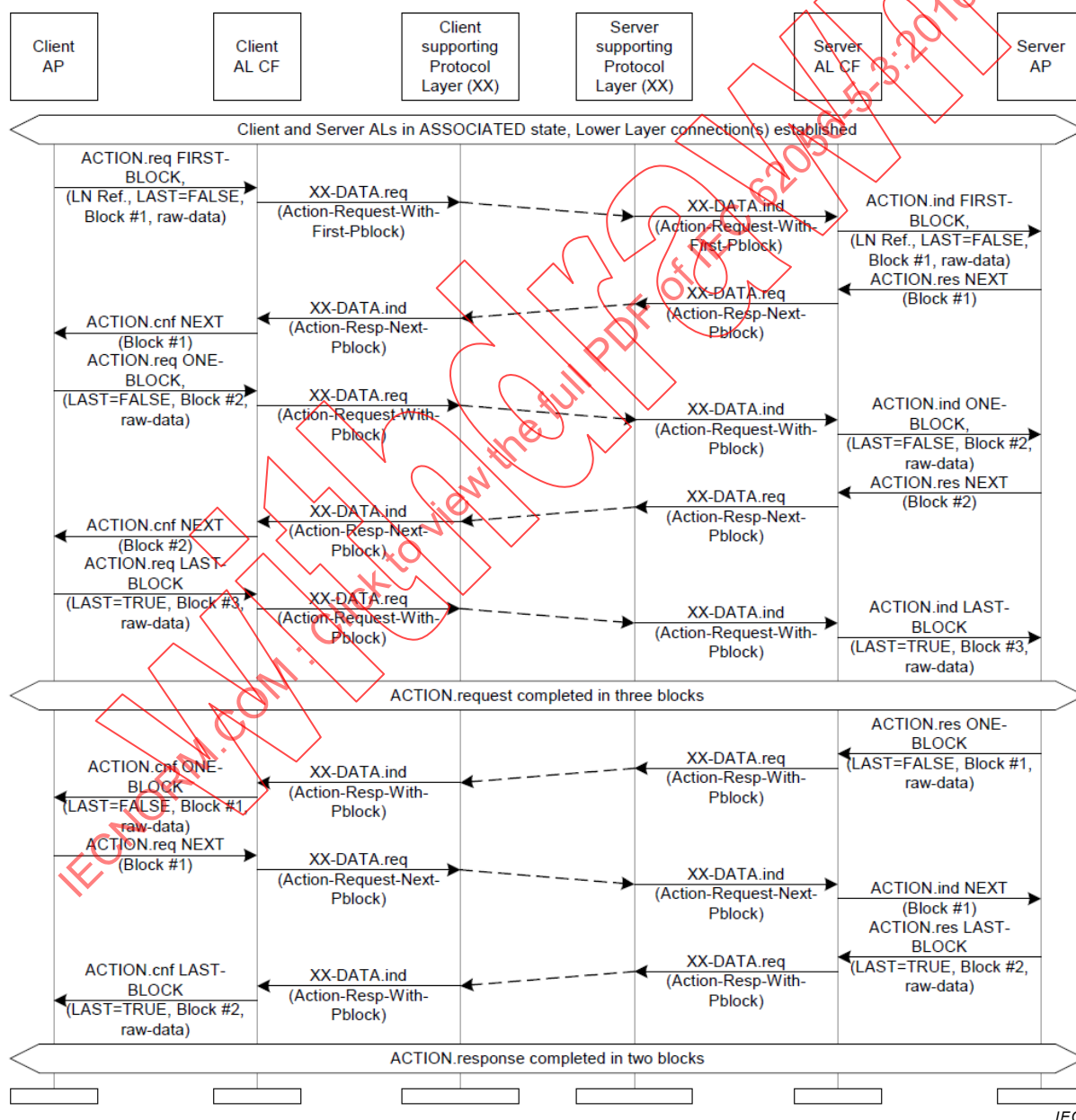


Figure 22 – MSC of the ACTION service with block transfer

Figure 22 illustrates the MSC in the case when block transfer takes place in both directions.

If any error occurs during the long data transfer, the transfer shall be aborted. Error cases are the same as in the case of the GET and SET services.

7.3.6 Protocol of the DataNotification service

When the server AP invokes a DataNotification.request service primitive, the server AL builds the DataNotification APDU and sends it to the client.

When the client AL receives this APDU, it invokes the DataNotification.indication service primitive.

If the service primitives are long partial service invocations can be used.

If the encoded form of the service primitive is too long, then the general block transfer mechanism can be used. See also Figure 37.

7.3.7 Protocol for the EventNotification service

Upon invocation of the EventNotification.request service, the Server AL builds an EventNotificationRequest APDU. The possibilities to send out this APDU depend on the communication profile and the connection status of the lower layers. Therefore, the protocol of the EventNotification service is further discussed in the parts of IEC 62056 describing the communication profiles;

In any case, in order to send the value(s) of attribute(s) to the client, without the client requesting it:

- the server uses the EventNotification.request service primitive;
- upon invocation of this primitive, the server AL builds an EventNotificationRequest APDU;
- this APDU is carried by the supporting layer service at the first opportunity to the client. The service type and the availability of this first opportunity depends on the communications profile used;
- upon reception of the EventNotificationRequest APDU, the client AL generates an EventNotification.indication primitive to the COSEM client AP;

NOTE At the client side, it is always EventNotification.indication, independently of the referencing scheme (LN or SN) used by the server.

- by default, event notifications are sent from the management logical device (server) to the management AP (client).

7.3.8 Protocol for the Read service

As explained in 6.13, the Read service is used when the server uses SN referencing, either to read (a) COSEM interface object attribute(s), or to invoke (a) method(s) when return parameters are expected:

- in the first case, the GET.request service primitives are mapped to Read.request primitives and the Read.confirm primitives are mapped to GET.confirm primitives. The mapping and the corresponding SN APDUs are shown in Table 43;
- in the second case, the ACTION.request service primitives are mapped to Read.request primitives and the Read.response primitives are mapped to ACTION.response primitives. The mapping and the corresponding SN APDUs is shown in Table 44.

NOTE In the mapping tables below, the following notation is used:

- for LN services, only the request and response types are shown without service parameters;
- for SN services, the name of the service primitive is followed by the service parameters in brackets. Service parameter name elements are capitalized and joined with an underscore to signify a single entity. Parameters that may be repeated are shown in curly brackets. The choices that can be taken for the Variable_Access_Specification parameter are listed following the symbol “=”. Alternatives are separated by the vertical bar “|”;
- for SN APDUs, the name of the APDU is followed by the symbol “::=” and the fields in brackets. The field name elements are not capitalized and are joined with a dash to signify a single entity. Fields that may be repeated are shown in curly brackets. Alternatives are separated by the vertical bar “|”.

Table 43 – Mapping between the GET and the Read services

From GET.request of type	To Read.request	SN APDU
NORMAL	Read.request (Variable_Access_Specification) Variable_Access_Specification = Variable_Name Parameterized_Access;	ReadRequest::= (variable-name parameterized-access)
NEXT	Read.request (Variable_Access_Specification) Variable_Access_Specification = Block_Number_Access;	ReadRequest::= (block-number-access)
WITH-LIST	Read.request ({Variable_Access_Specification}) Variable_Access_Specification = Variable_Name Parameterized_Access;	ReadRequest::= ({variable-name parameterized-access})
To GET.confirm of type	SN APDU	From Read.response
NORMAL	ReadResponse::= (data data-access-error)	Read.response (Data Data_Access_Error)
ONE-BLOCK	ReadResponse::= (data-block-result)	Read.response (Data_Block_Result) with Last_Block = FALSE
LAST-BLOCK	ReadResponse::= (data-block-result)	Read.response (Data_Block_Result) with Last_Block = TRUE
WITH-LIST	ReadResponse::= ({data data-access-error})	Read.response ({Data Data_Access_Error})

Table 44 – Mapping between the ACTION and the Read services

From ACTION.request of type	To Read.request	SN APDU
NORMAL	Read.request (Variable_Access_Specification) Variable_Access_Specification = Parameterized_Access; with Variable_Name = method reference, Selector = 0, Parameter = method invocation parameter or null-data	ReadRequest::= (parameterized-access)
NEXT	Read.request (Variable_Access_Specification) Variable_Access_Specification = Block_Number_Access;	ReadRequest:: = (block-number-access)
FIRST-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Raw_Data = one part of the method reference(s) and method invocation parameter	ReadRequest::= (read-data-block-access)
ONE-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = FALSE, Block_Number = next number, Raw_Data = as above	ReadRequest::= (read-data-block-access)
LAST-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = TRUE, Block_Number = next number, Raw_Data = as above	ReadRequest::= (read-data-block-access)
WITH-LIST	Read.request (Variable_Access_Specification) Variable_Access_Specification = Parameterized_Access; with Variable_Name = method reference, Selector = 0, Parameter = method invocation parameter or null-data	ReadRequest::= (parameterized-access)
WITH-LIST-AND-FIRST-BLOCK	Read.request (Variable_Access_Specification) Variable_Access_Specification = Read_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Raw_Data = as above	ReadRequest::= (read-data-block-access)
To ACTION.confirm	SN APDU	From Read.response
NORMAL	ReadResponse::= (data data-access-error)	Read.response (Read_Result) Read_Result = Data Data_Access_Error;

From ACTION.request of type	To Read.request	SN APDU
ONE-BLOCK	ReadResponse::= (data-block-result)	Read.response (Read_Result) Read_Result = Data_Block_Result; with Last_Block = FALSE
LAST-BLOCK	ReadResponse::= (data-block-result)	Read.response (Read_Result) Read_result = Data_Block_Result; with Last_Block = TRUE
NEXT	ReadResponse::= (block-number)	Read.confirm (Read_Result) Read_Result = Block_Number;
WITH-LIST	ReadResponse::= ({data data-access-error})	Read.response ({Read_Result}) Read_Result = Data Data_Access_Error;

Figure 23 shows the MSC of a Read service used to read the value of a single attribute.

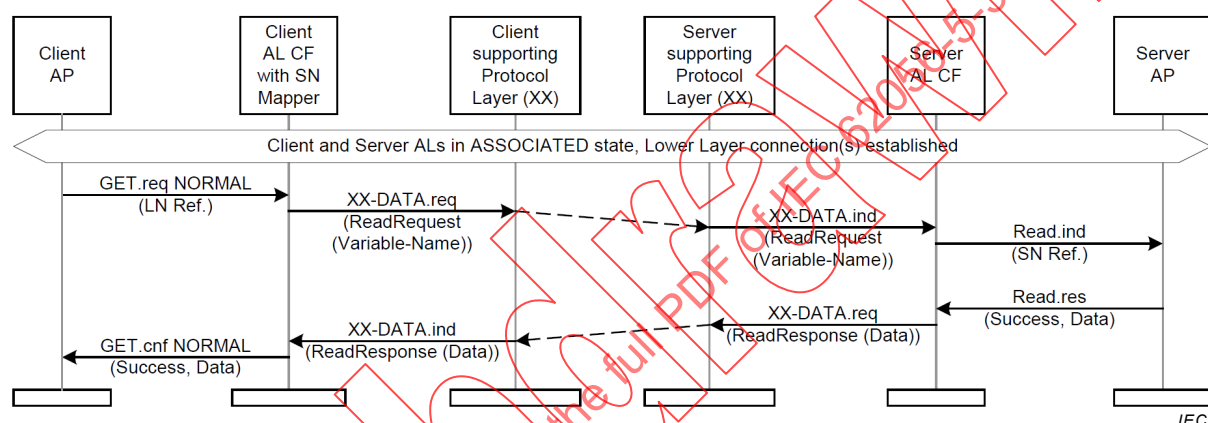


Figure 23 – MSC of the Read service used for reading an attribute

Figure 24 shows the MSC of a Read service used to invoke a single method.

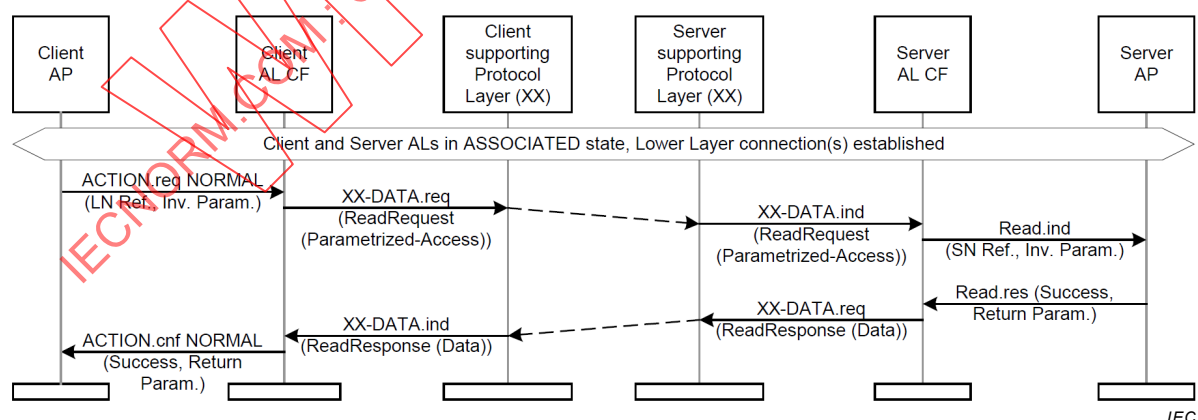


Figure 24 – MSC of the Read service used for invoking a method

Figure 25 shows the MSC of a Read service for reading a single attribute, with the result returned in three blocks using the service-specific block transfer mechanism.

Alternatively, the general block transfer mechanism can be used.

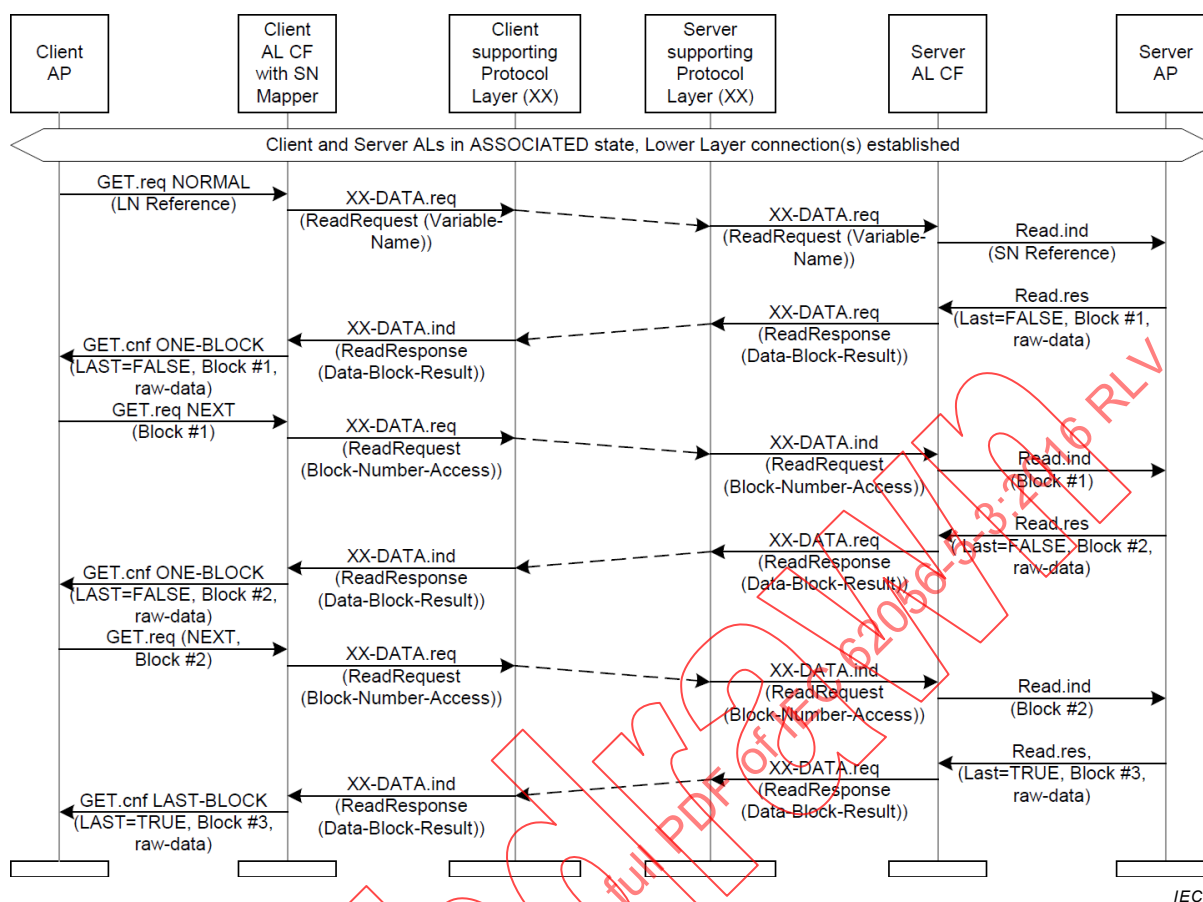


Figure 25 – MSC of the Read Service used for reading an attribute, with block transfer

The process of preparing and transporting the long data is essentially the same as in the case of the GET and ACTION services.

- if the Read service is used to read the value of (a) COSEM object attribute(s), the Raw_Data element of the Data_Block_Result construct carries one part of the list of Read_Result(s);
- if the Read service is used to invoke (a) COSEM object method(s) and long method invocation parameters have to be sent, the Raw_Data element of the Read_Data_Block_Access construct carries one part of the method reference(s) and method invocation parameter(s). If long method invocation responses are returned, the Raw_Data element of the Data_Block_Result construct carries one part of the method invocation response(s).

If an error occurs, the server should return a Read.response service primitive with Data_Access_Error carrying appropriate diagnostic information; for example data-block-number-invalid.

7.3.9 Protocol for the Write service

As explained in 6.14, the Write service is used when the server uses SN referencing, either to write (a) COSEM object attribute(s), or to invoke (a) method(s) when no return parameters are expected:

- in the first case, the SET.request service primitives are mapped to Write.request primitives and the Write.confirm primitives to SET.confirm primitives. The mapping and the corresponding SN APDUs are shown in Table 45;

- in the second case, the ACTION.request service primitives are mapped to Write.request primitives and the Write.response primitives to ACTION.confirm primitives. The mapping and the corresponding SN APDUs are shown in Table 46.

Table 45 – Mapping between the SET and the Write services

From SET.request of type	To Write.request	SN APDU
NORMAL	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name I Parameterized_Access;	WriteRequest ::= (variable-name I parameterized-access, data)
FIRST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Data = raw-data, carrying the encoded form of the attribute reference(s) and write data.	WriteRequest ::= (write-data-block-access, data)
ONE-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = next number, Data = as above	WriteRequest ::= (write-data-block-access, data)
LAST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = TRUE, Block_Number = next number, Data = as above	WriteRequest ::= (write-data-block-access, data)
WITH-LIST	Write.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name I Parameterized_Access;	WriteRequest ::= ({variable-name I parameterized- access}, {data})
FIRST-BLOCK-WITH-LIST	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1 Data = as above	WriteRequest ::= (write-data-block-access, data)
To SET.confirm of type	SN APDU	From Write.response
NORMAL	WriteResponse ::= (success I data-access-error)	Write.response (Write_Result) Write_Result = Success I Data_Access_Error;
ACK-BLOCK	WriteResponse ::= (block-number)	Write.response (Write_Result) Write_Result = Block_Number;

From SET.request of type	To Write.request	SN APDU
LAST-BLOCK	WriteResponse::= (success data-access-error)	Write.response (Write_Result) Write_Result = Success Data_Access_Error;
WITH-LIST	WriteResponse::= ({success data-access-error})	Write.response ({Write_Result}) Write_Result = Success Data_Access_Error;
LAST-BLOCK-WITH-LIST	WriteResponse::= ({success data-access-error})	Write.response ({Write_Result}) Write_Result = Success Data_Access_Error;

Table 46 – Mapping between the ACTION and the Write service

From ACTION.request of type	To Write.request	SN APDU
NORMAL	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name; Data = method invocation parameters or null-data	WriteRequest::= (variable-name, data)
FIRST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Data = raw-data, carrying the encoded form of the method reference(s) and method invocation parameters;	WriteRequest::= (write-data-block-access, data)
ONE-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = next number, Data = as above	WriteRequest::= (write-data-block-access, data)
LAST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = TRUE, Block_Number = next number, Data = as above	WriteRequest::= (write-data-block-access, data)
WITH-LIST	Write.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name; Data = method invocation parameters or null data	WriteRequest::= ({variable-name}, {data})

From ACTION.request of type	To Write.request	SN APDU
WITH-LIST-AND-FIRST-BLOCK	Write.request (Variable_Access_Specification, Data) Variable_Access_Specification = Write_Data_Block_Access; with Last_Block = FALSE, Block_Number = 1, Data = as with first block	WriteRequest ::= (write-data-block-access, data)
To ACTION.confirm	SN APDU	From Write.response
NORMAL	WriteResponse ::= (success data-access-error)	Write.response (Write_Result) Write_Result = Success Data_Access_Error
NEXT	WriteResponse ::= (block-number)	Write.response (Block_Number)
To ACTION.confirm	SN APDU	From Write.response
WITH-LIST	WriteResponse ::= ({success data-access-error})	Write.response ({Write_Result}) Write_Result = Success Data_Access_Error

Figure 26 shows the MSC of a Write service used to write the value of a single attribute, in the case of success.

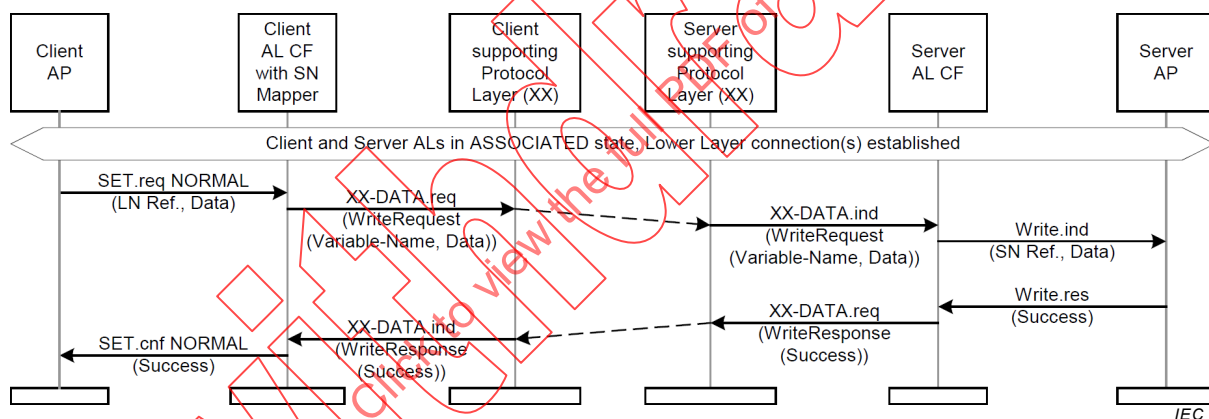


Figure 26 – MSC of the Write service used for writing an attribute

Figure 27 shows the MSC of a Write service used to invoke a single method, in the case of success.

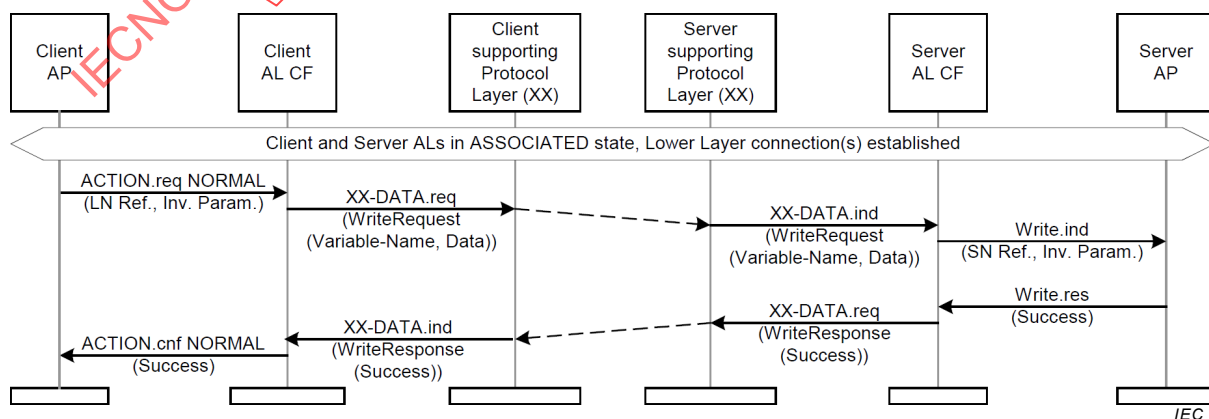


Figure 27 – MSC of the Write service used for invoking a method

Figure 28 shows the MSC of a Write service for writing a single attribute with the result returned in three blocks using the service-specific block transfer mechanism.

Alternatively, the general block transfer mechanism can be used.

The process of preparing and transporting the long data is essentially the same as in the case of the SET and ACTION services:

If an error occurs, the server should return a Write.response service primitive with the Data_Access_Error carrying appropriate diagnostic information; for example data-block-number-invalid.

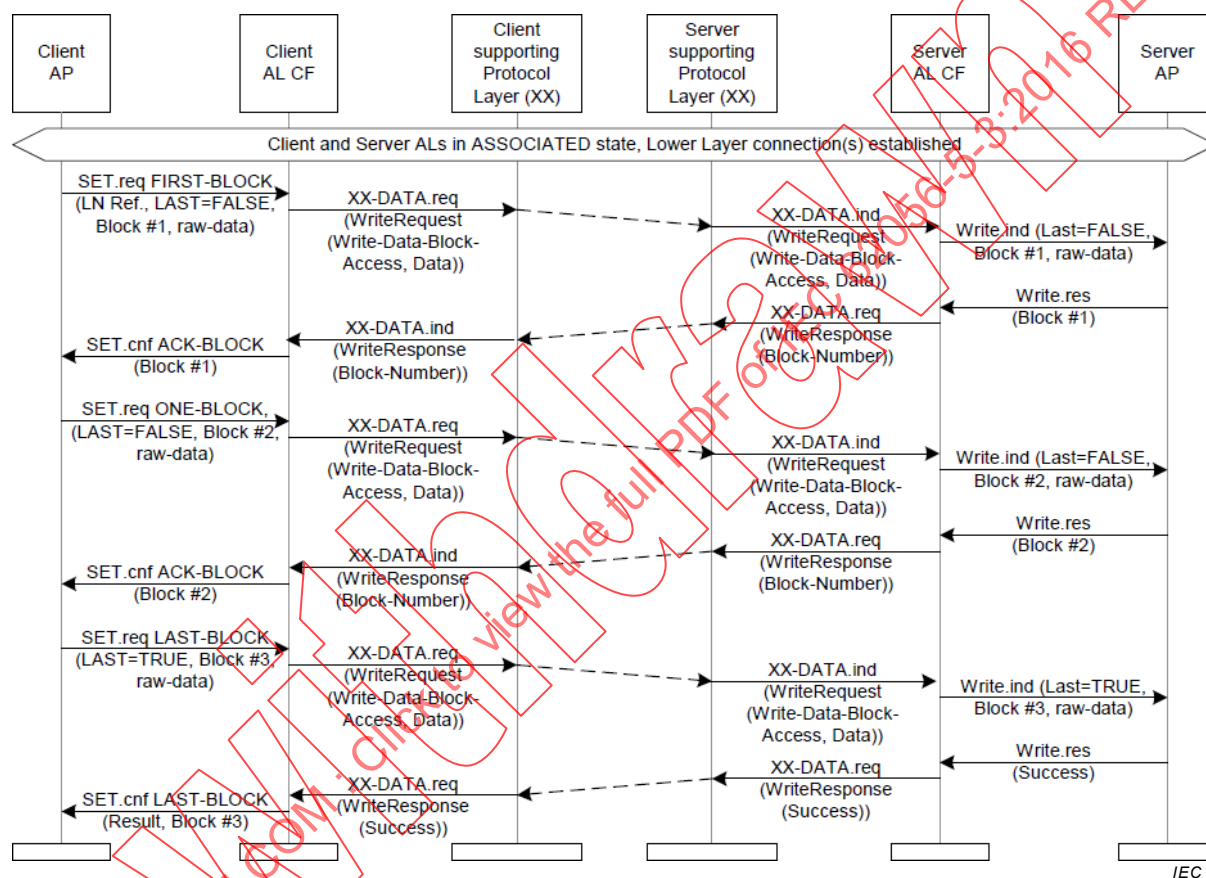


Figure 28 – MSC of the Write service used for writing an attribute, with block transfer

7.3.10 Protocol for the UnconfirmedWrite service

This service may be invoked only when an AA has already been established. Depending on the communication profile, the APDU corresponding to the request may be transported using the connection-oriented (CO) or connectionless data (CL) services of the supporting protocol layer.

As explained in 6.15, the UnconfirmedWrite service may be used either to write (a) COSEM object attribute(s), or to invoke (a) method(s) when no return parameters are expected:

- in the first case, the SET.request service primitives are mapped to UnconfirmedWrite.request primitives. The mapping and the corresponding SN APDUs are shown in Table 47;

- in the second case, the ACTION.request service primitives are mapped to UnconfirmedWrite.request primitives. The mapping and the corresponding SN APDUs are shown in Table 48.

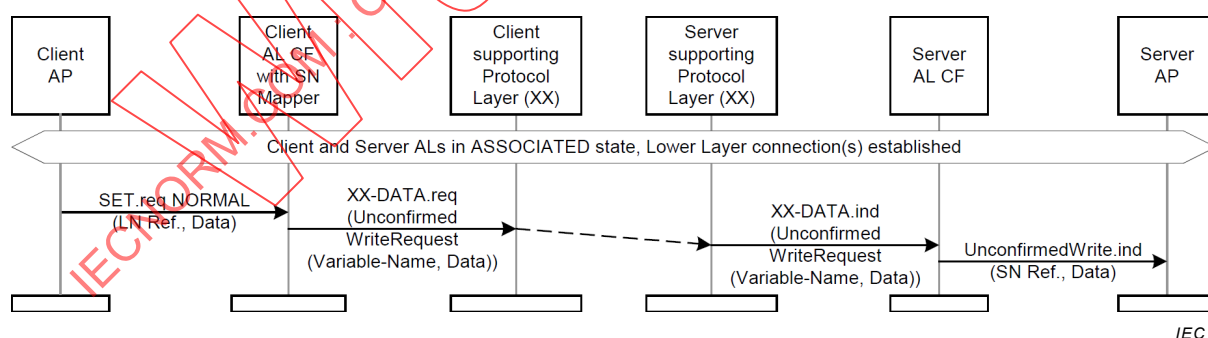
Table 47 – Mapping between the SET and the UnconfirmedWrite services

From SET.request of type	To UnconfirmedWrite.request	SN APDU
NORMAL	UnconfirmedWrite.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name I Parameterized_Access;	UnconfirmedWriteRequest ::= (variable-name I parameterized-access, data)
WITH-LIST	UnconfirmedWrite.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name I Parameterized_Access;	UnconfirmedWriteRequest ::= ({variable-name I parameterized- access}, {data})

Table 48 – Mapping between the ACTION and the UnconfirmedWrite services

From ACTION.request of type	To UnconfirmedWrite.request	SN APDU
NORMAL	UnconfirmedWrite.request (Variable_Access_Specification, Data) Variable_Access_Specification = Variable_Name; Data = method invocation parameters or null data	UnconfirmedWriteRequest ::= (variable-name, data)
WITH-LIST	UnconfirmedWrite.request ({Variable_Access_Specification}, {Data}) Variable_Access_Specification = Variable_Name; Data = as above	UnconfirmedWriteRequest ::= ({variable-name}, {data})

Figure 29 shows the MSC of a Write service used to write the value of a single attribute, in the case of success.

**Figure 29 – MSC of the Unconfirmed Write service used for writing an attribute**

When the service parameters are long, the general block transfer mechanism can be used.

7.3.11 Protocol for the InformationReport service

The protocol for the InformationReport service, specified in 6.16, is essentially the same as that of the EventNotification service, see 7.3.7.

As the InformationReport service does not contain the optional Application_Addresses parameter, unlike the EventNotification service, the information report is always sent by the Server Management Logical Device to the Client Management AP.

Upon invocation of the InformationReport.request service, the server AP builds an InformationReportRequest APDU. This APDU is sent from the SAP of the management logical device to the SAP of the client management device, using data services of the lower layers, in a non-solicited manner, at the first available opportunity.

The possibilities to send out this APDU depend on the communication profile and the connection status of the lower layers. Therefore, the protocol of the InformationReport service is further discussed in Annex A.

The InformationReport service may carry several attribute names and their contents. On the other hand, the EventNotification service specified in 6.10 contains only one attribute reference. Therefore, when the InformationReportRequest APDU contains more than one attribute, it shall be mapped to several EventNotification.ind services, as shown in Table 49.

Table 49 – Mapping between the EventNotification and InformationReport services

EventNotification.ind (one or more)	InformationReport.ind
Time (optional)	Current-time (optional)
COSEM_Class_Id, COSEM_Object_Instance_Id, COSEM_Object_Attribute_Id	Variable_Name {Variable_Name}
Attribute_Value	Data {Data}

7.3.12 Protocol of general block transfer mechanism

The general block transfer (GBT) mechanism can be used to carry any xDLMS service primitive when the service parameters are long i.e. their encoded form is longer than the Max Receive PDU Size negotiated. In this case, the AL uses one or more General-Block-Transfer (GBT) xDLMS APDUs to transport such long messages.

The service primitive invocations may be complete including all the service parameters or partial including only one part of the service parameters. Using complete or partial service invocations is left to the implementation.

Following the reception of a service .request / .response service primitive from the AP, the AL:

- builds the APDU that carries the service primitive;
- when ciphering is required it applies the protection as required by the Security_Options and builds the appropriate ciphered APDU;
- when the resulting APDU is longer than the negotiated max APDU size, then the AL uses the GBT mechanism to send the complete message in several GBT APDUs.

However, there is no direct relationship between partial invocations and the GBT APDUs sent. The AL may apply the protection using complete or partial service invocations.

Following the reception of GBT APDUs from a remote party, the AL:

- assembles the block-data fields of the GBT APDUs received together;
- when the resulting complete APDU is ciphered, it checks and removes the protection;
- it invokes the appropriate service primitive, passing the additional Security_Status, the General_Block_Transfer_Parameters and the Protection_Element.

However, there is no direct relationship between the GBT APDUs received and the partial service invocations. The AL may verify and remove the protection processing the GBT APDUs or processing the complete, assembled APDU.

See also Figure 9.

A message exchange may be started without or with using GBT. However, if one party sends a request or a response using GBT, the other party shall follow. The parties continue then using GBT until the end, i.e. until the complete response will have been received.

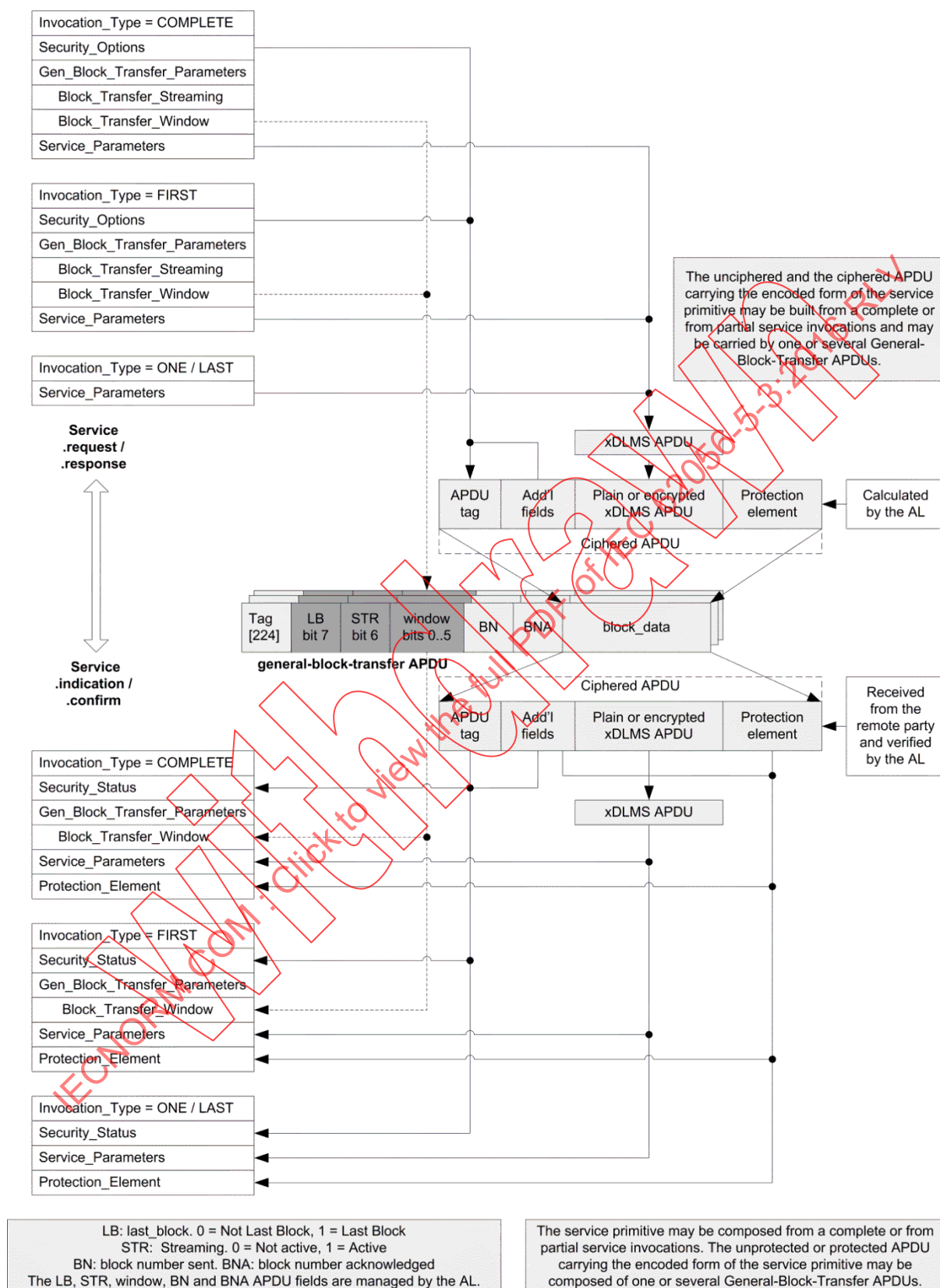
Streaming of blocks is managed by the AL taking into account the GBT parameters passed from the local AP to the AL – see 6.5 – and the fields of GBT APDUs – see Figure 30 – received from the remote AL.

The various service invocation types – COMPLETE, FIRST-PART, ONE-PART or LAST-PART – and the relationship between these invocations, the service parameters and the fields of the ciphered APDUs and the General-Block-Transfer (GBT) APDUs are shown in Figure 30.

The Block_Transfer_Streaming (BTS) parameter is passed by the AP to the AL to indicate that the AL can send blocks in streams, i.e. without waiting for a confirmation of each block received by the remote party. This parameter is not included in the APDU.

The Block_Transfer_Window (BTW) parameter indicates the size of the streaming window supported, i.e. the maximum number of blocks that can be received. The Block_Transfer_Window parameter of the other party may be known *a priori* by the parties. However, the window size is managed by the AL: it can use a lower value, for example during lost block recovery.

NOTE 1 This relationship is indicated using a dotted line in Figure 30 between the Block_Transfer_Window parameter and the window field of the APDU.



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NOTE Applying and checking/removing cryptographic protection on APDUs are independent from the GBT process. They are included here for completeness.

Figure 30 – Partial service invocations and GBT APDUs

In the case of unconfirmed services the `Block_Transfer_Streaming` parameter shall be set to `FALSE` and `Block_Transfer_Window` shall be set to 0. This indicates to the AL that it shall send the encoded form of the whole service primitive in as many GBT APDUs as needed without waiting for confirmation of the blocks sent.

The use of the fields of the GBT APDU is specified below:

- the last-block (LB) bit indicates if the block is the last one (LB = 1) or not (LB = 0);
- the streaming bit indicates if streaming is in progress (STR = 1) or finished (STR = 0). When streaming is finished, the remote party shall confirm the blocks received. When the `Block_Transfer_Streaming` parameter has been set to `FALSE`, the streaming bit shall be also set to 0;
- the window field indicates the number of blocks that can be received by the party sending the APDU. Its maximum value is equal to the `Block_Transfer_Window` parameter passed by the AP to the AL. Note, that the AL may use a lower value during lost block recovery. In the case when the GBT APDUs carry an unconfirmed service (BTS = `FALSE`, BTW = 0; see above), the value of the window shall be 0 indicating that no GBT APDUs shall be confirmed (and hence no lost blocks can be recovered);
- the block-number (BN) field indicates the number of the block sent. The first block sent shall have block-number = 1. Block-number shall be increased with each GBT APDU sent, even if block-data (BD) is empty. However, during lost block recovery a block number may be repeated;
- the block-number-acknowledged (BNA) field indicates the number of the block acknowledged. If no blocks have been lost, it shall be equal to the number of the last block received. However, if one or more blocks are lost, it shall be equal to the number of the block up to which no blocks are missing;
- the block-data (BD) field carries one part of the xDLMS APDU that is sent using the GBT mechanism.

If a party has no blocks to send, then the last-block bit of the APDU shall be set to 1 and the streaming bit shall be set to 0.

The protocol of the GBT mechanism is further explained with the help of Figure 31, Figure 32, Figure 33, Figure 34, Figure 35, Figure 36 and Figure 37. In these examples, it is assumed that both parties support GBT and six blocks are required to transfer the complete response or request (except in the DataNotification example, where four blocks are required).

NOTE 2 In these examples the service specific block transfer mechanism is not used.

Abbreviations used in the Figures:

- BTS: `Block_Transfer_Streaming`, BTW: `Block_Transfer_Window`;
- GBT: General-Block-Transfer APDU;
- LB: last-block;
- STR: Streaming;
- BN: block-number, BNA: block-number-acknowledged;
- BD (APDU): block-data containing one block of the APDU.

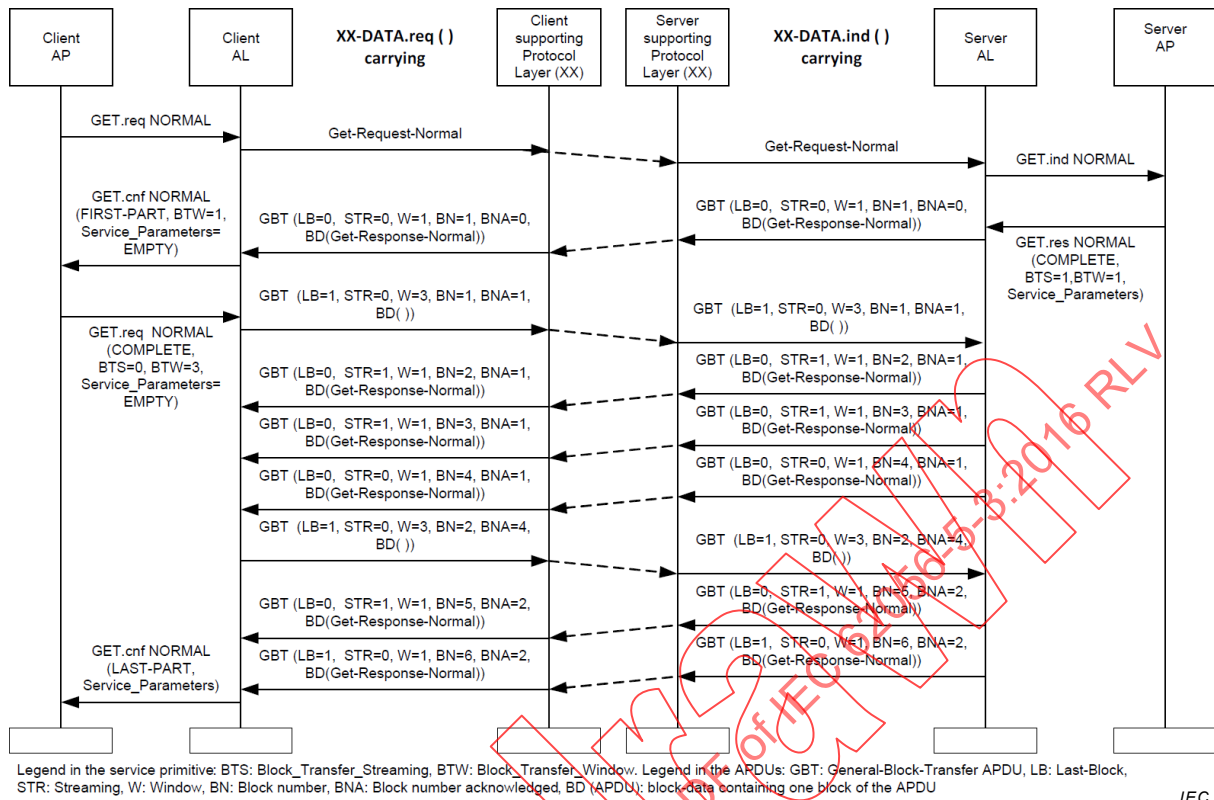


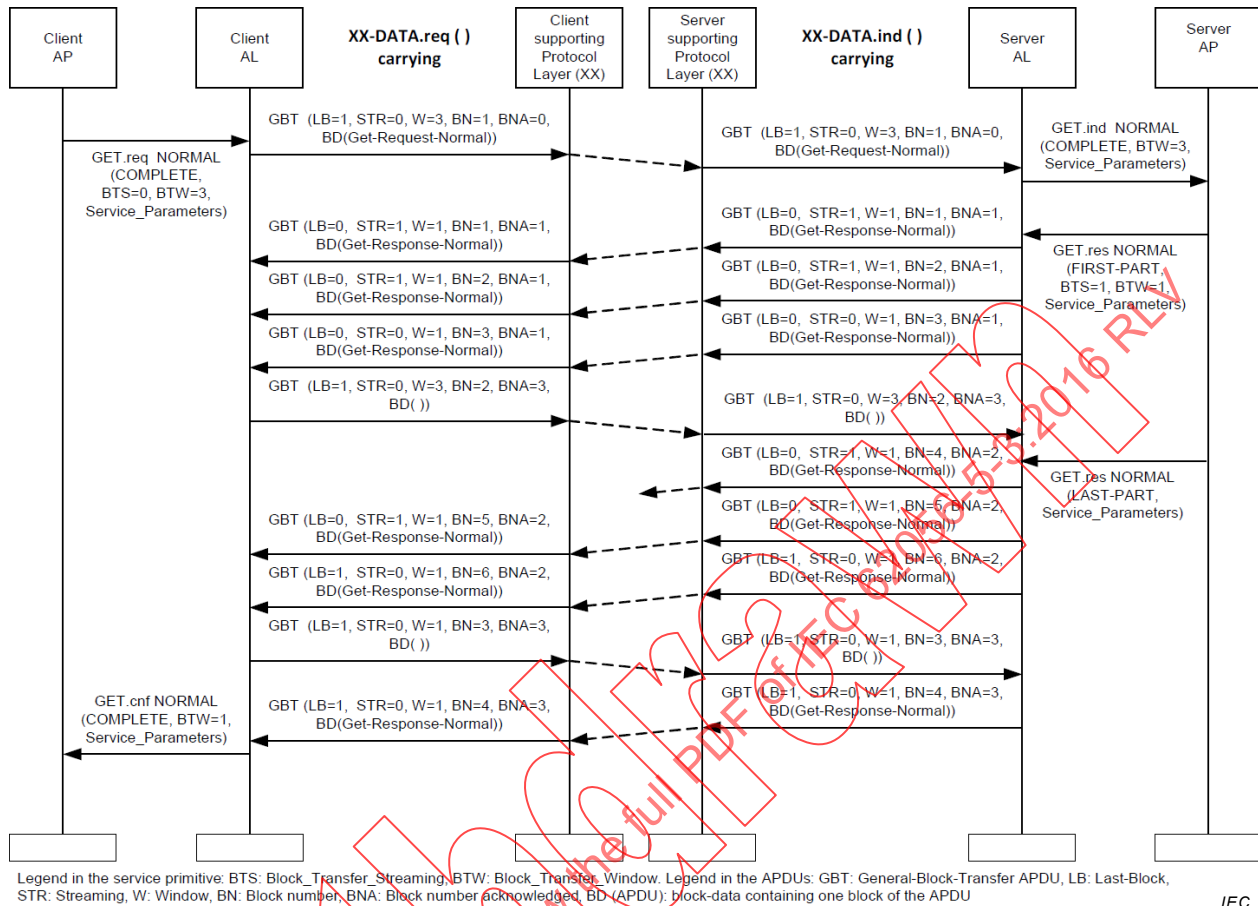
Figure 31 – GET service with GBT, switching to streaming

Figure 31 shows a GET service using GBT. After receiving the first GBT APDU, the client informs the server that it supports streaming. The server switches then to streaming. The process is the following:

- the client AP invokes a GET.request NORMAL service primitive, without additional service parameters. The client AL sends the request in a Get-Request-Normal APDU;
- the GET.response service parameters are long so the server invokes a GET.response NORMAL service primitive with additional service parameters: *Invocation_Type* = COMPLETE, *BTS* = 1, *BTW* = 1 meaning that the server allows sending block streams, but it does not accept block streams from the client. The server AL sends a GBT APDU, containing the first block of the response;
- the client AL invokes a GET.confirm NORMAL service primitive, *Invocation_Type* = FIRST-PART, *BTW* = 1. The *Service_Parameters* are empty. With this, it informs the AP that the response from the server is long;
- the client AP invokes a GET.request NORMAL service primitive, with *Invocation_Type* = COMPLETE, *BTS* = 0, *BTW* = 3, to advertise its capabilities to receive block streams. Note that the *Service_Parameters* are empty, as these have been passed already in the first GET.request NORMAL service invocation. The client AL sends a GBT APDU. The last-block bit in the APDU is set to 1 and the streaming bit is set to 0 as the client has no blocks to send;
- the server sends then the 2nd (STR = 1, BN = 2), 3rd (STR = 1, BN = 3) and 4th (STR = 0, BN = 4) blocks;
- the client AL sends a GBT APDU to confirm the reception of the 2nd, 3rd and 4th blocks (LB = 1, STR = 0, W = 3, BNA = 4);
- the server AL sends the 5th block (STR = 1, BN = 5) and the 6th, last block (LB = 1, STR = 0, BN = 6);

NOTE 3 The last block is not confirmed. However, when lost, it can be recovered. See Figure 34.

- the client AL invokes a GET.confirm NORMAL service primitive with Invocation_Type = LAST-PART. The service parameters include the complete response to the GET.request.



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Figure 32 – GET service with partial invocations, GBT and streaming, recovery of 4th block sent in the 2nd stream

Figure 32 shows a GET service using GBT, with partial service invocations on the server side and streaming. The client advertises in the first request its streaming capabilities (BTW = 3; BTW > 1 means that block streams can be received). The 4th block, sent in the second stream by the server is lost and it is recovered. The process is the following:

- the client AP invokes a GET.request NORMAL service primitive, with Invocation_Type = COMPLETE, BTS = 0, BTW = 3. The client AL sends a GBT APDU with STR = 0, Window = 3. The server AL invokes the GET.indication NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 3;
- the server AP invokes a GET.response NORMAL service primitive with Invocation_Type = FIRST-PART, BTS = 1, BTW = 1. Service_Parameters include the first part of the response. The server AL sends the 1st, 2nd and 3rd blocks;
- the client AL sends a GBT APDU to confirm the reception of the three blocks. The server AP invokes a GET.response NORMAL service primitive with Invocation_Type = LAST-PART. Service_Parameters include the second, last part of the response. The server AL sends the 4th, 5th and 6th blocks (LB = 1, STR = 0, BN = 6). However, the 4th block gets lost;
- the client AL indicates that the 4th block has not been received by sending a GBT APDU confirming the reception of the 3rd block (STR = 0, window = 1, BNA = 3). Notice that the client AL drops down the window size to 1 to indicate that only one block has to be re-sent;
- the server sends again the 4th block (LB = 1, STR = 0, BN = 4, BNA = 3);

- as the client has already received all blocks, it invokes a GET.confirm NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 1. The Service_Parameters of this invocation contain the complete response to the GET.request.

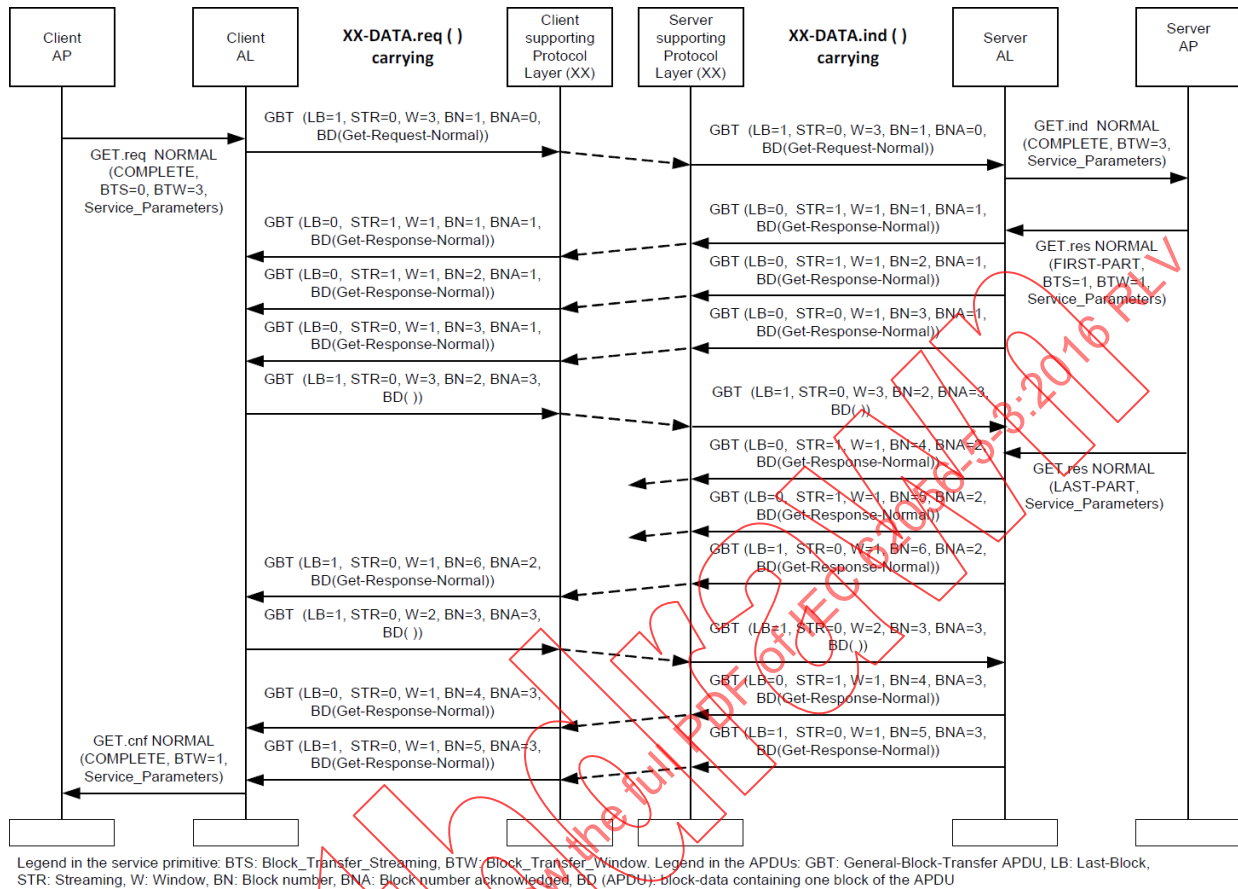
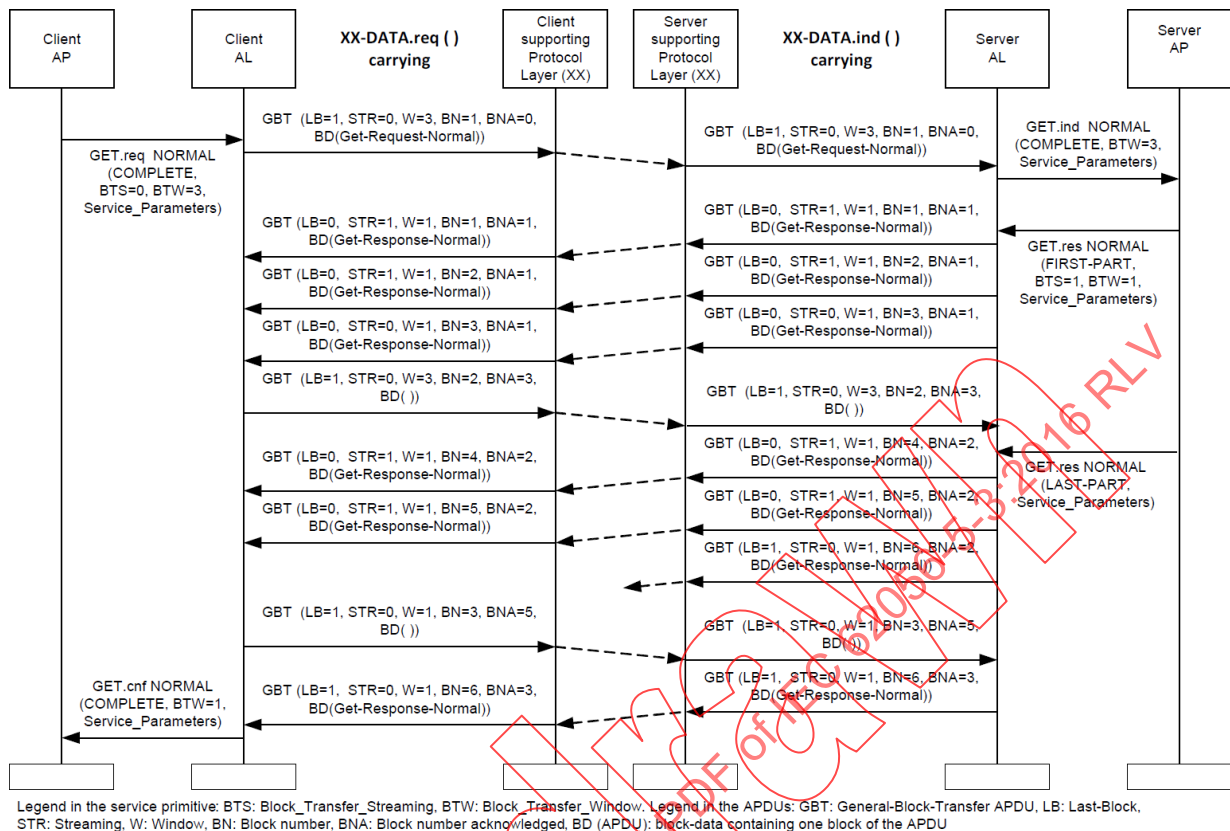


Figure 33 – GET service with partial invocations, GBT and streaming, recovery of 4th and 5th blocks

Figure 33 shows a scenario which is essentially the same as in Figure 32 except that the 4th and 5th blocks are lost and recovered. The process is the following:

- the client receives the 6th block (LB = 1, STR = 0, BN = 6, BNA = 2);
- the client indicates that the 4th and the 5th blocks have been lost, by sending a GBT APDU with W = 2, BNA = 3, i.e. meaning that no blocks are missing up to the 3rd block but two blocks have been lost and that the server can send these two using streaming;
- the server sends then the lost (not confirmed) 4th (LB = 0, STR = 1, BN = 4) and 5th block (LB = 1, STR = 0, BN = 5). Notice here that LB has been set to 1;
- the client has received now each block. It invokes then a GET.confirm NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 1. The Service_Parameters include the parameters of the complete response to the GET.request.

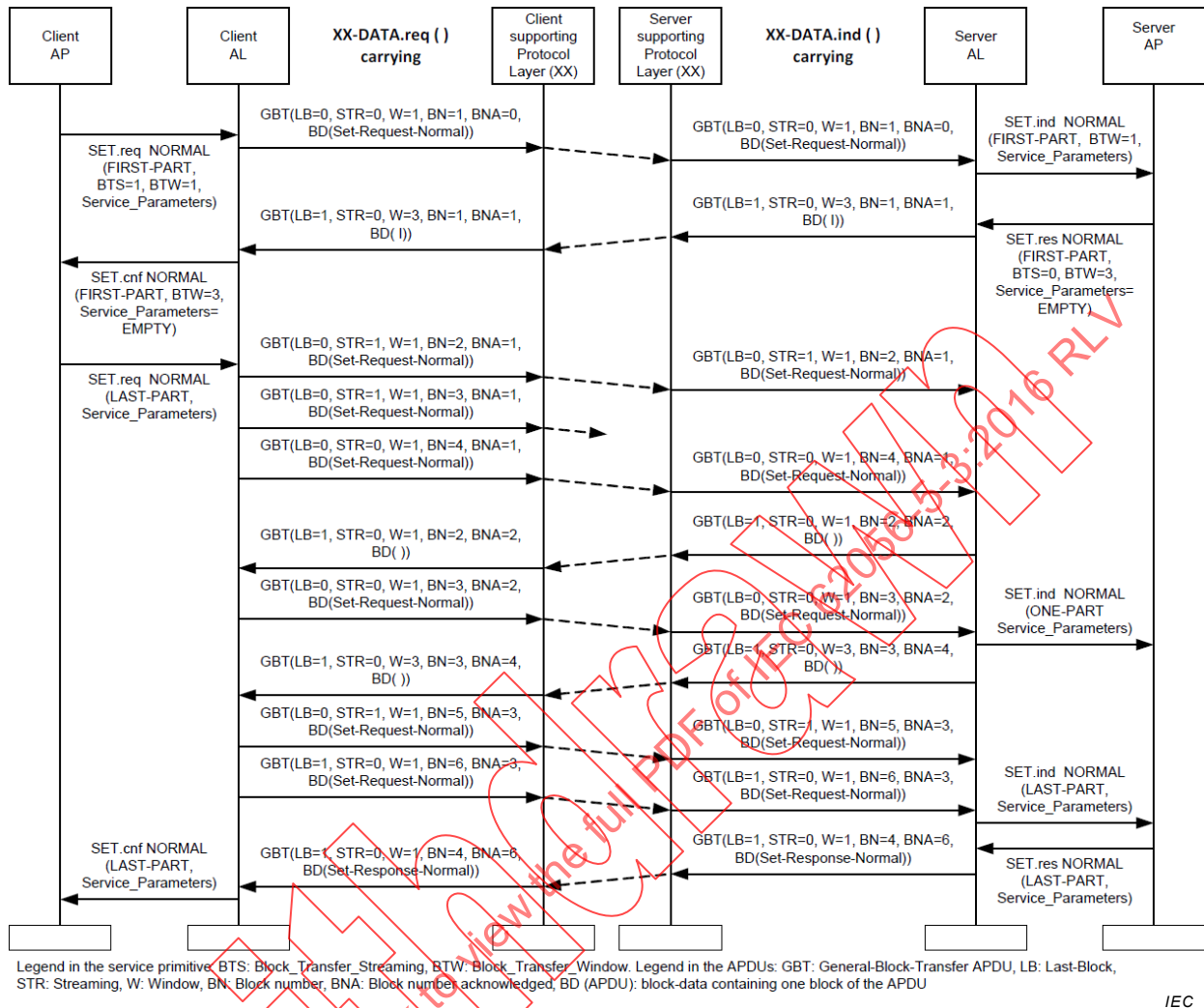


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Figure 34 – GET service with partial invocations, GBT and streaming, recovery of last block

Figure 34 shows a scenario when the last block sent in the second stream gets lost and is recovered. The process is the following:

- the client receives the 5th block carried by a GBT APDU (LB = 0, STR = 1, BN = 5);
- as this is not the last block, after an implementation specific timeout the client sends a GBT APDU (LB = 1, STR = 0, BN = 3, BNA = 5);
- the server sends then the lost (not confirmed) 6th block carried by a GBT APDU (LB = 1, STR = 0, W = 1, BN = 6 and BNA = 3);
- when the client receives this APDU, it invokes a GET.confirm NORMAL service primitive with Invocation_Type = COMPLETE, BTW = 1. The Service_Parameters include the parameters of the complete response to the GET.request.



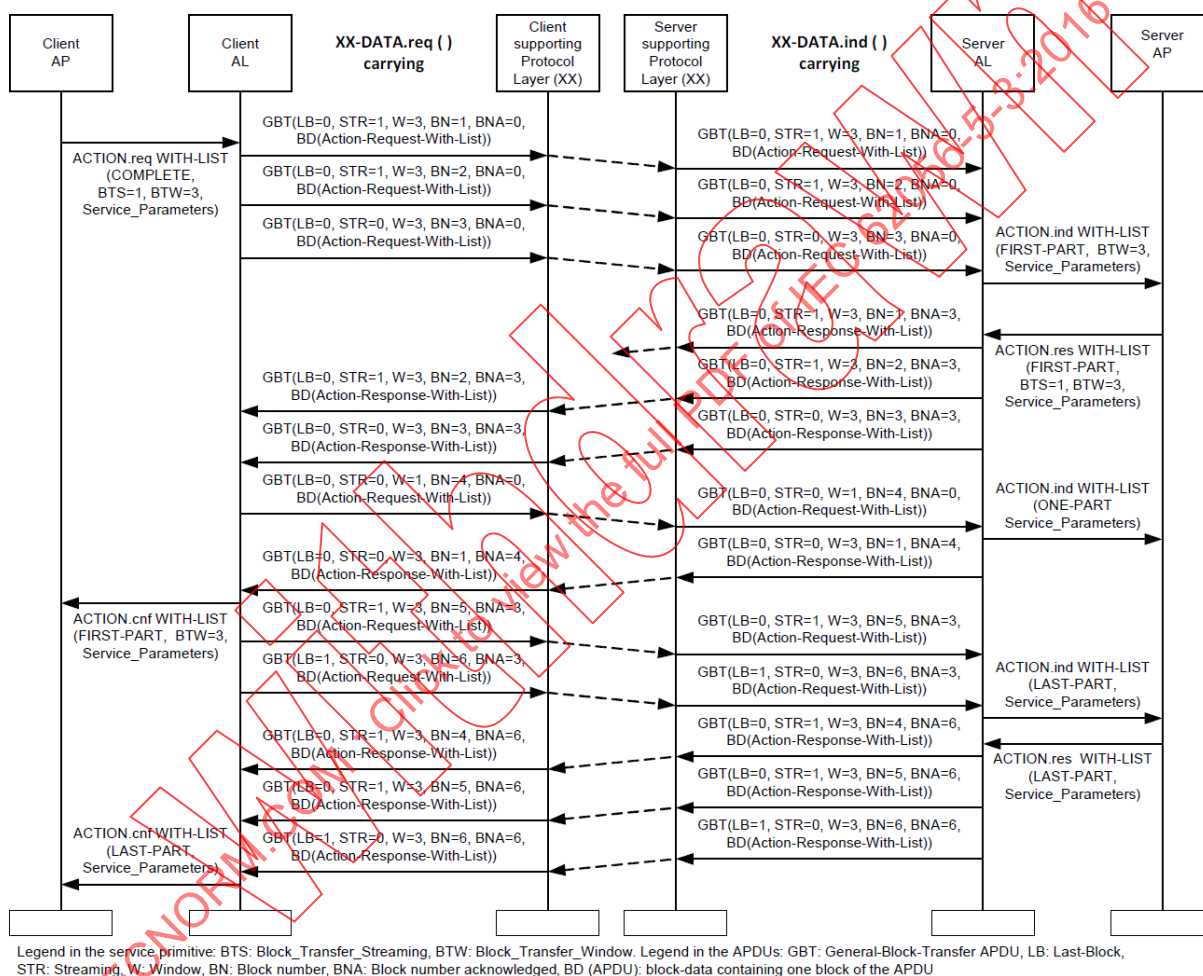
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Figure 35 – SET service with GBT, with server not supporting streaming, recovery of 3rd block

Figure 35 shows a SET service with GBT and streaming. The 3rd block sent by the client is lost and recovered. The process is the following:

- the client AP invokes a SET.request NORMAL service primitive with Invocation_Type = FIRST-PART, BTS = 1, BTW = 1. The Service_Parameters include the first part of the SET request. The client AL sends the first block only because it does not know the streaming window size supported by the server;
- the server AL invokes a SET.indication NORMAL service primitive with Invocation_Type = FIRST-PART, BTW = 1. The Service_Parameters include the first part of the parameters of the SET.request;
- the server AP responds with a SET.response NORMAL service primitive with Invocation_Type = FIRST-PART, BTS = 0, BTW = 3. The Service_Parameters are empty. The server AL sends a GBT APDU with LB = 1, STR = 0, Window = 3; block-data is empty. From this, the client knows that the server can receive block streams and the window size = 3. Therefore it sends the 2nd, 3rd and 4th blocks in a stream. However, the 3rd block gets lost;
- the server indicates that block 3 is lost by confirming the reception of the 2nd block and dropping down the window size to 1 (LB = 1, STR = 0, W = 1, BN = 2, BNA = 2). The client sends then again the 3rd block (LB = 0, STR = 0, BN = 3, BNA = 2);

- the server invokes a SET.indication NORMAL service primitive with Invocation_Type = ONE-PART. The server AL confirms the reception of the blocks up to the 4th block (LB = 1, STR = 0, W = 3, BNA = 4). Notice that the window size has been raised again to 3;
- the client sends then the 5th and the 6th blocks using streaming;
- when the server AL receives the 6th, last block it invokes a SET.indication NORMAL service primitive with Invocation_Type = LAST-PART. Service_Parameters include the last part of the parameters of the SET.request;
- the server AP invokes a SET.request NORMAL service primitive with Invocation_Type = LAST-PART, and with the Service_Parameters containing the result of the set operation(s). This is sent by the server AL in a GBT APDU. The client AL invokes the SET.confirm NORMAL service primitive with Invocation_Type = LAST-PART. Service_Parameters include the result of the set operations.



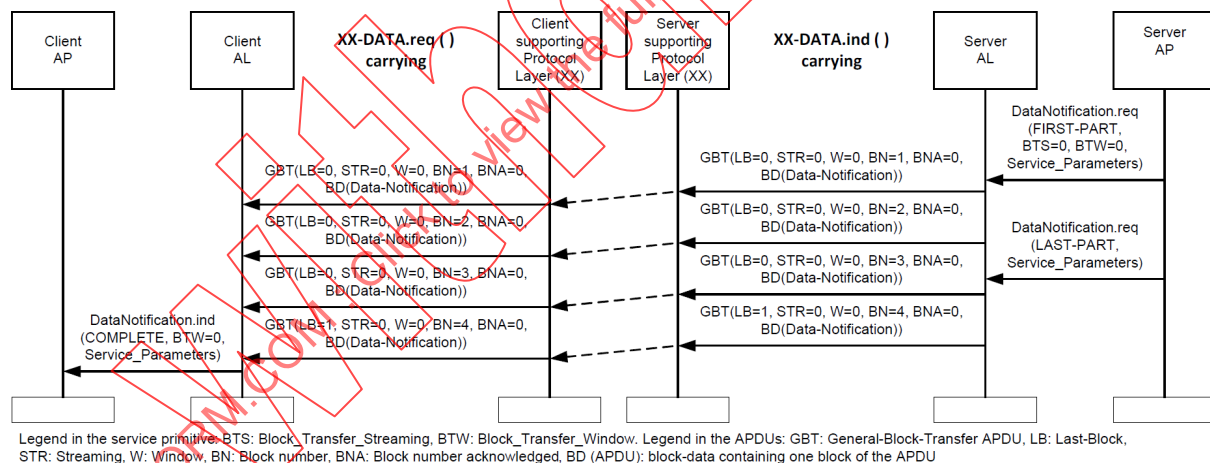
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Figure 36 – ACTION-WITH-LIST service with bi-directional GBT and block recovery

Figure 36 shows an ACTION-WITH-LIST service with partial service invocations, bidirectional block transfer and streaming. Both parties know *a priori* that the other party supports streaming with window size = 3. The first block sent by the server is lost and recovered. The process is the following:

- the client invokes an ACTION.request of type WITH-LIST service primitive with Invocation_Type = COMPLETE, BTS = 1, BTW = 3. The client AL sends the first three blocks that carry a part of this request to the server. The server AL invokes an ACTION.indication of type WITH-LIST service primitive with Invocation_Type = FIRST-PART, BTW = 3. Service parameters contain the first part of the request;

- the server AP processes this request and has the first part of the response available. It invokes an ACTION.response of type WITH-LIST service primitive with Invocation_Type = FIRST-PART, BTS = 1, BTW = 3. The server AL sends this in three blocks using streaming. However, the 1st block is lost;
- the client AL asks the server to send the lost 1st block again by not confirming any blocks received. It also sends its 4th block (LB = 0, STR = 0, W = 1, BN = 4, BNA = 0). Notice that the client AL has dropped down the window size to 1;
- the server AL invokes an ACTION.indication of type WITH-LIST service primitive with INVOCATION_Type = ONE-PART. Service_Parameters contain one part of the request;
- the server sends the lost 1st block and confirms the 4th block received from the client (BN = 1, BNA = 4);
- the client AL invokes an ACTION.confirm of type WITH-LIST service primitive with additional parameters: Invocation_Type = FIRST-PART, BTW = 3. The Service_Parameters include one part of the response from the server;
- the client AL sends the 5th block and the 6th, last block. Window size is raised again to 3;
- the server AL invokes an ACTION.indication of type WITH-LIST service primitive with Invocation_Type = LAST-PART and with Service_Parameters containing the last part of the ACTION.request;
- the server AP processes this and invokes an ACTION.response of type WITH-LIST service primitive with Invocation_Type = LAST-PART; the Service_Parameters contain the remaining part of the response. This is sent to client in three blocks using streaming;
- the client AL invokes an ACTION.confirm of type WITH-LIST service primitive with Invocation_Type = LAST-PART. The Service_Parameters include the last part of the response from the server.



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Figure 37 – DataNotification service with GBT with partial invocation

Figure 37 shows a DataNotification service with GBT, with partial service invocations on the server side. The process is the following:

- the server AP invokes a DataNotification.request service primitive with Invocation_Type = FIRST-PART, BTS = 0, BTW = 0. The Service_Parameters include one part of the DataNotification.request;
- the server AL sends the GBT APDUs to the client. The reception of the blocks is not confirmed, block recovery is not available;
- when the client AL receives the last block, it assembles the block-data together and invokes a DataNotification.indication service primitive with Invocation_Type = COMPLETE, BTW = 0. The Service_Parameters include the complete DataNotification service parameters.

Aborting the GBT process

The client or the server may want to abort the GBT process. To do so, it shall send a GBT APDU with LB = 1, STR = 0, BN = 0 and BNA = 0. The block transfer process shall also be aborted if a party confirms the reception of a block not yet sent by the other party.

It is not possible to abort GBT with DataNotification.

8 Abstract syntax of ACSE and COSEM APDUs

The abstract syntax of COSEM APDUs is specified in this Clause 8 using ASN.1. See ISO/IEC 8824-1..

COSEMpdu DEFINITIONS ::= BEGIN

CI-PDU ::= CHOICE

```
{
    pingRequestPDU                [25] PingRequestPDU,
    pingResponsePDU              [26] PingResponsePDU,
    -- reserved                   [27]
    registerPDU                  [28] RegisterPDU,
    discoverPDU                  [29] DiscoverPDU,
    discoverReportPDU            [30] DiscoverReportPDU,
    repeaterCallPDU              [31] RepeaterCallPDU,
    clearAlarmPDU                [57] ClearAlarmPDU

    -- CI-PDU tags are above 24, corresponding to the last unciphered DLMS APDU specified
    -- in IEC 61334-4-41.

    -- IEC 62056-8-3 specifies the abstract syntax of the CIASE APDUs.
}
```

ACSE-APDU ::= CHOICE

```
{
    aarq                         AARQ-apdu,
    aare                         AARE-apdu,
    rlrq                         RLREQ-apdu, -- OPTIONAL
    rlre                         RLRE-apdu -- OPTIONAL
}
```

xDLMS-APDU ::= CHOICE

```
{
    -- standardised xDLMS pdus used in DLMS/COSEM
    -- standardized DLMS pdus
    -- with no ciphering

    initiateRequest              [1]  IMPLICIT    InitiateRequest,
    readRequest                  [5]  IMPLICIT    ReadRequest,
    writeRequest                 [6]  IMPLICIT    WriteRequest,

    initiateResponse             [8]  IMPLICIT    InitiateResponse,
    readResponse                 [12] IMPLICIT    ReadResponse,
    writeResponse                [13] IMPLICIT    WriteResponse,

    confirmedServiceError        [14]

    -- data-notification

    data-notification            [15] IMPLICIT    Data-Notification,

    unconfirmedWriteRequest      [22] IMPLICIT    UnconfirmedWriteRequest,
    informationReportRequest     [24] IMPLICIT    InformationReportRequest,

    -- The APDU tag of each ciphered xDLMS APDU indicates the type of the unciphered APDU
    -- and whether global or dedicated key is used. The type of the key is carried by the
    -- security header, and after removing the encryption and/or verifying the
    -- authentication tag, the original APDU with its APDU tag is restored. Therefore, the
    -- APDU tags of the ciphered APDUs carry redundant information, but they are retained
    -- for consistency.

    -- with global ciphering
```

```

glo-initiateRequest      [33]  IMPLICIT  OCTET STRING,
glo-readRequest          [37]  IMPLICIT  OCTET STRING,
glo-writeRequest         [38]  IMPLICIT  OCTET STRING,

glo-initiateResponse     [40]  IMPLICIT  OCTET STRING,
glo-readResponse         [44]  IMPLICIT  OCTET STRING,
glo-writeResponse        [45]  IMPLICIT  OCTET STRING,

glo-confirmedServiceError [46]  IMPLICIT  OCTET STRING,

glo-unconfirmedWriteRequest [54]  IMPLICIT  OCTET STRING,
glo-informationReportRequest [56]  IMPLICIT  OCTET STRING,

-- with dedicated ciphering

-- not used in DLMS/COSEM
ded-initiateRequest      [65]  IMPLICIT  OCTET STRING,

ded-readRequest          [69]  IMPLICIT  OCTET STRING,
ded-writeRequest         [70]  IMPLICIT  OCTET STRING,

-- not used in DLMS/COSEM
ded-initiateResponse     [72]  IMPLICIT  OCTET STRING,

ded-readResponse         [76]  IMPLICIT  OCTET STRING,
ded-writeResponse        [77]  IMPLICIT  OCTET STRING,
ded-confirmedServiceError [78]  IMPLICIT  OCTET STRING,
ded-unconfirmedWriteRequest [86]  IMPLICIT  OCTET STRING,
ded-informationReportRequest [88]  IMPLICIT  OCTET STRING,

-- xDLMS APDUs used with LN referencing
-- with no ciphering

get-request              [192]  IMPLICIT  GET-Request,
set-request              [193]  IMPLICIT  SET-Request,
event-notification-request [194]  IMPLICIT  EVENT-NOTIFICATION-Request,
action-request           [195]  IMPLICIT  ACTION-Request,

get-response             [196]  IMPLICIT  GET-Response,
set-response             [197]  IMPLICIT  SET-Response,
action-response          [199]  IMPLICIT  ACTION-Response,

-- with global ciphering

glo-get-request          [200]  IMPLICIT  OCTET STRING,
glo-set-request          [201]  IMPLICIT  OCTET STRING,
glo-event-notification-request [202]  IMPLICIT  OCTET STRING,
glo-action-request       [203]  IMPLICIT  OCTET STRING,

glo-get-response         [204]  IMPLICIT  OCTET STRING,
glo-set-response         [205]  IMPLICIT  OCTET STRING,
glo-action-response       [207]  IMPLICIT  OCTET STRING,

-- with dedicated ciphering

ded-get-request          [208]  IMPLICIT  OCTET STRING,
ded-set-request          [209]  IMPLICIT  OCTET STRING,
ded-event-notification-request [210]  IMPLICIT  OCTET STRING,
ded-actionRequest        [211]  IMPLICIT  OCTET STRING,

ded-get-response         [212]  IMPLICIT  OCTET STRING,
ded-set-response         [213]  IMPLICIT  OCTET STRING,
ded-action-response       [215]  IMPLICIT  OCTET STRING

-- the exception response pdu

exception-response       [216]  IMPLICIT  ExceptionResponse

-- general APDUs
general-glo-ciphering    [219]  IMPLICIT  General-Glo-Ciphering,
general-ded-ciphering    [220]  IMPLICIT  General-Ded-Ciphering,
general-block-transfer    [224]  IMPLICIT  General-Block-Transfer

-- The tags 230 and 231 are reserved for DLMS Gateway
-- reserved              [230]  -- 0xE6
-- reserved              [231]  -- 0xE7
}

```


AARQ-apdu ::= [APPLICATION 0] IMPLICIT SEQUENCE

```
{
-- [APPLICATION 0] == [ 60H ] = [ 96 ]

    protocol-version                [0] IMPLICIT   BIT STRING {version1 (0)}
                                     DEFAULT {version1},
    application-context-name        [1]
    called-AP-title                 [2]            AP-title OPTIONAL,
    called-AE-qualifier              [3]            AE-qualifier OPTIONAL,
    called-AP-invocation-id          [4]            AP-invocation-identifier OPTIONAL,
    called-AE-invocation-id          [5]            AE-invocation-identifier OPTIONAL,
    calling-AP-title                 [6]            AP-title OPTIONAL,
    calling-AE-qualifier              [7]            AE-qualifier OPTIONAL,
    calling-AP-invocation-id          [8]            AP-invocation-identifier OPTIONAL,
    calling-AE-invocation-id          [9]            AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
    sender-acse-requirements         [10] IMPLICIT  ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    mechanism-name                   [11] IMPLICIT  Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    calling-authentication-value      [12] EXPLICIT  Authentication-value OPTIONAL,
    implementation-information        [29] IMPLICIT  Implementation-data OPTIONAL,
    user-information                  [30] EXPLICIT  Association-information OPTIONAL
}

-- The user-information field shall carry an xDLMS InitiateRequest APDU encoded in
-- A-XDR. The resulting OCTET STRING shall be encoded in BER.
```

AARE-apdu ::= [APPLICATION 1] IMPLICIT SEQUENCE

```
{
-- [APPLICATION 1] == [ 61H ] = [ 97 ]

    protocol-version                [0] IMPLICIT   BIT STRING {version1 (0)}
                                     DEFAULT {version1},
    application-context-name        [1]
    result                           [2]            Association-result,
    result-source-diagnostic         [3]            Associate-source-diagnostic,
    responding-AP-title              [4]            AP-title OPTIONAL,
    responding-AE-qualifier           [5]            AE-qualifier OPTIONAL,
    responding-AP-invocation-id       [6]            AP-invocation-identifier OPTIONAL,
    responding-AE-invocation-id       [7]            AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
    responder-acse-requirements      [8] IMPLICIT  ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    mechanism-name                   [9] IMPLICIT  Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    responding-authentication-value   [10] EXPLICIT  Authentication-value OPTIONAL,
    implementation-information        [29] IMPLICIT  Implementation-data OPTIONAL,
    user-information                  [30] EXPLICIT  Association-information OPTIONAL
}

-- The user-information field shall carry either an InitiateResponse (or, when the
-- proposed xDLMS context is not accepted by the server, a ConfirmedServiceError) APDU
-- encoded in A-XDR. The resulting OCTET STRING shall be encoded in BER.
```

RLRQ-apdu ::= [APPLICATION 2] IMPLICIT SEQUENCE

```
{
-- [APPLICATION 2] == [ 62H ] = [ 98 ]

    reason                           [0] IMPLICIT  Release-request-reason OPTIONAL,
    user-information                  [30] EXPLICIT  Association-information OPTIONAL
}
```

RLRE-apdu ::= [APPLICATION 3] IMPLICIT SEQUENCE

```
{
-- [APPLICATION 3] == [ 63H ] = [ 99 ]

    reason                           [0] IMPLICIT  Release-response-reason OPTIONAL,
```

```

    user-information                [30] EXPLICIT    Association-information OPTIONAL
}

-- The user-information field of the RLRQ / RLRE APDU may carry an InitiateRequest APDU
-- encoded in A-XDR, and then encoding the resulting OCTET STRING in BER, when the AA
-- to be released uses ciphering.

-- types used in the fields of the ACSE APDUs, in the order of their occurrence

Application-context-name    ::= OBJECT IDENTIFIER

AP-title                    ::= OCTET STRING

AE-qualifier                ::= OCTET STRING

AP-invocation-identifier    ::= INTEGER

AE-invocation-identifier    ::= INTEGER

ACSE-requirements ::= BIT STRING {authentication(0)}

Mechanism-name ::= OBJECT IDENTIFIER

Authentication-value ::= CHOICE
{
    charstring                [0] IMPLICIT    GraphicString,
    bitstring                 [1] IMPLICIT    BIT STRING,
    external                  [2] IMPLICIT    EXTERNAL,
    other                     [3] IMPLICIT    SEQUENCE
    {
        other-mechanism-name Mechanism-name,
        other-mechanism-value ANY DEFINED BY other-mechanism-name
    }
}

Implementation-data    ::= GraphicString

Association-information ::= OCTET STRING

Association-result      ::= INTEGER
{
    accepted                (0),
    rejected-permanent      (1),
    rejected-transient      (2)
}

Associate-source-diagnostic ::= CHOICE
{
    acse-service-user       [1] INTEGER
    {
        null                (0),
        no-reason-given     (1),
        application-context-name-not-supported (2),
        calling-AP-title-not-recognized (3),
        calling-AP-invocation-identifier-not-recognized (4),
        calling-AE-qualifier-not-recognized (5),
        calling-AE-invocation-identifier-not-recognized (6),
        called-AP-title-not-recognized (7),
        called-AP-invocation-identifier-not-recognized (8),
        called-AE-qualifier-not-recognized (9),
        called-AE-invocation-identifier-not-recognized (10),
        authentication-mechanism-name-not-recognised (11),
        authentication-mechanism-name-required (12),
        authentication-failure (13),
        authentication-required (14)
    },
    acse-service-provider   [2] INTEGER
    {
        null                (0),
        no-reason-given     (1),
        no-common-acse-version (2)
    }
}

Release-request-reason ::= INTEGER
{

```

```

        normal          (0),
        urgent          (1),
        user-defined    (30)
    }

Release-response-reason ::= INTEGER
{
    normal          (0),
    not-finished    (1),
    user-defined    (30)
}

-- Useful types

Integer8          ::= INTEGER(-128..127)
Integer16         ::= INTEGER(-32768..32767)
Integer32         ::= INTEGER(-2147483648..2147483647)
Integer64         ::= INTEGER(-9223372036854775808..9223372036854775807)
Unsigned8         ::= INTEGER(0..255)
Unsigned16        ::= INTEGER(0..65535)
Unsigned32        ::= INTEGER(0..4294967295)
Unsigned64        ::= INTEGER(0..18446744073709551615)

-- xDLMS APDU-s used during Association establishment

InitiateRequest ::= SEQUENCE
{
    -- shall not be encoded in DLMS without ciphering
    dedicated-key          OCTET STRING OPTIONAL,
    response-allowed       BOOLEAN DEFAULT TRUE,
    proposed-quality-of-service [0] IMPLICIT Integer8 OPTIONAL,
    proposed-dlms-version-number Unsigned8,
    proposed-conformance    Conformance -- Shall be encoded in BER
    client-max-receive-pdu-size Unsigned16
}
-- In DLMS/COSEM, the quality-of-service parameter is not used. Any value shall be
-- accepted.

-- The Conformance field shall be encoded in BER. See IEC 61334-6:2000, Annex C,
-- Example 1.

InitiateResponse ::= SEQUENCE
{
    negotiated-quality-of-service [0] IMPLICIT Integer8 OPTIONAL,
    negotiated-dlms-version-number Unsigned8,
    negotiated-conformance        Conformance, -- Shall be encoded in BER
    server-max-receive-pdu-size   Unsigned16,
    vaa-name                      ObjectName
}

-- In the case of IN referencing, the value of the vaa-name is 0x0007
-- In the case of SN referencing, the value of the vaa-name is the base name of the
-- Current Association object, 0xFA00

-- Conformance Block

-- SIZE constrained BIT STRING is extension of ASN.1 notation

Conformance ::= [APPLICATION 31] IMPLICIT BIT STRING
{
    -- the bit is set when the corresponding service or functionality is available
    reserved-zero          (0),
    -- The actual list of general protection services depends on the security suite
    general-protection      (1),
    general-block-transfer  (2),
    read                    (3),
    write                   (4),
    unconfirmed-write       (5),
    reserved-six            (6),
    reserved-seven         (7),
    attribute0-supported-with-set (8),
    priority-mgmt-supported (9),
    attribute0-supported-with-get (10),
    block-transfer-with-get-or-read (11),
    block-transfer-with-set-or-write (12),
    block-transfer-with-action (13),
    multiple-references     (14),
    information-report      (15),

```

```

data-notification          (16),
reserved-seventeen        (17),
parameterized-access      (18),
get                        (19),
set                        (20),
selective-access          (21),
event-notification        (22),
action                    (23)
}

} (SIZE(24))

ObjectName ::= Integer16
-- for named variable objects (short names), the last three bits shall be set to 000;
-- for vaa-name objects, the last three bits shall be set to 111.

-- The Confirmed ServiceError APDU is used only with the InitiateRequest, ReadRequest
--and WriteRequest APDUs when the request fails, to provide diagnostic information.

ConfirmedServiceError ::= CHOICE
{
-- tag 0 is reserved
-- In DLMS/COSEM only initiateError, read and write are relevant

initiateError              [1] ServiceError,
getStatus                  [2] ServiceError,
getNameList                [3] ServiceError,
getVariableAttribute       [4] ServiceError,
read                       [5] ServiceError,
write                      [6] ServiceError,
getDataSetAttribute        [7] ServiceError,
getTIAttribute             [8] ServiceError,
changeScope                [9] ServiceError,
start                     [10] ServiceError,
stop                      [11] ServiceError,
resume                    [12] ServiceError,
makeUsable                [13] ServiceError,
initiateLoad               [14] ServiceError,
loadSegment                [15] ServiceError,
terminateLoad              [16] ServiceError,
initiateUpload             [17] ServiceError,
uploadSegment              [18] ServiceError,
terminateUpload            [19] ServiceError
}

ServiceError ::= CHOICE
{
application-reference [0] IMPLICIT ENUMERATED
{
-- DLMS provider only
other (0),
time-elapsed (1), -- time out since request sent
application-unreachable (2), -- peer AEi not reachable
application-reference-invalid (3), -- addressing trouble
application-context-unsupported (4), -- application-context incompatibility
provider-communication-error (5), -- error at the local or distant equipment
deciphering-error (6) -- error detected by the deciphering function
},
hardware-resource [1] IMPLICIT ENUMERATED
{
-- VDE hardware troubles
other (0),
memory-unavailable (1),
processor-resource-unavailable (2),
mass-storage-unavailable (3),
other-resource-unavailable (4)
},
vde-state-error [2] IMPLICIT ENUMERATED
{
-- Error source description
other (0),
no-dlms-context (1),
loading-data-set (2),
status-nochange (3),
status-inoperable (4)
}
}

```

```

    },

    service                                [3] IMPLICIT ENUMERATED
    {
    -- service handling troubles
        other                                (0),
        pdu-size                            (1), -- pdu too long
        service-unsupported                 (2)  -- as defined in the conformance block
    },

    definition                             [4] IMPLICIT ENUMERATED
    {
    -- object bound troubles in a service
        other                                (0),
        object-undefined                    (1), -- object not defined at the VDE
        object-class-inconsistent           (2), -- class of object incompatible with asked
                                                -- service
    object-attribute-inconsistent           (3)  -- object attributes are inconsistent
    },

    access                                 [5] IMPLICIT ENUMERATED
    {
    -- object access error
        other                                (0),
        scope-of-access-violated            (1), -- access denied through authorisation reason
        object-access-violated              (2), -- access incompatible with object attribute
        hardware-fault                      (3), -- access fail for hardware reason
        object-unavailable                  (4)  -- VDE hands object for unavailable
    },

    initiate                               [6] IMPLICIT ENUMERATED
    {
    -- initiate service error
        other                                (0),
        dlms-version-too-low                (1), -- proposed DLMS version too low
        incompatible-conformance            (2), -- proposed service not sufficient
        pdu-size-too-short                  (3), -- proposed PDU size too short
        refused-by-the-VDE-Handler          (4)  -- vaa creation impossible or not allowed
    },

    load-data-set                          [7] IMPLICIT ENUMERATED
    {
    -- data set load services error
        other                                (0),
        primitive-out-of-sequence           (1), -- according to the DataSet loading state
                                                -- transitions
        not-loadable                        (2), -- loadable attribute set to FALSE
        dataset-size-too-large              (3), -- evaluated Data Set size too large
        not-awaited-segment                 (4), -- proposed segment not awaited
        interpretation-failure              (5), -- segment interpretation error
        storage-failure                     (6), -- segment storage error
        data-set-not-ready                   (7)  -- Data Set not in correct state for
                                                -- uploading
    },

    -- change-scope                        [8] IMPLICIT ENUMERATED

    task                                   [9] IMPLICIT ENUMERATED
    {
    -- TI services error
        other                                (0),
        no-remote-control                   (1), -- Remote Control parameter set to FALSE
        ti-stopped                          (2), -- TI in stopped state
        ti-running                           (3), -- TI in running state
        ti-unusable                          (4)  -- TI in unusable state
    }

    -- other                               [10] IMPLICIT ENUMERATED
}

-- COSEM APDUs using short name referencing

ReadRequest ::= SEQUENCE OF Variable-Access-Specification

ReadResponse ::= SEQUENCE OF CHOICE
{
    data [0] Data,

```

```

data-access-error          [1] IMPLICIT Data-Access-Result,
data-block-result          [2] IMPLICIT Data-Block-Result,
block-number               [3] IMPLICIT Unsigned16
}

WriteRequest                ::= SEQUENCE
{
    variable-access-specification SEQUENCE OF Variable-Access-Specification,
    list-of-data                 SEQUENCE OF Data
}

WriteResponse               ::= SEQUENCE OF CHOICE
{
    success                   [0] IMPLICIT NULL,
    data-access-error         [1] IMPLICIT Data-Access-Result,
    block-number              [2] IMPLICIT Unsigned16
}

UnconfirmedWriteRequest ::= SEQUENCE
{
    variable-access-specification SEQUENCE OF Variable-Access-Specification,
    list-of-data                 SEQUENCE OF Data
}

InformationReportRequest ::= SEQUENCE
{
    current-time              GeneralizedTime OPTIONAL,
    variable-access-specification SEQUENCE OF Variable-Access-Specification,
    list-of-data              SEQUENCE OF Data
}

-- COSEM APDUs using logical name referencing

Get-Request ::= CHOICE
{
    get-request-normal        [1] IMPLICIT Get-Request-Normal,
    get-request-next          [2] IMPLICIT Get-Request-Next,
    get-request-with-list     [3] IMPLICIT Get-Request-With-List
}

Get-Request-Normal          ::= SEQUENCE
{
    invoke-id-and-priority    Invoke-Id-And-Priority,
    cosem-attribute-descriptor Cosem-Attribute-Descriptor,
    access-selection          Selective-Access-Descriptor OPTIONAL
}

Get-Request-Next            ::= SEQUENCE
{
    invoke-id-and-priority    Invoke-Id-And-Priority,
    block-number              Unsigned32
}

Get-Request-With-List       ::= SEQUENCE
{
    invoke-id-and-priority    Invoke-Id-And-Priority,
    attribute-descriptor-list SEQUENCE OF Cosem-Attribute-Descriptor-With-Selection
}

Get-Response                ::= CHOICE
{
    get-response-normal       [1] IMPLICIT Get-Response-Normal,
    get-response-with-datablock [2] IMPLICIT Get-Response-With-Datablock,
    get-response-with-list     [3] IMPLICIT Get-Response-With-List
}

Get-Response-Normal         ::= SEQUENCE
{
    invoke-id-and-priority    Invoke-Id-And-Priority,
    result                   Get-Data-Result
}

Get-Response-With-Datablock ::= SEQUENCE
{
    invoke-id-and-priority    Invoke-Id-And-Priority,
    result                   DataBlock-G
}

Get-Response-With-List      ::= SEQUENCE

```

```

{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      SEQUENCE OF Get-Data-Result
}

Set-Request ::= CHOICE
{
    set-request-normal                [1] IMPLICIT Set-Request-Normal,
    set-request-with-first-datablock [2] IMPLICIT Set-Request-With-First-Datablock,
    set-request-with-datablock        [3] IMPLICIT Set-Request-With-Datablock,
    set-request-with-list             [4] IMPLICIT Set-Request-With-List,
    set-request-with-list-and-first-datablock [5] IMPLICIT Set-Request-With-List-And-First-Datablock
}

Set-Request-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-attribute-descriptor  Cosem-Attribute-Descriptor,
    access-selection            Selective-Access-Descriptor OPTIONAL,
    value                       Data
}

Set-Request-With-First-Datablock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-attribute-descriptor  Cosem-Attribute-Descriptor,
    access-selection            Selective-Access-Descriptor OPTIONAL,
    datablock                  DataBlock-SA
}

Set-Request-With-Datablock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    datablock                  DataBlock-SA
}

Set-Request-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    attribute-descriptor-list   SEQUENCE OF Cosem-Attribute-Descriptor-With-Selection,
    value-list                  SEQUENCE OF Data
}

Set-Request-With-List-And-First-Datablock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    attribute-descriptor-list   SEQUENCE OF Cosem-Attribute-Descriptor-With-Selection,
    datablock                  DataBlock-SA
}

Set-Response ::= CHOICE
{
    set-response-normal                [1] IMPLICIT Set-Response-Normal,
    set-response-datablock             [2] IMPLICIT Set-Response-Datablock,
    set-response-last-datablock        [3] IMPLICIT Set-Response-Last-Datablock,
    set-response-last-datablock-with-list [4] IMPLICIT Set-Response-Last-Datablock-With-List,
    set-response-with-list             [5] IMPLICIT Set-Response-With-List
}

Set-Response-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      Data-Access-Result
}

Set-Response-Datablock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    block-number                Unsigned32
}

Set-Response-Last-Datablock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      Data-Access-Result,
    block-number                Unsigned32
}

```



```

Set-Response-Last-Datablock-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      SEQUENCE OF Data-Access-Result,
    block-number                Unsigned32
}

Set-Response-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    result                      SEQUENCE OF Data-Access-Result
}

Action-Request ::= CHOICE
{
    action-request-normal                [1] IMPLICIT Action-Request-Normal,
    action-request-next-pblock           [2] IMPLICIT Action-Request-Next-Pblock,
    action-request-with-list             [3] IMPLICIT Action-Request-With-List,
    action-request-with-first-pblock     [4] IMPLICIT Action-Request-With-First-Pblock,
    action-request-with-list-and-first-pblock [5] IMPLICIT Action-Request-With-List-And-First-Pblock,
    action-request-with-pblock           [6] IMPLICIT Action-Request-With-Pblock
}

Action-Request-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor     Cosem-Method-Descriptor,
    method-invocation-parameters Data OPTIONAL
}

Action-Request-Next-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    block-number                Unsigned32
}

Action-Request-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor-list SEQUENCE OF Cosem-Method-Descriptor,
    method-invocation-parameters SEQUENCE OF Data
}

Action-Request-With-First-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor     Cosem-Method-Descriptor,
    pblock                     DataBlock-SA
}

Action-Request-With-List-And-First-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    cosem-method-descriptor-list SEQUENCE OF Cosem-Method-Descriptor,
    pblock                     DataBlock-SA
}

Action-Request-With-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    pblock                     DataBlock-SA
}

Action-Response ::= CHOICE
{
    action-response-normal                [1] IMPLICIT Action-Response-Normal,
    action-response-with-pblock           [2] IMPLICIT Action-Response-With-Pblock,
    action-response-with-list             [3] IMPLICIT Action-Response-With-List,
    action-response-next-pblock           [4] IMPLICIT Action-Response-Next-Pblock
}

Action-Response-Normal ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    single-response             Action-Response-With-Optional-Data
}

Action-Response-With-Pblock ::= SEQUENCE

```

```

{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    pblock                     DataBlock-SA
}

Action-Response-With-List ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    list-of-responses          SEQUENCE OF Action-Response-With-Optional-Data
}

Action-Response-Next-Pblock ::= SEQUENCE
{
    invoke-id-and-priority      Invoke-Id-And-Priority,
    block-number               Unsigned32
}

EventNotificationRequest ::= SEQUENCE
{
    time                       OCTET STRING OPTIONAL,
    cosem-attribute-descriptor Cosem-Attribute-Descriptor,
    attribute-value            Data
}

ExceptionResponse ::= SEQUENCE
{
    state-error                [0] IMPLICIT ENUMERATED
    {
        service-not-allowed    (1),
        service-unknown        (2)
    },
    service-error              [1] IMPLICIT ENUMERATED
    {
        operation-not-possible (1),
        service-not-supported  (2),
        other-reason           (3)
    }
}

-- Data-Notification
Data-Notification ::= SEQUENCE
{
    long-invoke-id-and-priority Long-Invoke-Id-And-Priority,
    date-time                  OCTET STRING,
    notification-body          Notification-Body
}

-- General APDUs
General-Ded-Ciphering ::= SEQUENCE
{
    system-title               OCTET STRING,
    ciphered-content           OCTET STRING
}

General-Glo-Ciphering ::= SEQUENCE
{
    system-title               OCTET STRING,
    ciphered-content           OCTET STRING
}

General-Block-Transfer ::= SEQUENCE
{
    block-control              Block-Control,
    block-number               Unsigned16,
    block-number-ack           Unsigned16,
    block-data                 OCTET STRING
}

-- Types used in the xDLMS data transfer services

Variable-Access-Specification ::= CHOICE
{
    variable-name              [2] IMPLICIT ObjectName,
    -- detailed-access [3] is not used in DLMS/COSEM
    parameterized-access       [4] IMPLICIT Parameterized-Access,
    block-number-access         [5] IMPLICIT Block-Number-Access,

```

```

read-data-block-access      [6] IMPLICIT Read-Data-Block-Access,
write-data-block-access     [7] IMPLICIT Write-Data-Block-Access
}

Parameterized-Access ::= SEQUENCE
{
    variable-name            ObjectName,
    selector                 Unsigned8,
    parameter                Data
}

Block-Number-Access ::= SEQUENCE
{
    block-number             Unsigned16
}

Read-Data-Block-Access ::= SEQUENCE
{
    last-block               BOOLEAN,
    block-number             Unsigned16,
    raw-data                 OCTET STRING
}

Write-Data-Block-Access ::= SEQUENCE
{
    last-block               BOOLEAN,
    block-number             Unsigned16
}

Data ::= CHOICE
{
    null-data                [0] IMPLICIT NULL,
    array                    [1] IMPLICIT SEQUENCE OF Data,
    structure                 [2] IMPLICIT SEQUENCE OF Data,
    boolean                  [3] IMPLICIT BOOLEAN,
    bit-string               [4] IMPLICIT BIT STRING,
    double-long              [5] IMPLICIT Integer32,
    double-long-unsigned     [6] IMPLICIT Unsigned32,
    octet-string             [9] IMPLICIT OCTET STRING,
    visible-string           [10] IMPLICIT VisibleString,
    utf8-string              [12] IMPLICIT UTF8String,
    bcd                      [13] IMPLICIT Integer8,
    integer                  [15] IMPLICIT Integer8,
    long                     [16] IMPLICIT Integer16,
    unsigned                 [17] IMPLICIT Unsigned8,
    long-unsigned            [18] IMPLICIT Unsigned16,
    compact-array            [19] IMPLICIT SEQUENCE
    {
        contents-description [0] TypeDescription,
        array-contents       [1] IMPLICIT OCTET STRING
    },
    long64                   [20] IMPLICIT Integer64,
    long64-unsigned          [21] IMPLICIT Unsigned64,
    enum                     [22] IMPLICIT Unsigned8,
    float32                  [23] IMPLICIT OCTET STRING (SIZE(4)),
    float64                  [24] IMPLICIT OCTET STRING (SIZE(8)),
    date time                 [25] IMPLICIT OCTET STRING (SIZE(12)),
    date                     [26] IMPLICIT OCTET STRING (SIZE(5)),
    time                     [27] IMPLICIT OCTET STRING (SIZE(4)),
    dont-care                 [255] IMPLICIT NULL
}

```

-- The following TypeDescription relates to the compact-array data Type

```

TypeDescription ::= CHOICE
{
    NULL-data                [0] IMPLICIT NULL,
    array                    [1] IMPLICIT SEQUENCE
    {
        number-of-elements  Unsigned16,
        type-description     TypeDescription
    },
    structure                 [2] IMPLICIT SEQUENCE OF TypeDescription,
    boolean                  [3] IMPLICIT NULL,
    bit-string               [4] IMPLICIT NULL,
    double-long              [5] IMPLICIT NULL,
    double-long-unsigned     [6] IMPLICIT NULL,
    octet-string             [9] IMPLICIT NULL,
}

```

visible-string	[10]	IMPLICIT	NULL,
utf8-string	[12]	IMPLICIT	NULL,
bcd	[13]	IMPLICIT	NULL,
integer	[15]	IMPLICIT	NULL,
long	[16]	IMPLICIT	NULL,
unsigned	[17]	IMPLICIT	NULL,
long-unsigned	[18]	IMPLICIT	NULL,
long64	[20]	IMPLICIT	NULL,
long64-unsigned	[21]	IMPLICIT	NULL,
enum	[22]	IMPLICIT	NULL,
float32	[23]	IMPLICIT	NULL,
float64	[24]	IMPLICIT	NULL,
date_time	[25]	IMPLICIT	NULL,
date	[26]	IMPLICIT	NULL,
time	[27]	IMPLICIT	NULL,
dont-care	[255]	IMPLICIT	NULL

Data-Access-Result ::= **ENUMERATED**

```
{
    success                (0),
    hardware-fault         (1),
    temporary-failure      (2),
    read-write-denied      (3),
    object-undefined       (4),
    object-class-inconsistent (9),
    object-unavailable     (11),
    type-unmatched        (12),
    scope-of-access-violated (13),
    data-block-unavailable (14),
    long-get-aborted       (15),
    no-long-get-in-progress (16),
    long-set-aborted       (17),
    no-long-set-in-progress (18),
    data-block-number-invalid (19),
    other-reason           (250)
}
```

Action-Result ::= **ENUMERATED**

```
{
    success                (0),
    hardware-fault         (1),
    temporary-failure      (2),
    read-write-denied      (3),
    object-undefined       (4),
    object-class-inconsistent (9),
    object-unavailable     (11),
    type-unmatched        (12),
    scope-of-access-violated (13),
    data-block-unavailable (14),
    long-action-aborted    (15),
    no-long-action-in-progress (16),
    other-reason           (250)
}
```

-- IEC 61334-6:2000, Clause 5 specifies that bits of any byte are numbered from 1 to 8,
 -- where bit 8 is the most significant.
 -- In IEC 62056-5-3 bits are numbered from 0 to 7.

-- Use of Invoke-Id-And-Priority

-- invoke-id	bits 0-3	
-- reserved	bits 4-5	
-- service-class	bit 6	0 = Unconfirmed, 1 = Confirmed
-- priority	bit 7	0 = Normal, 1 = High

Invoke-Id-And-Priority ::= Unsigned8

-- Use of Long-Invoke-Id-And-Priority

-- invoke-id	bits 0-23	
-- reserved	bits 24-27	
-- self-descriptive	bit 28	0 = Not-Self-Descriptive, 1 = Self-Descriptive
-- processing-option	bit 29	0 = Continue on Error, 1 = Break on Error
-- service-class	bit 30	0 = Unconfirmed, 1 = Confirmed
-- priority	bit 31	0 = Normal, 1 = High

Long-Invoke-Id-And-Priority ::= Unsigned32

Cosem-Attribute-Descriptor ::= **SEQUENCE**

```
{
```



```
--      last-block          bit 7          0 = Not Last Block, 1 = Last Block  
Block-Control::=          Unsigned8
```

END

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Annex A (normative)

Using the COSEM application layer in various communications profiles

A.1 General

As specified in IEC 62056-1-0 the COSEM interface model for energy metering equipment, specified in IEC 62056-6-2:2016 has been designed for use with a variety of communication profiles for exchanging data over various communication media. In each such profile, the application layer is the COSEM AL, providing the xDLMS services to access attributes and methods of COSEM objects. For each communication profile, the following elements shall be specified:

- the targeted communication environments;
- the structure of the profile (the set of protocol layers);
- the identification / addressing scheme;
- mapping of the COSEM AL services to the service set provided and used by the supporting layer;
- communication profile specific parameters of the COSEM AL services;
- other specific considerations / constraints for using certain services within a given profile.

A.2 Targeted communication environments

This part identifies the communication environments, for which the given communication profile is specified.

A.3 The structure of the profile

This part specifies the protocol layers included in the given profile.

A.4 Identification and addressing schemes

This part describes the identification and addressing schemes specific for the profile.

As described in IEC 62056-6-2:2016, 4.7, metering equipment are modelled in COSEM as physical devices, containing one or more logical devices. In the COSEM client/server type model, data exchange takes place within application associations, between a COSEM client AP and a COSEM Logical Device, playing the role of a server AP.

To be able to establish the required AA and then to exchange data with the help of the supporting lower layer protocols, the client- and server APs shall be identified and addressed, according to the rules of a communication profile. At least the following elements need to be identified / addressed:

- physical devices hosting clients and servers;
- client- and server APs;

The client- and server APs also identify the AAs.

A.5 Supporting layer services and service mapping

This part specifies the service mapping between the services requested by the COSEM AL and the services provided by its supporting layer.

In each communication profile, the COSEM AL provides the same set of services to the client- and server APs. However, the supporting protocol layer in the various profiles provides a different set of services to the service user AL.

The service mapping specifies how the AL is using the services of its supporting layer to provide ACSE and xDLMS services to its service user. For this purpose, MSCs are generally used, showing the sequence of the events following a service invocation by the COSEM AP.

A.6 Communication profile specific parameters of the COSEM AL services

In COSEM, only the COSEM-OPEN service has communication profile specific parameters (the Protocol_Connection_Parameters). Their values and use are defined as part of the communication profile specification.

A.7 Specific considerations / constraints using certain services within a given profile

The availability and the protocol of some of the services may depend on the communication profile. These elements are specified as part of the communication profile specification.

A.8 The 3-layer, connection-oriented, HDLC based communication profile

This profile is specified in IEC 62056-7-6.

A.9 The TCP-UDP/IP based communication profiles (COSEM_on_IP)

This profile is specified in IEC 62056-9-7.

A.10 The S-FSK PLC profile

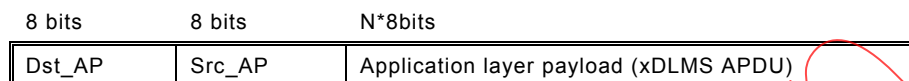
This profile is specified in IEC 62056-8-3.

Annex B (normative)

SMS short wrapper

This Annex specifies the transport of xDLMS APDUs in an SMS.

The payload of an SMS message is the xDLMS APDU prepended with the identifier of the Destination_AP and the Source_AP as shown in Figure B.1:



Where:

- Dst_AP = Destination AP identifies the destination Application Process;
- Src_AP = Source AP identifies the source Application Process.

Figure B.1 – Short wrapper

Table B.1 specifies the identifiers of reserved Application Processes.

Table B.1 – Reserved Application Processes

Client side reserved AP	
No-station	0x00
Client Management Process	0x01
Public client	0x10
Server side reserved AP	
No-station	0x00
Management Logical device	0x01
Reserved	0x02..0xF
All-station (Broadcast)	0x7F

Annex C (informative)

AARQ and AARE encoding examples

C.1 General

This annex contains examples of encoding of the AARQ and AARE APDUs, in cases of using various levels of authentication and in cases of success and failure.

The AARQ, AARE, RLRQ and RLRE APDUs – see 7.2 – shall be encoded in BER (ISO/IEC 8825-1). The user-information field of the AARQ and AARE APDUs contains the xDLMS InitiateRequest / InitiateResponse or ConfirmedServiceError APDUs, respectively, encoded in A-XDR as OCTET STRING.

C.2 Encoding of the xDLMS InitiateRequest / InitiateResponse APDUs

The xDLMS InitiateRequest / InitiateResponse APDUs are specified as follows:

```
InitiateRequest ::= SEQUENCE
{
  -- shall not be encoded in DLMS without ciphering
  dedicated-key          OCTET STRING OPTIONAL,
  response-allowed       BOOLEAN DEFAULT TRUE,
  proposed-quality-of-service IMPLICIT Integer8 OPTIONAL,
  proposed-dlms-version-number Unsigned8,
  proposed-conformance   Conformance,
  client-max-receive-pdu-size Unsigned16
}

InitiateResponse ::= SEQUENCE
{
  negotiated-quality-of-service IMPLICIT Integer8 OPTIONAL,
  negotiated-dlms-version-number Unsigned8,
  negotiated-conformance       Conformance,
  server-max-receive-pdu-size  Unsigned16,
  vaa-name                     ObjectName
}
```

The xDLMS InitiateRequest and InitiateResponse APDUs are encoded in A-XDR and they are inserted in the user-information field of the AARQ / AARE APDUs respectively.

In the examples below, the following values are used:

- dedicated key: not present; no ciphering is used;
- response-allowed: TRUE (default value);
- proposed-quality-of-service and negotiated-quality-of-service: not present (not used in DLMS/COSEM);
- proposed-conformance and negotiated-conformance: see below;
- proposed-dlms-version-number and negotiated-dlms-version-number = 6;
- client-max-receive-pdu-size: 1200_D = 0x04B0;
- server-max-receive-pdu-size: 500_D = 0x01F4;
- vaa-name in the case of LN referencing: the dummy value 0x0007;
- vaa-name in the case of SN referencing: the base_name of the current “Association SN” object, 0xFA00.
- the proposed-conformance and the negotiated-conformance elements carry the proposed conformance block and the negotiated conformance block respectively. The values of

these examples, for LN referencing and SN referencing respectively, are shown in Table C.1.

Table C.1 – Conformance block

Conformance ::= [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24))		LN referencing		SN referencing	
-- the bit is set when the corresponding service or functionality is available	Used with	Proposed/ Negotiated		Proposed / Negotiated	
reserved-zero (0),		0	0	0	0
reserved-one (1),		0	0	0	0
reserved-two (2),		0	0	0	0
read (3),	SN	0	0	1	1
write (4),	SN	0	0	1	1
unconfirmed-write (5),	SN	0	0	1	1
reserved-six (6),		0	0	0	0
reserved-seven (7),		0	0	0	0
attribute0-supported-with-set (8),	LN	0	0	0	0
priority-mgmt-supported (9),	LN	1	1	0	0
attribute0-supported-with-get (10),	LN	1	0	0	0
block-transfer-with-get-or-read (11),	LN	1	1	0	0
block-transfer-with-set-or-write (12),	LN	1	0	0	0
block-transfer-with-action (13),	LN	1	0	0	0
multiple-references (14),	LN/SN	1	0	1	1
information-report (15),	SN	0	0	1	1
reserved-sixteen (16),		0	0	0	0
reserved-seventeen (17),		0	0	0	0
parameterized-access (18),	SN	0	0	1	1
get (19),	LN	1	1	0	0
set (20),	LN	1	1	0	0
selective-access (21),	LN	1	1	0	0
event-notification (22),	LN	1	1	0	0
action (23),	LN	1	1	0	0
Value of the bit string		00 7E 1F	00 50 1F	1C 03 20	1C 03 20

With these parameters, the A-XDR encoding of the xDLMS InitiateRequest APDU is the following, see Table C.2:

Table C.2 – A-XDR encoding of the xDLMS InitiateRequest APDU

-- A-XDR encoding of the xDLMS InitiateRequest APDU	LN referencing	SN referencing
// encoding of the tag of the DLMS APDU CHOICE (InitiateRequest)	01	01
-- encoding of the dedicated-key component (OCTET STRING OPTIONAL)		
// usage flag (FALSE, not present)	00	00
-- encoding of the response-allowed component (BOOLEAN DEFAULT TRUE)		
// usage flag (FALSE, default value TRUE conveyed)	00	00
-- encoding of the proposed-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)		
// usage flag (FALSE, not present)	00	00
-- encoding of the proposed-dlms-version-number component (Unsigned8)		
// value= 6, the encoding of an Unsigned8 is its value	06	06
-- encoding of the proposed-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)) ¹		
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag) ²	5F 1F	5F 1F
// encoding of the length of the 'contents' field in octet (4)	04	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00	00
// encoding of the fixed length BIT STRING value	00 7E 1F	1C 03 20
-- encoding of the client-max-receive-pdu-size component (Unsigned16)		
// value = 0x04B0, the encoding of an Unsigned16 is its value	04 B0	04 B0
-- resulting octet-string, to be inserted in the user-information field of the AARQ APDU	01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0	01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0
¹ As specified in IEC 61334-6:2000, Annex C, Examples 1 and 2, the proposed-conformance element of the xDLMS InitiateRequest APDU and the negotiated-conformance element of the xDLMS InitiateResponse APDU are encoded in BER. That's why the length of the bit-string and the number of the unused bits are encoded. ² For encoding of identifier octets see ISO/IEC 8825-1:2008, 8.1.2. For compliance with existing implementations, encoding of the [Application 31] tag on one byte (5F) instead of two bytes (5F 1F) is accepted when the 3-layer, connection-oriented, HDLC-based profile is used.		

The A-XDR encoding of the xDLMS InitiateResponse APDU is the following, see Table C.3:

Table C.3 – A-XDR encoding of the xDLMS InitiateResponse APDU

-- A-XDR encoding of the xDLMS InitiateResponse APDU	LN referencing	SN referencing
// encoding of the tag of the DLMS APDU CHOICE (InitiateResponse)	08	08
-- encoding of the negotiated-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)		
// usage flag(FALSE , not present)	00	00
-- encoding of the negotiated-dlms-version-number component (Unsigned8)		
// value = 6, the encoding of an Unsigned8 is its value	06	06
-- encoding of the negotiated-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)))		
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag)	5F 1F	5F 1F
// encoding of the length of the 'contents' field in octet (4)	04	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00	00
// encoding of the fixed length BIT STRING value	00 50 1F	1C 03 20
-- encoding of the server-max-receive-pdu-size component (Unsigned16)		
// value = 0x01F4, the encoding of an Unsigned16 is its value	01 F4	01 F4
-- encoding of the VAA-Name component (ObjectName, Integer16)		
// value=0x0007 for LN and 0xFA00 for SN referencing; the encoding of a value constrained Integer16 is its value	00 07	FA 00
-- resulting octet-string, to be inserted in the user-information field of the AARE APDU	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00

C.3 Specification of the AARQ and AARE APDUs

AARQ-apdu ::= [APPLICATION 0] IMPLICIT SEQUENCE

{

-- [APPLICATION 0] == [60H] = [96]

protocol-version	[0] IMPLICIT	BIT STRING {version1 (0)} DEFAULT {version1},
application-context-name	[1]	Application-context-name,
called-AP-title	[2]	AP-title OPTIONAL,
called-AE-qualifier	[3]	AE-qualifier OPTIONAL,
called-AP-invocation-id	[4]	AP-invocation-identifier OPTIONAL,
called-AE-invocation-id	[5]	AE-invocation-identifier OPTIONAL,
calling-AP-title	[6]	AP-title OPTIONAL,
calling-AE-qualifier	[7]	AE-qualifier OPTIONAL,
calling-AP-invocation-id	[8]	AP-invocation-identifier OPTIONAL,
calling-AE-invocation-id	[9]	AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
sender-acse-requirements [10] IMPLICIT ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is selected.
mechanism-name [11] IMPLICIT Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is selected.
calling-authentication-value [12] EXPLICIT Authentication-value OPTIONAL,
implementation-information [29] IMPLICIT Implementation-data OPTIONAL,

```

    user-information          [30] EXPLICIT  Association-information OPTIONAL
}

-- The user-information field shall carry an xDLMS InitiateRequest APDU encoded in
-- A-XDR. The resulting OCTET STRING shall be encoded in BER.

AARE-apdu ::= [APPLICATION 1] IMPLICIT SEQUENCE
{
-- [APPLICATION 1] == [ 61H ] = [ 97 ]

    protocol-version          [0] IMPLICIT  BIT STRING {version1 (0)}
                                DEFAULT {version1},
    application-context-name   [1]          Application-context-name,
    result                     [2]          Association-result,
    result-source-diagnostic   [3]          Associate-source-diagnostic,
    responding-AP-title        [4]          AP-title OPTIONAL,
    responding-AE-qualifier     [5]          AE-qualifier OPTIONAL,
    responding-AP-invocation-id [6]          AP-invocation-identifier OPTIONAL,
    responding-AE-invocation-id [7]          AE-invocation-identifier OPTIONAL,

-- The following field shall not be present if only the kernel is used.
    responder-acse-requirements [8] IMPLICIT ACSE-requirements OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    mechanism-name             [9] IMPLICIT  Mechanism-name OPTIONAL,

-- The following field shall only be present if the authentication functional unit is
-- selected.
    responding-authentication-value [10] EXPLICIT Authentication-value OPTIONAL,
    implementation-information      [29] IMPLICIT Implementation-data OPTIONAL,
    user-information              [30] EXPLICIT Association-information OPTIONAL
}

-- The user-information field shall carry either an InitiateResponse (or, when the
-- proposed xDLMS context is not accepted by the server, a ConfirmedServiceError) APDU
-- encoded in A-XDR. The resulting OCTET STRING shall be encoded in BER.

```

C.4 Data for the examples

In these examples:

- the protocol-version is the default ACSE version;
- the value of the application-context-name:
 - in the case of LN referencing, with no ciphering: 2, 16, 756, 5, 8, 1, 1;
 - in the case of SN referencing, with no ciphering: 2, 16, 756, 5, 8, 1, 2;
- the optional called-AP-title, called-AE-qualifier, called-AP-invocation-id, called-AE-invocation-id, calling-AP-title, calling-AE-qualifier, calling-AP-invocation-id, calling-AE-invocation-id fields of the AARQ, and the optional responding-AP-title, responding-AE-qualifier, responding-AP-invocation-id, responding-AE-invocation-id fields of the AARE are not present;
- the value of the mechanism-name:
 - in the case of low-level-security: 2, 16, 756, 5, 8, 2, 1;
 - in the case of high-level-security (5): 2, 16, 756, 5, 8, 2, 5;
- the calling-authentication-value:
 - in the case of low-level-security is 12345678 (encoded as 31 32 33 34 35 36 37 38);
 - in the case of high-level security, (challenge CtoS) is K56iVagY (encoded as 4B 35 36 69 56 61 67 59);
- the responding authentication-value (challenge StoC) is P6wRJ21F (encoded as 50 36 77 52 4A 32 31 46);
- the optional implementation-information field in the AARQ and AARE APDUs is not present;

- the user-information field carries the xDLMS InitiateRequest / InitiateResponse APDUs as shown above.

The application-context-name and the (authentication) mechanism-name OBJECT IDENTIFIERS are encoded as follows:

- BER Encoding for OBJECT IDENTIFIER is a packed sequence of numbers representing the arc labels. Each number – except the first two, which are combined into one – is represented as a series of octets, with 7 bits being used from each octet and the most significant bit is set to 1 in all but the last octet. The fewest possible number of octets shall be used;
- in the case of the application context name LN referencing with no ciphering, the arc labels of the object identifier are (2, 16, 756, 5, 8, 1, 1);
 - the first octet of the encoding is the combination of the first two numbers into a single number, following the rule of $40 \times \text{First} + \text{Second} \rightarrow 40 \times 2 + 16 = 96 = 0x60$;
 - the third number of the Object Identifier (756) requires two octets: its hexadecimal value is 0x02F4, which is 00000010 11110100, but following the above rule, the MSB of the first octet shall be set to 1 and the MSB of the second (last) octet shall be set to 0, thus this bit shall be shifted into the LSB of the first octet. This gives binary 10000101 01110100, which is 0x8574;
 - each remaining number of the Object Identifier required to be encoded on one octet;
 - this results in the encoding 60 85 74 05 08 01 01.
- similarly, in the case of application context name SN referencing with no ciphering the BER encoding is 60 85 74 05 08 01 02;
- in the case of mechanism name low-level-security, the BER encoding is 60 85 74 05 08 02 01;
- in the case of mechanism name high-level-security (5), the BER encoding is 60 85 74 05 08 02 05.

C.5 Encoding of the AARQ APDU

Here, six different cases are shown:

- LN referencing with no ciphering, no security, LLS and HLS;
- SN referencing with no ciphering, no security, LLS and HLS;

The encoding is shown in Table C.4. See also Table C.5.

Table C.4 – BER encoding of the AARQ APDU

-- BER encoding of the AARQ APDU	LN referencing			SN referencing		
	no sec.	LIS	HLS	no sec.	LIS	HLS
// encoding of the tag of the AARQ APDU ([APPLICATION 0], Application)	60			60		
// encoding of the length of the AARQ's content's field	1D	36	36	1D	36	36
-- protocol-version field ([0], IMPLICIT BIT STRING { version1 (0) } DEFAULT { version1 })						
// no encoding, thus it is considered with its DEFAULT value						
-- encoding of the fields of the Kernel						
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)						
// encoding of the tag ([1], Context-specific)	A1			A1		
// encoding of the length of the tagged component's value field	09			09		
// encoding of the choice for application-context-name (OBJECT IDENTIFIER, Universal)	06			06		
// encoding of the length of the Object Identifier's value field	07			07		
// encoding of the value of the Object Identifier		60 85 74 05 08 01 01			60 85 74 05 08 01 02	
-- encoding of the fields of the authentication functional unit						
--sender-acse-requirements field ([10], ACSE-requirements, BIT STRING { authentication (0) })						
// encoding of the tag of the acse-requirements field ([10], IMPLICIT, Context-specific)	-	8A	8A	-	8A	8A
// encoding of the length of the tagged component's value field	-	02	02	-	02	02
// encoding of the number of unused bits in the last byte of the BIT STRING	-	07	07	-	07	07
// encoding of the authentication functional unit (0)						
The number of bits coded may vary from client to client, but within the COSEM environment, only bit 0 set to 1 (indicating the requirement of the authentication functional unit) is to be respected.	-	80	80	-	80	80
-- mechanism-name field ([11], IMPLICIT Mechanism-name OBJECT IDENTIFIER)						
// encoding of the tag ([11], IMPLICIT, Context-specific)	-	8B	8B	-	8B	8B

-- BER encoding of the AARQ APDU		LN referencing			SN referencing		
		no sec.	LLS	HLS	no sec.	LLS	HLS
// encoding of the length of the tagged component's value field		-	07	07	-	07	07
// encoding of the value of the OBJECT IDENTIFIER :							
- low-level-security-mechanism-name (1)		-	60 85 74 05 08 02 01	60 85 74 05 08 02 05	-	60 85 74 05 08 02 01	60 85 74 05 08 02 05
- high-level-security-mechanism-name (5)							
-- calling-authentication-value field ([12], Authentication-value CHOICE)							
// encoding of the tag ([12], EXPLICIT , Context-specific)		-	AC	AC	-	AC	AC
// encoding of the length of the tagged component's value field		-	0A	0A	-	0A	0A
// encoding of the choice for Authentication-value (characterstring [0], IMPLICIT GraphicString)		-	80	80	-	80	80
// encoding of the length of the Authentication-value's value field (8 octets)			08	08	-	08	08
// encoding of the calling-authentication-value:							
- in the case of LLS, the value of the Password "12345678"			31 32 33 34 35 36 37 38	4B 35 36 69 56 61 67 59	-	31 32 33 34 35 36 37 38	4B 35 36 69 56 61 67 59
- in the case of HLS, the value of challenge CtoS "K56iVagY"							
-- encoding of the user-information field component (Association-information, OCTET STRING)							
// encoding of the tag ([30], Context-specific, Constructed)		BE	BE	BE	BE	BE	BE
// encoding of the length of the tagged component's value field		10	10	10	10	10	10
// encoding of the choice for user-information (OCTET STRING , Universal)		04	04	04	04	04	04
// encoding of the length of the OCTET STRING 's value field (14 octets)		0E	0E	0E	0E	0E	0E
// user-information: xDLMS InitiateRequest APDU		01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0	06 5F 1F 04 B0	06 5F 1F 04 B0	01 00 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0	06 5F 1F 04 B0	06 5F 1F 04 B0

Table C.5 – Complete AARQ APDU

LN referencing with no ciphering, lowest level security;	60 1D A1 09 06 07 60 85 74 05 08 01 01 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0
LN referencing with no ciphering, low level security;	60 36 A1 09 06 07 60 85 74 05 08 01 01 8A 02 07 80 8B 07 60 85 74 05 08 02 01 AC 0A 80 08 31 32 33 34 35 36 37 38 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0
LN referencing with no ciphering, high level security;	60 36 A1 09 06 07 60 85 74 05 08 01 01 8A 02 07 80 8B 07 60 85 74 05 08 02 05 AC 0A 80 08 4B 35 36 69 56 61 67 59 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 00 7E 1F 04 B0
SN referencing with no ciphering, lowest level security;	60 1D A1 09 06 07 60 85 74 05 08 01 02 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0
SN referencing with no ciphering, low level security;	60 36 A1 09 06 07 60 85 74 05 08 01 02 8A 02 07 80 8B 07 60 85 74 05 08 02 01 AC 0A 80 08 31 32 33 34 35 36 37 38 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0
SN referencing with no ciphering, high level security	60 36 A1 09 06 07 60 85 74 05 08 01 02 8A 02 07 80 8B 07 60 85 74 05 08 02 05 AC 0A 80 08 4B 35 36 69 56 61 67 59 BE 10 04 0E 01 00 00 00 06 5F 1F 04 00 1C 03 20 04 B0

C.6 Encoding of the AARE APDU

Here, six different cases are shown:

- LN referencing with no ciphering, no security or LLS, successful establishment of the AA;
- LN referencing with no ciphering, no security or LLS, failure because the proposed application-context-name does not fit the application-context-name supported by the server (failure case 1):
 - when the meter uses LN referencing, SN referencing is proposed;
 - when the meter uses SN referencing, LN referencing is proposed;
- LN referencing with no ciphering, no security or LLS, failure because the proposed-dlms-version-number is too low; (failure case 2)
- LN referencing with no ciphering, HLS, successful establishment of the AA;
- SN referencing with no ciphering, no security or LLS, successful establishment of the AA;
- SN referencing with no ciphering, HLS, successful establishment of the AA.

The encoding is shown in Table C.6. See also Table C.7.

Table C.6 – BER encoding of the AARE APDU

-- BER encoding of the AARE APDU		LN referencing				SN referencing	
		No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success
// encoding of the tag for the AARE APDU ([APPLICATION 1], Application)		61				61	
// encoding of the length of the AARE's contents field		29	29	1F	42	29	42
-- protocol-version field ([0], IMPLICIT BIT STRING { version1 (0) } DEFAULT { version1 })							
// no encoding, thus it is considered with its DEFAULT value							
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)							
// encoding of the tag ([1], Context-specific)		A1				A1	
// encoding of the length of the tagged component's value field		09				09	
// encoding of the choice for application-context-name (OBJECT IDENTIFIER, Universal)		06				06	
// encoding of the length of the Object Identifier's value field		07				07	
// encoding of the value of the Object Identifier: NOTE when the proposed application-context does not fit the application-context supported by the server, the server responds either with the application-context name proposed or the application-context-name supported.		60 85 74 05 08 01 01	60 85 74 05 08 01 01	60 85 74 05 08 01 01	60 85 74 05 08 01 01	60 85 74 05 08 01 02	60 85 74 05 08 01 02
-- result field ([2], Association-result, INTEGER)							
// encoding of the tag ([2], Context-specific)		A2				A2	
// encoding of the length of the tagged component's value field		03				03	
// encoding of the choice for the result (INTEGER, Universal)		02				02	
// encoding of the length of the result's value field		01				01	

-- BER encoding of the AARE APDU		LN referencing				SN referencing		
		No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success	
// encoding of the value of the Result: // success: 0, accepted // failure case 1 and 2: 1, rejected-permanent		00	01	01	00	00	00	00
-- result-source-diagnostic field ([3], Associate-source-diagnostic, CHOICE)								
// encoding of the tag ([3], Context-specific)		A3				A3		
// encoding of the length of the tagged component's value field		05				05		
// encoding of the tag for the acse-service-user CHOICE (1)		A1				A1		
// encoding of the length of the tagged component's value field		03				03		
// encoding of the choice for associate-source-diagnostics (INTEGER, Universal)		02				02		
// encoding of the length of the value field		01				01		
// encoding of the value: - success, no security and LLS: 0, no diagnostics provided; - failure 1: 2, application-context-name not supported; - failure 2: 1, no-reason-given. - success, HLS security (5): 14, authentication required;		00	02	01	0E	00	0E	0E
-- encoding of the fields of the authentication functional unit								
-- responder-acse-requirements field ([8], IMPLICIT, ACSE-requirements, BIT STRING { authentication (0) })								
// encoding of the tag of the acse-requirements field ([8], IMPLICIT, Context-specific)		-			88	-	88	88
// encoding of the length of the tagged component's value field.		-			02	-	02	02

-- BER encoding of the AARE APDU		LN referencing				SN referencing	
		No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success
// encoding of the number of unused bits in the last byte of the BIT STRING		-			07	-	07
// encoding of the authentication functional unit (0)		-			80	-	80
-- mechanism-name field ([9], IMPLICIT, Mechanism-name OBJECT IDENTIFIER)							
// encoding of the tag ([9], IMPLICIT, Context-specific)		-			89	-	89
// encoding of the length of the tagged component's value field		-			07	-	07
// encoding of the value of the object identifier: high-level-security-mechanism-name (5)		-			60 85 74 05 08 02 05	-	60 85 74 05 08 02 05
-- responding-authentication-value field ([10], EXPLICIT, Authentication-value CHOICE)							
// encoding of the tag ([10], Context-specific)		-	-	-	AA	-	AA
// encoding of the length of the tagged component's value field		-	-	-	0A	-	0A
// encoding of the choice for Authentication-value (charstring [0] IMPLICIT GraphicString)		-	-	-	80	-	80
// encoding of the length of the Authentication-information's value field (8 octets)		-	-	-	08	-	08
// encoding of the value of the challenge Stoc "P6wRJ21F"		-	-	-	50 36 77 52 4A 32 31 46	-	50 36 77 52 4A 32 31 46
-- encoding of the user-information field component (Association-information, OCTET STRING)							
// encoding of the tag for the user-information field component ([30], Context-specific, Constructed)	BE	BE	BE	BE	BE	BE	BE
// encoding of the length of the tagged component's value field	10	10	06	10	10	10	10
// encoding of the choice for user-information (OCTET STRING, Universal)	04	04	04	04	04	04	04
// encoding of the length of the OCTET STRING's value field	0E	0E	04	0E	0E	0E	0E

-- BER encoding of the AARE APDU	LN referencing				SN referencing	
	No sec./LLS success	No sec./LLS failure 1	No sec./LLS failure 2	HLS success	No sec./LLS success	HLS success
// failure case 1: xDLMS-InitiateResponse; // failure case 2: ConfirmedServiceError (14), InitiateError [1], ServiceError, initiate [6], dlms- version-too-low (1)	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	0E 01 06 01	08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07	08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00	08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00

Table C.7 – The complete AARE APDU

LN referencing with no ciphering, no security or LLS, successful establishment of the AA	61 29 A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 00 A3 05 A1 03 02 01 00 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07
LN referencing with no ciphering, no security or LLS, failure because the proposed application-context- name does not fit the application- context-name supported by the server (failure case 1):	61 29 A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 01 A3 05 A1 03 02 01 02 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07 or 61 29 A1 09 06 07 60 85 74 05 08 01 02 A2 03 02 01 01 A3 05 A1 03 02 01 02 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07
LN referencing with no ciphering, no security or LLS, failure because the proposed-dlms-version-number is too low; (failure case 2)	61 1F A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 01 A3 05 A1 03 02 01 01 BE 06 04 04 0E 01 06 01
LN referencing with no ciphering, high level security;	61 42 A1 09 06 07 60 85 74 05 08 01 01 A2 03 02 01 00 A3 05 A1 03 02 01 0E 88 02 07 80 89 07 60 85 74 05 08 02 05 AA 0A 80 08 50 36 77 52 4A 32 31 46 BE 10 04 0E 08 00 06 5F 1F 04 00 00 50 1F 01 F4 00 07
SN referencing with no ciphering, lowest level security;	61 29 A1 09 06 07 60 85 74 05 08 01 02 A2 03 02 01 00 A3 05 A1 03 02 01 00 BE 10 04 0E 08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00
SN referencing with no ciphering, high level security	61 42 A1 09 06 07 60 85 74 05 08 01 02 A2 03 02 01 00 A3 05 A1 03 02 01 0E 88 02 07 80 89 07 60 85 74 05 08 02 05 AA 0A 80 08 50 36 77 52 4A 32 31 46 BE 10 04 0E 08 00 06 5F 1F 04 00 1C 03 20 01 F4 FA 00

Annex D (informative)

Encoding examples: AARQ and AARE APDUs using a ciphered application context

D.1 A-XDR encoding of the xDLMS InitiateRequest APDU, carrying a dedicated key

NOTE The System Title is the same in each example. In reality, the System Title in the request and in the response APDUs are different, as they are originated by different systems.

In this example:

- the value of the dedicated key is 00112233445566778899AABBCCDDEEFF;
- the value of the Conformance block is 007E1F;
- the value of the client-max-receive-pdu-size is 1 200 bytes (0x04B0).

The A-XDR encoding of the xDLMS InitiateRequest APDU carrying a dedicated key is shown in Table D.1.

Table D.1 – A-XDR encoding of the xDLMS InitiateRequest APDU

// encoding of the tag of the DLMS APDU CHOICE (<i>InitiateRequest</i>)	01
-- encoding of the dedicated-key component (OCTET STRING OPTIONAL)	
// usage flag (TRUE , present)	01
// length of the OCTET STRING	10
// contents of the OCTET STRING	0011223344556677 8899AABBCCDDEEFF
-- encoding of the response-allowed component (BOOLEAN DEFAULT TRUE)	
// usage flag (FALSE , default value TRUE conveyed)	00
-- encoding of the proposed-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)	
// usage flag (FALSE , not present)	00
-- encoding of the proposed-dlms-version-number component (Unsigned8)	
// value = 6; the A-XDR encoding of an Unsigned8 is its value	06
-- encoding of the proposed-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24))) ¹	
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag) ²	5F1F
// encoding of the length of the 'contents' field in octet (4)	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00
// encoding of the fixed length BIT STRING value	007E1F
-- encoding of the client-max-receive-pdu-size component (Unsigned16)	
// value = 0x04B0, the encoding of an Unsigned16 is its value	04B0
-- resulting octet-string	0101100011223344 5566778899AABBCC DDEEFF0000065F1F 0400007E1F04B0

- ¹ As specified in IEC 61334-6:2000, Annex C, Examples 1 and 2, the proposed-conformance element of the xDLMS InitiateRequest APDU and the negotiated-conformance element of the xDLMS InitiateResponse APDU are encoded in BER. That is why the length of the bit-string and the number of the unused bits are encoded.
- ² For encoding of identifier octets see ISO/IEC 8825-1:2008, 8.1.2. For compliance with existing implementations, encoding of the [Application 31] tag on one byte (5F) instead of two bytes (5F 1F) is accepted when the 3-layer, connection-oriented, HDLC-based profile is used.

D.2 Authenticated encryption of the xDLMS InitiateRequest APDU

Table D.2 shows the encoding of an xDLMS InitiateRequest APDU which is also authenticated and encrypted.

Table D.2 – Authenticated encryption of the xDLMS InitiateRequest APDU

	<i>X</i>	Contents	LEN(X) bytes	len(X) bits
Security material				
Security suite		GCM-AES-128		
System Title	<i>Sys-T</i>	4D4D4D 0000BC614E (here, the five last octets contain the manufacturing number in hexadecimal form)	8	64
Frame Counter	<i>FC</i>	01234567	4	32
Initialization Vector	<i>IV</i>	<i>Sys-T</i> <i>FC</i> 4D4D4D0000BC614E01234567	12	96
Block cipher key (global)	<i>EK</i>	000102030405060708090A0B0C0D0E0F	16	128
Authentication Key	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Security applied		Authenticated encryption		
Security control byte (with unicast key)	<i>SC</i>	<i>SC</i> = <i>AE</i> 30	1	8
Security header	<i>SH</i>	<i>SH</i> = <i>SC</i> - <i>AE</i> <i>FC</i> 3001234567	5	40
Inputs				
xDLMS APDU to be protected	<i>APDU</i>	01011000112233445566778899AABBCC DDEEFF0000065F1F0400007E1F04B0	31	188
Plaintext	<i>P</i>	01011000112233445566778899AABBCC DDEEFF0000065F1F0400007E1F04B0	31	188
Associated data	<i>A</i>	<i>SC</i> <i>AK</i> 30D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	17	136
Outputs				
Ciphertext	<i>C</i>	801302FF8A7874133D414CED25B42534 D28DB0047720606B175BD52211BE68	31	188
Authentication tag	<i>T</i>	41DB204D39EE6FDB8E356855	12	96
The complete ciphered APDU		<i>TAG</i> <i>LEN</i> <i>SH</i> <i>C</i> <i>T</i> 21303001234567801302FF8A7874133D 414CED25B42534D28DB0047720606B17 5BD52211BE6841DB204D39EE6FDB8E35 6855	50	400

D.3 The AARQ APDU

In this example, the following values are used:

- Application-Context-Name: Logical_Name_Referencing_With_Ciphering;
- Calling-AP-Title (carries the System title): 4D4D4D0000BC614E;
- Mechanism-Name: COSEM_Low_Level_Security;
- Calling-Authentication-Value: 12345678

The BER encoding of the AARQ APDU is shown in Table D.3.

Table D.3 – BER encoding of the AARQ APDU

// encoding of the tag of the AARQ APDU ([APPLICATION 0], Application)	60
// encoding of the length of the AARQ's contents field (102 octets)	66
-- protocol-version field ([0], IMPLICIT BIT STRING { version 1 (0) } DEFAULT { version1 })	
// no encoding, thus it is considered with its DEFAULT value	
-- encoding of the fields of the Kernel	
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)	
// encoding of the tag ([1], Context-specific)	A1
// encoding of the length of the tagged component's value field	09
// encoding of the choice for application-context-name (OBJECT IDENTIFIER , Universal)	06
// encoding of the length of the Object Identifier's value field	07
// encoding of the value of the Object Identifier	60857405080103
-- encoding of the calling-AP-title field	
// encoding of the tag ([6], Context-specific)	A6
// encoding of the length of the tagged component's value field	0A
// encoding of the type ([4], Universal, Octetstring type)	04
// encoding of the length of the calling-AP-title-field	08
// encoding of the value	4D4D4D0000BC614E
-- encoding of the fields of the authentication functional unit	
--sender-acse-requirements field ([10], ACSE-requirements, BIT STRING { authentication (0) })	
// encoding of the tag of the acse-requirements field ([10], IMPLICIT , Context-specific)	8A
// encoding of the length of the tagged component's value field	02
// encoding of the number of unused bits in the last byte of the BIT STRING	07
// encoding of the authentication functional unit (0) The number of bits coded may vary from client to client, but within the COSEM environment, only bit 0 set to 1 (indicating the requirement of the authentication functional unit) is to be respected.	80

-- mechanism-name field ([11], IMPLICIT Mechanism-name OBJECT IDENTIFIER)	
// encoding of the tag ([11], IMPLICIT , Context-specific)	8B
// encoding of the length of the tagged component's value field	07
// encoding of the value of the OBJECT IDENTIFIER : - low-level-security-mechanism-name,	60857405080201
-- calling-authentication-value field ([12], Authentication-value CHOICE)	
// encoding of the tag ([12], EXPLICIT , Context-specific)	AC
// encoding of the length of the tagged component's value field	0A
// encoding of the choice for Authentication-value (charstring [0] IMPLICIT GraphicString)	80
// encoding of the length of the Authentication-value's value field (8 octets)	08
// encoding of the calling-authentication-value (12345678)	3132333435363738
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	34
// encoding of the choice for user-information (OCTET STRING , Universal)	04
// encoding of the length of the OCTET STRING 's value field (32 octets)	32
-- ciphered xDLMS InitiateRequest APDU	2130300123456780 1302FF8A7874133D 414CED25B42534D2 8DB0047720606B17 5BD52211BE6841DB 204D39EE6FDB8E35 6855

D.4 A-XDR encoding of the xDLMS InitiateResponse APDU

In this example:

- the value of the Conformance block is 007C1F;
- the value of the server-max-receive-pdu-size is 1 024 bytes (0x0400).

The A-XDR encoding of the xDLMS InitiateResponse APDU is shown in Table D.4.

Table D.4 – A-XDR encoding of the xDLMS InitiateResponse APDU

// encoding of the tag of the DLMS APDU CHOICE (InitiateResponse)	08
-- encoding of the negotiated-quality-of-service component ([0] IMPLICIT Integer8 OPTIONAL)	
// usage flag (FALSE , not present)	00
-- encoding of the negotiated-dlms-version-number component (Unsigned8)	
// value = 6, the A-XDR encoding of an Unsigned8 is its value	06
-- encoding of the negotiated-conformance component (Conformance, [APPLICATION 31] IMPLICIT BIT STRING (SIZE(24)))	
// encoding of the [APPLICATION 31] tag (ASN.1 explicit tag)	5F1F
// encoding of the length of the 'contents' field in octet (4)	04
// encoding of the number of unused bits in the final octet of the BIT STRING (0)	00
// encoding of the fixed length BIT STRING value	007C1F
-- encoding of the server-max-receive-pdu-size component (Unsigned16)	
// value = 0x0400, the encoding of an Unsigned16 is its value	0400
-- encoding of the VAA-Name component (ObjectName, Integer16)	
// value=0x0007; the encoding of a value constrained Integer16 is its value	0007
-- resulting octet-string, to be inserted in the user-information field of the AARE APDU	0800065F1F040000 7C1F04000007

D.5 Authenticated encryption of the xDLMS InitiateResponse APDU

Table D.5 shows the encoding of the xDLMS InitiateResponse APDU which is also authenticated and encrypted.

Table D.5 – Authenticated encryption of the xDLMS InitiateResponse APDU

	<i>X</i>	Contents	LEN(X) bytes	len(X) bits
Security material				
Security suite		GCM-AES-128		
System Title	<i>Sys-T</i>	4D4D4D0000BC614E (here, the five last octets contain the manufacturing number in hexadecimal form)	8	64
Frame Counter	<i>FC</i>	01234567	4	32
Initialization Vector	<i>IV</i>	<i>Sys-T</i> <i>FC</i> 4D4D4D0000BC614E01234567	12	96
Block cipher key (global)	<i>EK</i>	000102030405060708090A0B0C0D0E0F	16	128
Authentication Key	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Security applied		Authenticated encryption		
Security control byte (with unicast key)	<i>SC</i>	<i>SC-AE</i> 30	1	8
Security header	<i>SH</i>	<i>SH</i> = <i>SC-AE</i> <i>FC</i> 3001234567	5	40
Inputs				

	<i>X</i>	Contents	LEN(X) bytes	len(X) bits
xDLMS APDU to be protected	<i>APDU</i>	0800065F1F0400007C1F04000007	14	112
Plaintext	<i>P</i>	0800065F1F0400007C1F04000007	14	112
Associated data	<i>A</i>	SC II AK 30D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	17	136
Outputs				
Ciphertext	<i>C</i>	891214A0845E475714383F65BC19	14	112
Authentication tag	<i>T</i>	745CA235906525E4F3E1C893	12	96
The complete Ciphertext APDU		TAG II LEN II SH II C II T 281F3001234567891214A0845E475714 383F65BC19745CA235906525E4F3E1C8 93	33	264

D.6 The AARE APDU

The BER encoding of the AARE APDU is shown in Table D.6.

Table D.6 – BER encoding of the AARE APDU

-- BER encoding of the AARE APDU	
// encoding of the tag for the AARE APDU ([APPLICATION 1], Application)	61
// encoding of the length of the AARE's contents field (72 octets)	48
-- protocol-version field ([0], IMPLICIT BIT STRING { version1 (0) } DEFAULT { version1 })	
// no encoding, thus it is considered with its DEFAULT value	
-- encoding of the fields of the Kernel	
-- application-context-name field ([1], Application-context-name, OBJECT IDENTIFIER)	
// encoding of the tag ([1], Context-specific)	A1
// encoding of the length of the tagged component's value field	09
// encoding of the choice for application-context-name (OBJECT IDENTIFIER , Universal)	06
// encoding of the length of the Object Identifier's value field	07
// encoding of the value of the Object Identifier: NOTE When the proposed application-context does not fit the application-context supported by the server, the server responds either with the application-context name proposed or the application-context-name supported.	60857405080103
-- result field ([2], Association-result, INTEGER)	
// encoding of the tag ([2], Context-specific)	A2
// encoding of the length of the tagged component's value field	03
// encoding of the choice for the result (INTEGER , Universal)	02
// encoding of the length of the result's value field	01
// encoding of the value of the Result: 0, accepted	00
-- result-source-diagnostic field ([3], Associate-source-diagnostic, CHOICE)	

-- BER encoding of the AARE APDU	
// encoding of the tag ([3], Context-specific)	A3
// encoding of the length of the tagged component's value field	05
// encoding of the tag for the acse-service-user CHOICE (1)	A1
// encoding of the length of the tagged component's value field	03
// encoding of the choice for associate-source-diagnostics (INTEGER, Universal)	02
// encoding of the length of the value field	01
// encoding of the value (0, no diagnostics provided)	00
-- encoding of the responding-AP-title field	
// encoding of the tag ([4], Context-specific)	A4
// encoding of the length of the tagged component's value field	0A
// encoding of the type ([4], Universal, Octetstring type)	04
// encoding of the length of the responding-AP-title-field	08
// encoding of the value	4D4D4D0000BC614E
-- encoding of the fields of the authentication functional unit	
-- In this example the Authentication functional unit is not -- present; it is not necessary in the case of ILS, but if it -- is -- present it is also acceptable.	
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	23
// encoding of the choice for user-information (OCTET STRING, Universal)	04
// encoding of the length of the OCTET STRING's value field	21
-- ciphered xDLMS InitiateResponse APDU	281F300123456789 1214A0845E475714 383F65BC19745CA2 35906525E4F3E1C8 93

D.7 The RLRQ APDU (carrying a ciphered xDLMS InitiateRequest APDU)

The BER encoding of the RLRQ APDU is shown in Table D.7.

Table D.7 – BER encoding of the RLRQ APDU

-- BER encoding of the RLRQ APDU	
// encoding of the tag of the RLRQ APDU ([APPLICATION 2], Application)	62
// encoding of the length of the RLRQ's contents field	39
-- reason field	
// encoding of the tag ([0], IMPLICIT)	80
// encoding of the length of the tagged component's value field	01
// encoding of the value (0, normal)	00
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	34
// encoding of the choice for user-information (OCTET STRING, Universal)	04
// encoding of the length of the OCTET STRING's value field (14 octets)	32
// user-information: xDLMS InitiateRequest APDU	2130300123456780 1302FF8A7874133D 414CED25B42534D2 8DB0047720606B17 5BD52211BE6841DB 204D39EE6FDB8E35 6855

D.8 The RLRE APDU (carrying a ciphered xDLMS InitiateResponse APDU)

The BER encoding of the RLRQ APDU is shown in Table D.8.

Table D.8 – BER encoding of the RLRE APDU

-- BER encoding of the RLRE APDU	
// encoding of the tag of the RLRE APDU ([APPLICATION 3], Application)	63
// encoding of the length of the RLRE's contents field	28
-- reason field	
// encoding of the tag ([0], IMPLICIT)	80
// encoding of the length of the tagged component's value field	01
// encoding of the value (0, normal)	00
-- encoding of the user-information field component (Association-information, OCTET STRING)	
// encoding of the tag ([30], Context-specific, Constructed)	BE
// encoding of the length of the tagged component's value field	23
// encoding of the choice for user-information (OCTET STRING, Universal)	04
// encoding of the length of the OCTET STRING's value field (14 octets)	21
// user-information: xDLMS InitiateResponse APDU	281F300123456789 1214A0845E475714 383F65BC19745CA2 35906525E4F3E1C8 93

Annex E (informative)

Data transfer service examples

Table E.2 to Table E.9 show examples for data exchange using xDLMS services with LN referencing (left column) and SN referencing (right column). Table E.1 shows the objects used in the examples.

Table E.1 – Objects used in the examples

<pre>Object 1: - Class: Data - Logical name: 0000800000FF - Short name of value attribute: 0100 - Value: octet string of 50 elements - 01020304050607080910111213141516 - 17181920212223242526272829303132 - 33343536373839404142434445464748 - 4950 Object 2: - Class: Data - Logical name: 0000800100FF - Short name of value attribute: 0110 - Value: visible string of 3 elements 303030</pre>

In the case of block transfer, the negotiated APDU size is 40 bytes.

NOTE What is negotiated is the APDU size, not the block size. Therefore, the block size is smaller than the APDU size.

Table E.2 – Example: Reading the value of a single attribute without block transfer

<pre> C001C1 00010000800000FF0200 <GetRequest> <GetRequestNormal> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </GetRequestNormal> </GetRequest> </pre>	<pre> 0501 020100 <ReadRequest Qty="0001" > <VariableName Value="0100" /> </ReadRequest> </pre>
<pre> C401C1 00 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <GetResponse> <GetResponseNormal> <InvokeIdAndPriority Value="C1" /> <Result> <Data> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Data> </Result> </GetResponseNormal> </GetResponse> </pre>	<pre> 0C01 60 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <ReadResponse Qty="0001" > <Data> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Data> </ReadResponse> </pre>

Table E.3 – Example: Reading the value of a list of attributes without block transfer

<pre>C003C1 02 00010000800000FF0200 00010000800100FF0200 <GetRequestWithList> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="000800100FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </_AttributeDescriptorWithSelection> </AttributeDescriptorList> </GetRequestWithList> </GetRequest></pre>	<pre>0502 020100 020110 <ReadRequest Qty="0002" > <VariableName Value="0100" /> <VariableName Value="0110" /> </ReadRequest></pre>

C403C1	0C02
02	00
00	0932
0932	01020304050607080910111213141516
01020304050607080910111213141516	17181920212223242526272829303132
17181920212223242526272829303132	33343536373839404142434445464748
33343536373839404142434445464748	4950
4950	00
00	0A03
0A03	303030
303030	<ReadResponse Qty="0002" >
<GetResponse>	<Data>
<GetResponseWithList>	<OctetString Value="01020304050607080910111213141516
<InvokeIdAndPriority Value="C1" />	17181920212223242526272829303132
<Result Qty="0002" >	33343536373839404142434445464748
<Data>	4950" />
<OctetString Value="01020304050607080910111213141516	</Data>
17181920212223242526272829303132	<Data>
33343536373839404142434445464748	<VisibleString Value="303030" />
4950" />	</Data>
</Data>	</ReadResponse>
<Data>	
<VisibleString Value="303030" />	
</Data>	
</Result>	
</GetResponseWithList>	
</GetResponse>	

Table E.4 – Example: Reading the value of a single attribute with block transfer

C001C1 00010000800000FF0200 <GetRequest> <GetRequestNormal> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </GetRequestNormal> </GetRequest>	0501 020100 <ReadRequest Qty="0001" > <VariableName Value="0100" /> </ReadRequest>
C402C1 00 00000001 00 1E 093201020304050607080910111213 141516171819202122232425262728 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> <Result> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <Result> <RawData Value="09320102030405060708091011121314 1516171819202122232425262728" /> </Result> </Result> </GetResponseWithDataBlock> </GetResponse> // 30 bytes of raw-data contains data type, length and 28 bytes // of data. Note that Data is encoded, not Get-Data-result.	0C01 02 00 00000001 21 01000932010203040506070809101112 13141516171819202122232425262728 29 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="00" /> <BlockNumber Value="0001" /> <RawData Value="01000932010203040506070809101112 13141516171819202122232425262728 29" /> </DataBlockResult> </ReadResponse> // 33 bytes of raw-data contains number of data, success, data // type, length and 29 bytes of data. // As the raw-data contains the data encoded exactly as without // block transfer, the number of results is encoded because the // ReadResponse is a SEQUENCE OF CHOICE .

<pre> C402C1 00000001 <GetRequest> <GetRequestForNextDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </GetRequestForNextDataBlock> </GetRequest> </pre>	<pre> 0501 050001 <ReadRequest Qty="0001" > <BlockNumberAccess> <BlockNumber Value="0001" /> </BlockNumberAccess> </ReadRequest> </pre>
<pre> C402C1 01 00000002 00 16 29303132333435363738394041424344 454647484950 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> <Result> <LastBlock Value="01" /> <BlockNumber Value="00000002" /> <RawData Value="29303132333435363738394041424344 454647484950" /> </Result> </GetResponse> // APDU length 32 bytes, 22 bytes of raw-data carries the // remaining part of data requested. </pre>	<pre> 0C01 02 01 0002 15 30313233343536373839404142434445 4647484950 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="01" /> <BlockNumber Value="0002" /> <RawData Value="30313233343536373839404142434445 4647484950" /> </DataBlockResult> </ReadResponse> // APDU length 28 bytes, 21 bytes of raw-data carries the // remaining part of data requested. </pre>

Table E.5 – Example: Reading the value of a list of attributes with block transfer

<pre>C003C1 02 00010000800000FF0200 00010000800100FF0200 <GetRequestWithList> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="000800100FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <_AttributeDescriptorWithSelection> <AttributeDescriptorList> <GetRequestWithList> </GetRequest> </GetRequest> </AttributeDescriptorList> </AttributeDescriptorWithSelection> </AttributeDescriptorWithSelection> </_AttributeDescriptorWithSelection> </AttributeDescriptorList> </GetRequestWithList></pre>	<pre>0502 020100 020110 <ReadRequest Qty="0002" > <VariableName Value="0100" /> <VariableName Value="0110" /> </ReadRequest></pre>

<pre> C402C1 00 00 00000001 00 1E 02000932010203040506070809101112 1314151617181920212223242526 <GetResponse> <GetResponseWithDataBlock> <InvokeIdAndPriority Value="C1" /> </Result> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <Result> <RawData Value="02000932010203040506070809101112 1314151617181920212223242526" /> </Result> </Result> </GetResponseWithDataBlock> </GetResponse> // 30 bytes of raw-data contains the number of results and part // of the data. The first one is success, octet-string of 32 // elements; the first 26 bytes fit in. </pre>	<pre> 0C01 00 02 00 0001 21 02000932010203040506070809101112 13141516171819202122232425262728 29 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="00" /> <BlockNumber Value="0001" /> <RawData Value="02000932010203040506070809101112 13141516171819202122232425262728 29" /> </DataBlockResult> </ReadResponse> // 33 bytes of raw-data contains the number of results and part // of the data. The first one is success, octet-string of 32 // elements; the first 29 bytes fit in. </pre>
<pre> C002C1 00000001 <GetRequest> <GetRequestForNextDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </GetRequestForNextDataBlock> </GetRequest> </pre>	<pre> 0501 05 0001 <ReadRequest Qty="0001" > <BlockNumberAccess> <BlockNumber Value="0001" /> </BlockNumberAccess> </ReadRequest> </pre>

<pre>C402C1 01 00000002 00 1E 27282930313233343536373839404142 4344454647484950000A03303030 <GetResponse> <GetResponsewithDataBlock> <InvokeIdAndPriority Value="C1" /> </Result> <LastBlock Value="01" /> <BlockNumber Value="00000002" /> <Result> <RawData Value="27282930313233343536373839404142 4344454647484950000A03303030" /> </Result> </GetResponsewithDataBlock> </GetResponse> // 30 bytes of raw-data contains the remaining 24 bytes of the // first result and it also contains the six bytes of the second // result: success, visible string of 3 elements.</pre>	<pre>0C01 02 01 0002 1B 30313233343536373839404142434445 4647484950000A03303030 <ReadResponse Qty="0001" > <DataBlockResult> <LastBlock Value="01" /> <BlockNumber Value="0002" /> <RawData Value="30313233343536373839404142434445 4647484950000A03303030" /> </DataBlockResult> </ReadResponse> // The APDU is 34 bytes. It contains the second and last block. // 27 bytes of raw-data contains the remaining 21 bytes of the // first result and the six bytes of the second result: success, // visible string of 3 elements</pre>

Table E.6 – Example: Writing the value of a single attribute without block transfer

C101C1 00010000800000FF0200 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <SetRequest> <SetRequestNormal> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0008000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <Value> <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </Value> </SetRequestNormal> </SetRequest>	06 01 020100 01 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <VariableName Value="0100" /> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> </ListOfData> </WriteRequest>
C501C1 00 <SetResponse> <SetResponseNormal> <InvokeIdAndPriority Value="C1" /> <Result Value="Success" /> </SetResponseNormal> </SetResponse>	0501 00 <WriteResponse Qty="0001" > <Success /> </WriteResponse>

Table E.7 – Example: Writing the value of a list of attributes without block transfer

C104C1 02 00010000800000FF0200 00010000800100FF0200 02 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 0A03 303030	0602 020100 020110 02 0932 01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950 0A03 303030 <WriteRequest> <ListOfVariableAccessSpecification Qty="0002" > <VariableName Value="0100" /> <VariableName Value="0110" /> </ListOfVariableAccessSpecification> <ListOfData Qty="0002" > <OctetString Value="01020304050607080910111213141516 17181920212223242526272829303132 33343536373839404142434445464748 4950" /> <VisibleString Value="303030" /> </ListOfData> </WriteRequest>

C505C1 02 00 00 00	0D02 00 00 00 <WriteResponse Qty="0002" > <Success /> <Success /> </WriteResponse>

Table E.8 – Example: Writing the value of a single attribute with block transfer

C102C1 00 00 00000001 15 09320102030405060708091011121314 1516171819	0601 07 00 0001 01 091F 01020100010932010203040506070809 161112131415161718192021222324 <SetRequest> <SetRequestWithFirstDataBlock> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="000080000000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> </DataBlock> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <RawData Value="09320102030405060708091011121314 1516171819" /> </DataBlock> </SetRequestWithFirstDataBlock> </SetRequest> // 21 bytes of raw-data contain the type, length and the first 19 // bytes of data to be written.

C502C1 00000001 <SetResponse> <SetResponseForDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </SetResponseForDataBlock> </SetResponse>	0D01 02 0001 <WriteResponse Qty="0001" > <BlockNumber Value="0001" /> </WriteResponse>
C103C1 01 00000002 1F 20212223242526272829303132333435 363738394041424344454647484950 <SetRequest> <SetRequestWithDataBlock> <DataBlock> <LastBlock Value="01" /> <BlockNumber Value="00000002" /> <RawData Value="20212223242526272829303132333435 363738394041424344454647484950" /> </DataBlock> </SetRequestWithDataBlock> </SetRequest> // 31 bytes of raw-data contains the remaining 21 bytes of the // data to be written.	0601 07 01 0002 01 091A 25262728293031323334353637383940 41424344454647484950 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="01" /> <BlockNumber Value="0002" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="25262728293031323334353637383940 41424344454647484950" /> </ListOfData> </WriteRequest> // The APDU is 35 bytes. 26 bytes of octet-string contains raw- // data: the remaining 26 bytes of data to be written.
C503C10000000002 <SetResponse> <SetResponseForLastDataBlock> <InvokeIdAndPriority Value="C1" /> <Result Value="Success" /> <BlockNumber Value="00000002" /> </SetResponseForLastDataBlock> </SetResponse>	0D0100 <WriteResponse Qty="0001" > <Success /> </WriteResponse>

Table E.9 – Example: Writing the value of a list of attributes with block transfer

<pre> C105C1 02 00010000800000FF0200 00010000800100FF0200 00 00 00000001 0A 02093201020304050607 <SetRequest> <SetRequestWithListAndWithFirstDataBlock> <InvokeIdAndPriority Value="C1" /> <AttributeDescriptorList Qty="0002" > <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800000FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <_AttributeDescriptorWithSelection> <AttributeDescriptor> <ClassId Value="0001" /> <InstanceId Value="0000800100FF" /> <AttributeId Value="02" /> </AttributeDescriptor> <_AttributeDescriptorWithSelection> <AttributeDescriptorList> <DataBlock> <LastBlock Value="00" /> <BlockNumber Value="00000001" /> <RawData Value="02093201020304050607" /> </DataBlock> </SetRequestWithListAndWithFirstDataBlock> </SetRequest> // The APDU is 40 bytes. It contains the two attribute // descriptors and 10 bytes of raw-data containing the type and // length of the first data and the first 7 bytes to be written. </pre>	<pre> 0601 07 00 0001 01 091F 02020100020110020932010203040506 070809101112131415161718192021 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="00" /> <BlockNumber Value="0001" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfDataQty="0001" > <OctetString Value="02020100020110020932010203040506 070809101112131415161718192021" /> </ListOfData> </WriteRequest> // The APDU is 40 bytes. 31 bytes of octet-string contains raw- // data: the number and the name of objects to be written, the // number of data to be written and the first 21 bytes of the // first data to be written. </pre>

C502C1 00000001 <SetResponse> <SetResponseForDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000001" /> </SetResponseForDataBlock> </SetResponse>	0D01 02 0001 <WriteResponse Qty="0001" > <BlockNumber Value="0001" /> </WriteResponse>
C103C1 00 00000002 1F 08091011121314151617181920212223 242526272829303132333435363738 <SetRequest> <SetRequestWithDataBlock> <InvokeIdAndPriority Value="C1" /> <DataBlock> <LastBlock Value="00" /> <BlockNumber Value="00000002" /> <RawData Value="08091011121314151617181920212223 242526272829303132333435363738" /> </DataBlock> </SetRequestWithDataBlock> </SetRequest> // The APDU is 40 bytes. 31 bytes of raw-data contain the second // part of data to be written.	0601 07 00 0002 01 091F 22232425262728293031323334353637 383940414243444546474849500A03 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="00" /> <BlockNumber Value="0002" /> <WriteDataBlockAccess> <ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="22232425262728293031323334353637 383940414243444546474849500A03" /> </ListOfData> </ListOfData> </WriteRequest> // The APDU is 40 bytes. 31 bytes of octet-string contains raw- // data: the second 29 bytes of the first data to be written and // the data type and length of the second data to be written. The // value follows in the next block.
C502C100000002 <SetResponse> <SetResponseForDataBlock> <InvokeIdAndPriority Value="C1" /> <BlockNumber Value="00000002" /> </SetResponseForDataBlock> </SetResponse>	0D01 02 0002 <WriteResponse Qty="0001" > <BlockNumber Value="0002" /> </WriteResponse>

<pre> C103C1 01 00000003 11 3940414243444546474849500A033030 30 <SetRequest> <SetRequestWithDataBlock> <InvokeIdAndPriority Value="C1" /> <DataBlock> <LastBlock Value="01" /> <BlockNumber Value="00000003" /> <RawData Value="3940414243444546474849500A033030 30" /> </DataBlock> </SetRequestWithDataBlock> </SetRequest> // The APDU is 26 bytes. 17 bytes of raw-data contain the third // part of the first data and the second data to be written. </pre>	<pre> 0601 07 01 0003 01 0903 303030 <WriteRequest> <ListOfVariableAccessSpecification Qty="0001" > <WriteDataBlockAccess> <LastBlock Value="01" /> <BlockNumber Value="0003" /> </WriteDataBlockAccess> </ListOfVariableAccessSpecification> <ListOfData Qty="0001" > <OctetString Value="303030" /> </ListOfData> </WriteRequest> // The APDU is 12 bytes. 3 bytes of octet-string contains // raw-data: the value of the second attribute. </pre>
<pre> C504C1 02 00 00 00 00000003 <SetResponse> <SetResponseForLastDataBlockWithList> <InvokeIdAndPriority Value="C1" /> <Result Qty="0002" > <_DataAccessResult Value="Success" /> <_DataAccessResult Value="Success" /> </Result> <BlockNumber Value="00000003" /> </SetResponseForLastDataBlockWithList> </SetResponse> </pre>	<pre> 0D02 00 00 00 <WriteResponse Qty="0002" > <Success /> <Success /> </WriteResponse> </pre>

Annex F (informative)

Overview of cryptography

F.1 General

NOTE 1 Annex F is provided as a brief introduction to the cryptography tools selected. More information can be found in the documents referenced.

NOTE 2 The following text is quoted from NIST SP 800-21:2005, 3.1.

Cryptography is a branch of mathematics that is based on the transformation of data and can be used to provide several security services: confidentiality, data integrity, authentication, authorization and non-repudiation. Cryptography relies upon two basic components: an *algorithm* (or cryptographic methodology) and a *key*. The algorithm is a mathematical function, and the key is a parameter used in the transformation.

A cryptographic algorithm and a key are used to apply cryptographic protection to data (e.g., encrypt the data or generate a digital signature) and to remove or check the protection (e.g., decrypt the encrypted data or verify the digital signature). There are three basic types of approved cryptographic algorithms: cryptographic hash functions, symmetric key algorithms and asymmetric key algorithms:

- cryptographic hash functions do not require keys (although they can be used in a mode in which keys are used). A hash function is often used as a component of an algorithm to provide a security service. See Clause F.2;
- symmetric algorithms (often called secret key algorithms) use a single key to both apply the protection and to remove or check the protection. See Clause F.3;
- asymmetric algorithms (often called public key algorithms) use two keys (i.e., a key pair): a public key and a private key that are mathematically related to each other. See Clause F.4.

In order to use cryptography, cryptographic keys shall be “in place”, i.e., keys shall be established for parties using cryptography.

F.2 Hash functions

NOTE The following text is quoted from NIST SP 800-21:2005, 3.2.

A hash function produces a short representation of a longer message. A good hash function is a one-way function: it is easy to compute the hash value from a particular input; however, backing up the process from the hash value back to the input is extremely difficult. With a good hash function, it is also extremely difficult to find two specific inputs that produce the same hash value. Because of these characteristics, hash functions are often used to determine whether or not data has changed.

A hash function takes an input of arbitrary length and outputs a fixed length value. Common names for the output of a hash function include *hash value* and *message digest*. Figure F.1 depicts the use of a hash function.

A hash value (H1) is computed on data (M1). M1 and H1 are then saved or transmitted. At a later time, the correctness of the retrieved or received data is checked by labelling the received data as M2 (rather than M1) and computing a new hash value (H2) on the received value. If the newly computed hash value (H2) is equal to the retrieved or received hash value (H1), then it can be assumed that the retrieved or received data (M2) is the same as the original data (M1) (i.e. $M1 = M2$).

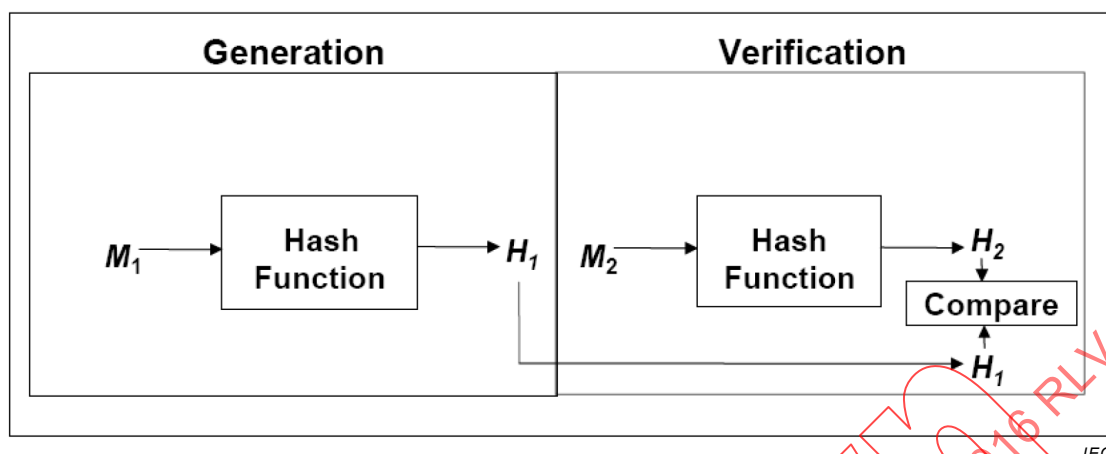


Figure F.1 – Hash function

F.3 Symmetric key algorithms

F.3.1 General

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.

Symmetric key algorithms (often called secret key algorithms) use a single key to both apply the protection and to remove or check the protection. For example, the key used to encrypt data is also used to decrypt the encrypted data. This key shall be kept secret if the data is to retain its cryptographic protection. Symmetric algorithms are used to provide confidentiality via encryption, or an assurance of authenticity or integrity via authentication, or are used during key establishment.

Keys used for one purpose shall not be used for other purposes. (See NIST SP 800-57:2006).

F.3.2 Encryption and decryption

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.1. In this context, “for Federal Government use” means “for the purposes of this standard”.

Encryption is used to provide confidentiality for data. The data to be protected is called *plaintext*. Encryption transforms the data into *ciphertext*. Ciphertext can be transformed back into plaintext using decryption. The approved algorithms for encryption and decryption algorithms are: the Advanced Encryption Standard (AES) and the Triple Data Encryption Algorithm (TDEA). TDEA is based on the Data Encryption Standard (DES), which is no longer approved for Federal Government use except as a component of TDEA. Each of these algorithms operates on blocks (chunks) of data during an encryption or decryption operation. For this reason, these algorithms are commonly referred to as block cipher algorithms.

Plaintext data can be recovered from ciphertext only by using the same key that was used to encrypt the data. Unauthorized recipients of the ciphertext who know the cryptographic algorithm but do not have the correct key should not be able to decrypt the ciphertext. However, anyone who has the key and the cryptographic algorithm can easily decrypt the ciphertext and obtain the original plaintext data.

Figure F.2 depicts the encryption and decryption processes. The plaintext (P) and a key (K) are used by the encryption process to produce the ciphertext (C). To decrypt, the ciphertext (C) and the same key (K) are used by the decryption process to recover the plaintext (P).

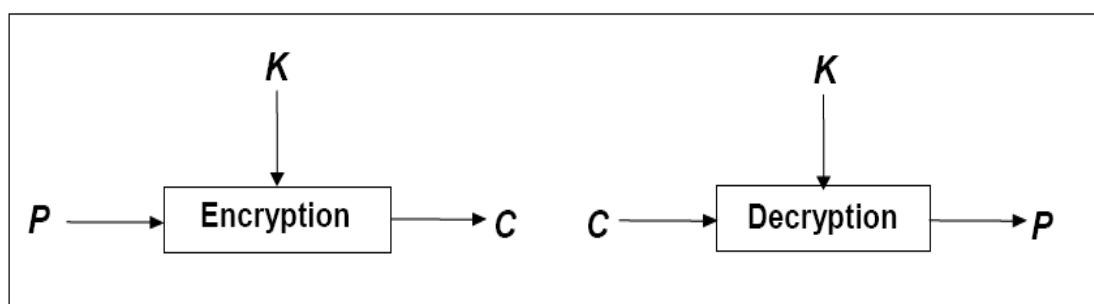


Figure F.2 – Encryption and decryption

With symmetric key block cipher algorithms, the same plaintext block and key will always produce the same ciphertext block. This property does not provide acceptable security. Therefore, cryptographic modes of operation have been defined to address this problem (see F.3.4).

F.3.3 Advanced Encryption Standard (AES)

NOTE 1 The following text is quoted from NIST SP 800-21:2005, 3.3.1.3.

The Advanced Encryption Standard (AES) was developed as a replacement for DES and is the preferred algorithm for new products. AES is specified in FIPS PUB 197. AES encrypts and decrypts data in 128-bit blocks, using 128, 192 or 256 bit keys. All three key sizes are adequate.

NOTE 2 The following text is quoted from RFC 5084.

AES offers a combination of security, performance, efficiency, ease of implementation, and flexibility. Specifically, the algorithm performs well in both hardware and software across a wide range of computing environments. Also, the very low memory requirements of the algorithm make it very well suited for restricted-space environments.

F.3.4 Encryption Modes of Operation

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.1.4.

With a symmetric key block cipher algorithm, the same plaintext block will always encrypt to the same ciphertext block when the same symmetric key is used. If the multiple blocks in a typical message (data stream) are encrypted separately, an adversary could easily substitute individual blocks, possibly without detection. Furthermore, certain kinds of data patterns in the plaintext, such as repeated blocks, would be apparent in the ciphertext.

Cryptographic modes of operation have been defined to address this problem by combining the basic cryptographic algorithm with variable initialization values (commonly known as initialization vectors) and feedback rules for the information derived from the cryptographic operation.

NIST SP 800-38D:2007 specifies the Galois/Counter Mode (GCM), an algorithm for authenticated encryption with associated data, and its specialization, GMAC, for generating a message authentication code (MAC) on data that is not encrypted. GCM and GMAC are modes of operation for an underlying approved symmetric key block cipher. See 5.4.8.

F.3.5 Message Authentication Code

F.3.5.1 General

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.2. In this context, “for Federal Government use” means “for the purposes of this standard”.

Message Authentication Codes (MACs) provide an assurance of authenticity and integrity. A MAC is a cryptographic checksum on the data that is used to provide assurance that the data has not changed or been altered and that the MAC was computed by the expected party (the sender). Typically, MACs are used between two parties that share a secret key to authenticate information exchanged between those parties.

Figure F.3 depicts the use of message authentication codes (MACs).

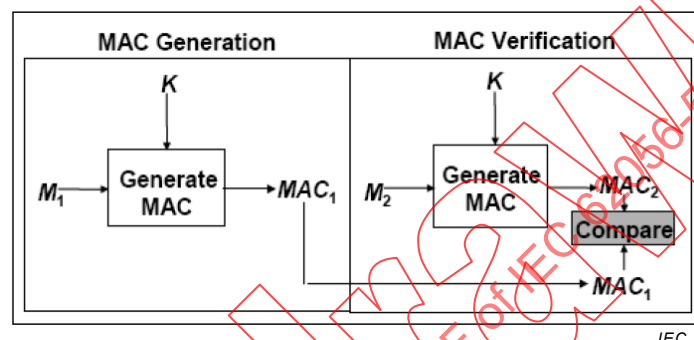


Figure F.3 – Message Authentication Codes (MACs)

A MAC (MAC1) is computed on data (M1) using a key (K). M1 and MAC1 are then saved or transmitted. At a later time, the authenticity of the retrieved or received data is checked by labelling the retrieved or received data as M2 and computing a MAC (MAC2) on it using the same key (K). If the retrieved or received MAC (MAC1) is the same as the newly computed MAC (MAC2), then it can be assumed that the retrieved or received data (M2) is the same as the original data (M1) (i.e. $M1 = M2$). The verifying party also knows who the sending party is because no one else knows the key.

Typically, MACs are used to detect data modifications that occur between the initial generation of the MAC and the verification of the received MAC. They do not detect errors that occur before the MAC is originally generated.

Message integrity is frequently provided using non-cryptographic techniques known as error detection codes. However, these codes can be altered by an adversary to the adversary's benefit. The use of an approved cryptographic mechanism, such as a MAC, addresses this problem. That is, the integrity provided by a MAC is based on the assumption that it is not possible to generate a MAC without knowing the cryptographic key. An adversary without knowledge of the key will be unable to modify data and then generate an authentic MAC on the modified data. It is therefore crucial that MAC keys be kept secret.

Two types of algorithms for computing a MAC have been approved for Federal government use: MAC algorithms that are based on block cipher algorithms, and MAC algorithms that are based on hash functions.

F.3.5.2 The Keyed-Hash Message Authentication Code (HMAC)

NOTE The following text is quoted from FIPS PUB 198.

The Keyed-Hash Message Authentication Code (HMAC) uses a cryptographic hash function in conjunction with a secret key. HMAC shall be used in combination with an approved

cryptographic hash function. HMAC uses a secret key for the calculation and verification of the MACs. For details, see FIPS PUB 198.

F.3.6 Key establishment

NOTE The following text is quoted from NIST SP 800-21:2005, 3.3.3.

Symmetric key algorithms may be used to wrap (i.e. encrypt) keying material using a key-wrapping key (also known as a key encrypting key). The wrapped keying material can then be stored or transmitted securely. Unwrapping the keying material requires the use of the same key-wrapping key that was used during the original wrapping process.

Key wrapping differs from simple encryption in that the wrapping process includes an integrity feature. During the unwrapping process, this integrity feature detects accidental or intentional modifications to the wrapped keying material.

F.4 Asymmetric key algorithms

F.4.1 General

The use of asymmetric key algorithms for DLMS/COSEM is under consideration.

NOTE 1 The following text is quoted from NIST SP 800-21:2005, 3.4.

Asymmetric algorithms (often called public key algorithms) use two keys: a public key and a private key, which are mathematically related to each other. The public key may be made public; the private key shall remain secret if the data is to retain its cryptographic protection. Even though there is a relationship between the two keys, the private key cannot be determined from the public key. Which key to be used to apply versus remove or check the protection depends on the service to be provided. For example, a digital signature is computed using a private key, and the signature is verified using the public key; for those algorithms also capable of encryption, the encryption is performed using the public key, and the decryption is performed using the private key.

NOTE 2 Not all public key algorithms are capable of multiple functions, e.g., generating digital signatures and encryption.

Asymmetric algorithms are used primarily as data integrity, authentication, and non-repudiation mechanisms (i.e., digital signatures), and for key establishment.

Some asymmetric algorithms use domain parameters, which are additional values necessary for the operation of the cryptographic algorithm. These values are mathematically related to each other. Domain parameters are usually public and are used by a community of users for a substantial period of time.

The secure use of asymmetric algorithms requires that users obtain certain assurances:

- assurance of domain parameter validity provides confidence that the domain parameters are mathematically correct;
- assurance of public key validity provides confidence that the public key appears to be a suitable key; and
- assurance of private key possession provides confidence that the party that is supposedly the owner of the private key really has the key.

Some asymmetric algorithms may be used for multiple purposes (e.g., for both digital signatures and key establishment). Keys used for one purpose shall not be used for other purposes.

F.4.2 Digital signatures

NOTE The following text is quoted from NIST SP 800-21:2005, 3.4.1.

A digital signature is an electronic analogue of a written signature that can be used in proving to the recipient or a third party that the message was signed by the originator (a property known as non-repudiation). Digital signatures may also be generated for stored data and programs so that the integrity of the data and programs may be verified at a later time.

Digital signatures authenticate the integrity of the signed data and the identity of the signatory. A digital signature is represented in a computer as a string of bits and is computed using a digital signature algorithm that provides the capability to generate and verify signatures. Signature generation uses a private key to generate a digital signature. Signature verification uses the public key that corresponds to, but is not the same as, the private key to verify the signature. Each signatory possesses a private and public key pair. Signature generation can be performed only by the possessor of the signatory's private key. However, anyone can verify the signature by employing the signatory's public key. The security of a digital signature system is dependent on maintaining the secrecy of a signatory's private key. Therefore, users shall guard against the unauthorized acquisition of their private keys.

F.4.3 Key establishment

NOTE 1 The following text is quoted from NIST SP 800-21:2005, 3.4.2.

Two types of asymmetric key (i.e., public key) establishment are defined: *key transport* and *key agreement*. Approved key establishment schemes are specified in NIST SP 800-56, *Recommendation on Key Establishment Schemes*.

Key transport is the distribution of a key (and other keying material) from one party to another party. The transported key is created by the sending party. The keying material is encrypted by the sending party and decrypted by the receiving party. The sending party encrypts the keying material using the receiving party's public key; the receiving party decrypts the received keying material using the associated private key.

Key agreement is the participation by both parties (i.e., the sending and receiving parties) in the creation of shared keying material. Each party has either one or two key pairs, and the public keys are made known to the other party. The key pairs are used to compute a shared secret value, which is then used with other information to derive keying material using a key derivation function. Typically, a hash function (see Clause F.2) is used during the key derivation process.

NOTE 2 A key pair consists of a private key and its associated public key.

NOTE 3 The shared secret is never transmitted from one party to the other.

Annex G

(informative)

Significant technical changes with respect to IEC 62056-5-3 Ed.1.0:2013

This part of IEC 62056 series includes the following significant technical changes with respect to IEC 62056-5-3 Ed.1.0:2013:

- an Introduction explaining the relationship to the DLMS UA Green Book Editions has been added;
- subclause 4.2.3.1: the DataNotification service has been added;
- subclause 4.2.3.6: the DataNotification service has been added;
- subclause 4.2.3.7: the Long-Invoke-Id parameter has been added;
- subclause 4.2.3.12 has been re-formulated to introduce the general block transfer (GBT) mechanism;
- subclause 4.2.3.13 describes the GBT mechanism;
- subclause 4.2.5, Figure 2 showing the summary of DLMS/COSEM AL services has been amended and includes now the DataNotification service;
- subclause 5.3: the specification of the authentication mechanisms and Figure 3 have been amended;
- subclause 5.4.1 Applying, removing or checking the protection: ciphering and deciphering has been amended;
- subclause 5.4.6: the specification of the ciphered xDLMS APDUs has been amended. The new general global ciphering and dedicated ciphering APDUs have been added;
- subclause 5.4.8.3.2.3 Figure 6 – Cryptographic protection of xDLMS APDUs using GCM has been amended;
- subclause 5.4.8.3.3 specifies now the security header with GCM;
- subclause 5.4.8.4: the specification of the High Level Security authentication with GMAC (authentication_mechanism_id(5) has been amended (editorial changes only);
- subclause 6.2: the specification of the COSEM-OPEN service has been amended: the AARQ APDU may carry now the identifier of the client-side user;
- subclause 6.2, Table 11: and in the text that follows, the missing Response_Allowed field has been added;
- subclause 6.2: a Note 2 has been added on the User_Information parameter;
- subclause 6.5: the specification of the additional service parameter has been amended;
- subclause 6.6 the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 6.7: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 6.8: a clarification on the Method_Invocation_Parameter has been added and the alternative of using the service specific or the general block transfer mechanism have been added;
- subclause 6.9 specifies the DataNotification service;
- subclause 6.10: the possibility of using the general block transfer mechanism has been added;
- subclause 6.13: the alternatives of using the service specific or the general block transfer mechanism has been added;
- subclause 6.14: the alternative of using the service specific or the general block transfer mechanism has been added;

- subclause 6.15: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 6.18: the DataNotification service has been added to the summary of xDLMS services;
- subclause 7.1.1, Figure 10: the DataNotification service has been added;
- subclause 7.1.2, Figure 11: the DataNotification service has been added;
- subclause 7.2.3.2 Encoding of the xDLMS APDUs has been added;
- subclause 7.2.4.1 Protocol for the establishment of confirmed application associations has been amended to specify the use of Calling_AE_Invocation_Identifier. The missing description of the fields of the AARE authentication functional unit has been added;
- subclause 7.3.1: new elements have been added to the conformance block: general-protection, general-block-transfer, data-notification;
- subclause 7.3.3: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.4: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.5: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.6 specifies the protocol of the DataNotification service;
- subclause 7.3.8: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.9: the alternative of using the service specific or the general block transfer mechanism has been added;
- subclause 7.3.10: the possibility of using the general block transfer mechanism has been added;
- subclause 7.3.12 specifies the protocol of general block transfer mechanism;
- Clause 8 Abstract syntax of ACSE and COSEM APDUs of ACSE and COSEM APDUs has been amended to include the new APDUs and types;
- Clauses A.8, A.9 and A.10 reference other parts of the IEC 62056 series specifying media specific communication profiles;
- Annex B specifies the SMS short wrapper.

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Index

- AA, confirmed, 17
- AA, pre-established, 17
- AA, unconfirmed, 17
- A-ASSOCIATE service, 16, 45
- Abstract syntax, 23
- Abstract syntax, COSEM APDUs, 127, 190
- Access right, 24
- Access_Selection_Parameters, 58, 61
- ACSE functional units, 82
- ACSE procedures, 23
- ACSE protocol version, 47, 91
- ACSE requirements, 84
- ACSE services and APDUs, 82
- ACTION service, 19, 62, 104
- ACTION.confirm, 66
- ACTION.indication, 66
- ACTION.request, 65
- ACTION.response, 66
- Action-Request, 65
- ACTION-REQUEST-FIRST-BLOCK, 64, 104, 108, 112
- ACTION-REQUEST-LAST-BLOCK, 64, 104, 108, 112
- ACTION-REQUEST-NEXT, 64, 104, 107
- Action-Request-Next-Pblock, 104
- Action-Request-Normal, 104
- ACTION-REQUEST-NORMAL, 64, 104, 107, 112, 115
- ACTION-REQUEST-ONE-BLOCK, 64, 104, 108, 112
- Action-Request-With-First-Pblock, 104
- Action-Request-With-List, 104
- ACTION-REQUEST-WITH-LIST, 64, 104, 108, 112, 115
- ACTION-REQUEST-WITH-LIST-AND-FIRST-BLOCK, 64, 104, 108, 113
- Action-Request-With-List-And-With-Frist-Pblock, 104
- Action-Request-With-Pblock, 104
- Action-Response, 66
- ACTION-RESPONSE-LAST-BLOCK, 64, 104, 108
- ACTION-RESPONSE-NEXT, 64, 104, 108, 113
- Action-Response-Next-Pblock, 104
- Action-Response-Normal, 104
- ACTION-RESPONSE-NORMAL, 64, 104, 108, 113
- ACTION-RESPONSE-ONE-BLOCK, 64, 104
- ACTION-RESPONSE-ONE-ONE-BLOCK, 108
- Action-Response-With-List, 104
- ACTION-RESPONSE-WITH-LIST, 64, 104, 109, 113
- Action-Response-With-Pblock, 104
- Additional authenticated data, 36, 37, 38
- Additional data, 34
- Advanced Encryption Standard, 34, 184, 185
- AES-128 key wrap algorithm, 29, 33
- AL services, AA establishment and release, 16
- AL services, client/server type, 18
- AL services, data transfer, 17
- AL, management services, 78
- Application association, 15, 50
- Application association, confirmed, 87
- Application association, establishment, 87
- Application association, graceful release, 92
- Application association, non-graceful release, 95
- Application association, pre-established, 91
- Application association, release, 92
- Application association, unconfirmed, 91
- Application context, 24
- Application context name, 16, 47, 84, 85, 89
- Application Control Service Element, 15
- Application Programming Interface, 19
- Application Addresses parameter, 67
- A-RELEASE, 50
- A-RELEASE service, 17
- ASN.1, 85
- Association LN, 24
- Association SN, 24
- Attribute_0 referencing, 21
- Authenticated decryption, 36, 37
- Authenticated encryption, 34, 36
- Authentication, 23, 28, 183, 187
- Authentication key, 29, 35, 36, 38, 39, 41
- Authentication mechanism, 24
- Authentication mechanism name, 16, 86
- Authentication tag, 35, 36, 37, 38
- Authentication value, 84
- authentication_mechanism_id(5), 41
- Authenticity, 184
- Authorization, 183
- A-XDR encoding, 16
- BER encoding, 16
- Bi-directional block transfer, 22
- Block cipher, 35
- Block cipher algorithm, 184
- Block cipher key, 29, 36, 38
- Block_Number, 59, 62, 65, 72, 75, 99, 103
- Block_Number_Access, 69, 71, 72
- Broadcast, 32, 40
- Calling authentication value, 25, 26, 48
- Central DCS, 32
- Challenge, 26
- Ciphered APDUs, 24
- Ciphered xDLMS APDU, 29
- Ciphertext, 31, 35, 36, 37, 184
- Client side layer management services, 78
- Client SN_MAPPER, 19

- Client system title, 89
- Client_Max_Receive_PDU_Size, 48
- client_system_title, 40
- client-max-receive-pdu-size, 89
- Communication environment, 142
- Communication profile, 11
- Communication profile specific parameters, 143
- Communication profile structure, 142
- Concentrator, 32
- Confidentiality, 23, 32, 183, 184
- ConfirmedServiceError, 28, 72, 75, 97
- Conformance block, 19, 95
- Control function, 15, 79
- COSEM AL, ASO services, 16
- COSEM AL, layer management services, 22
- COSEM AL, protocol specification, 23
- COSEM AL, service specification, 43
- COSEM AL, services, 16
- COSEM application context, 19
- COSEM application context name, 85
- COSEM application layer, protocol specification, 79
- COSEM client/server type services, 19
- COSEM interface object, 16, 18
- COSEM_Application_Context_Name, 85
- COSEM_Attribute_Descriptor, 58, 61
- COSEM_Authentication_Mechanism_Name, 86
- COSEM_Class_Id, 58, 61, 64
- COSEM_Method_Descriptor, 64
- COSEM_Method_Id, 64
- COSEM_Object_Attribute_Id, 58, 61
- COSEM_Object_Instance_Id, 58, 61, 64
- COSEM-ABORT service, 17, 52
- COSEM-OPEN service, 16, 25, 45
- COSEM-OPEN service invocations, repeated, 91
- COSEM-RELEASE service, 17, 50
- Counter mode, 34
- Cryptographic keys, 31
- Cryptography, 183
- Data access security, 24
- Data integrity, 183, 187
- Data transfer services, protocol, 95
- Data transport security, 24
- Data_Access_Error, 72, 75
- Data_Access_Result, 62
- DataBlock_G, 59, 99, 100
- DataBlock_SA, 103
- DataNotification service, 66
- Decryption, 184
- Dedicated key, 32, 33, 48
- Definitions, 13
- Denial-of-service attack, 51
- Deterministic construction, 39
- Digital signature, 187, 188
- DLMS conformance, 48
- DLMS version number, 48
- Eavesdropping, 25
- Encryption, 29, 184
- Event notification, 20
- EventNotification service, 20, 67
- ExceptionResponse, 28, 97
- Failure_type, 47
- Fixed field, 39
- Forward cipher function, 36
- Galois/Counter Mode, 29, 34, 185
- General block transfer mechanism, 21
- GET service, 19, 57, 98
- GET.confirm, 59
- GET.indication, 59
- GET.request, 59
- GET.response, 59
- Get_Data_Result, 58
- Get-Request, 59
- Get-Request-Next, 98
- GET-REQUEST-NEXT, 58, 98, 100, 107
- Get-Request-Normal, 98
- GET-REQUEST-NORMAL, 58, 98, 107
- Get-Request-With-List, 98
- GET-REQUEST-WITH-LIST, 58, 98, 107
- Get-Response, 59
- GET-RESPONSE-LAST-BLOCK, 58, 98, 107
- Get-Response-Normal, 98
- GET-RESPONSE-NORMAL, 58, 98, 107
- GET-RESPONSE-ONE-BLOCK, 58, 98, 99, 107
- Get-Response-With-Datablock, 98
- Get-Response-With-List, 98
- GET-RESPONSE-WITH-LIST, 58, 98, 107
- Global key, 32, 33
- Global unicast encryption key, 41
- global_key_transfer, 33
- Hash value, 183
- High level security, 25, 41
- HLS secret, 41
- Identification and addressing scheme, 142
- Identifying service invocations, 20
- Implementation information, 48, 84
- InformationReport service, 20, 77, 115
- InformationReport.request, 116
- InformationReportRequest, 116
- Initialization vector, 29, 35, 36, 37, 39, 185
- Integrity, 24, 184
- Intrinsic security, 25
- Invocation field, 35, 39, 40
- Invoke_Id, 58, 60, 63, 100, 103, 105
- Invoke_Id parameter, 20
- Key agreement, 188
- Key encrypting keys, 32
- Key establishment, 187, 188
- Key management, 32
- Key transport, 188
- Key wrapping key, 32, 187
- Keyed-Hash Message Authentication Code, 186
- Last_Block, 59, 62, 65, 72, 75, 99, 103
- LN referencing, 18
- LN/SN data transfer service mapping, 79
- Local_or_Remote, 47, 51
- Logical Name, 16

Long service parameters, 21
 Lost block recovery, 22
 Low level security, 25
 Lowest level security, 25
 Manufacturer ID, 39
 Manufacturing number, 39
 Master key, 32
 Mechanism name, 84
 Message Authentication Code, 186
 Message digest, 183
 Message integrity, 32, 186
 Message replay, 25
 Message source, 32
 Mode of Operation, 185
 Multiple references, 21
 Nonce, 35, 36
 Non-repudiation, 183, 187
 Parameterized_Access, 69, 71, 74, 75, 77
 Plaintext, 31, 35, 36, 37, 38, 184
 Pre-established application association, 49
 Presentation layer, 16
 Priority, 58, 60, 63, 100, 103, 105
 Priority parameter, 20
 Private key, 31, 187
 proposed-conformance, 89
 proposed-dlms-version-number, 89
 Protocol connection parameters, 47
 Protocol version, 84
 Public key, 31, 187
 Raw_Data, 59, 62, 65, 72, 103
 Read service, 19, 69, 106
 Read.confirm, 73
 Read.indication, 73
 Read.request, 73
 Read.response, 73
 Read_Data_Block_Access, 69, 71
 ReadRequest, 73, 107
 ReadResponse, 72, 73, 107, 108
 Reason, 85
 Referencing method, 16
 Registered COSEM names, 85
 Request_Type, 58, 60, 63
 Responding-AP-title, 90
 Response_Type, 58, 60
 response-allowed, 87, 89, 91
 Result, 47, 84, 99
 Result (-), 72, 75
 Result (+), 72, 75
 Result Source-Diagnostic, 84
 RLRE APDU, 50
 RLRQ APDU, 50
 Secret, 25
 Secret key, 26
 Security attributes, 28
 Security context, 28
 Security control, 38
 Security header, 38
 Security mechanism name, 26, 48
 Security policy, 28
 Security setup, 33
 Security suite, 29
 Selective access, 20
 Sender ACSE requirements, 89
 Server system title, 90
 Server_Max_Receive_PDU_Size, 49
 server_system_title, 40
 Service_Class, 58, 60, 63
 Service_Class == Unconfirmed, 50
 Service_Class parameter, 49
 SET service, 19, 59, 101
 SET.confirm, 62
 SET.indication, 62
 SET.request, 62
 SET.response, 62
 SetMapperTables.request, 78
 Set-Request, 62
 SET-REQUEST-FIRST-BLOCK, 61, 101, 111
 SET-REQUEST-FIRST-BLOCK-WITH-LIST, 61, 101, 111
 SET-REQUEST-LAST-BLOCK, 61, 101, 111
 Set-Request-Normal, 101
 SET-REQUEST-NORMAL, 61, 101, 111, 115
 SET-REQUEST-ONE-BLOCK, 61, 101, 111
 Set-Request-With-Datablock, 101
 SET-REQUEST-WITH-FIRST-BLOCK, 61
 Set-Request-With-First-Datablock, 101
 Set-Request-With-List, 101
 SET-REQUEST-WITH-LIST, 61, 101, 111, 115
 Set-Request-With-List-And-With-First-Datablock, 101
 Set-Response, 62
 SET-RESPONSE-ACK-BLOCK, 61, 101, 111
 Set-Response-Datablock, 101
 SET-RESPONSE-LAST-BLOCK, 61, 101, 112
 SET-RESPONSE-LAST-BLOCK-WITH-LIST, 61, 101, 112
 Set-Response-Last-Datablock, 101
 Set-Response-Normal, 101
 SET-RESPONSE-NORMAL, 61, 101, 111
 Set-Response-With-List, 101
 SET-RESPONSE-WITH-LIST, 61, 101, 112
 S-FSK PLC environment, 40
 SHA-1 algorithm, 26
 Short Name, 16
 SN referencing, 18
 SN_MAPPER ASE, 73, 76, 77
 Streaming, 22
 Supporting layer services and service mapping, 143
 Symmetric key, 31
 Symmetric key algorithm, 184
 Symmetric key block cipher, 34
 System title, 39
 TriggerEventNotificationSending service, 68
 UnconfirmedWrite service, 19, 76, 114

UnconfirmedWrite.indication, 77	Write.indication, 76
UnconfirmedWrite.request, 77	Write.request, 76
UnconfirmedWriteRequest, 77	Write.response, 76
Unicast, 32	Write_Data_Block_Access, 69, 74
Uni-directional block transfer, 22	WriteRequest, 76, 111
User information, 49, 85	WriteResponse, 75, 76, 111
Variable Access Specification, 69	xDLMS context, 17
Variable_Access_Specification, 71	xDLMS InitiateRequest, 33
Variable_Name, 69, 71, 74, 75, 77	xDLMS InitiateResponse, 33
Variable-Access-Specification, 70, 74, 77	xDLMS procedures, 23
Write service, 19, 73, 110	xDLMS_ASE, 15
Write.confirm, 76	

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SOMMAIRE

AVANT-PROPOS.....	204
INTRODUCTION.....	206
1 Domaine d'application	207
2 Références normatives	207
3 Termes, définitions et abréviations.....	209
3.1 Termes et définitions.....	209
3.2 Abréviations.....	209
4 Vue d'ensemble.....	211
4.1 Structure de la couche application DLMS/COSEM.....	211
4.2 Services de la couche application DLMS/COSEM	213
4.2.1 Services ASO	213
4.2.2 Services fournis pour l'établissement et la libération d'associations d'applications.....	213
4.2.3 Services fournis pour le transfert de données.....	214
4.2.4 Services de gestion de couche	219
4.2.5 Récapitulatif des services de la couche application DLMS/COSEM	219
4.3 Protocoles de la couche application DLMS/COSEM	220
5 Sécurité des informations dans DLMS/COSEM.....	221
5.1 Définitions.....	221
5.2 Généralités	221
5.3 Sécurité de l'accès aux données.....	222
5.3.1 Vue d'ensemble	222
5.3.2 Authentification sans sécurité (niveau de sécurité le plus faible)	222
5.3.3 Authentification de niveau de sécurité faible (LLS).....	222
5.3.4 Authentification de niveau de sécurité élevé (HLS)	223
5.4 Sécurité de transport des données	226
5.4.1 Application, suppression ou vérification de la protection: chiffrement et déchiffrement.....	226
5.4.2 Contexte de sécurité	227
5.4.3 Politique de sécurité.....	227
5.4.4 Suite de sécurité.....	228
5.4.5 Matériel de sécurité.....	228
5.4.6 APDU xDLMS chiffrées	228
5.4.7 Clés cryptographiques.....	231
5.4.8 Mode de fonctionnement Galois/Counter (GCM)	235
6 Spécification de service de la couche application DLMS/COSEM.....	244
6.1 Primitives de service et paramètres	244
6.2 Service COSEM-OPEN	247
6.3 Service COSEM-RELEASE.....	252
6.4 Service COSEM-ABORT	255
6.5 Paramètres de protection et de transfert général de blocs.....	255
6.6 Service GET	260
6.7 Service SET.....	263
6.8 Service ACTION.....	266
6.9 Service DataNotification	269
6.10 Service EventNotification.....	270

6.11	Service TriggerEventNotificationSending	272
6.12	Spécification d'accès variable.....	272
6.13	Service Read	273
6.14	Service Write	277
6.15	Service UnconfirmedWrite	280
6.16	Service InformationReport.....	282
6.17	Services de gestion de couches côté client: Demande SetMapperTable.request	283
6.18	Récapitulatif des services et de la mise en correspondance de services de transfert de données LN/SN	283
7	Spécification du protocole de couche application DLMS/COSEM	284
7.1	Fonction de commande	284
7.1.1	Définitions des états de la fonction de commande côté client	284
7.1.2	Définitions des états de la fonction de commande côté serveur	286
7.2	Services ACSE et APDU	287
7.2.1	Unités fonctionnelles ACSE, services et paramètres de service	287
7.2.2	Noms COSEM enregistrés.....	290
7.2.3	Règles de codage d'APDU	292
7.2.4	Protocole d'établissement d'association d'applications	292
7.2.5	Protocole de libération d'association d'applications.....	298
7.3	Protocole des services de transfert de données	303
7.3.1	Négociation de services et d'options – Bloc de conformité.....	303
7.3.2	Appels de service confirmés et non confirmés.....	304
7.3.3	Protocole du service GET	305
7.3.4	Protocole du service SET	310
7.3.5	Protocole du service ACTION.....	314
7.3.6	Protocole du service DataNotification	317
7.3.7	Protocole du service EventNotification	317
7.3.8	Protocole du service Read	317
7.3.9	Protocole du service Write.....	322
7.3.10	Protocole du service UnconfirmedWrite	326
7.3.11	Protocole du service InformationReport	328
7.3.12	Protocole du mécanisme de transfert général de blocs.....	329
8	Syntaxe abstraite des APDU ACSE et COSEM.....	345
Annexe A (normative) Utilisation de la couche application COSEM dans différents profils de communication		360
A.1	Généralités	360
A.2	Environnements de communication ciblés	360
A.3	Structure du profil	360
A.4	Schéma d'identification et d'adressage	360
A.5	Services de couche de support et mise en correspondance de services	361
A.6	Paramètres spécifiques au profil de communication des services d'AL COSEM	361
A.7	Considérations / contraintes spécifiques à l'utilisation de certains services dans un profil donné.....	361
A.8	Profil de communication à 3 couches, orienté connexion et basé sur HDLC	361
A.9	Profils de communication basés sur TCP-UDP/IP (COSEM_on_IP)	361
A.10	Profil S-FSK PLC	361
Annexe B (normative) Emballage réduit pour SMS.....		362

Annexe C (informative) Exemples de codage AARQ et AARE	363
C.1 Généralités	363
C.2 Codage des APDU xDLMS InitiateRequest / InitiateResponse	363
C.3 Spécification des APDU AARQ et AARE	366
C.4 Données pour les exemples	367
C.5 Codage de l'APDU AARQ	368
C.6 Codage de l'APDU AARE	371
Annexe D (informative) Exemples de codage: APDU AARQ et AARE utilisant un contexte d'application chiffré	377
D.1 Codage A-XDR de l'APDU xDLMS InitiateRequest contenant une clé dédiée	377
D.2 Chiffrement authentifié de l'APDU xDLMS InitiateRequest	378
D.3 APDU AARQ	379
D.4 Codage A-XDR de l'APDU xDLMS InitiateResponse	380
D.5 Chiffrement authentifié de l'APDU xDLMS InitiateResponse	381
D.6 APDU AARQ	382
D.7 APDU RLRQ (contenant une APDU xDLMS InitiateRequest chiffrée)	383
D.8 APDU RLRE (contenant une APDU xDLMS InitiateResponse chiffrée)	384
Annexe E (informative) Exemples de services de transfert de données	385
Annexe F (informative) Présentation de la cryptographie	401
F.1 Généralités	401
F.2 Fonctions de hachage	401
F.3 Algorithmes de clé symétrique	402
F.3.1 Généralités	402
F.3.2 Chiffrement et déchiffrement	402
F.3.3 Advanced Encryption Standard (AES)	403
F.3.4 Mode de fonctionnement du chiffrement	404
F.3.5 Code d'authentification de message	404
F.3.6 Établissement de la clé	405
F.4 Algorithmes de clé asymétrique	405
F.4.1 Généralités	405
F.4.2 Signatures numériques	406
F.4.3 Établissement de la clé	407
Annexe G (informative) Modifications techniques majeures par rapport à l'IEC 62056- 5-3 Éd. 1.0:2013	408
Bibliographie	410
Index	413
Figure 1 – Structure des couches application COSEM	212
Figure 2 – Récapitulatif des services de l'AL DLMS/COSEM	220
Figure 3 – Mécanismes d'authentification pendant l'établissement de l'AA	226
Figure 4 – Structure d'APDU de chiffrement global et de chiffrement dédié spécifiques au service	229
Figure 5 – Structure d'APDU de chiffrement général global et de chiffrement général dédié	230
Figure 6 – Protection cryptographique des APDU xDLMS à l'aide de GCM	239
Figure 7 – Primitives de service	245
Figure 8 – Diagrammes de séquences temporelles	246

Figure 9 – Paramètres supplémentaires de service pour contrôler la protection cryptographique et le transfert général de blocs	257
Figure 10 – Diagramme d'états partiel pour la fonction de commande côté client.....	285
Figure 11 – Diagramme d'états partiel pour la fonction de commande côté serveur	286
Figure 12 – MSC pour l'établissement réussi d'une AA précédé de l'établissement réussi d'une connexion de couche inférieure de support	294
Figure 13 – Libération d'AA sans perte de données à l'aide du service A-RELEASE	299
Figure 14 – Libération d'AA sans perte de données par déconnexion de la couche de support.....	301
Figure 15 – Abandon d'une AA suite à la primitive PH-ABORT.indication	303
Figure 16 – MSC du service GET	306
Figure 17 – MSC du service GET avec transfert de bloc	307
Figure 18 – MSC du service GET avec transfert de bloc, GET long abandonné	310
Figure 19 – MSC du service SET	311
Figure 20 – MSC du service SET avec transfert de bloc.....	312
Figure 21 – MSC du service ACTION	315
Figure 22 – MSC du service ACTION avec transfert de bloc.....	316
Figure 23 – MSC du service Read utilisé pour lire un attribut.....	320
Figure 24 – MSC du service Read utilisé pour appeler une méthode	320
Figure 25 – MSC du service Read utilisé pour lire un attribut, avec transfert de blocs.....	321
Figure 26 – MSC du service Write utilisé pour écrire un attribut	325
Figure 27 – MSC du service Write utilisé pour appeler une méthode	325
Figure 28 – MSC du service Write utilisé pour écrire un attribut, avec transfert de blocs.....	326
Figure 29 – MSC du service Unconfirmed Write utilisé pour écrire un attribut	328
Figure 30 – Appels de service partiels et APDU GBT.....	331
Figure 31 – Service GET avec GBT, passage à la diffusion en flux	333
Figure 32 – Service GET avec appels partiels, GBT et diffusion en flux, récupération du 4 ^{ème} bloc envoyé dans le deuxième flux.....	335
Figure 33 – Service GET avec appels partiels, GBT et diffusion en flux, récupération des 4 ^{ème} et 5 ^{ème} blocs	337
Figure 34 – Service GET avec appels partiels, GBT et diffusion en flux, récupération du dernier bloc.....	339
Figure 35 – Service SET avec GBT, avec serveur ne prenant pas en charge la diffusion en flux, récupération du 3 ^{ème} bloc.....	340
Figure 36 – Service ACTION-WITH-LIST avec GBT bidirectionnel et récupération de blocs	342
Figure 37 – Service DataNotification avec GBT, avec appel partiel	344
Figure B.1 – Emballage réduit.....	362
Figure F.1 – Fonction de hachage	402
Figure F.2 – Chiffrement et déchiffrement.....	403
Figure F.3 – Codes d'authentification de message (MAC)	404
Tableau 1 – Explication de la signification des paramètres PDU Size pour DLMS/COSEM.....	215
Tableau 2 – Suites de sécurité	228
Tableau 3 – APDU xDLMS chiffrées	228

Tableau 4 – Utilisation des champs des APDU chiffrées	231
Tableau 5 – Clés cryptographiques et leur gestion.....	234
Tableau 6 – Octet de contrôle de sécurité	239
Tableau 7 – Texte brut et AAD	240
Tableau 8 – Exemple d'APDU chiffrées	242
Tableau 9 – Exemple HLS avec GMAC.....	244
Tableau 10 – Codes des paramètres de service de l'AL	247
Tableau 11 – Paramètres de service des primitives de service COSEM-OPEN	248
Tableau 12 – Paramètres de service des primitives de service COSEM-RELEASE	252
Tableau 13 – Paramètres de service des primitives de service COSEM-ABORT	255
Tableau 14 – Paramètres supplémentaires de service	257
Tableau 15 – Paramètres de sécurité	259
Tableau 16 – Paramètres de service du service GET	260
Tableau 17 – Types de demandes et de réponses du service GET	261
Tableau 18 – Paramètres du service SET	263
Tableau 19 – Types de demandes et de réponses du service SET	264
Tableau 20 – Paramètres du service ACTION	266
Tableau 21 – Types de demandes et de réponses du service ACTION	267
Tableau 22 – Paramètres de service des primitives de service DataNotification	270
Tableau 23 – Paramètres de service des primitives du service EventNotification	271
Tableau 24 – Paramètres de service de la primitive de service TriggerEventNotificationSending.request	272
Tableau 25 – Spécification d'accès variable	273
Tableau 26 – Paramètres du service Read	274
Tableau 27 – Utilisation des variantes du paramètre Variable_Access_Specification et des choix de Read.response	275
Tableau 28 – Paramètres du service Write	278
Tableau 29 – Utilisation des variantes de Variable_Access_Specification et des choix de Write.response.....	279
Tableau 30 – Paramètres du service UnconfirmedWrite	281
Tableau 31 – Utilisation des variantes de Variable_Access_Specification.....	281
Tableau 32 – Paramètres du service InformationReport	282
Tableau 33 – Paramètres de service des primitives de service SetMapperTable.request	283
Tableau 34 – Récapitulatif des services ACSE	283
Tableau 35 – Récapitulatif des services xDLMS pour le référencement LN.....	284
Tableau 36 – Récapitulatif des services xDLMS pour le référencement SN	284
Tableau 37 – Unités fonctionnelles ACSE, services et paramètres de service	288
Tableau 38 – Utilisation des APDU chiffrées et non chiffrées	291
Tableau 39 – Bloc de conformité xDLMS	304
Tableau 40 – Types et APDU de service GET.....	306
Tableau 41 – Types et APDU de service SET	311
Tableau 42 – Types et APDU de service ACTION	314
Tableau 43 – Mise en correspondance du service GET et du service Read	318
Tableau 44 – Mise en correspondance du service ACTION et du service Read	318

Tableau 45 – Mise en correspondance du service SET et du service Write.....	322
Tableau 46 – Mise en correspondance du service ACTION et du service Write.....	323
Tableau 47 – Mise en correspondance du service SET et du service UnconfirmedWrite	327
Tableau 48 – Mise en correspondance du service ACTION et du service UnconfirmedWrite	327
Tableau 49 – Mise en correspondance des services EventNotification et InformationReport.....	329
Tableau B.1 – Processus d'application réservés	362
Tableau C.1 – Bloc de conformité.....	364
Tableau C.2 – Codage A-XDR de l'APDU xDLMS InitiateRequest	365
Tableau C.3 – Codage A-XDR de l'APDU xDLMS InitiateResponse.....	366
Tableau C.4 – Codage BER de l'APDU AARQ	369
Tableau C.5 – APDU AARQ complète	371
Tableau C.6 – Codage BER de l'APDU AARE.....	372
Tableau C.7 – APDU AARE complète.....	376
Tableau D.1 – Codage A-XDR de l'APDU xDLMS InitiateRequest.....	377
Tableau D.2 – Chiffrement authentifié de l'APDU xDLMS InitiateRequest.....	378
Tableau D.3 – Codage BER de l'APDU AARQ	379
Tableau D.4 – Codage A-XDR de l'APDU xDLMS InitiateResponse.....	381
Tableau D.5 – Chiffrement authentifié de l'APDU xDLMS InitiateResponse	381
Tableau D.6 – Codage BER de l'APDU AARE.....	382
Tableau D.7 – Codage BER de l'APDU RLRO.....	384
Tableau D.8 – Codage BER de l'APDU RLRE.....	384
Tableau E.1 – Objets utilisés dans les exemples	385
Tableau E.2 – Exemple: Lecture de la valeur d'un attribut unique sans transfert de bloc.....	386
Tableau E.3 – Exemple: Lecture de la valeur d'une liste d'attributs sans transfert de bloc	387
Tableau E.4 – Exemple: Lecture de la valeur d'un attribut unique avec transfert de bloc.....	389
Tableau E.5 – Exemple: Lecture de la valeur d'une liste d'attributs avec transfert de bloc	391
Tableau E.6 – Exemple: Écriture de la valeur d'un attribut unique sans transfert de bloc	394
Tableau E.7 – Exemple: Écriture de la valeur d'une liste d'attributs sans transfert de bloc	395
Tableau E.8 – Exemple: Écriture de la valeur d'un attribut unique avec transfert de bloc	396
Tableau E.9 – Exemple: Écriture de la valeur d'une liste d'attributs avec transfert de bloc	398

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

**ÉCHANGE DES DONNÉES DE COMPTAGE DE L'ÉLECTRICITÉ –
LA SUITE DLMS/COSEM –****Partie 5-3: Couche application DLMS/COSEM****AVANT-PROPOS**

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La Commission Électrotechnique Internationale (IEC) attire l'attention sur le fait qu'il est déclaré que la conformité avec les dispositions de la présente Norme internationale peut impliquer l'utilisation d'un service de maintenance concernant la pile de protocoles sur laquelle est basée la présente norme IEC 62056-5-3.

L'IEC ne prend pas position quant à la preuve, à la validité et à la portée de ce service de maintenance.

Le fournisseur du service de maintenance a donné l'assurance à l'IEC qu'il consent à fournir des services avec des demandeurs du monde entier, à des termes et conditions raisonnables et non discriminatoires. À ce propos, la déclaration du fournisseur du service de maintenance est enregistrée à l'IEC. Des informations peuvent être demandées à :

DLMS¹ User Association
Zug/Switzerland
www.dlms.com

La Norme internationale IEC 62056-5-3 a été établie par le comité d'études 13 de l'IEC: Comptage et pilotage de l'énergie électrique.

Cette deuxième édition annule et remplace la première édition de l'IEC 62056-5-3 parue en 2013. Cette édition constitue une révision technique.

Les modifications techniques majeures par rapport à l'édition précédente sont énumérées à l'Annexe G (informative).

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
13/1648/FDIS	13/1657/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/IEC, Partie 2.

Une liste de toutes les parties de la série IEC 62056, publiées sous le titre général *Échange des données de comptage de l'électricité – La suite DLMS/COSEM*, peut être consultée sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous "<http://webstore.iec.ch>" dans les données relatives à la publication recherchée. A cette date, la publication sera

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- supprimée,
- remplacée par une édition révisée, ou
- amendée.

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¹ Spécification de message de langage de dispositif.

INTRODUCTION

Cette deuxième édition de l'IEC 62056-5-3 a été établie par le groupe de travail 14 du comité d'études 13 de l'IEC avec la contribution significative de la DLMS User Association, son partenaire de liaison de type D.

Cette édition est conforme à l'Amendement 3 de l'édition 7.0 du Livre Vert de la DLMS UA. Les principales nouvelles fonctions sont le service DataNotification, la protection générale et les mécanismes de transfert général de blocs ainsi que l'emballage réduit pour SMS.

En 2014, la DLMS UA a publié l'édition 8.0 du Livre Vert, qui prévoit de nouvelles caractéristiques en matière de fonctionnalité, d'efficacité et de sécurité tout en maintenant une rétrocompatibilité totale.

En outre, l'intention de la DLMS UA est de mettre ces derniers développements en conformité avec la normalisation internationale. Par conséquent, le groupe de travail 14 du comité d'études 13 de l'IEC a lancé un projet visant à rendre conformes ces nouveaux éléments également à la série IEC 62056 en vue de présenter l'Édition 3.0 de la norme.

L'Article 5 et l'Annexe F sont basés sur des parties de documents du NIST. Réimprimé avec l'aimable autorisation du NIST (National Institute of Standards and Technology), Technology Administration, U.S. Department of Commerce.

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ÉCHANGE DES DONNÉES DE COMPTAGE DE L'ÉLECTRICITÉ – LA SUITE DLMS/COSEM –

Partie 5-3: Couche application DLMS/COSEM

1 Domaine d'application

La présente partie de l'IEC 62056 indique la couche application DLMS/COSEM en termes de structure, de services et de protocoles pour les clients et serveurs COSEM, et définit comment utiliser la couche application DLMS/COSEM dans différents profils de communication.

Elle définit les services permettant d'établir et de libérer des associations d'applications, ainsi que les services de communication de données permettant d'accéder aux méthodes et aux attributs des objets d'interface COSEM, définis dans l'IEC 62056-6-2, à l'aide du référencement par nom logique (LN) ou par nom abrégé (SN).

L'Annexe A (normative) définit comment utiliser la couche application COSEM dans différents profils de communication. Elle indique comment différents profils de communication peuvent être construits de sorte à échanger des données avec les équipements de mesure à l'aide du modèle d'interface COSEM, ainsi que les éléments nécessaires à indiquer dans chaque profil de communication. Les profils de communication réels, spécifiques au support, sont spécifiés dans des parties distinctes de la série IEC 62056.

L'Annexe B (normative) spécifie l'emballage réduit pour SMS.

L'Annexe C, l'Annexe D et l'Annexe E (informatives) incluent des exemples de codage d'APDU.

L'Annexe F (informative) présente la cryptographie.

L'Annexe G (informative) énumère les modifications techniques majeures contenues dans cette édition de la norme.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 61334-4-41:1996, *Automatisation de la distribution à l'aide de systèmes de communication à courants porteurs – Partie 4: Protocoles de communication de données – Section 41: Protocoles d'application – Spécification des messages de ligne de distribution*

IEC 61334-6:2000, *Automatisation de la distribution à l'aide de systèmes de communication à courants porteurs – Partie 6: Règles d'encodage A-XDR*

IEC TR 62051:1999, *Electricity metering – Glossary of terms* (disponible en anglais seulement)

IEC TR 62051-1:2004, *Electricity metering – Data exchange for meter reading, tariff and load control – Glossary of terms – Part 1: Terms related to data exchange with metering equipment using DLMS/COSEM* (disponible en anglais seulement)

IEC 62056-1-0, *Échange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 1-0: Cadre de normalisation du comptage intelligent*

IEC 62056-6-1:2015, *Échange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 6-1: Système d'identification des objets (OBIS)*

IEC 62056-6-2:2016, *Échange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 6-2: Classes d'interface COSEM*

IEC 62056-8-3:2013, *Échange des données de comptage de l'électricité – La suite DLMS/COSEM – Partie 8-3: Profil de communication pour réseaux de voisinage CPL S-FSK*

ISO/IEC 15953:1999, *Technologies de l'information – Interconnexion des systèmes ouverts – Définition du service pour l'élément de service de contrôle d'association des objets de service d'application*

ISO/IEC 15954:1999, *Technologies de l'information – Interconnexion des systèmes ouverts – Protocole en mode connexion pour l'élément de service de contrôle d'association des objets de service d'application*

ISO/IEC 8824-1:2008, *Information technology – Abstract Syntax Notation One (ASN.1): Specification of basic notation* (disponible en anglais seulement)

ISO/IEC 8825-1:2008, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)* (disponible en anglais seulement)

FIPS PUB 180-4:2012, *Secure hash standard*

FIPS PUB 197:2001, *Advanced Encryption Standard (AES)*

NIST SP 800-38D:2007, *Recommendation for Block Cipher Modes of Operation: Galois/Counter Mode (GCM) and GMAC*

NIST SP 800-57:2006, *Recommendation for Key Management – Part 1: General* (Révisé)

Les références suivantes sont disponibles en ligne à partir du Internet Engineering Task Force (IETF, Groupe de travail d'ingénierie Internet): <http://www.ietf.org/rfc/std-index.txt>, <http://www.ietf.org/rfc/>

RFC 1321, *The MD5 Message-Digest Algorithm*. Édité par R. Rivest (MIT Laboratory for Computer Science and RSA Data Security, Inc.) avril 1992

RFC 3394, *Advanced Encryption Standard (AES) Key Wrap Algorithm*. Éditée par J. Schaad (Soaring Hawk Consulting) et R. Housley (RSA Laboratories) septembre 2002

RFC 4106:2005, *The Use of Galois/Counter Mode (GCM) in IPsec Encapsulating Security Payload (ESP)*

3 Termes, définitions et abréviations

3.1 Termes et définitions

Pour les besoins du présent document, les termes et définitions donnés dans l'IEC TR 62051:1999, dans l'IEC TR 62051-1 et dans la RFC 4106 s'appliquent.

3.2 Abréviations

AA	Application Association (Association d'applications)
AAD	Additional Authenticated Data (données supplémentaires authentifiées) (utilisé avec le chiffrement d'APDU)
AARE	A-Associate Response (Réponse d'association d'applications) – une APDU de l'ACSE
AARQ	A-Associate Request (Demande d'association d'applications) – une APDU de l'ACSE
ACPM	Association Control Protocol Machine (Machine de protocole de commande d'association)
ACSE	Association Control Service Element (Élément de service de contrôle d'association)
AE	Application Entity (Entité d'application)
AES	Advanced Encryption Standard (Norme de cryptage évolué)
AL	Application Layer (Couche application)
AP	Application Process (Processus d'application)
APDU	Application Layer Protocol Data Unit (Unité de données de protocole d'application)
API	Application Programming Interface (Interface de programmes d'applications)
ASE	Application Service Element (Élément de service d'application)
ASO	Application Service Object (Objet de service d'application)
A-XDR	Adapted Extended Data Representation (Représentation de données étendues adaptée)
base_name	Attribut short_name correspondant au premier attribut ("logical_name") d'un objet COSEM
BER	Basic Encoding Rules (Règles de codage de base)
CF	Control Function (Fonction de commande)
CL	Connectionless (Sans connexion)
Client	Une station demandant des services. Dans le cas du profil à 3 couches, orienté connexion et basé sur HDLC, il s'agit de la station maîtresse
.cnf	Primitive de service .confirm
CO	Connection-oriented (Orienté connexion)
COSEM	Companion Specification for Energy Metering (Spécification d'accompagnement pour le comptage de l'énergie)
COSEM class_id	COSEM interface class identifier (identifiant de classe d'interface COSEM)
Objet COSEM	Instance d'une classe d'interface COSEM
DCS	Data Collection System (Système de collecte de données)
DLMS	Device Language Message Specification (Spécification de message de langage de dispositif)
DLMS UA	DLMS User Association (Association des utilisateurs de la DLMS)

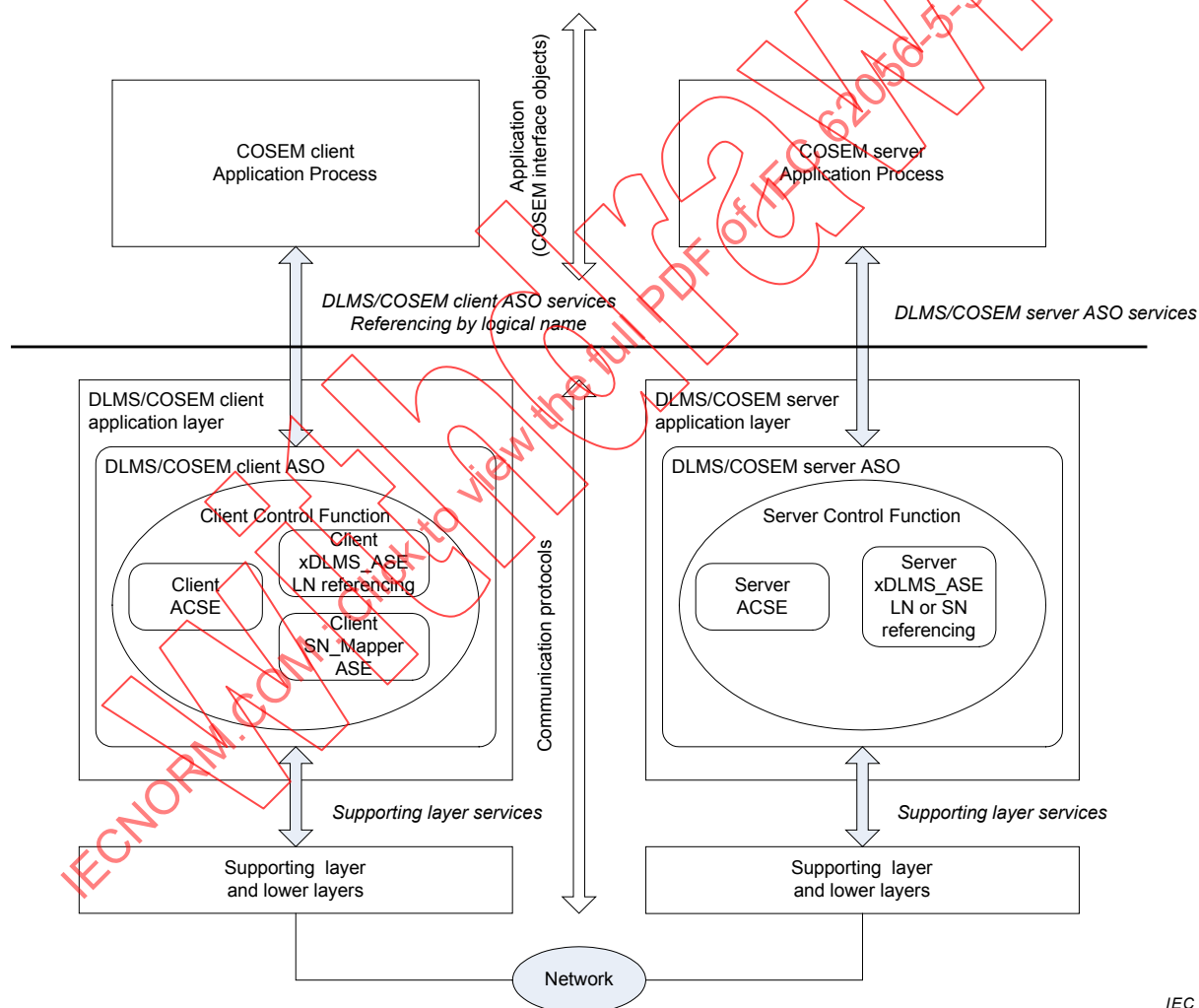
FCS	Frame Check Sequence (Séquence de contrôle de trame)
GBT	General Block Transfer (Transfert général de bloc)
GCM	Galois/Counter Mode (Mode Galois/Compteur), un algorithme de chiffrement authentifié avec données associées
GMAC	Spécialisation du GCM pour la génération de codes d'authentification de messages (Message Authentication Code, MAC) sur des données non chiffrées
HDLC	High-level Data Link Control (Commande de liaison de données à haut niveau)
HLS	High Level Security (Sécurité de niveau élevé)
HMAC	Keyed-Hash Message Authentication Code (Code d'authentification de message avec hachage par clé)
IEEE	Institute of Electrical and Electronics Engineers (Institut d'ingénieurs en électricité et en électronique)
IETF	Internet Engineering Task Force (Groupe de travail d'ingénierie Internet)
.ind	Primitive de service .indication
IP	Internet Protocol (Protocole Internet)
ISO	International Organization for Standardization (Organisation Internationale de Normalisation)
IV	Initialization Vector (Vecteur d'initialisation)
LDN	Logical Device Name (Nom de dispositif logique)
LLC	Logical Link Control (Commande de liaison logique) – sous-couche
LLS	Low Level Security (Sécurité de niveau faible)
LSB	Least Significant Bit (Bit de poids faible)
MAC	Medium Access Control (Contrôle d'accès au support) – sous-couche
MAC	Message Authentication Code (Code d'authentification de message) – cryptographie
maître	Station centrale qui prend l'initiative et contrôle le flux de données
MSB	Most Significant Bit (Bit de poids fort)
MSC	Message Sequence Chart (Diagramme de séquence de message)
NIST	National Institute of Standards and Technology (Institut national des normes et de la technologie)
OBIS	Object Identification System (Système d'identification d'objet)
OSI	Open System Interconnection (Interconnexion de systèmes ouverts)
PDU	Protocol Data Unit (Unité de données de protocole)
PHSDU	PH SDU
CPL	Power Line Carrier (Courant porteur sur ligne)
PPP	Point-to-Point Protocol (Protocole point à point)
.req	Primitive de service .request
.res	Primitive de service .response
RLRE	A-Release Response (Réponse de libération A) – une APDU de l'ACSE
RLRQ	A-Release Request (Demande de libération A) – une APDU de l'ACSE
SAP	Service Access Point (Point d'accès au service)
Serveur	Station fournissant des services. Le dispositif de tarification (compteur) est généralement le serveur, qui fournit les valeurs demandées ou exécute les tâches demandées.

TCP	Transmission Control Protocol (Protocole de contrôle de transmission)
TDEA	Triple Data Encryption Algorithm (Triple algorithme de chiffrement de données)
UDP	User Datagram Protocol (Protocole datagramme d'utilisateur)
VAA	Virtual Application Association (Association d'applications virtuelles)
xDLMS_ASE	Extended DLMS Application Service Element (Élément de service d'application DLMS étendu)

4 Vue d'ensemble

4.1 Structure de la couche application DLMS/COSEM

La structure des couches application COSEM du client et du serveur est représentée à la Figure 1.



IEC

Anglais	Français
COSEM client application process	Processus d'application client COSEM
Applications (interface objects)	Applications (objets d'interface)
COSEM server application process	Processus d'application serveur COSEM
COSEM client ASO services	Services ASO du client COSEM
Referencing by logical name	Référencement par nom logique
COSEM server ASO services	Services ASO du serveur COSEM

Anglais	Français
COSEM client application layer	Couche application du client COSEM
COSEM server application layer	Couche application du serveur COSEM
COSEM client ASO	ASO client COSEM
COSEM server ASO	ASO serveur COSEM
Client control function	Fonction de com. client
Server control function	Fonction de com. serveur
Client xDLMS_ASE	xDLMS_ASE client
Client ACSE	ACSE client
Client SN_MAPPER	SN_MAPPER client
Protocol (communications)	Protocole (communications)
Server xDLMS_ASE	xDLMS_ASE serveur
Server ACSE	ACSE serveur
Supporting layer services	Services de couche de support
Supporting layer and other protocol layers	Couche de support et autres couches de protocole

Figure 1 – Structure des couches application COSEM

Le composant principal de l'AL COSEM est l'objet de service d'application COSEM. Il fournit des services à son usager, le processus d'application COSEM, et utilise les services fournis par la couche inférieure de support. Il contient les trois composants obligatoires du côté client et serveur:

- l'élément de service de contrôle d'association, ACSE;
- l'élément de service d'application DLMS étendu, xDLMS_ASE;
- la fonction de commande, (CF).

Du côté client, il existe un quatrième élément facultatif, appelé l'ASE SN_MAPPER.

La tâche de l'ACSE consiste à établir, maintenir et libérer les associations d'applications. Pour les besoins des profils de communication DLMS/COSEM orientés connexion (CO), l'ACSE CO indiqué dans l'ISO/IEC 15953 et l'ISO/IEC 15954 est utilisé.

La tâche de xDLMS_ASE est de fournir des services de transfert de données entre les AP COSEM. Cet ASE est basé sur la norme DLMS, l'IEC 61334-4-41:1996. Il a été étendu pour DLMS/COSEM; voir 4.2.3.1. L'objectif principal de DLMS/COSEM est de fournir un modèle d'objet d'interface, orienté domaine de métier, destiné aux dispositifs et aux systèmes de mesure, tout en conservant une compatibilité rétroactive avec la norme DLMS. Pour atteindre ces objectifs, DLMS/COSEM inclut une évolution de DLMS. Tout en restant entièrement conforme à la norme DLMS, DLMS/COSEM offre un aperçu du compteur plus spécifique au comptage grâce aux objets d'interface COSEM.

L'IEC 62056-6-2:—, en 4.2 indique deux méthodes de référencement pour les attributs et les méthodes des objets d'interface COSEM à utiliser sur les serveurs COSEM: le référencement par LN et par SN. Lorsque le référencement par LN est utilisé, le Nom logique des objets COSEM doit être tel que spécifié dans l'IEC 62056-6-1. Par conséquent, du côté serveur, deux ensembles de services xDLMS distincts sont indiqués: l'un exclusivement pour le référencement LN et l'autre exclusivement pour le référencement SN. Il est possible de considérer qu'il existe deux xDLMS_ASE distincts: l'un fournissant des services pour le référencement LN et l'autre, pour le référencement SN. L'AL du serveur peut inclure un xDLMS_ASE, l'autre ou les deux.

L'élément CF indique comment les services ASO appellent les primitives de service appropriées de l'ACSE, du xDLMS_ASE et des services de la couche de support.

NOTE Les ASO COSEM du client et du serveur peuvent tous deux contenir d'autres composants de protocole d'application facultatifs.

L'ASE SN_MAPPER facultatif est présent dans l'ASO de l'AL du côté client, lorsque le serveur utilise le référencement SN. Il fournit une mise en correspondance entre les services utilisant le référencement LN et le référencement SN. Voir également 6.18.

L'AL COSEM exécute également quelques fonctions de la couche présentation OSI:

- codage de l'APDU de l'ACSE en BER (ISO/IEC 8825-1). Voir également 7.2.3;
- codage des APDU xDLMS contenant les services de transfert de données dans A-XDR (IEC 61334-6).

4.2 Services de la couche application DLMS/COSEM

4.2.1 Services ASO

Les services exigés par, ou fournis pour les AP du client et du serveur COSEM au niveau des interfaces logiques avec l'AL COSEM respective, à l'aide de procédures CO, sont répartis en trois catégories:

- établissement et libération d'associations d'applications;
- transfert de données;
- gestion des couches.

4.2.2 Services fournis pour l'établissement et la libération d'associations d'applications

Les services fournis pour l'établissement et la libération des AA sont les suivants:

- COSEM-OPEN;
- COSEM-RELEASE;
- COSEM-ABORT.

Le service COSEM-OPEN permet d'établir des AA. Il est basé sur le service A-ASSOCIATE de l'ACSE. Il entraîne le démarrage de l'utilisation d'une AA par ces procédures ACSE identifiées par la valeur des paramètres `Application_Context_Name`, `Security_Mechanism_Name` et de contexte xDLMS. Les AA peuvent être établies de différentes manières:

- Les AA confirmées sont établies par l'intermédiaire d'un échange de messages, à l'aide du service COSEM-OPEN, entre le client et le serveur pour négocier les contextes. Les AA confirmées peuvent être établies entre un client et un serveur uniques;
- Les AA non confirmées sont établies par l'intermédiaire d'un envoi de messages, à l'aide du service COSEM-OPEN, du client vers le serveur, en utilisant les paramètres des contextes potentiellement utilisés par le serveur. Les AA non confirmées peuvent être établies entre un client et un ou plusieurs serveurs;
- Des AA préétablies peuvent préexister. Dans ce cas, le service COSEM-OPEN n'est pas utilisé. Une AA préétablie peut être confirmée ou non confirmée.

Le service COSEM-RELEASE permet de libérer des AA. Si le service aboutit, il entraîne l'arrêt de l'utilisation de l'AA sans perte d'informations en transit (libération sans perte de données). Dans certains profils de communication (par exemple, dans le profil basé sur TCP-UDP/IP), le service COSEM-RELEASE est basé sur le service A-RELEASE de l'ACSE. Dans d'autres profils de communication (par exemple, dans le profil à 3 couches, CO, basé sur HDLC), il existe une relation un-à-un entre une AA confirmée et la connexion à la couche de protocole de support. Par conséquent, les AA peuvent être libérées simplement en déconnectant la connexion à la couche de support correspondante. Les AA préétablies ne peuvent pas être libérées.

Le service COSEM-ABORT entraîne la libération anormale d'une AA ainsi que la perte potentielle d'informations en transit. Il n'est pas basé sur le service A-ABORT de l'ACSE.

Le service COSEM-OPEN est spécifié en 6.2, le service COSEM-RELEASE en 6.3 et le service COSEM-ABORT en 6.4.

4.2.3 Services fournis pour le transfert de données

4.2.3.1 Élément de service d'application xDLMS

Comme indiqué en 4.1, xDLMS inclut certaines extensions à la norme DLMS, l'IEC 61334-4-41:1996. Ces extensions définissent des fonctionnalités ajoutées. Les fonctionnalités existantes ne sont pas modifiées. Elles sont élaborées de sorte qu'il n'existe aucun conflit avec la norme DLMS existante et comprennent les éléments suivants:

- des services supplémentaires;
- des types de données supplémentaires;
- un nouveau numéro de version DLMS;
- un nouveau bloc de conformité;
- l'explication de la signification des paramètres PDU Size.

Les services supplémentaires sont:

- les services GET, SET disponibles pour accéder aux attributs des objets COSEM et le service ACTION disponible pour accéder aux méthodes des objets COSEM à l'aide du référencement LN, voir 4.2.3.5;
- le service DataNotification utilisé par le serveur pour «notifier» des données au client, voir 4.2.3.6.
- le service EventNotification utilisé par le serveur pour notifier au client les événements qui surviennent dans le serveur, voir 4.2.3.6;

Les types de données supplémentaires sont spécifiés dans l'Article 8.

Le nouveau numéro de version DLMS, qui correspond à la première version de l'ASE xDLMS, est 6.

Le nouveau bloc de conformité xDLMS permet les implémentations de serveur DLMS/COSEM optimisées, avec des fonctionnalités étendues. Il se distingue du bloc de conformité DLMS par sa balise «Application 31». Voir 7.3.1 et l'Article 8.

Pour les services utilisant le référencement SN, de nouvelles variantes du paramètre de service Variable_Access_Specification, les services Read.response et Write.response, ont été ajoutées pour prendre en charge l'accès sélectif et le transfert de bloc.

Pour clarifier la signification des paramètres Max PDU Size utilisables par le client et le serveur, les modifications présentées au Tableau 1 ont été effectuées. Le service xDLMS-Initiate utilise ces noms pour les paramètres PDU Size.

Tableau 1 – Explication de la signification des paramètres PDU Size pour DLMS/COSEM

avant:	maintenant:
Page 61, Tableau 3, IEC 61334-4-41:1996	
Proposed Max PDU Size	Client Max Receive PDU Size
Negotiated Max PDU Size	Server Max Receive PDU Size
Page 63, 5e alinéa, IEC 61334-4-41:1996	
Le paramètre Proposed Max PDU Size (taille maximale proposée du PDU), de type Unsigned16 (nombre non signé sur 16 bits), propose une longueur maximale exprimée en octets, des PDU de DLMS échangés. La valeur proposée dans une demande Initiate doit être suffisante pour toujours permettre la transmission du PDU «Initiate Error» (erreur d'initialisation).	Le paramètre Client Max Receive PDU Size, de type Unsigned16, contient la longueur maximale, exprimée en octets, pour une PDU DLMS pouvant être envoyée par le serveur. Le client supprimera toute PDU reçue dont la taille est supérieure à cette longueur maximale. La valeur doit être suffisamment élevée pour toujours permettre la transmission des APDU AARE. Les valeurs inférieures à 12 sont réservées. La valeur 0 indique qu'il n'existe aucune limite pour la taille de PDU.
Page 63, dernier alinéa, IEC 61334-4-41:1996	
Le paramètre Negotiated Max PDU Size (Taille maximale négociée du PDU), de type Unsigned16, contient la longueur maximale exprimée en octets, pour les PDU de DLMS échangées. Une PDU qui serait plus longue que cette longueur maximale ne serait pas prise en considération. La longueur maximale est traitée comme le minimum de Proposed Max PDU Size et le maximum de la taille de PDU que le VDE-handler peut supporter.	Le paramètre Server Max Receive PDU Size, de type Unsigned16, contient la longueur maximale exprimée en octets pour une PDU DLMS pouvant être envoyée par le client. Le serveur supprime toute PDU reçue dont la taille est supérieure à cette longueur maximale. Les valeurs inférieures à 12 sont réservées. La valeur 0 indique qu'il n'existe aucune limite pour la taille de PDU.

4.2.3.2 Services de type client/serveur et non-client/serveur

Les services de transfert de données xDLMS sont liés aux attributs et aux méthodes des objets d'interface COSEM, indiqués dans l'IEC 62056-6-2 et fournissent l'interface entre le modèle d'application COSEM et les protocoles de communication.

Lorsque le serveur utilise le référencement SN, les attributs et les méthodes des objets d'interface COSEM sont mis en correspondance avec les variables nommées DLMS. La mise en correspondance est contenue par le ou les objets d'interface Association SN.

Pour accéder aux attributs et aux méthodes, les services de type client/serveur sont utilisés: le client demande des services et le serveur les fournit.

Il existe également des services non sollicités et non confirmés. Ces services sont demandés par le serveur dans des conditions prédéfinies, par exemple, à des instants programmés, déclenchements ou événements, afin d'informer le client de la valeur d'un ou de plusieurs attributs, comme s'ils avaient été demandés par le client.

4.2.3.3 Méthodes de référencement et mise en correspondance de services

Comme spécifié en 4.1, deux ensembles de services distincts sont disponibles: l'un pour le référencement LN et l'autre pour le référencement SN.

Du côté client, afin de traiter les différentes méthodes de référencement de manière transparente pour l'AP, l'AL ne fournit qu'un seul ensemble de services utilisant le référencement LN. L'utilisation d'un ensemble de services unique et standardisé entre les AP du client COSEM et le protocole de communication, en masquant les caractéristiques des serveurs COSEM utilisant différentes méthodes de référencement, permet d'indiquer une interface de programmes d'applications (API). Il s'agit d'une interface explicitement spécifiée qui correspond à cet ensemble de services pour des applications s'exécutant dans un environnement informatique donné (par exemple, Windows, UNIX, etc.). À l'aide de cette

spécification (publique) d'API, des applications client peuvent être développées sans connaître les caractéristiques d'un serveur donné.

Du côté serveur, des services utilisant le référencement LN et/ou le référencement SN peuvent être fournis.

Dans le cas des AA confirmées, la méthode de référencement et l'ensemble de services à utiliser sont négociés durant la phase d'établissement de l'AA via le contexte d'application COSEM, voir 7.2.2.2 et le bloc de conformité, voir 7.3.1. Elle ne doit pas changer pendant la durée de vie de l'AA établie. L'utilisation de services LN ou SN avec une AA donnée est exclusive.

Dans le cas d'AA non confirmées et préétablies, l'AL du client est censée connaître la méthode de référencement et l'ensemble de services pris en charge par le serveur.

Lorsque le serveur utilise le référencement LN, les services sont identiques des deux côtés. Lorsque le serveur n'utilise pas le référencement LN, une mise en correspondance entre les services côté client et côté serveur a lieu. Comme expliqué en 4.1, si le serveur utilise le référencement SN, cette mise en correspondance est effectuée par l'ASE SN_MAPPER du client. Voir aussi 6.18.

4.2.3.4 Services confirmés et non confirmés

Dans les AA confirmées, les services de transfert de données de type client/serveur peuvent être appelés de manière confirmée ou non confirmée. Dans les AA non confirmées, les services de transfert de données de type client/serveur peuvent être appelés de manière non confirmée uniquement. Voir aussi 7.3.2.

4.2.3.5 DLMS/COSEM, services de type client/serveur

Les services de transfert de données de type client/serveur COSEM pour le référencement LN sont les suivants:

- le service GET, utilisé pour lire la valeur d'un ou de plusieurs attributs des objets d'interface COSEM. Voir 6.6;
- le service SET, utilisé pour écrire la valeur d'un ou de plusieurs attributs des objets d'interface COSEM. Voir 6.7;
- le service ACTION, utilisé pour appeler une ou plusieurs méthodes des objets d'interface COSEM. L'appel de méthodes peut impliquer l'envoi de paramètres de service et le renvoi de données. Voir 6.8.

Les services de transfert de données de type client/serveur COSEM pour le référencement SN sont les suivants:

- le service Read, utilisé pour lire la valeur d'un ou de plusieurs attributs, ou pour appeler une ou plusieurs méthodes des objets d'interface COSEM lorsque des paramètres de retour sont attendus. Il s'agit d'un service confirmé. Voir 6.13;
- le service Write, utilisé pour écrire la valeur d'un ou de plusieurs attributs, ou pour appeler une ou plusieurs méthodes des objets d'interface COSEM lorsqu'aucun paramètre de retour n'est attendu. Il s'agit d'un service confirmé. Voir 6.14;
- le service UnconfirmedWrite, utilisé pour écrire la valeur d'un ou de plusieurs attributs, ou pour appeler une ou plusieurs méthodes des objets d'interface COSEM. Il s'agit d'un service non confirmé. Voir 6.15.

4.2.3.6 Services de notification de données et d'événements

Le service DataNotification est disponible pour la prise en charge de l'opération Push (pousser), voir 6.9. Il peut être utilisé à la fois dans les contextes d'application utilisant le référencement SN et ceux utilisant le référencement LN.

NOTE Le service DataNotification est utilisé en association avec les objets d'interface COSEM «Push setup», voir 5.3.8 de l'IEC 62056-6-2:—.

Pour prendre en charge la notification d'événements, COSEM fournit également des services non sollicités, de type non-client/serveur:

- avec le référencement LN, le service EventNotification. Voir 6.10;
- avec le référencement SN, le service InformationReport. Voir 6.16.

4.2.3.7 Identification des appels de services: paramètre Invoke_Id

Dans le modèle client/serveur, les demandes sont envoyées par le client et les réponses par le serveur. Le client est autorisé à envoyer plusieurs demandes avant de recevoir la réponse aux précédentes. Par conséquent, pour pouvoir identifier quelle réponse correspond à quelle demande, il est nécessaire d'inclure une référence dans la demande.

Le paramètre Invoke_Id est utilisé à cet effet. La valeur de ce paramètre est attribuée par le client de sorte que chaque demande contient un Invoke_Id différent. Le serveur doit copier le paramètre Invoke_Id dans la réponse correspondante.

Cette fonctionnalité est disponible uniquement avec le référencement LN.

Dans le service DataNotification (voir 6.9), le paramètre Long-Invoke-Id est utilisé au lieu du paramètre Invoke_Id.

En tant que service de type non-client/serveur, le service EventNotification ne contient pas le paramètre Invoke_Id.

4.2.3.8 Priorité des appels de services: paramètre Priority

Pour les services de transfert de données utilisant le référencement LN, deux niveaux de priorité sont disponibles: normal (FALSE) et élevé (TRUE). Cette fonctionnalité permet de recevoir une réponse à une nouvelle demande avant que la réponse à une demande précédente ne soit achevée.

En règle générale, le serveur traite les demandes de service entrantes dans l'ordre de réception (FIFS, First In-First Served ou Premier arrivé, premier traité). Cependant, une demande pour laquelle le paramètre Priority est défini sur ÉLEVÉ doit être traitée avant les demandes précédentes définies sur NORMAL. L'indicateur de priorité de la réponse doit être identique à celui de la demande correspondante. La gestion de la priorité est une fonctionnalité négociable, voir 7.3.1.

NOTE 1 Étant donné que les appels de services sont identifiés par un Invoke_Id, les services dont la priorité est identique peuvent être traités dans n'importe quel ordre.

NOTE 2 Si la fonctionnalité n'est pas prise en charge, les demandes dont la priorité est ÉLEVÉE sont traitées avec une priorité NORMALE.

Cette fonctionnalité n'est pas disponible avec les services utilisant le référencement SN. Le serveur traite les services sur une base FIFS.

4.2.3.9 Accès sélectif

Dans le cas de certaines classes d'interface COSEM, un accès sélectif aux attributs est disponible, ce qui signifie qu'il est possible d'accéder soit à tout l'attribut, soit à une partie sélectionnée de celui-ci. À cet effet, les sélecteurs et les paramètres d'accès sont indiqués dans le cadre de la spécification des attributs concernés.

Pour utiliser cette option, les services liés aux attributs peuvent être appelés avec ces paramètres de sélection d'accès. Dans le cas du référencement LN, cette fonctionnalité est appelée Accès sélectif. Voir 6.6 et 6.7. Il s'agit d'une fonctionnalité négociable. Voir 7.3.1.

Dans le cas du référencement SN, cette fonctionnalité est appelée Accès paramétré. Voir 6.13, 6.14 et 6.15. Il s'agit d'une fonctionnalité négociable. Voir 7.3.1.

4.2.3.10 Références multiples

Dans un appel de services lié à un objet COSEM, il est possible de faire référence à une ou plusieurs méthodes ou des attributs. L'utilisation de références multiples est une fonctionnalité négociable. Voir 7.3.1.

4.2.3.11 Référencement Attribute_0

Avec les services GET et SET, une fonctionnalité spéciale appelée référencement Attribute_0 est disponible. Par convention, les attributs des objets d'interface COSEM sont numérotés de 1 à n, où Attribute_1 est le nom logique de l'objet d'interface COSEM. Attribute_0 a une signification spéciale: il référence tous les attributs possédant un index positif (attributs publics). L'utilisation du référencement Attribute_0 avec le service GET est expliquée en 6.6 et avec le service SET, en 6.7.

NOTE Comme indiqué en 4.1 et 4.2 de l'IEC 62056-6-2:—, les fabricants peuvent ajouter des méthodes et/ou des attributs propriétaires à n'importe quel objet, à l'aide de numéros négatifs.

Le référencement Attribute_0 est une fonctionnalité négociable. Voir 7.3.1.

4.2.3.12 Transfert de paramètres de service longs

Les primitives de service xDLMS sont transportées sous une forme codée par des APDU xDLMS. Cette forme codée peut être plus longue que le paramètre Client/Server Max Receive PDU Size négocié. Pour transférer de longs messages, deux mécanismes de transport sont disponibles:

- a) le mécanisme de transfert de blocs spécifique au service: dans ce cas les appels des primitives de service contiennent uniquement une partie – un bloc – des données (par exemple, les valeurs d'attribut) afin que la forme codée soit contenue dans une seule APDU. Le transfert de blocs à l'aide de GET / SET / ACTION (référencement LN) et de Read / Write (référencement SN) est une fonctionnalité négociable, voir 7.3.1;

NOTE 1 Le transfert de blocs n'est pas disponible avec les services InformationReport et EventNotification non sollicités.

NOTE 2 Il n'y a aucun mécanisme de récupération de blocs disponible avec ces services.

- b) le mécanisme de transfert général de blocs spécifié en 4.2.3.13.

Les deux mécanismes peuvent coexister.

Une APDU qui est contenue dans le paramètre Client / Server Max Receive PDU Size négocié peut être trop longue pour être contenue dans une trame / un paquet unique de la couche de support. Ces APDU peuvent être transportées si la ou les couches de support offrent une possibilité de segmentation; voir l'Annexe A.

4.2.3.13 Mécanisme de transfert général de blocs

Le mécanisme de transfert général de blocs (GBT) – prenant également en charge la diffusion en flux de blocs – peut être utilisé avec n'importe quel service xDLMS.

NOTE Le service DataNotification n'a pas son propre mécanisme de transfert de blocs spécifique au service. Par conséquent, le mécanisme GBT est disponible pour le transport des APDU de type long du service DataNotification.

Avec ce mécanisme, les longs messages au niveau de la couche application sont transportés par les APDU de GBT au lieu des APDU «avec blocs de données» spécifiques au service.

Le mécanisme GBT prend en charge le transfert de blocs unidirectionnel et bidirectionnel, la diffusion en flux et la récupération des blocs perdus:

- le transfert de blocs unidirectionnel signifie que pendant qu'une partie envoie des blocs, l'autre partie confirme seulement les blocs reçus. Si elle a des blocs à envoyer, elle peut commencer à les envoyer dès que l'autre partie a terminé son envoi;
- le transfert de blocs bidirectionnel signifie que pendant qu'une partie envoie des blocs, l'autre partie non seulement confirme les blocs reçus mais aussi, si elle doit envoyer des blocs, peut envoyer également lesdits blocs pendant qu'elle continue de recevoir des blocs;

Le transfert de blocs bidirectionnel est utile lorsqu'il est nécessaire de transporter des paramètres de service longs dans les deux directions.

- la diffusion en flux signifie que plusieurs blocs peuvent être envoyés – transmis en continu – par une partie sans acquittement de chaque bloc de la part de l'autre partie;
- la récupération de blocs perdus signifie que si la réception d'un bloc n'est pas confirmée, il peut être envoyé à nouveau. Si la diffusion en flux est utilisée, la récupération des blocs perdus a lieu à la fin de la fenêtre de transfert.

L'utilisation du mécanisme GBT est une fonctionnalité négociable, voir 7.3.1.

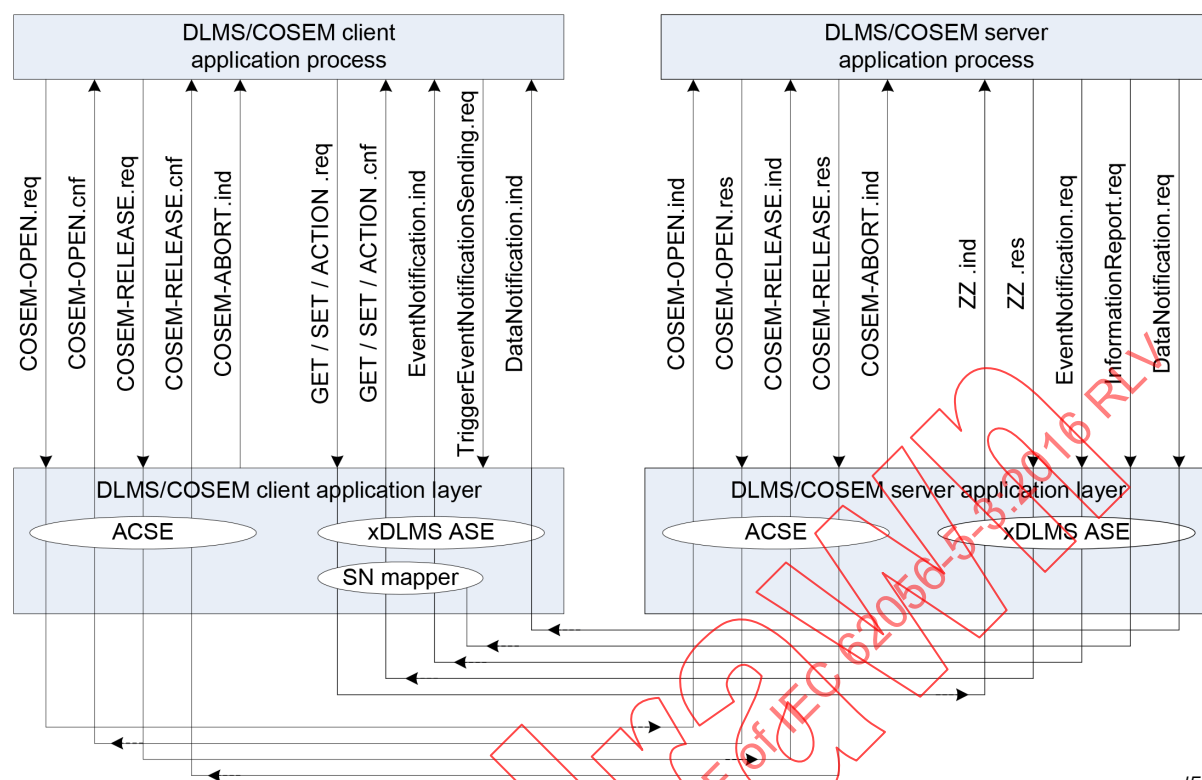
Le protocole du mécanisme GBT est spécifié en 7.3.12.

4.2.4 Services de gestion de couche

Les services de gestion de couche ont une importance locale uniquement. Par conséquent, l'indication de ces services n'entre pas dans le domaine d'application de la présente norme internationale. Le service SetMapperTable spécifique est défini en 6.17.

4.2.5 Récapitulatif des services de la couche application DLMS/COSEM

Un récapitulatif des services disponibles en haut de l'AL COSEM est présenté dans la Figure 2. Les services de gestion de couche ne sont pas présentés. Même si les primitives de service sont différentes du côté client et serveur, les APDU sont identiques. Les services de la couche application DLMS/COSEM sont spécifiés à l'Article 6. Le protocole de la couche application DLMS/COSEM est spécifié à l'Article 7. La syntaxe abstraite des APDU ACSE et xDLMS est spécifiée à l'Article 8. Des exemples de codage sont fournis à l'Annexe C, l'Annexe D et l'Annexe E.



Anglais	français
DLMS/COSEM client application process	Processus d'application client DLMS /COSEM
DLMS/COSEM server application process	Processus d'application serveur DLMS /COSEM
DLMS/COSEM client application layer	Couche application client DLMS /COSEM
DLMS/COSEM server application layer	Couche application serveur DLMS /COSEM

NOTE L'AP client utilise toujours le référencement LN. Si le serveur utilise le référencement SN, alors une mise en correspondance est réalisée par l'entité de mise en correspondance SN de l'AL client. En conséquence, les primitives de service ZZ.ind et ZZ.res peuvent être les primitives de service LN ou SN. La mise en correspondance de services LN/SN est spécifié en 6.18.

Figure 2 – Récapitulatif des services de l'AL DLMS/COSEM

4.3 Protocoles de la couche application DLMS/COSEM

Les protocoles de l'AL DLMS/COSEM indiquent les procédures utilisées pour le transfert d'informations, pour le contrôle et l'authentification de l'AA à l'aide de procédures ACSE orientées connexion et pour le transfert de données entre les clients et les serveurs DLMS/COSEM à l'aide de procédures xDLMS. Par conséquent, le protocole de l'AL est basé sur les protocoles ACSE et DLMS, comme indiqué dans l'ISO/IEC 15954 et l'IEC 61334-4-41:1996 (y compris les extensions pour DLMS/COSEM) respectivement. Les procédures sont définies en termes:

- d'interactions entre les machines de protocole ACSE et xDLMS homologues par l'intermédiaire de l'utilisation des services de la couche de protocole de support;
- d'interactions entre les machines de protocole ACSE et xDLMS et leur usager;
- de syntaxe abstraite des APDU utilisant ASN.1, comme indiqué dans l'ISO/IEC 8824-1.

Les protocoles de l'AL DLMS/COSEM sont spécifiés à l'Article 7.

5 Sécurité des informations dans DLMS/COSEM

5.1 Définitions

5.1.1

confidentialité

garantir les restrictions autorisées sur l'accès aux informations et leur divulgation, y compris les moyens de protection des informations privées et exclusives. Une perte de la confidentialité correspond à la divulgation non autorisée d'informations

[SOURCE: FIPS PUB 199]

5.1.2

intégrité

protéger contre une modification abusive ou une destruction d'informations; inclut la garantie de la non-répudiation et de l'authenticité des informations. Une perte d'intégrité correspond à la modification ou la destruction non autorisée d'informations

[SOURCE: FIPS PUB 199]

5.2 Généralités

La confidentialité et l'intégrité font partie des exigences clés lorsque des systèmes ouverts se connectent à des supports publics. Avec l'augmentation de la puissance informatique, les exigences en matière de méthodes cryptographiques sûres sont d'autant plus importantes. DLMS/COSEM fournit deux fonctionnalités principales de sécurité des informations pour accéder aux données et les transporter:

- la *sécurité de l'accès aux données* contrôle l'accès aux données stockées sur un serveur DLMS/COSEM. Voir 5.3;
- la *sécurité de transport des données* permet à l'expéditeur d'appliquer la protection cryptographique aux APDU xDLMS envoyées pour garantir la confidentialité et l'intégrité. Elle requiert des APDU chiffrées. Le destinataire peut supprimer ou vérifier cette protection. Voir 5.4.

Ces fonctionnalités de sécurité des informations sont en partie fournies par l'AL COSEM et par des objets COSEM:

- lors de l'établissement d'une AA, le client et le serveur négocient le *contexte d'application* et le *mécanisme d'authentification* à l'aide des services ACSE. Le contexte d'application détermine si des APDU chiffrées peuvent être utilisées ou non. Le mécanisme d'authentification détermine le protocole à utiliser par les entités de communication pour pouvoir s'authentifier. Les APDU de l'ACSE ne sont pas protégées de manière cryptographique;

Le champ user-information des APDU de l'ACSE doit être protégé de manière cryptographique, tel que déterminé par l'application-context et la politique de sécurité.

- une fois une AA établie avec succès, les services COSEM peuvent être utilisés pour accéder aux attributs et aux méthodes des objets COSEM, en fonction des droits d'accès valides dans l'association donnée. Ces services sont fournis par les APDU xDLMS et celles-ci peuvent être protégées de manière cryptographique, c'est-à-dire authentifiées et/ou chiffrées, en fonction de la politique de sécurité en vigueur. La protection cryptographique est appliquée, supprimée ou vérifiée par l'AL COSEM. L'AP COSEM de l'expéditeur informe, via des paramètres de service, l'AL COSEM de la protection à appliquer à l'APDU à envoyer. L'AL COSEM du destinataire informe l'AP COSEM de la protection qui a été appliquée à l'APDU reçue.

Les méthodes de sécurité des messages décrites dans la présente partie de l'IEC 62056 ont été sélectionnées parmi les normes indiquées par le NIST et l'IETF.

Pour obtenir une vue d'ensemble de la cryptographie, voir l'Annexe F.

5.3 Sécurité de l'accès aux données

5.3.1 Vue d'ensemble

La sécurité de l'accès aux données concerne l'accès aux données basé sur les rôles dans un dispositif DLMS/COSEM.

Elle est gérée par les objets «Association LN» / «Association SN». Chaque serveur COSEM, c'est-à-dire un dispositif logique, peut prendre en charge des AA avec différents clients, chacun d'entre eux ayant un rôle différent et donc des droits d'accès différents. Chaque AA est identifiée par une paire d'adresses de couches inférieures. Chaque objet Association fournit une liste d'objets visibles dans cette AA spécifique et des droits d'accès à ses attributs et méthodes.

Pour pouvoir accéder aux données, le client doit être correctement authentifié. Lors de l'établissement de l'AA, un mécanisme d'authentification est négocié entre le client et le serveur. Celui-ci indique l'authentification requise des homologues, et, le cas échéant, l'algorithme de sécurité permettant de vérifier l'authentification. Trois niveaux de sécurité de l'accès aux données sont fournis:

- Le niveau de sécurité le plus faible (pas de sécurité);
- Le niveau de sécurité faible (ou sécurité de bas niveau) (LLS);
- Le niveau de sécurité élevé (ou sécurité de haut niveau) (HLS).

5.3.2 Authentification sans sécurité (niveau de sécurité le plus faible)

L'objectif de l'Authentification sans sécurité (niveau de sécurité le plus faible) est de permettre au client de récupérer du serveur quelques informations élémentaires. Ce mécanisme d'authentification ne requiert pas d'authentification. Il permet l'accès direct aux données contenues dans le serveur, en fonction des droits d'accès disponibles dans l'AA donnée. Le mécanisme d'Authentification sans sécurité est représenté à la Figure 3.

5.3.3 Authentification de niveau de sécurité faible (LLS)

L'objectif du niveau de sécurité faible est de permettre l'authentification des clients en vérifiant le mot de passe fourni. Le serveur n'est pas authentifié. Ce mécanisme d'authentification est généralement utilisé lorsque le canal de communication offre une sécurité adéquate, qui permet d'éviter les écoutes clandestines et la reproduction (de mots de passe) de messages.

Il faut que le client fournisse le mot de passe correct durant le processus d'établissement de l'AA. Si le mot de passe est correct, l'AA est établie et le client peut accéder aux données, en fonction des droits d'accès disponibles dans l'AA donnée. Sinon, l'AA n'est pas établie.

Le processus d'authentification LLS est pris en charge par le service COSEM-OPEN de l'AL COSEM. Voir 6.2. Le processus fonctionne de la manière suivante:

- le client transmet un «secret» (par exemple, un mot de passe) au serveur à l'aide du paramètre «Calling_Authentication_Value» de la primitive de service COSEM-OPEN.request;
- le serveur vérifie si le «secret» reçu correspond à l'identification du client;
- si oui, le client est authentifié et l'AA peut être établie. Si non, l'AA est rejetée;
- le résultat et les informations de diagnostic sont renvoyés par le serveur à l'aide de la primitive de service COSEM-OPEN.response.

Les objets Association offrent une méthode/un attribut pour modifier le «secret». Voir 5.3.3 et 5.3.4 de l'IEC 62056-6-2:—.

Le mécanisme d'authentification LLS est représenté à la Figure 3.

5.3.4 Authentification de niveau de sécurité élevé (HLS)

L'objectif du niveau de sécurité élevé est de permettre l'authentification mutuelle du client et du serveur participant à une association. Ce mécanisme d'authentification est généralement utilisé lorsque le canal de communication n'offre aucune sécurité intrinsèque et des précautions sont à prendre contre les écoutes clandestines et la reproduction (de mots de passe) de messages.

HLS requiert que le client et le serveur s'authentifient mutuellement l'un auprès de l'autre. Ce processus s'effectue en quatre passes, qui impliquent l'échange de défis durant l'établissement de l'AA, puis l'échange des résultats du traitement de ces demandes d'accès à l'aide de méthodes cryptographiques. Si l'authentification a lieu, le client peut accéder aux données, en fonction des droits d'accès disponibles dans l'AA donnée, et accepte les données provenant du serveur. Sinon, l'AA n'est pas établie.

Le processus d'authentification HLS est pris en charge par le service COSEM-OPEN (voir 6.2) et par les objets Association LN/SN comme suit:

Passe 1: Le client transmet un «défi» CtoS (par exemple, une chaîne aléatoire) au serveur;

Passe 2: Le serveur transmet un «défi» StoC (par exemple, une chaîne aléatoire) au client.

La longueur des défis doit être comprise entre 8 octets et 64 octets.

Si la StoC est identique au CtoS, le client doit la rejeter.

Passe 3: Le client traite le «défi» StoC en fonction des règles du mécanisme d'authentification HLS négocié:

- dans le cas du mécanisme authentication_mechanism_id(2) HLS, la méthode de traitement du défi est un secret (par exemple, le chiffrement à l'aide d'une clé secrète). Il s'agit du secret HLS qui est connu du client et du serveur;
- dans le cas du mécanisme authentication_mechanism_id(3) HLS, le client traite la StoC en concaténant la StoC et le secret HLS partagé et en calculant une empreinte à l'aide de l'algorithme MD5 (RFC 1321):

$$f(\text{StoC}) = \mathbf{MD5}(\text{StoC} \parallel \text{HLS secret})$$

- dans le cas du mécanisme authentication_mechanism_id(4) HLS, le processus est identique, mais le client génère une empreinte à l'aide de l'algorithme SHA-1. La norme FIPS PUB 180-4 s'applique à cet égard;
- dans le cas du mécanisme authentication_mechanism_id(5) HLS, le client traite la StoC en calculant une valeur de hachage T à l'aide de l'algorithme GMAC:

$$f(\text{StoC}) = \text{SC} \parallel \text{FC} \parallel \text{T} = \text{SC} \parallel \text{FC} \parallel \mathbf{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{StoC})$$

Voir aussi 5.4.8.4.

Le résultat ($f(\text{StoC})$) est renvoyé au serveur. Le serveur vérifie si $f(\text{StoC})$ est le résultat du traitement correct et, le cas échéant, accepte l'authentification du client.

Passe 4: Si le client est authentifié, le serveur traite le «défi» CtoS de la même manière que décrit dans la Passe 3. Le résultat ($f(\text{CtoS})$) est renvoyé au client. Le client

vérifie si $f(\text{CtoS})$ est le résultat du traitement correct et, le cas échéant, accepte l'authentification du serveur.

Le mécanisme d'authentification HLS est présenté à la Figure 3.

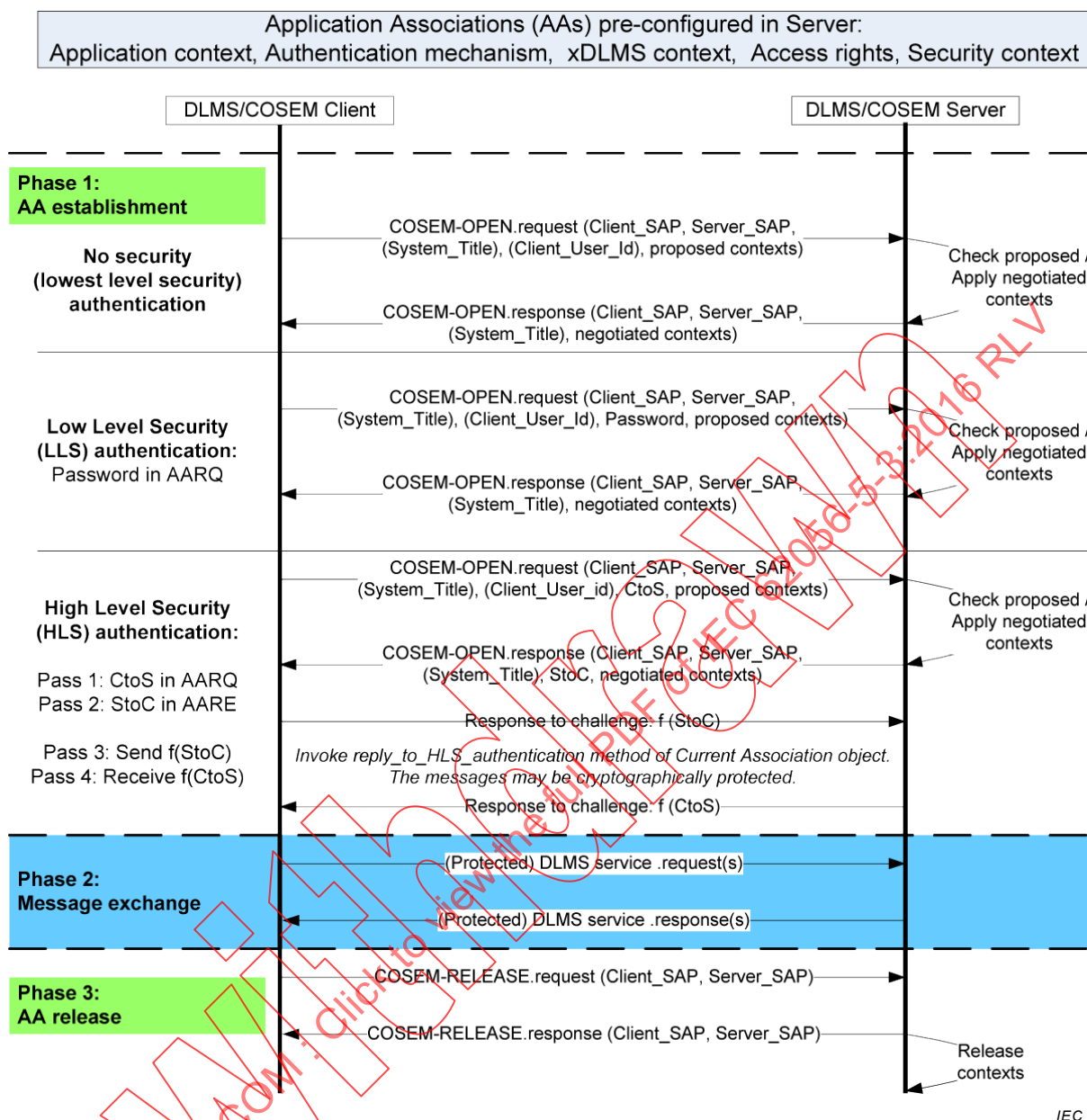
Il est important de noter que la sécurité de la phase d'échange des messages est indépendante de la sécurité du mécanisme d'authentification. Même dans le cas où les parties ne sont pas authentifiées, la sécurité de l'échange de messages peut être assurée à l'aide d'APDU à protection cryptographique.

La Passe 1 est prise en charge par la primitive de service COSEM-OPEN.request de l'AL du client. Le paramètre «Security_Mechanism_Name» contient l'identifiant du mécanisme HLS et le paramètre «Calling_Authentication_Value» contient le défi CtoS.

La Passe 2 est prise en charge par la primitive de service COSEM-OPEN.response de l'AL du serveur. Le paramètre «Security_Mechanism_Name» contient l'identifiant du mécanisme HLS et le paramètre «Responding_Authentication_Value» contient le défi StoC.

Après l'étape 2, l'AA est formellement établie, mais l'accès du client est restreint à la méthode «reply_to_HLS_authentication» de l'objet «Association» actuel.

La Passe 3 et la Passe 4 sont prises en charge par la méthode reply_to_HLS_authentication de l'objet ou des objets Association. Voir 5.3.3 et 5.3.4 de l'IEC 62056-6-2:—. Si les deux passes sont exécutées avec succès, l'accès complet est accordé en fonction de l'AA actuelle. Sinon, soit le client, soit le serveur annule l'AA.



NOTE 1 Les éléments System_Title et Client_user (présents dans les parenthèses) sont facultatifs.

NOTE 2 Aucune authentification n'a lieu dans les AA préétablies.

Anglais	Français
Application associations (AAs) pre-configured in Server: application context, authentication mechanism, xDLMS context, access rights, security context	Associations d'applications (AA) préconfigurées dans le serveur, contexte d'application, mécanisme d'authentification, contexte xDLMS, droits d'accès, contexte de sécurité
DLMS/COSEM Client	Client DLMS/COSEM
DLMS/COSEM Server	Serveur DLMS/COSEM
Phase 1 AA establishment	Phase 1 Établissement d'AA
No security (lowest level security) authentication	Authentification sans sécurité (niveau de sécurité le plus faible)
COSEM-OPEN.request	Demande COSEM-OPEN
COSEM-OPEN.response	Réponse COSEM-OPEN
Proposed contexts	Contextes proposés

Anglais	Français
Negotiated contexts	Contextes négociés
Check proposed/apply negotiated contexts	Vérifier les contextes proposés/ Appliquer les contextes négociés
Low Level Security (LLS) authentication:	Authentification de niveau de sécurité faible (LLS):
Password in AARQ	Mot de passe dans AARQ
Password, proposed contexts	Mot de passe, contextes proposés
High Level Security (HLS) authentication	Authentification de niveau de sécurité élevé (HLS)
Pass 1: CtoS in AARQ	Passe 1: CtoS dans AARQ
Pass 2: StoC in AARE	Passe 2: StoC dans AARE
Pass 3: Send f(StoC)	Passe 3: Envoyer f(StoC)
Pass 4: Receive f(CtoS)	Passe 4: Recevoir f(CtoS)
Response to challenge f(StoC)	Réponse au défi f(StoC)
<i>Invoke reply_to_HLS_Authentication method of Current Association object. The messages may be cryptographically protected</i>	Invoke la méthode reply_to_HLS_authentication de l'objet association courante. Les messages peuvent être protégés par cryptographie.
Phase 2	Phase 2
Message exchange	Échange de messages
(Protected) DLMS service.request(s)	Demande(s) service DLMS (protégé)
(Protected) DLMS service.response(s)	Réponse(s) service DLMS (protégé)
Phase 3	Phase 3
AA release	Libération d'AA
COSEM-RELEASE.request	Demande COSEM-RELEASE
COSEM-RELEASE.response	Réponse COSEM-RELEASE
Release contexts	Contextes de libération

Figure 3 – Mécanismes d'authentification pendant l'établissement de l'AA

En outre, l'objet Association SN/LN offre la méthode pour modifier le «secret» HLS: change_HLS_secret.

REMARQUE Une fois que le client a émis la méthode change_HLS_secret () ou change_LLS_secret (), il s'attend à une réponse du serveur confirmant la modification du secret. Il est possible que le serveur transmette la confirmation, mais en raison de problèmes de communication, la confirmation n'est pas reçue du côté client. Par conséquent, le client ne sait pas si le secret a été modifié ou non. Pour des raisons de simplicité, le serveur n'offre pas de prise en charge spéciale pour ce cas. En d'autres termes, c'est au client de résoudre ce problème.

5.4 Sécurité de transport des données

5.4.1 Application, suppression ou vérification de la protection: chiffrement et déchiffrement

Les APDU xDLMS (les messages) transportées entre le client et le serveur peuvent être protégées en utilisant des méthodes cryptographiques.

NOTE Ceci s'applique aussi aux APDU xDLMS Initiate transportées par les APDU AARQ / AARE.

Lorsqu'une primitive de service xDLMS relative à un attribut d'objet ou une méthode COSEM est appelée par l'AP, les paramètres de service comprennent le paramètre Security_Options. Ce paramètre informe l'AL sur le type d'APDU chiffrée à utiliser, sur la protection à appliquer et comprend le matériel de sécurité nécessaire. L'AL construit d'abord l'APDU correspondant à la primitive de service et ensuite construit l'APDU chiffrée.

Lorsque l'AL reçoit une APDU chiffrée, elle la déchiffre en vérifiant et supprimant la protection, en restaurant l'APDU d'origine, non chiffrée. Lorsque ceci est réalisé avec succès,

elle appelle la primitive de service appropriée. Les paramètres de service incluent le paramètre `Security_Status` qui informe l'AP sur le type d'APDU chiffrée utilisée, sur la protection qui a été vérifiée et supprimée, et peut inclure le matériel de sécurité. Ils comprennent également le paramètre `Protection_Element`.

Les paramètres `Security_Options`, `Security_Status` et `Protection_Element` sont spécifiés en 6.5.

5.4.2 Contexte de sécurité

Le contexte de sécurité définit les attributs de sécurité pertinents pour le processus de chiffrement/déchiffrement:

- la politique de sécurité en vigueur, qui détermine le type de protection à appliquer. Voir 5.4.3;
- la suite de sécurité, qui indique l'algorithme ou les algorithmes de sécurité. Voir 5.4.4;
- le matériel de sécurité concerné pour la suite de sécurité donnée, y compris les éléments tels que les clés de chiffrement de bloc, les clés d'authentification, les vecteurs d'initialisation, etc. Voir 5.4.5.

5.4.3 Politique de sécurité

Les politiques de sécurité suivantes sont indiquées:

- la sécurité n'est pas imposée;
- tous les messages sont authentifiés;
- tous les messages sont chiffrés;
- tous les messages sont authentifiés et chiffrés.

La politique de sécurité est conservée par l'attribut `security_policy` de l'objet de configuration «Security setup». Voir 5.3.7 de l'IEC 62056-6-2:—.

L'accès authentifié peut être requis de manière sélective: il est possible d'accéder à certains attributs et méthodes uniquement à l'aide de messages authentifiés. Celui-ci est indiqué par le mode d'accès à chaque attribut et méthode. Voir 5.3.3 et 5.3.4 respectivement de l'IEC 62056-6-2:—. Par conséquent, les APDU xDLMS authentifiées peuvent être utilisées, dans un contexte chiffré d'application, même lorsque la politique de sécurité en vigueur n'exige pas que tous les messages soient authentifiés.

À noter que si l'accès authentifié est requis, mais que le contexte d'application n'est pas chiffré, les attributs et les méthodes exigeant une authentification ne sont pas accessibles. Si le client tente d'envoyer une APDU chiffrée dans un contexte d'application non chiffré, la couche application du serveur doit la rejeter. Dans le cas du référencement SN, la réponse doit être l'APDU `ConfirmedServiceError`, qui contient l'étiquette de l'APDU rejetée. Dans le cas du référencement LN, la réponse doit être une APDU `ExceptionResponse`.

D'autre part, le chiffrement s'applique en règle générale à tous les messages d'une AA donnée: si la politique de sécurité exige que tous les messages soient chiffrés, toutes les APDU doivent être chiffrées. En outre, elles peuvent être authentifiées.

Lorsque la politique de sécurité exige que tous les messages soient authentifiés et chiffrés, seules les APDU chiffrées et authentifiées peuvent être utilisées.

Les messages protégés par une sécurité plus élevée que celle exigée par la politique de sécurité sont toujours autorisés (à condition que le contexte d'application négocié les autorise).

5.4.4 Suite de sécurité

Une suite de sécurité détermine l'algorithme ou les algorithmes cryptographiques utilisés pour la sécurité des messages. Une suite de sécurité est identifiée par un identifiant de la suite de sécurité (Security Suite ID). Voir le Tableau 2. Actuellement, une suite de sécurité est spécifiée, le mode Galois/Counter (GCM) avec AES-128. Dans cette suite de sécurité, les clés globales (voir 5.4.7.3.3) sont protégées lors du transport à l'aide de l'algorithme de chiffrement de clés AES-128.

Tableau 2 – Suites de sécurité

Identifiant de la suite de sécurité	Algorithme d'authentification	Algorithme de chiffrement	Méthode de transport de clé
0	AES-GCM-128	AES-GCM-128	Enveloppement de clé à l'aide de l'algorithme de chiffrement AES-128
Tous les autres réservés	–	–	–

5.4.5 Matériel de sécurité

Les éléments du matériel de sécurité sont les suivants:

- une clé de chiffrement de bloc, symbolisée par EK ;
- une clé d'authentification, symbolisée par AK ;
- un vecteur d'initialisation, symbolisé par IV .

Les éléments dépendent de la suite de sécurité. Pour AES-GCM-128, ils sont définis en 5.4.8.

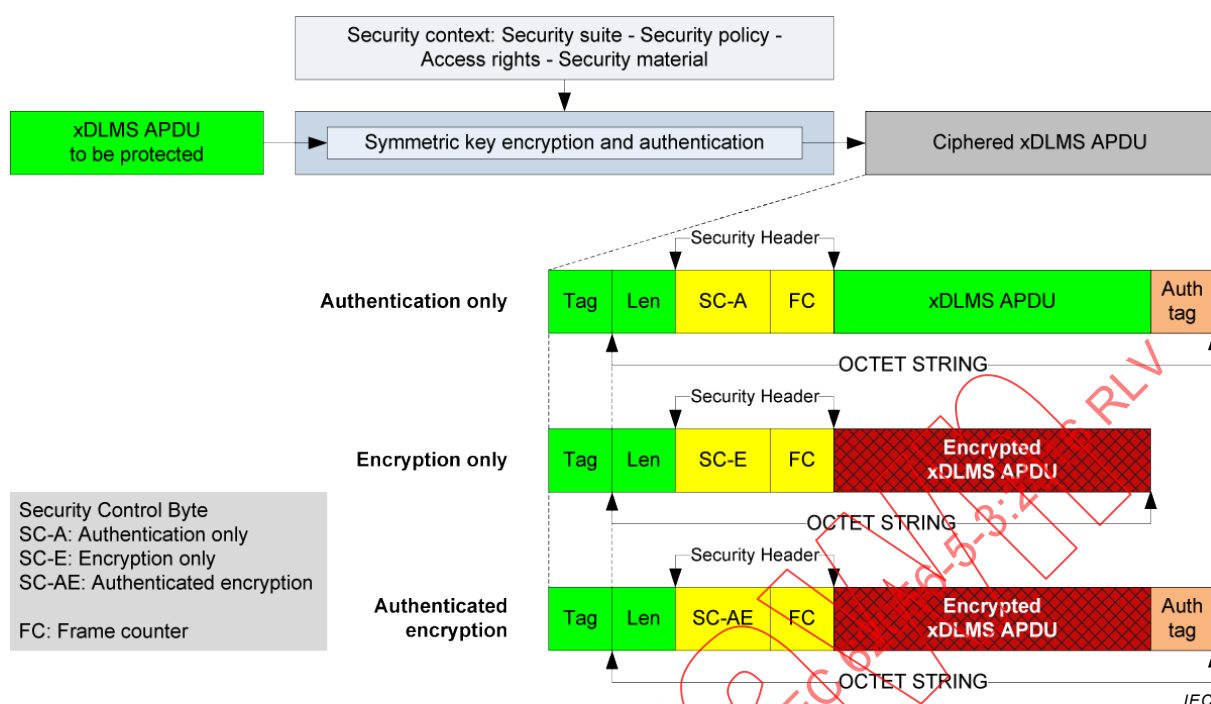
5.4.6 APDU xDLMS chiffrées

Les APDU xDLMS chiffrées peuvent être utilisées uniquement dans un contexte d'application chiffré. Des APDU non chiffrées dans un contexte d'application chiffré peuvent également être utilisées.

Les différents types d'APDU chiffrées sont présentés dans le Tableau 3. Leur structure est présentée dans la Figure 4 et la Figure 5.

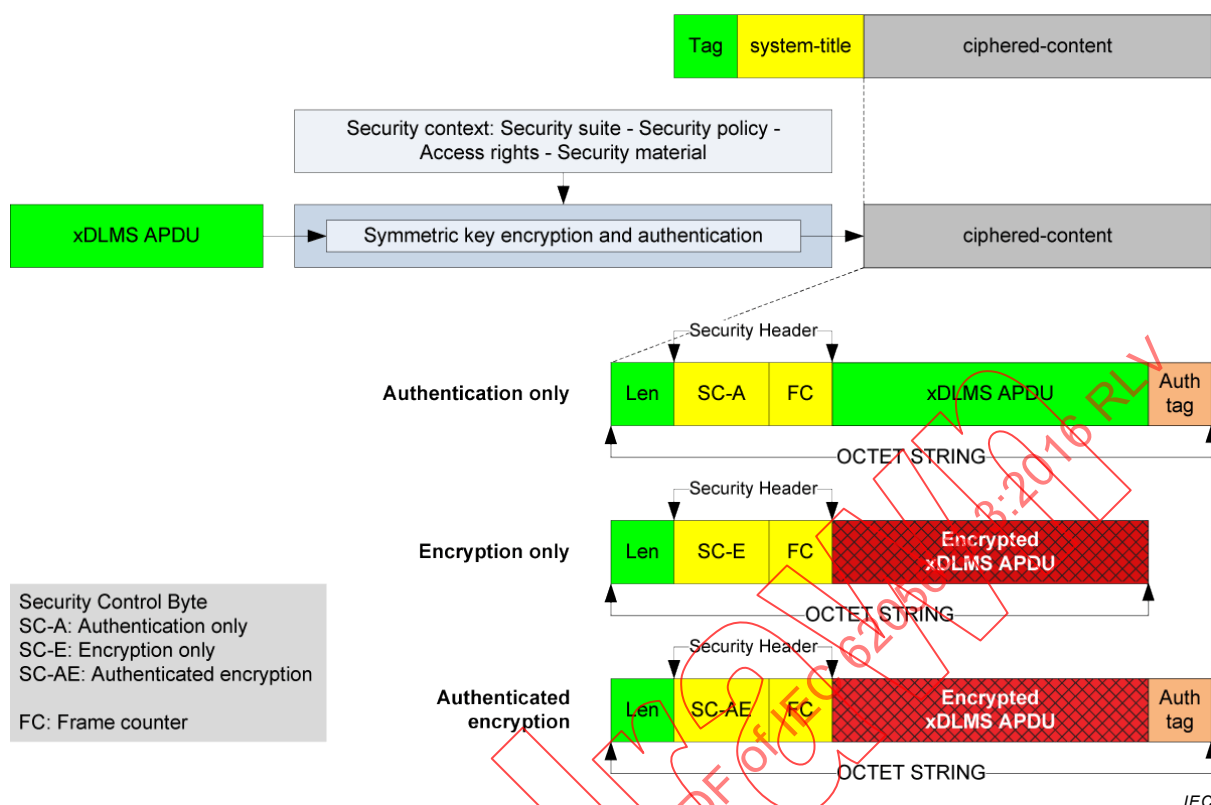
Tableau 3 – APDU xDLMS chiffrées

Type d'APDU	Parties	Type de cryptographie	Services de sécurité	Clé utilisée
Chiffrement global/dédié spécifique au service	Client – Serveur	Symétrique	Authentification Chiffrement	Clé globale/dédiée partagée
general-glo-ciphering				
general-ded-ciphering				



Anglais	Français
Security context: security suite, security policy, access rights, security material	Contexte de sécurité, suite de sécurité, politique de sécurité, droits d'accès, matériel de sécurité
xDLMS APDU to be protected	APDU xDLMS à protéger
Symmetric key encryption and authentication	Chiffrement et authentification de clés symétriques
Ciphred xDLMS APDU	APDU xDLMS chiffrée
Security header	En-tête de sécurité
Tag	Étiquette
Auth tag	Étiquette d'authentification
Len	Longueur
Encrypted xDLMS APDU	APDU xDLMS chiffrée
Octet string	Chaîne d'octets
Security control byte	Octet de contrôle de sécurité
Encryption only	Chiffrement uniquement
Authentication only	Authentification uniquement
Authenticated encryption	Chiffrement authentifié
Frame counter	Compteur de trames

Figure 4 – Structure d'APDU de chiffrement global et de chiffrement dédié spécifiques au service



Anglais	Français
Tag	Étiquette
System-title	Titre-système
Ciphred content	Contenu chiffré
Security context: security suite, security policy, access rights, security material	Contexte de sécurité, suite de sécurité, politique de sécurité, droits d'accès, matériel de sécurité
Symmetric key encryption and authentication	Chiffrement et authentification de clés symétriques
xDLMS APDU	APDU xDLMS
Security header	Entête de sécurité
Auth tag	Étiquette d'authentification
Len	Longueur
Encrypted xDLMS APDU	APDU xDLMS chiffrée
Octet string	Chaîne d'octets
Security control byte	Octet de contrôle de sécurité
Encryption only	Chiffrement uniquement
Authentication only	Authentification uniquement
Authenticated encryption	Chiffrement authentifié
Frame counter	Compteur de trames

Figure 5 – Structure d'APDU de chiffrement général global et de chiffrement général dédié

Le Tableau 4 résume l'utilisation des champs des APDU chiffrées.

Tableau 4 – Utilisation des champs des APDU chiffrées

Champ APDU	Chiffrement global/dédié spécifique au service	general-glo-/general-ded-ciphering (chiffrement général-glo-/général-déd-)	Signification
étiquette	Spécifique au service	[219] [220]	L'étiquette de l'APDU chiffrée; voir Article 8.
titre-système	–	o	Le titre-système de l'émetteur. NOTE Il s'agit d'une chaîne d'octets, qui peut être de longueur nulle lorsque la transmission du titre-système n'est pas exigée.
longueur	+	+	Longueur de la chaîne d'octets qui contient l'APDU xDLMS chiffrée / contenu chiffré.
octet de contrôle de sécurité	+	+	Fournit des informations sur la protection appliquée, le key_set et la suite de sécurité utilisées. Voir le Tableau 6.
Compteur de trames	+	+	Le champ d'appel du vecteur d'initialisation. Il s'agit d'un compteur d'entiers qui incrémente avec chaque appel de la fonction authentifiée de chiffrement utilisant la même clé. Lorsqu'une nouvelle clé est établie, le compteur de trames lié à celle-ci doit être réinitialisé à 0.
APDU xDLMS non protégée	(+)	(+)	L'APDU qui est protégée.
APDU xDLMS chiffrée	(+)	(+)	L'APDU qui est chiffrée, c'est-à-dire le texte chiffré.
étiquette d'authentification	(+)	(+)	Calculée par l'algorithme AES-GCM; voir 5.4.8.

5.4.7 Clés cryptographiques

5.4.7.1 Généralités

Une clé cryptographique est un paramètre utilisé en association avec un algorithme cryptographique qui détermine son fonctionnement de sorte qu'une entité connaissant la clé peut reproduire ou inverser l'opération, alors qu'une entité ne connaissant pas la clé en est incapable. Pour les besoins de DLMS/COSEM, voici quelques exemples d'opérations:

- transformation de données en texte brut en données en texte chiffré;
- transformation de données en texte chiffré en données en texte brut;
- calcul d'un code d'authentification à partir de données;
- vérification d'un code d'authentification à partir de données et d'un code d'authentification reçu.

5.4.7.2 Types de clés

Différents types de clés sont définis. Ils sont identifiés en fonction de leur classification, de leur fonction cryptographique, de leur utilisation et de leur portée.

Pour leur classification, une distinction est faite entre:

- les clés *symétriques*. Une clé symétrique est une clé cryptographique unique utilisée avec un algorithme de clé (symétrique) secret. Pour obtenir un aperçu des algorithmes de clés symétriques, voir Article F.3;
- les clés *publiques* et *privées*, utilisées avec les algorithmes cryptographiques de clés publiques. Pour obtenir un aperçu des algorithmes de clés asymétriques, voir Article F.4.

Pour les clés symétriques, une distinction est faite entre:

- les clés *d'authentification symétriques*, utilisées avec les algorithmes de clés symétriques pour garantir l'intégrité et la source des messages;
- les clés *de chiffrement de données symétriques*, utilisées avec les algorithmes de clés symétriques pour appliquer la protection de confidentialité aux informations; et
- les clés *symétriques d'enveloppement de clés*, utilisées pour chiffrer d'autres clés à l'aide d'algorithmes de clés symétriques. Les clés d'enveloppement de clés sont également connues sous le nom de clés de chiffrement de clés (Key Encrypting Keys ou KEK).

Pour leur utilisation, une distinction est faite entre:

- les clés *de monodiffusion*, utilisées pour sécuriser des communications en mode monodiffusion entre deux homologues;
- les clés *de diffusion*, utilisées pour sécuriser des communications de diffusion entre un client DLMS/COSEM et plusieurs serveurs DLMS/COSEM. Dans DLMS/COSEM, la diffusion peut être initiée uniquement par le client.

Pour leur portée, une distinction est faite entre les clés *dédiées* et les clés *globales*. Ces termes sont spécifiques à DLMS/COSEM:

- une *clé dédiée* est une clé de chiffrement qui peut être utilisée pour chiffrer des APDU xDLMS de l'établissement d'une AA entre un client et un serveur à la libération de l'AA. Par conséquent, sa durée de vie est la même que celle de l'AA. Elle est fournie durant l'établissement de l'AA et utilisée lors des transmissions ultérieures au sein de la même AA.
Lorsque l'AA est libérée, il convient que la clé dédiée soit supprimée par le serveur ainsi que par le client.
- une *clé globale* est une clé de chiffrement qui peut être (ré)utilisée pour chiffrer des APDU xDLMS, échangées entre le même client et le même serveur, dans plusieurs instances de l'AA.

Les clés de chiffrement (symétriques) suivantes peuvent être disponibles: clé de monodiffusion globale, clé de diffusion globale, clé de monodiffusion dédiée.

Une clé d'authentification (symétrique) est toujours une clé globale qui peut être utilisée dans des messages monodiffusion et dans des messages à diffusion générale.

En outre, des règles spécifiques à la suite de sécurité peuvent s'appliquer. Voir aussi le Tableau 5.

5.4.7.3 Gestion des clés

5.4.7.3.1 Architectures de système

NOTE Le paragraphe 5.4.7.3 fournit des lignes directrices générales pour une implémentation sécurisée. La gestion du système de sécurité, y compris les clés de sécurité, est de la responsabilité de l'opérateur du système.

Aux fins du 5.4.7.3, deux architectures de systèmes généraux sont considérées:

- le client est le DCS central, qui échange des données directement avec les serveurs;

- le client est un concentrateur, qui échange des données d'une part avec les serveurs et d'autre part avec le DCS central. Dans ce cas, le concentrateur peut ou non également être un serveur. Le DCS central peut ou non être un client.

Pour la génération et la distribution des clés symétriques, la norme NIST SP 800-57:2006, 8.1.5.2 s'applique.

5.4.7.3.2 Clé principale

Une clé principale doit être présente sur chaque dispositif logique de serveur configuré dans le système. Cette clé permet d'envelopper les clés globales. Voir 5.4.7.3.3.

NOTE 1 La méthode de génération et d'installation de la clé principale n'entre pas dans le domaine d'application de la présente norme internationale.

Un mécanisme sécurisé doit être mis en place pour garantir que le DCS central de données connaît la clé principale de chaque dispositif logique de serveur dans le système.

NOTE 2 L'indication d'un tel mécanisme n'entre pas dans le domaine d'application de la présente norme internationale.

S'ils sont présents dans le système, les concentrateurs ne doivent pas connaître les clés principales.

Pour des raisons de sécurité, il convient que la durée de vie de la clé principale soit limitée. La méthode de remplacement des clés principales n'entre pas dans le domaine d'application de la présente norme. Pour obtenir des lignes directrices, voir la norme NIST SP 800-57:2006, 8.2.3 intitulée «Key change function».

5.4.7.3.3 Clés globales

Avant de pouvoir utiliser le chiffrement, les clés globales sont à générer et à fournir aux dispositifs logiques COSEM faisant partie du système.

Les clés globales doivent être générées par le DCS central.

La méthode de génération des clés globales n'entre pas dans le domaine d'application de la présente norme internationale. Pour des raisons de sécurité, il convient que leur durée de vie soit limitée.

Pour la livraison, les clés globales doivent être enveloppées à l'aide de l'algorithme de chiffrement de clés AES-128 comme spécifié dans la norme RFC 3394, et de la clé principale comme clé de chiffrement de clé (KEK).

Lorsque le système fonctionne sans concentrateur, les clés globales doivent être fournies par le DCS central appelant la méthode `global_key_transfer` de l'objet d'interface «Security setup» sur le serveur COSEM avec la clé globale enveloppée définie comme paramètre. Voir l'IEC 62056-6-2:—, 5.3.7.

Lorsque le système fonctionne avec un ou plusieurs concentrateurs, les clés globales doivent être fournies, enveloppées à l'aide de la clé principale, au concentrateur. La méthode `global_key_transfer` de l'objet d'interface «Security setup» du serveur doit être appelée par le concentrateur avec la clé globale enveloppée définie comme paramètre. Pour plus de détails, voir l'IEC 62056-6-2:—, 5.3.7.

Dans tous les cas, la clé globale est enveloppée par la clé principale.

Il convient que le concentrateur ne connaisse pas les clés principales. Par conséquent, il convient qu'il ne puisse pas envelopper/désenvelopper des clés globales.

Les clés globales doivent également être mises à disposition du/des concentrateur(s), le cas échéant, par le DCS central, d'une manière sécurisée.

NOTE L'indication d'un tel processus n'entre pas dans le domaine d'application de la présente partie de l'IEC 62056.

5.4.7.3.4 Clés dédiées

Lorsque le système fonctionne sans concentrateur, les clés dédiées doivent être générées par le DCS central. Lorsque le système fonctionne avec un ou plusieurs concentrateurs, les clés dédiées doivent être générées par les concentrateurs.

Pour la livraison, elles doivent être incluses dans le champ de l'APDU xDLMS InitiateRequest prévu à cet effet (dedicated-key), contenu dans le champ relatif aux informations sur l'utilisateur (user-information) de l'APDU AARQ. L'APDU xDLMS InitiateRequest doit être authentifiée et chiffrée à l'aide de l'algorithme AES-GCM-128, de la clé globale de chiffrement de monodiffusion et, le cas échéant, de la clé d'authentification (voir 5.4.8.3.4.4). De la même manière, l'APDU xDLMS InitiateResponse, contenue dans le champ relatif aux informations sur l'utilisateur de l'APDU AARE, doit également être chiffrée et authentifiée. Voir également 5.2.

5.4.7.3.5 Récapitulatif

Les différents types de clés cryptographiques, leur utilisation et leur gestion sont récapitulés dans le Tableau 5.

Tableau 5 – Clés cryptographiques et leur gestion

Type de clé	Utilisation	Génération	Livraison	Emplacement
Clés symétriques				
Clé principale	Clé de chiffrement de clés (KEK) pour les clés globales	Non spécifiée	Non spécifiée	DCS central et serveur DLMS/COSEM
Clé globale de chiffrement de monodiffusion	Chiffrement global d'APDU xDLMS de monodiffusion	DCS central	Enveloppée à l'aide de la clé principale, appel de la méthode global_key_transfer par le DCS central ou le concentrateur	DCS central (et concentrateur) et serveur COSEM
Clé globale de chiffrement de diffusion	Chiffrement global d'APDU xDLMS de diffusion	DCS central	Enveloppée à l'aide de la clé principale, appel de la méthode global_key_transfer par le DCS central ou le concentrateur	DCS central (et concentrateur) et serveur DLMS/COSEM
Clé d'authentification (globale)	Authentification d'APDU xDLMS	DCS central	Enveloppée à l'aide de la clé principale, appel de la méthode global_key_transfer par le DCS central ou le concentrateur	DCS central (et concentrateur) et serveur DLMS/COSEM
Clé de chiffrement (monodiffusion) dédiée	Chiffrement dédié d'APDU xDLMS de monodiffusion	DCS central ou concentrateur	Transportée dans le cadre de l'APDU xDLMS InitiateRequest, qui est chiffrée et authentifiée à l'aide de l'algorithme AES-GCM-128, de la clé globale de chiffrement de monodiffusion et de la clé d'authentification	DCS central (ou concentrateur) et serveur DLMS/COSEM (durant la durée de vie de l'AA)

NOTE Si des alternatives sont proposées, la première alternative est valide pour les systèmes n'utilisant pas de concentrateur et la deuxième, pour les systèmes utilisant des concentrateurs.

5.4.8 Mode de fonctionnement Galois/Counter (GCM)

5.4.8.1 Généralités

NOTE Le texte suivant est issu de l'Article 3 de la norme NIST SP 800-38D:2007.

Le mode Galois/Counter (GCM) est un algorithme de chiffrement authentifié avec des données associées. GCM est construit à partir d'un chiffrement de bloc à clé symétrique approuvé, avec une taille de bloc de 128 bits, tel que l'algorithme de la Norme de cryptage évolué (Advanced Encryption Standard, AES). Voir la norme FIPS PUB 197. Par conséquent, GCM est un mode de fonctionnement de l'algorithme AES.

GCM offre la garantie de la confidentialité des données à l'aide d'une variation du mode de fonctionnement Counter pour le chiffrement.

GCM offre la garantie de l'authenticité des données confidentielles (jusqu'à environ 64 gigaoctets par appel) à l'aide d'une fonction universelle de hachage qui est définie dans un champ Galois binaire (c'est-à-dire défini). GCM peut également offrir la garantie de l'authentification des données supplémentaires (longueur presque illimitée par appel) qui ne sont pas chiffrées.

Si les entrées GCM sont limitées aux données qui ne sont pas chiffrées, la spécialisation résultante de GCM, appelée GMAC, est simplement un mode d'authentification appliqué aux données entrantes.

GCM offre une garantie d'authentification supérieure à celle d'une somme de contrôle ou d'un code de détection d'erreur (non cryptographique). GCM peut en particulier détecter les modifications accidentelles des données et les modifications intentionnelles, non autorisées.

Dans DLMS/COSEM, il est également possible d'utiliser GCM pour offrir uniquement la confidentialité. Dans ce cas, les étiquettes d'authentification ne sont simplement pas calculées ni vérifiées.

Pour plus d'informations, voir la norme NIST SP 800-38D:2007.

5.4.8.2 Définitions, abréviations, symboles et notation pertinents pour le mode Galois/Counter

Terme/Abréviation	Symbole	Signification
Données supplémentaires authentifiées (AAD)	<i>A</i>	Données entrantes pour la fonction de chiffrement authentifié, qui sont authentifiées, mais pas chiffrées. Elles sont également connues sous le nom de Données associées.
Déchiffrement authentifié		Fonction de GCM dans laquelle le texte chiffré est déchiffré en texte brut, et l'authenticité du texte chiffré ainsi que les AAD sont vérifiées.
Chiffrement authentifié		Fonction de GCM dans laquelle le texte brut est chiffré en texte chiffré, et une étiquette d'authentification est générée pour le texte chiffré ainsi que les AAD.
Clé d'authentification	<i>AK</i>	Partie des AAD
Chiffrement de bloc		Famille paramétrée de permutations sur des chaînes de bits d'une longueur fixe. Le paramètre qui détermine la permutation est une chaîne de bits appelée la clé.
Texte chiffré	<i>C</i>	Forme chiffrée du texte brut
	<i>EK</i>	Clé de chiffrement de bloc
Champ fixe		Dans la construction déterministe des IV, champ qui identifie le dispositif ou le contexte de l'instance de la fonction de chiffrement authentifié.
	<i>FC</i>	Compteur de trames.
Fraîche		Pour une clé récemment générée, propriété qui consiste à être différente de toutes les clés précédemment utilisées.

Terme/Abréviation	Symbole	Signification
GCM		Mode Galois/Counter
Vecteur d'initialisation	IV	Valeur unique associée à l'appel d'un chiffrement authentifié pour un texte brut spécifique et des AAD.
Champ d'appel		Dans la construction déterministe des IV , champ qui identifie les ensembles d'entrées dans la fonction de chiffrement authentifié dans un dispositif ou un contexte spécifique. Pour les besoins de la présente norme internationale, le champ d'appel est le compteur de trames.
Clé		Paramètre du chiffrement de bloc qui détermine la sélection de la fonction de transmission de chiffrement dans la famille de permutations.
	KEK	Clé de chiffrement de clé
	$len(X)$	Longueur en bits de la chaîne de bits X
	$LEN(X)$	Longueur en octets de la chaîne d'octets X
Valeur unique		Valeur utilisée une seule fois dans un contexte spécifique.
Texte brut	P	Données entrantes pour la fonction de chiffrement authentifié, qui sont authentifiées et chiffrées.
	SC	Octet de contrôle de sécurité
	SH	En-tête de sécurité; concaténation de l'octet de contrôle de sécurité (SC) et du compteur de trames FC : $SH = SC \parallel FC$.
Titre système	$Sys-T$	Identifiant unique du système.
Étiquette d'authentification	T	Somme de contrôle cryptographique appliquée à des données, qui est conçue pour révéler les erreurs accidentelles et les modifications intentionnelles des données.
	t	Longueur en bits de l'étiquette d'authentification NOTE Cette valeur est identique à $len(T)$.
	$X \parallel Y$	Concaténation de deux chaînes, X et Y .

5.4.8.3 Éléments de GCM

5.4.8.3.1 Chiffrement de bloc et clés

Pour les besoins de la présente norme internationale, la norme de chiffrement AES a été sélectionnée. GCM utilise la fonction de transmission de chiffrement et non celle d'inversion de chiffrement.

GCM utilise une clé unique, la clé de chiffrement de bloc (abrégée en clé). Sa taille doit être de 128 bits. Pour plus de sécurité, une clé d'authentification est également indiquée dans DLMS/COSEM. Elle fait partie des données supplémentaires authentifiées, AAD. La clé de chiffrement de bloc est symbolisée par EK et la clé d'authentification par AK .

5.4.8.3.2 Fonctions du GCM

5.4.8.3.2.1 Généralités

NOTE Le texte suivant est basé sur la norme NIST SP 800-38D:2007, 5.2.

Les deux fonctions qui constituent GCM sont appelées chiffrement authentifié et déchiffrement authentifié. La fonction de chiffrement authentifié chiffre les données confidentielles et calcule une étiquette d'authentification pour les données confidentielles ainsi que pour toutes les données supplémentaires, non confidentielles. La fonction de déchiffrement authentifié déchiffre les données confidentielles en fonction de la vérification de l'étiquette.

Lorsque l'entrée est limitée à des données non confidentielles, la variante résultant de GCM est appelée GMAC. Pour GMAC, les fonctions de chiffrement et de déchiffrement authentifiés

deviennent les fonctions de génération et de vérification d'une étiquette d'authentification pour les données non confidentielles.

Enfin, si l'authentification n'est pas requise, la fonction de chiffrement authentifié chiffre les données confidentielles, mais l'étiquette d'authentification n'est pas calculée. La fonction de déchiffrement authentifié déchiffre les données confidentielles, mais aucune étiquette d'authentification n'est calculée ni vérifiée.

5.4.8.3.2.2 Chiffrement authentifié – données entrantes et sortantes

NOTE Le texte suivant est basé sur la norme NIST SP 800-38D:2007, 5.2.1.1 et la norme RFC 4106:2005, 2.1.

L'opération de chiffrement authentifié comprend quatre entrées, chacune d'entre elles doit être une chaîne d'octets:

- du texte brut, symbolisé par P ;
- des données supplémentaires authentifiées (AAD), symbolisées par A . Elles doivent inclure, parmi tous les éléments, la clé d'authentification, symbolisée par AK .
- une clé secrète de chiffrement de bloc, symbolisée par EK ;
- un vecteur d'initialisation, symbolisé par IV .

Le texte brut et les AAD constituent les deux catégories de données protégées par GCM. GCM protège l'authenticité du texte brut et des AAD. Il protège également la confidentialité du texte brut, alors que les AAD sont conservées en clair.

L' IV est une variable unique, c'est-à-dire une valeur qui est unique dans le contexte (de sécurité) spécifié, qui détermine un appel de la fonction de chiffrement authentifié pour les données entrantes à protéger. Voir 5.4.8.3.4.5.

Il existe deux sorties:

- du texte chiffré, symbolisé par C , dont la longueur est exactement la même que celle du texte brut P ;
- une étiquette d'authentification, symbolisée par T .

5.4.8.3.2.3 Déchiffrement authentifié – données entrantes et sortantes

L'opération de déchiffrement authentifié comprend cinq entrées:

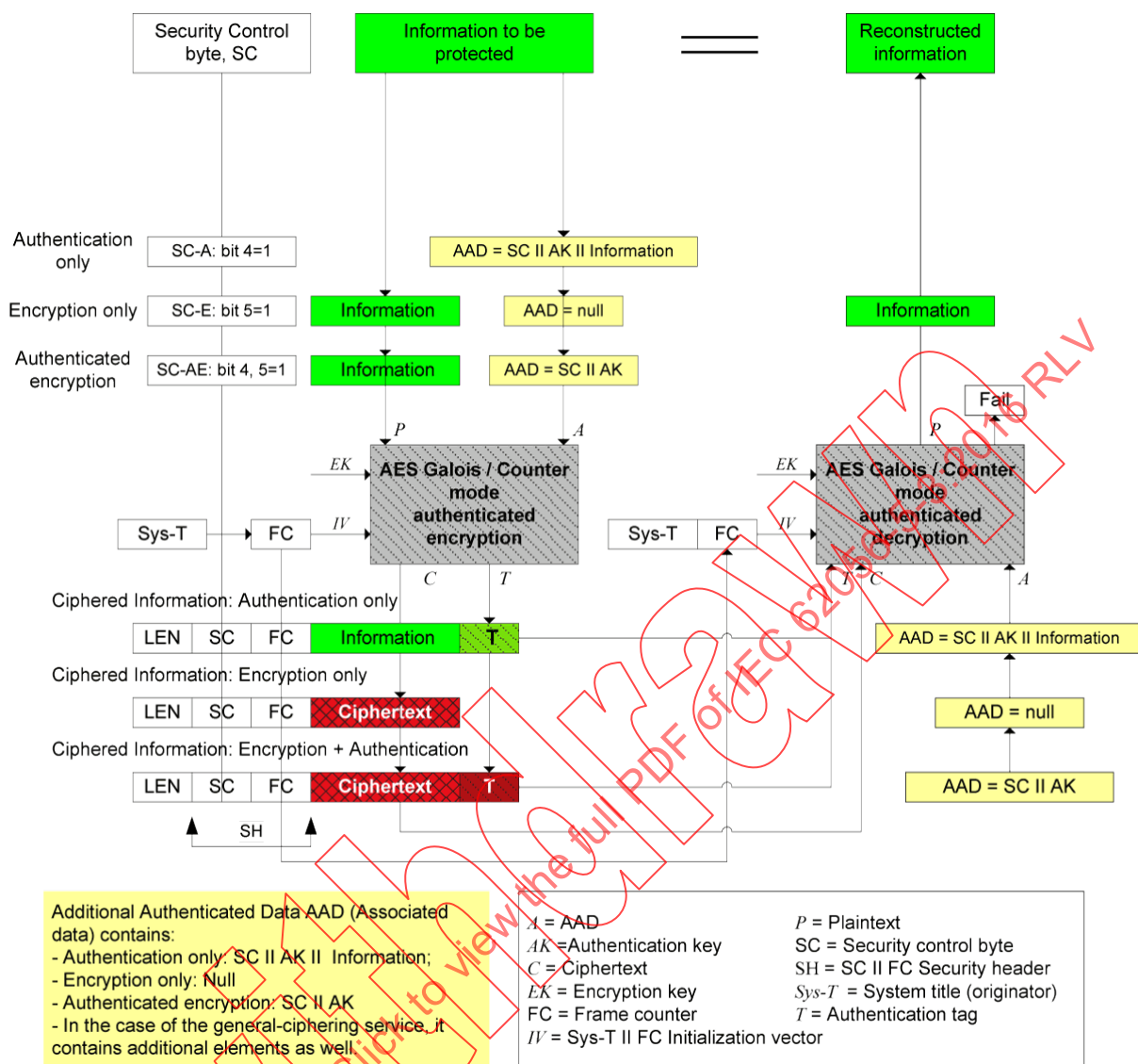
- la clé secrète de chiffrement de bloc, symbolisée par EK ;
- le vecteur d'initialisation, symbolisé par IV ;
- le texte chiffré, symbolisé par C ;
- les données supplémentaires authentifiées (AAD), symbolisées par A ;
- l'étiquette d'authentification, symbolisée par T .

La sortie est l'une des suivantes:

- le texte brut P qui correspond au texte chiffré C ou
- un code d'erreur spécial, symbolisé par $FAIL$ dans la présente norme.

La sortie P indique que T est l'étiquette d'authentification correcte pour IV , A et C . Sinon, la sortie est $FAIL$.

Les fonctions de chiffrement et de déchiffrement authentifiés, leurs entrées et leurs sorties, ainsi que la structure des APDU xDLMS chiffrées / du contenu chiffré sont représentées dans la Figure 6 ci-dessous.



IEC

Anglais	Français
Security Control byte	Octet de contrôle de sécurité
information to be protected	Informations à protéger
Reconstructed information	Informations restaurées
Authentication only	Authentification uniquement
Encryption only	Chiffrement uniquement
Information	Informations
Authenticated encryption	Chiffrement authentifié
Fail	Échec
AES Galois/Counter Mode authenticated encryption	Chiffrement authentifié à l'aide de GCM AES
AES Galois/Counter mode authenticated decryption	Déchiffrement authentifié à l'aide de GCM AES
Ciphered Information: Authentication only	Information chiffrée: authentification uniquement
Ciphered information: Encryption only	Information chiffrée: chiffrement uniquement
Ciphertext	Texte chiffré
Ciphered information: Encryption + Authentication	Information chiffrée: cryptage+ authentification

Anglais	Français
Additional Authenticated Data, AAD (Associated Data) contain: - Authentication only: SC II AK II Information; - Encryption only: null - Authenticated encryption: SC II AK - In the case of the general-cyphering service, it contains additional elements as well	Les AAD (données associées supplémentaires) contiennent: - Authentification uniquement: SC II AK II Information; - Chiffrement uniquement: nul - Chiffrement authentifié: SC II AK - Dans le cas du service de chiffrement général, il contient également des éléments supplémentaires
AK = Authentication Key	AK = Clé d'authentification
C = Cyphertext	C = Texte chiffré
EK = Encryption Key	EK = Clé de chiffrement
FC = Frame counter	FC = Compteur de trames
IV = Syst-T II FC Initialization vector	IV = Syst-T II FC Vecteur d'initialisation
P = Plaintext	P = Texte brut
SC = Security control byte: SH= SC II FC Security header	SC = Octet de contrôle de sécurité SH= SC II FC En-tête de sécurité
Sys-T = System Title	Sys-T = Titre système
T = Authentication Tag	T = Étiquette d'authentification

Figure 6 – Protection cryptographique des APDU xDLMS à l'aide de GCM

5.4.8.3.3 En-tête de sécurité avec GCM

L'en-tête de sécurité SH inclut l'octet de contrôle de sécurité concaténé avec le compteur d'appels: SH = SC II FC. L'octet de contrôle de sécurité est présenté au Tableau 6, où:

- Bit 3...0: Security_Suite_Id, voir 5.4.4;
- Bit 4: sous-champ «A»: indique que l'authentification est appliquée;
- Bit 5: sous-champ «E»: indique que le chiffrement est appliqué;
- Bit 6: sous-champ Key_set 0 = Monodiffusion;
1 = Diffusion générale
- Bit 7: Réservé, doit être défini sur 0.

Tableau 6 – Octet de contrôle de sécurité

Bit 7	Bit 6	Bit 5	Bit 4	Bit 3..0
Réservé	Key_Set	E	A	Security_Suite_Id

Le champ Frame Counter (Compteur de trames) est un compteur interne maintenu par l'expéditeur et le destinataire.

5.4.8.3.4 Paramètres de GCM et éléments de données

5.4.8.3.4.1 Longueur de l'étiquette d'authentification

La longueur en bits de l'étiquette d'authentification, symbolisée par t , est un paramètre de sécurité. Sa valeur doit être de 96 bits.

5.4.8.3.4.2 Texte brut et AAD

Le texte brut, symbolisé par P et les AAD, symbolisées par A , dépendent du type de protection. Ils sont présentés au Tableau 7, où SC désigne l'octet de contrôle de sécurité, AK , la clé d'authentification et M , le message, c'est-à-dire, l'APDU xDLMS à protéger.

Les longueurs en bits de P et de A doivent remplir les exigences suivantes:

- $\text{len}(P) < 2^{39}-256$;
- $\text{len}(A) < 2^{64}-1$;
- les longueurs en bits de P et de A doivent être des multiples de 8, de sorte que ces valeurs sont des chaînes d'octets.

Tableau 7 – Texte brut et AAD

Contrôle de sécurité, SC		Sécurité	P	A
Champ E	Champ A			
0	0	Aucune	–	–
0	1	Authentifiée uniquement	–	$SC \parallel AK \parallel M$
1	0	Chiffrée uniquement	M	–
1	1	Chiffrée et authentifiée	M	$SC \parallel AK$

5.4.8.3.4.3 Clé de chiffrement de bloc, EK

La taille de la clé de chiffrement de bloc, symbolisée par EK , doit être de 128 bits (16 octets): $\text{len}(EK) = 128$.

La clé doit être générée uniformément et de manière aléatoire, ou presque uniformément et de manière aléatoire. En d'autres termes, chaque clé possible a (quasiment) autant de chances d'être générée. Par conséquent, la clé est « fraîche », c'est-à-dire qu'il y a de fortes probabilités qu'elle ne soit égale à aucune autre clé. La clé doit être secrète et utilisée exclusivement pour GCM avec le chiffrement de bloc AES choisi. Les autres exigences relatives à l'établissement et à la gestion de clés sont abordées dans la norme NIST SP 800-38D:2007, 8.1.

5.4.8.3.4.4 Clé d'authentification, AK

Même si elle n'est pas requise par GCM, une clé d'authentification, symbolisée par AK , est indiquée pour accroître la sécurité dans DLMS/COSEM. Pour sa longueur et sa génération, les mêmes règles que pour la clé de chiffrement s'appliquent. La clé d'authentification doit faire partie des AAD. Si une clé d'authentification a été transférée, elle doit être utilisée jusqu'à ce qu'une clé d'authentification nulle soit transférée.

5.4.8.3.4.5 Vecteur d'initialisation, IV

Pour la construction du vecteur d'initialisation, IV , la construction déterministe indiquée dans la norme NIST SP 800-38D:2007, 8.2.1, doit être utilisée.

Dans la construction déterministe, l' IV est la concaténation de deux champs, appelés le champ fixe et le champ d'appel. Le champ fixe doit identifier le dispositif physique ou, de manière plus générale, le contexte (de sécurité) pour l'instance de la fonction de chiffrement authentifié. Le champ d'appel doit identifier les ensembles d'entrées dans la fonction de chiffrement authentifié pour ce dispositif spécifique.

Pour n'importe quelle clé donnée, deux dispositifs physiques distincts ne doivent pas partager le même champ fixe et deux ensembles distincts d'entrées pour un seul dispositif ne doivent pas partager le même champ d'appel.

La longueur de l' IV doit être de 96 bits (12 octets): $\text{len}(IV) = 96$. Dans cette formule:

- les 64 bits (8 octets) de départ (c'est-à-dire les plus à gauche) doivent contenir le champ fixe. Ils doivent contenir le titre système. Voir 5.4.8.3.4.6;
- les 32 bits de fin (c'est-à-dire les plus à droite) doivent contenir le champ d'appel. Voir 5.4.8.3.4.7.

La longueur en bits du champ fixe limite à 2^{64} le nombre de dispositifs physiques distincts qui peuvent implémenter la fonction de chiffrement authentifié pour la clé donnée. La longueur en bits du champ d'appel limite à 2^{32} le nombre d'appels de la fonction de chiffrement authentifié, quels que soient les ensembles d'entrées, sans violation de l'exigence d'unicité.

5.4.8.3.4.6 Titre système

Chaque dispositif physique du système, y compris les compteurs, les concentrateurs (le cas échéant) et le DCS, doit être identifié de manière unique par son titre système. Le titre système, symbolisé par $Sys-T$, doit être construit de la manière suivante:

- sa longueur doit être de 8 octets;
- les octets de départ (c'est-à-dire les 3 les plus à gauche) doivent contenir l'ID à trois lettres du fabricant². Il est identique à celui utilisé dans les octets de départ du LDN des dispositifs logiques du serveur;

L'ID à trois lettres du fabricant doit être utilisé pour identifier tous les systèmes client et serveur.

NOTE 1 Il peut être obtenu auprès de la DLMS UA.

- les octets de fin (c'est-à-dire les 5 les plus à droite) et l'ID du fabricant doivent garantir l'unicité du titre système.

NOTE 2 Ces 5 octets peuvent être par exemple déduits des 12 derniers chiffres du numéro de fabrication, jusqu'à 999 999 999 999. Cette valeur est convertie en 0xE8D4A50FFF. Les valeurs supérieures, jusqu'à 0xFFFFFFFF (valeur décimale: 1 099 511 627 775), peuvent également être utilisées, mais ne peuvent pas être mises en correspondance avec les 12 derniers chiffres du numéro de fabrication.

Des spécifications auxiliaires spécifiques à un projet donné peuvent indiquer une structure différente pour le titre système. Cependant, dans tous les cas, la longueur du titre système doit être de 8 octets (et si nécessaire, rallongée de 8 octets vers la droite) et ce dernier doit être unique. Les informations détaillées doivent être indiquées par l'autorité de dénomination désignée comme telle pour le projet.

Avant de pouvoir utiliser les algorithmes de sécurité de message, qui exigent un contexte d'application chiffrée, il faut que les homologues échangent des titres système. Les possibilités suivantes sont disponibles:

- lorsque le profil CPL S-FSK est utilisé, les titres système sont échangés durant le processus d'enregistrement à l'aide du protocole CIASE. Voir l'IEC 62056-8-3;
- dans tous les profils de communication, les titres système sont échangés durant l'établissement de l'AA avec un contexte chiffré à l'aide du service COSEM-OPEN (voir 6.2) contenu dans les APDU AARQ/AARE;

Si les titres système envoyés/reçus durant l'établissement d'une AA ne sont pas identiques à ceux échangés durant le processus d'enregistrement CIASE, l'AA doit être rejetée.

- en écrivant l'attribut client_system_title et en lisant l'attribut server_system_title des objets «Security setup». Voir 5.3.7 de l'IEC 62056-6-2:—.

NOTE 3 Pour la communication de diffusion, seul le client COSEM l'envoie au serveur COSEM.

5.4.8.3.4.7 Champ d'appel

Le champ d'appel doit être un compteur d'entiers (compteur de trames).

² Géré par DLMS-UA agissant comme autorité d'enregistrement; identique à celui utilisé dans le LDN.

5.4.8.3.5 Exemple

L'exemple suivant (voir Tableau 8) présente le processus de création d'APDU xDLMS chiffrées lors de l'application de l'authentification uniquement, du chiffrement uniquement et du chiffrement authentifié.

Tableau 8 – Exemple d'APDU chiffrées

	<i>X</i>	Contenu			<i>LEN</i> (<i>X</i>) octets	<i>Len</i> (<i>X</i>) bits
Matériel de sécurité						
Suite de sécurité		GCM-AES-128				
Titre système	<i>Sys-T</i>	4D4D4D0000BC614E(ici, les cinq derniers octets contiennent le numéro de fabrication au format hexadécimal)			8	64
Compteur de trames	<i>FC</i>	01234567			4	32
Vecteur d'initialisation	<i>IV</i>	<i>Sys-T</i> <i>FC</i>			12	96
		4D4D4D0000BC614E01234567				
Clé de chiffrement de bloc (globale)	<i>EK</i>	000102030405060708090A0B0C0D0E0F			16	128
Clé d'authentification	<i>AK</i>	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF			16	128
Sécurité appliquée		Authentification	Chiffrement	Chiffrement authentifié		
Octet de contrôle de sécurité (avec clé de monodiffusion)	<i>SC</i>	<i>SC-A</i>	<i>SC-E</i>	<i>SC-AE</i>	1	8
		10	20	30		
En-tête de sécurité	<i>SH</i>	<i>SH = SC-A</i> <i>FC</i>	<i>SH = SC-E</i> <i>FC</i>	<i>SH = SC-AE</i> <i>FC</i>		
		1001234567	2001234567	3001234567	5	40
Entrées		Authentification	Chiffrement	Chiffrement authentifié		
APDU xDLMS à protéger	<i>APDU</i>	C00100000800000010000FF0200 (Get-request, attribut 2 de l'objet Clock)			13	104
Texte brut	<i>P</i>	Null	C001000008000000 10000FF0200	C001000008000000 10000FF0200	13	104
Données associées	<i>A</i>	<i>SC</i> <i>AK</i> <i>APDU</i>	–	<i>SC</i> <i>AK</i>		
Données associées – Authentification	<i>A-A</i>	10D0D1D2D3D4D5 D6D7D8D9DADBDC DDEDFC0010000 080000010000FF 0200	–	–	30	240
Données associées – Chiffrement	<i>A-E</i>	–	–	–	0	0
Données associées – Chiffrement authentifié	<i>A-AE</i>	–	–	30D0D1D2D3D4D5D 6D7D8D9DADBDCDD DEDF	17	136
Sorties		Authentification	Chiffrement	Chiffrement authentifié		
Texte chiffré	<i>C</i>	NULL	411312FF935A475 66827C467BC	411312FF935A475 66827C467BC	13	104
Étiquette d'authentification	<i>T</i>	06725D910F9221 D263877516	–	7D825C3BE4A77C3 FCC056B6B	12	96
APDU chiffrée complète		<i>TAG</i> <i>LEN</i> <i>SH</i> <i>APDU</i> <i>T</i>	<i>TAG</i> <i>LEN</i> <i>SH</i> <i>C</i>	<i>TAG</i> <i>LEN</i> <i>SH</i> <i>C</i> <i>T</i>	–	–

	X	Contenu			LEN (X) octets	Len (X) bits
APDU authentifiée		C81E1001234567 C0010000080000 010000FF020006 725D910F9221D2 63877516	–	–	32	256
APDU chiffrée		–	C81220012345674 11312FF935A4756 6827C467BC	–	20	160
APDU chiffrée et authentifiée		–	–	C81E30012345674 11312FF935A4756 6827C467BC7D825 C3BE4A77C3FCC05 6B6B	32	256

NOTE Dans cet exemple, la valeur du champ d'appel est 01234567. En réalité, la valeur doit être incrémentée par chaque appel de l'algorithme GCM.

5.4.8.4 Authentification de l'homologue HLS avec GMAC (authentication_mechanism_id(5))

NOTE Voir également 5.3.4.

Dans le cas d'authentication_mechanism_id(5), le processus est le suivant:

- La passe 1 et la passe 2 doivent être identiques à celles décrites en 5.3.4;
- dans les passes 3 et 4, au lieu du secret HLS (contenu dans les objets «Association LN» / «Association SN»), la clé globale de chiffrement de monodiffusion et la clé d'authentification (le cas échéant) sont utilisées. Celles-ci sont transférées au serveur à l'aide de la méthode `global_key_transfer` de la classe «Security setup». Voir 5.3.7 de l'IEC 62056-6-2:—;
- Dans la passe 3, le client traite StoC en calculant une valeur de hachage T à l'aide de l'algorithme GMAC:

$$f(\text{StoC}) = \text{SC} \parallel \text{FC} \parallel T = \text{SC} \parallel \text{FC} \parallel \mathbf{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{StoC})$$

Le résultat $f(\text{StoC})$ est renvoyé au serveur. Le serveur vérifie si $f(\text{StoC})$ est le résultat du traitement correct et, le cas échéant, accepte l'authentification du client.

- Dans la passe 4, le serveur traite CtoS en calculant une valeur de hachage T à l'aide de l'algorithme GMAC:

$$f(\text{CtoS}) = \text{SC} \parallel \text{FC} \parallel T = \text{SC} \parallel \text{FC} \parallel \mathbf{GMAC}(\text{SC} \parallel \text{AK} \parallel \text{CtoS})$$

Le résultat $f(\text{CtoS})$ est renvoyé au client. Le client vérifie si $f(\text{CtoS})$ est le résultat du traitement correct et, le cas échéant, accepte l'authentification du serveur.

Pour échanger $f(\text{StoC})$ et $f(\text{CtoS})$, le client appelle la méthode `reply_to_HLS_authentication` de l'Objet d'Association actuel. Les messages peuvent être protégés de manière cryptographique.

Un exemple est donné dans le Tableau 9 ci-dessous.

Tableau 9 – Exemple HLS avec GMAC

Matériel de sécurité	X	Contenu	LEN(X) octets	len(X) bits
Suite de sécurité		GCM-AES-128		
Titre système	Sys-T	Client		
		4D4D4D0000000001		
		Serveur		
		(ici, les cinq derniers octets contiennent le numéro de fabrication au format hexadécimal)	8	64
Compteur de trames	FC	00000001	4	32
Vecteur d'initialisation	IV	Sys-T II FC		
		Client		
		4D4D4D0000000001 00000001	12	96
		4D4D4D0000BC614E 01234567		
Clé de chiffrement de bloc (globale)	EK	000102030405060708090A0B0C0D0E0F	16	128
Clé d'authentification	AK	D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF	16	128
Contrôle de sécurité	SC	10	1	8
Passe 1: Le client envoie un défi au serveur				
CtoS		4B35366956616759 "K56ivagY"	8	64
Passe 2: Le serveur envoie un défi au client				
StoC		503677524A323146 "P6wRJ21F"	8	64
Passe 3: Le client traite StoC				
SC II AK II StoC		10D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF503 677524A323146		
T = GMAC (SC II AK II StoC)		1A52FE7DD3E72748973C1E28	12	96
f(StoC) = SC II FC II T		10000000011A52FE7DD3E72748973C1E28	17	136
Passe 4: Le serveur traite CtoS				
SC II AK II CtoS		10D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF4B3 5366956616759		
T = GMAC (SC II AK II CtoS)		FE1466AFB3DBCD4F9389E2B7	12	96
f(CtoS) = SC II FC II T		1001234567FE1466AFB3DBCD4F9389E2B7	17	136
NOTE Dans cet exemple, la valeur du champ d'appel est 01234567. En réalité, la valeur doit être incrémentée par chaque appel de l'algorithme GCM.				

6 Spécification de service de la couche application DLMS/COSEM

6.1 Primitives de service et paramètres

En général, les services d'une couche (ou d'une sous-couche) sont des capacités que cette couche offre à un utilisateur dans la prochaine couche (ou sous-couche) supérieure. Afin de fournir ses services, une couche base ses fonctions sur les services qu'elle requiert de la couche inférieure précédente. La Figure 7 représente cette notion de hiérarchie de service et présente la relation entre deux utilisateurs N correspondants et leurs entités de protocole homologue de couche N.

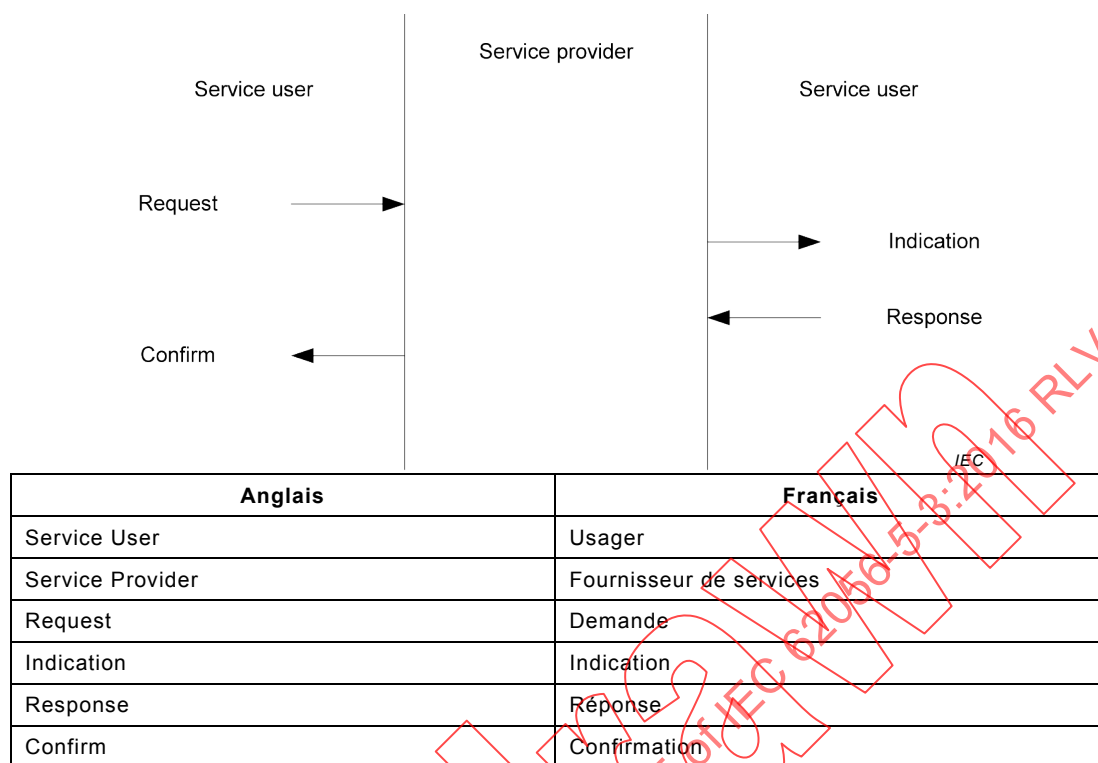


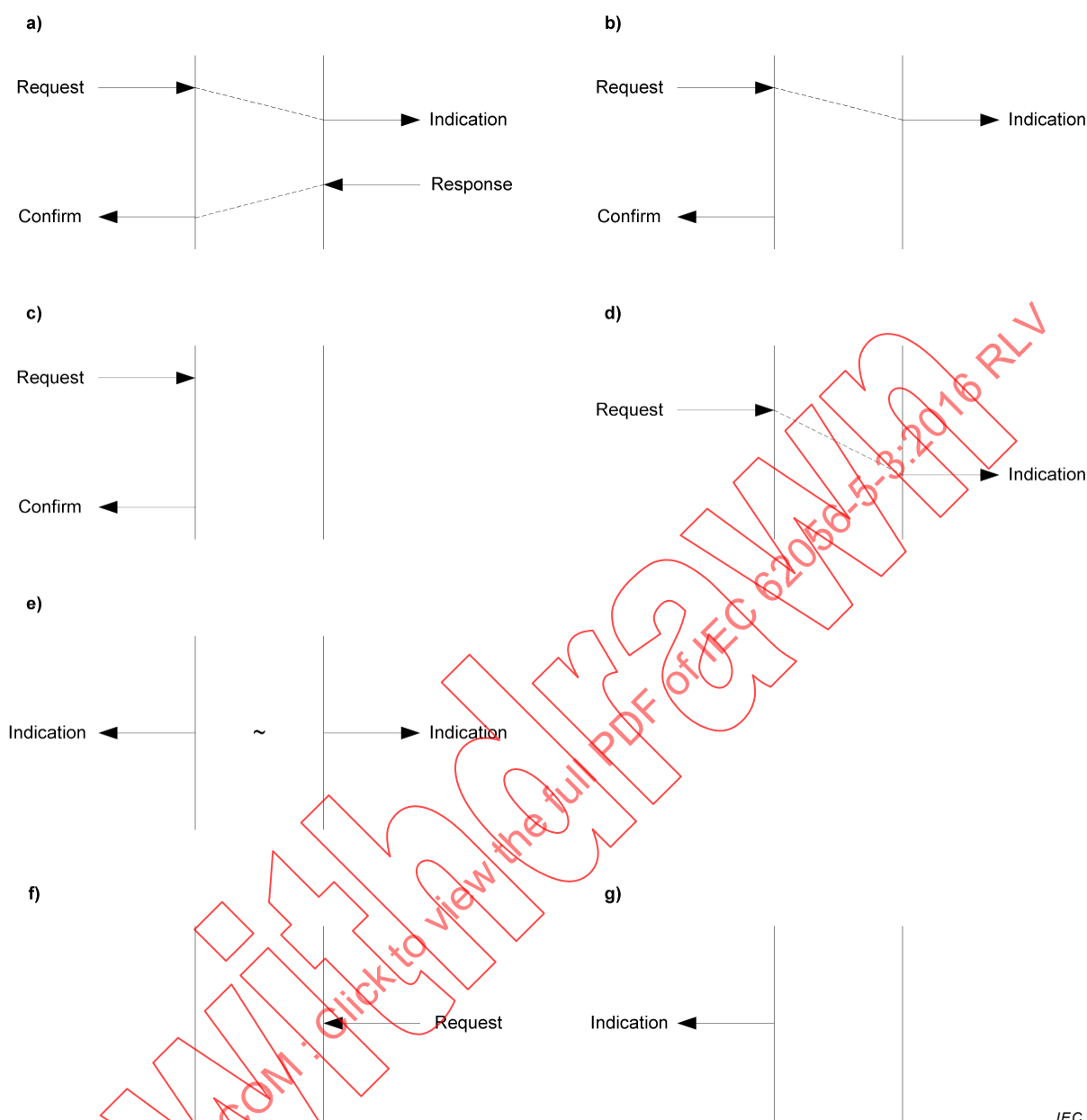
Figure 7 – Primitives de service

Les services sont indiqués en décrivant le flux d'informations entre l'utilisateur N et la couche N. Ce flux d'informations est modélisé par des événements discrets et instantanés, qui caractérisent la fourniture d'un service. Chaque événement consiste en la transmission d'une primitive de service d'une couche à l'autre via un point d'accès aux services de la couche N associé à un utilisateur N. Les primitives de service transportent les informations requises en fournissant un service spécifique. Ces primitives de service sont abstraites du fait qu'elles n'indiquent que le service fourni et non les moyens par lesquels le service est fourni. Cette définition de service est indépendante de toute implémentation d'interface spécifique.

Les services sont indiqués en décrivant les primitives de service et les paramètres qui caractérisent chaque service. Un service peut avoir une ou plusieurs primitives associées, qui constituent l'activité associée au service spécifique. Chaque primitive de service peut comprendre zéro paramètre ou plus transportant les informations requises pour fournir le service. Les primitives sont de quatre types génériques:

- **DEMANDE:** La primitive de demande est transmise de l'utilisateur N à la couche N pour demander l'initiation d'un service;
- **INDICATION:** La primitive d'indication est transmise de la couche N à l'utilisateur N pour indiquer un événement de couche N interne significatif pour l'utilisateur N. Cet événement peut être logiquement associé à une demande de service distant ou peut être provoqué par un événement interne à la couche N;
- **RÉPONSE:** La primitive de réponse est transmise de l'utilisateur N à la couche N pour exécuter une procédure précédemment appelée par une primitive d'indication;
- **CONFIRMATION:** La primitive de confirmation est transmise de la couche N à l'utilisateur N pour transporter les résultats d'une ou de plusieurs demandes de service précédentes associées.

Les relations possibles entre les types de primitives sont représentées par les diagrammes de séquences temporelles présentés dans la Figure 8. La figure indique également la relation logique des types de primitives. Les types de primitives qui se produisent plus tôt dans le temps et sont connectés par des lignes pointillées dans les diagrammes sont les antécédents logiques des types de primitives ultérieures.



Anglais	Français
Request	Demande
Indication	Indication
Response	Réponse
Confirm	Confirmation

Figure 8 – Diagrammes de séquences temporelles

Les paramètres de service des primitives de service de l'AL COSEM sont présentés sous forme de tableau. Chaque tableau comprend de deux à cinq colonnes qui décrivent les primitives de service et leurs paramètres. Dans chaque tableau, un paramètre (ou une partie de celui-ci) est répertorié sur chaque ligne. Dans les colonnes des primitives de service appropriées, un code est utilisé pour indiquer le type d'utilisation du paramètre. Les codes utilisés sont répertoriés dans le Tableau 10.

Certains paramètres peuvent contenir des sous-paramètres. Ceux-ci sont indiqués par l'intermédiaire d'une étiquette (M, U, S ou C) apposée sur les paramètres. Les sous-paramètres sont indentés sous chaque paramètre. La présence de sous-paramètres dépend

toujours de celle du paramètre sous lequel ils apparaissent. Par exemple, un paramètre facultatif peut comprendre des sous-paramètres. Si le paramètre n'est pas indiqué, aucun sous-paramètre ne peut être indiqué.

Tableau 10 – Codes des paramètres de service de l'AL

M	Paramètre obligatoire pour la primitive
U	Option de l'utilisateur; ce paramètre peut ou non être indiqué, en fonction de l'utilisation dynamique par l'utilisateur de l'ASE.
S	Paramètre sélectionné parmi les autres paramètres S en tant que réponse interne de l'environnement du serveur de l'ASE.
C	Paramètre dépendant d'autres paramètres ou de l'environnement de l'utilisateur de l'ASE.
(-)	Paramètre jamais spécifié.
=	Le code «(=)» suivant le code M, U, S ou C indique que le paramètre équivaut sur le plan sémantique au paramètre de la primitive de service se trouvant immédiatement à sa gauche dans le tableau. Par exemple, un code «M (=)» dans la colonne de la primitive de service .indication et un «M» dans la colonne de la primitive de service .request indiquent que le paramètre dans la primitive .indication équivaut sur le plan sémantique à celui dans la primitive .request.

Dans la présente norme, les règles suivantes sont observées en ce qui concerne la dénomination de termes:

- le nom des services ACSE et des services de transfert de données utilisant le référencement LN est écrit en majuscules. Exemples: COSEM-OPEN, GET;
- le nom des services de transfert de données utilisant le référencement SN est écrit en initiales majuscules. Exemples: Read, Write;
- le PascalCase est utilisé dans les cas suivants: DataNotification, EventNotification, TriggerEventNotificationSending, UnconfirmedWrite, InformationReport;
- les types de primitives de service LN peuvent être mentionnés sous deux formes alternatives. Exemples: «primitive de service GET.request de type Request_Type == NORMAL» ou «primitive de service GET-REQUEST-NORMAL»;
- Les éléments de nom de paramètre de service sont en majuscules et sont associés par un trait de soulignement afin de ne constituer qu'une seule entité. Exemples: Protocol_Connection_Parameters, COSEM_Attribute_Descriptor;
- lorsque le même paramètre peut revenir plusieurs fois, le paramètre est répété entre accolades. Exemple: Data { Data };
- dans les spécifications de service de transfert de données, les paramètres utilisés avec le transfert de bloc uniquement sont affichés en gras. Exemple: **DataBlock_G**;
- la référence directe à un paramètre de service utilise les majuscules, alors que la référence indirecte (non spécifique) utilise le texte normal sans trait de soulignement. Exemple de référence directe: «Le paramètre COSEM_Attribute_Descriptor se rapporte à un attribut d'objet COSEM.» Exemple de référence indirecte (non spécifique): «Une primitive de service GET-REQUEST-NORMAL contient un descripteur d'attribut COSEM unique.»;
- les noms des APDU de transfert de données COSEM utilisant le référencement LN sont écrits en majuscules et associés par un tiret afin de ne constituer qu'une seule entité. Exemple: Get-Request-Normal;
- les noms des APDU de transfert de données COSEM utilisant le référencement SN sont écrits en PascalCase. Exemple: ReadRequest.

6.2 Service COSEM-OPEN

Fonction

Le service COSEM-OPEN a pour fonction d'établir une AA entre des AP COSEM homologues. Il utilise le service A-ASSOCIATE de l'ACSE. Le service COSEM-OPEN fournit uniquement

l'infrastructure qui permet de *transporter* ces informations. L'AP COSEM appropriée est chargée de fournir et de vérifier ces informations.

Sémantique des primitives de service

Les primitives de service COSEM-OPEN doivent fournir des paramètres, comme indiqué dans le Tableau 11.

Tableau 11 – Paramètres de service des primitives de service COSEM-OPEN

	.request	.indication	.response	.confirm
Protocol_Connection_Parameters	M	M (=)	M	M (=)
ACSE_Protocol_Version	U	U (=)	U	U (=)
Application_Context_Name	M	M (=)	M	M (=)
Called_AP_Title	U	U (=)	–	–
Called_AE_Qualifier	U	U(=)	–	–
Called_AP_Invocation_Identifier	U	U(=)	–	–
Called_AE_Invocation_Identifier	U	U(=)	–	–
Calling_AP_Title	C	C(=)	–	–
Calling_AE_Qualifier	U	U(=)	–	–
Calling_AP_Invocation_Identifier	U	U(=)	–	–
Calling_AE_Invocation_Identifier	U	U(=)	–	–
Local_Or_Remote	–	–	–	M
Result	–	–	M	M
Failure_Type	–	–	M	M
Responding_AP_Title	–	–	C	C(=)
Responding_AE_Qualifier	–	–	U	U(=)
Responding_AP_Invocation_Identifier	–	–	U	U(=)
Responding_AE_Invocation_Identifier	–	–	U	U(=)
ACSE_Requirements	U	U(=)	U	U(=)
Security_Mechanism_Name	C	C(=)	C	C(=)
Calling_Authentication_Value	C	C(=)	–	–
Responding_Authentication_Value	–	–	C	C(=)
Implementation_Information	U	U(=)	U	U(=)
Proposed_xDLMS_Context	M	M(=)	–	–
Dedicated_Key	C	C(=)	–	–
Response_Allowed	C	C(=)	–	–
Proposed_DLMS_Version_Number	M	M(=)	–	–
Proposed_DLMS_Conformance	M	M(=)	–	–
Client_Max_Receive_PDU_Size	M	M(=)	–	–
Negotiated_xDLMS_Context	–	–	S	S(=)
Negotiated_DLMS_Version_Number	–	–	M	M(=)
Negotiated_DLMS_Conformance	–	–	M	M(=)
Server_Max_Receive_PDU_Size	–	–	M	M(=)
VAA_Name	–	–	M	M(=)
XLMS_Initiate_Error	–	–	S	S(=)
User_Information	U	C(=)	–	–
Service_Class	M	M(=)	–	–

Les paramètres de service de la primitive de service COSEM-OPEN.request, à l'exception des paramètres Protocol_Connection_Parameters, User_Information et, en fonction du profil de communications, Service_Class, sont contenus dans les champs de l'APDU AARQ envoyée par le client.

Les paramètres de service de la primitive de service COSEM-OPEN.response, à l'exception du paramètre Protocol_Connection_Parameters, sont contenus dans les champs de l'APDU AARE envoyée par le serveur.

Le service A-ASSOCIATE et les APDU AARQ et AARE sont indiqués en 7.2. Des exemples de codage sont fournis à l'Annexe C et l'Annexe D.

Le paramètre Protocol_Connection_Parameters est obligatoire. Il contient toutes les informations nécessaires pour utiliser les couches du profil de communication, y compris l'identifiant (de protocole) du profil de communication et les adresses requises. Il identifie les participants à l'AA. Les éléments de ce paramètre sont transmis aux entités qui gèrent les connexions aux couches inférieures et aux couches inférieures, selon le cas.

Le paramètre ACSE_Protocol_Version est facultatif. S'il est présent, la valeur par défaut doit être utilisée.

Le paramètre Application_Context_Name est obligatoire. Dans la primitive de demande, il contient la valeur proposée par le client. Dans la primitive de réponse, il contient la même valeur ou celle prise en charge par le serveur.

Le paramètre Calling_AP_Title est conditionnel. Lorsque le paramètre Application_Context_Name indique un contexte d'application utilisant le chiffrement, il doit contenir le titre système du client indiqué en 5.4.8.3.4.6.

L'utilisation des paramètres Called_AP_Title, Called_AE_Qualifier, Called_AP_Invocation_Identifier, Called_AE_Invocation_Identifier, Calling_AE_Qualifier, Calling_AP_Invocation_Identifier et Calling_AE_Invocation_Identifier est facultative. Le paramètre Calling_AE_Invocation_Identifier comporte l'identifiant de l'utilisateur côté client de l'AA. L'utilisation des autres paramètres n'est pas spécifiée dans la présente norme internationale.

NOTE 1 Le mécanisme d'identification de l'utilisateur client est spécifié en 5.3.2 de l'IEC 62056-6-2:—.

Le paramètre Local_or_Remote est obligatoire. Il indique l'origine de la primitive COSEM-OPEN.confirm. Il est défini sur Remote si la primitive a été générée à la suite de la réception d'une APDU AARE du serveur. Il est défini sur Local si la primitive a été générée localement.

Le paramètre Result est obligatoire. Dans le cas de la confirmation distante, il indique si le serveur a accepté l'AA proposée ou non. Dans le cas de la confirmation locale, il indique si la pile de protocole du côté client a accepté la demande ou non.

Le paramètre Failure_type est obligatoire. Dans le cas de la confirmation distante, il contient les informations fournies par le serveur. Dans le cas de la confirmation locale et négative, il indique la raison de l'échec.

L'utilisation du paramètre Responding_AP_Title est conditionnelle. Lorsque le paramètre Application_Context_Name indique un contexte d'application utilisant le chiffrement, il doit contenir le titre système du serveur indiqué en 5.4.8.3.4.6.

L'utilisation des paramètres Responding_AE_Qualifier, Responding_AP_Invocation_Identifier et Responding_AE_Invocation_Identifier est facultative. Leur utilisation n'est pas spécifiée dans la présente norme internationale.

Le paramètre ACSE_Requirements est facultatif. Il permet de sélectionner l'unité facultative fonctionnelle d'authentification du service A-Associate pour l'association. Voir 7.2.1.

La présence du paramètre ACSE_Requirements dépend du mécanisme de sécurité utilisé:

- dans le cas du niveau de sécurité le plus faible, il ne doit pas être présent; seule l'unité fonctionnelle Kernel sera utilisée;
- dans le cas du niveau de sécurité faible (LLS), il doit être présent dans la primitive .request et peut être présent dans la primitive de service .response et doit indiquer authentification
- dans le cas du niveau de sécurité élevé (HLS), il doit être présent dans les primitives de service .request et .response et doit indiquer authentification.

Le paramètre `Security_Mechanism_Name` est conditionnel. Il est présent uniquement si l'unité fonctionnelle d'authentification a été sélectionnée. S'il est présent, la primitive .request contient la valeur proposée par le client et la primitive .response contient la valeur requise par le serveur, c'est-à-dire celle à utiliser par le client.

Le paramètre `Calling_Authentication_Value` et les paramètres `Responding_Authentication_Value` sont conditionnels. Ils sont présents uniquement si l'unité fonctionnelle d'authentification a été sélectionnée. Ils contiennent la valeur d'authentification du client/du serveur respectivement, appropriée pour le paramètre `Security_Mechanism_Name`.

Le paramètre `Implementation_Information` est facultatif. Son utilisation n'est pas spécifiée dans la présente norme internationale.

Le paramètre `Proposed_xDLMS_Context` contient les éléments du contexte xDLMS proposé, qui est transporté par l'APDU xDLMS `InitiateRequest`, placé dans le champ des informations sur l'utilisateur de l'APDU AARQ.

L'élément `Dedicated_Key` est conditionnel. Il peut être présent uniquement lorsque le paramètre `Application_Context_Name` indique un contexte d'application utilisant le chiffrement. La clé dédiée est utilisée pour le chiffrement dédié des APDU xDLMS échangées dans l'AA établie.

Lorsque la clé dédiée est présente, l'APDU xDLMS `InitiateRequest` doit être chiffrée et authentifiée à l'aide de l'algorithme AES-GCM-128, de la clé globale de chiffrement de monodiffusion et de la clé d'authentification (le cas échéant). L'APDU xDLMS `InitiateRequest` doit être chiffrée de la même manière lorsque la clé dédiée est absente, mais il est nécessaire de protéger l'APDU RLRQ en incluant le xDLMS `InitiateRequest` chiffré dans son champ d'informations sur l'utilisateur. Voir 6.3.

L'utilisation de l'élément `Response_Allowed` est conditionnelle. Il indique si le serveur est autorisé à répondre à une APDU AARE, c'est-à-dire si l'AA à établir est confirmée (`Response_Allowed == TRUE`) ou non confirmée (`Response_Allowed == FALSE`).

L'élément `Proposed_DLMS_Version_Number` contient le numéro de version DLMS proposé. Voir 4.2.3.1.

L'élément `Proposed_DLMS_Conformance` contient le bloc de conformité proposé. Voir 7.3.1.

L'élément `Client_Max_Receive_PDU_Size` contient la longueur maximale des APDU xDLMS que le client peut recevoir. Voir le Tableau 1.

Si le contexte xDLMS proposé par le client est acceptable pour le serveur, la primitive de service de réponse doit contenir le paramètre `Negotiated_xDLMS_Context`. Il contient les éléments du contexte xDLMS négocié, contenus dans l'APDU xDLMS `InitiateResponse` et placés dans le champ des informations sur l'utilisateur de l'APDU AARE. Si l'APDU xDLMS `InitiateRequest` a été chiffrée, l'APDU xDLMS `InitiateResponse` doit également être chiffrée de la même manière.

L'élément `Negotiated_DLMS_Version_Number` contient le numéro de version DLMS négocié. Voir 4.2.3.1.

L'élément `Negotiated_DLMS_Conformance` contient le bloc de conformité négocié. Voir 7.3.1.

L'élément `Server_Max_Receive_PDU_Size` contient la longueur maximale des APDU xDLMS que le serveur peut recevoir. Voir le Tableau 1.

L'élément `VAA_name` contient la valeur fictive de 0x0007 dans le cas du référencement LN et l'attribut `base_name` de l'objet Association actuel, 0xFA00, dans le cas du référencement SN.

Si le contexte xDLMS proposé par le client n'est pas acceptable pour le serveur, la primitive de service de réponse doit contenir le paramètre `xDLMS_Initiate_Error`. Il est contenu dans l'APDU `ConfirmedServiceError`, avec les éléments de diagnostic appropriés, et placé dans le champ d'informations sur l'utilisateur de l'APDU AARE.

Le paramètre `User_Information` est facultatif. S'il est présent, il doit être transmis à la couche de support, à condition qu'elle soit capable de le supporter. La primitive d'indication doit alors contenir les informations spécifiques à l'utilisateur, contenues dans la ou les couches de protocole inférieures de support. Voir l'Annexe A.

NOTE 2 Le paramètre `User_Information` du service COSEM-OPEN ne doit pas être confondu avec le champ d'informations sur l'utilisateur des APDU AARQ/AARE.

Le paramètre `Service_Class` est obligatoire. Il indique si le service doit être appelé de manière confirmée ou non confirmée. La gestion de ce paramètre peut dépendre du profil de communication. Voir l'Annexe A.

Utilisation

Les séquences logiques possibles des primitives de service COSEM-OPEN sont présentées dans la Figure 8:

- pour l'établissement d'une AA confirmée, avec succès ou non, l'élément a);
- pour l'établissement d'une AA non confirmée, élément b);
- dans le cas d'une AA préétablie ou d'une tentative infructueuse en raison d'une erreur locale, l'élément c).

La primitive `.request` est appelée par l'AP du client pour demander l'établissement d'une AA confirmée ou non confirmée avec une AP du serveur.

NOTE 3 Avant l'appel de la primitive COSEM-OPEN.request, les couches physiques doivent être connectées. En fonction du profil de communication, l'appel de cette primitive peut également impliquer la connexion d'autres couches inférieures.

À réception de l'appel de demande, l'AL construit et envoie une APDU AARQ au serveur.

La primitive `.indication` est générée par l'AL du serveur à réception d'une APDU AARQ correctement formatée.

La primitive `.response` est appelée par l'AP du serveur pour indiquer à l'AL si l'AA proposée est acceptée ou non. Elle est appelée uniquement si l'AA proposée est confirmée. L'AL construit ensuite une APDU AARE et l'envoie à son homologue, en incluant les paramètres de service reçus de l'AP.

La primitive `.confirm` est générée par l'AL du client pour indiquer à l'AP du client si l'AA précédemment demandée est acceptée ou non:

- à distance, à réception d'une APDU AARE;

- localement, si l'AA demandée existe déjà. Cela inclut les AA préétablies;
- localement, si la primitive .request correspondante a été appelée avec Service_Class == Unconfirmed;
- localement, si l'AA demandée n'est pas autorisée;
- localement, si une erreur est détectée: paramètres manquants ou incorrects, échecs durant l'établissement des connexions aux couches inférieures demandées, connexion physique manquante, etc.

Le protocole d'établissement d'une AA est indiqué en 7.2.4. Les règles spécifiques au profil de communication sont indiquées à l'Annexe A.

6.3 Service COSEM-RELEASE

Fonction

La fonction du service COSEM-RELEASE consiste à libérer sans perte de données une AA existante. En fonction de la méthode d'appel de ce service, il utilise le service A-RELEASE de l'ACSE ou non.

Sémantique des primitives de service

Les primitives du service COSEM-RELEASE doivent spécifier des paramètres, comme indiqué dans le Tableau 12.

Tableau 12 – Paramètres de service des primitives de service COSEM-RELEASE

	.request	.indication	.response	.confirm
Use_RLRQ_RLRE	U	C(=)	C(=)	-
Reason	U	U(=)	U	U(=)
Proposed_xDLMS_Context	C	C(=)	-	-
Negotiated_xDLMS_Context	-	-	C	C(=)
Local_Or_Remote	-	-	-	M
Result	-	-	M	M
Failure_Type	-	-	-	C
User_Information	U	C(=)	U	C(=)

Le paramètre Use_RLRQ_RLRE de la primitive .request est facultatif. S'il est présent, sa valeur peut être FALSE (valeur par défaut) ou TRUE. Il indique s'il convient d'utiliser ou non le service A-RELEASE de l'ACSE, qui implique un échange d'APDU RLRQ/RLRE. Le service A-RELEASE et les APDU RLRQ/RLRE sont indiqués en 7.2. Le paramètre Use_RLRQ_RLRE de la primitive .response est conditionnel. S'il était présent dans la primitive .indication et si sa valeur était TRUE, il doit également être présent et sa valeur doit être TRUE. Sinon, il ne doit pas être présent ou sa valeur doit être FALSE.

Si la valeur du paramètre Use_RLRQ_RLRE est FALSE, l'AA peut être libérée en déconnectant la couche de support de l'AL.

Le paramètre Reason est facultatif. Il peut être présent uniquement si la valeur de Use_RLRQ_RLRE est TRUE. Il est contenu dans le champ Reason de l'APDU RLRQ/RLRE respectivement.

Lorsqu'il est utilisé dans la primitive .request, ce paramètre identifie le niveau général d'urgence de la demande. Il est défini sur l'une des valeurs symboliques suivantes:

- normal;

- urgent (non disponible dans DLMS/COSEM); ou
- user defined.

Lorsqu'il est utilisé dans la primitive .response, ce paramètre identifie des informations sur le motif d'acceptation ou de rejet par l'accepteur de la demande de libération. À noter que dans DLMS/COSEM, le serveur ne peut pas rejeter la demande de libération. Il est défini sur l'une des valeurs symboliques suivantes:

- normal;
- not finished; ou
- user defined.

NOTE La valeur «not finished» est utilisée dans la primitive .response lorsque l'accepteur est forcé de libérer l'association mais souhaite donner un avertissement indiquant qu'il a des informations supplémentaires à envoyer ou à recevoir.

Le paramètre Proposed_xDLMS_Context est conditionnel. Il est présent uniquement si la valeur du paramètre Use_RLRQ_RLRE est TRUE et si l'AA à libérer a été établie avec un contexte d'application utilisant le chiffrement. Cette option permet de sécuriser le service COSEM-RELEASE et d'éviter ainsi une attaque par déni de service qui peut être exécutée en libérant l'AA sans y être autorisé.

Dans la primitive .request, le paramètre Proposed_xDLMS_Context doit être le même que dans la primitive de service COSEM-OPEN.request, une fois l'AA à libérer établie. Il est contenu dans l'APDU xDLMS InitiateRequest, authentifié et chiffré de la même manière que dans l'AARQ et placé dans le champ des informations sur l'utilisateur de l'APDU RLRQ.

Si l'APDU xDLMS InitiateRequest peut être déchiffrée avec succès, la primitive .response doit comporter le même paramètre Negotiated_xDLMS_Context que dans la primitive COSEM-OPEN.response. Il est contenu dans l'APDU xDLMS InitiateResponse, authentifié et chiffré de la même manière que dans l'AARE et placé dans le champ des informations sur l'utilisateur de l'APDU RLRE.

Sinon, l'APDU RLRQ est supprimée de manière silencieuse.

Le paramètre Local_or_Remote est obligatoire. Il indique l'origine de la primitive COSEM-RELEASE.confirm.

Il est défini sur Remote si:

- une APDU RLRE a été reçue de la part du serveur; ou
- une primitive de service de confirmation de la déconnexion a été reçue.

Il est défini sur Local si la primitive a été générée localement.

Le paramètre Result est obligatoire. Dans la primitive .response, il indique si l'AP du serveur peut accepter la demande de libération de l'AA ou non. Étant donné que les serveurs ne peuvent pas refuser de telles demandes, il convient que sa valeur soit normalement SUCCESS, à moins que l'AA référencée n'existe pas.

Le paramètre Failure_Type est conditionnel. Il est présent si Result == ERROR. Dans ce cas, il indique la raison de l'échec. Il s'agit d'un paramètre généré localement du côté client.

Le paramètre User_Information de la primitive .request est facultatif. S'il est présent, il est transmis à la couche de support, à condition qu'elle soit capable de le supporter. La primitive .indication contient alors les informations spécifiques à l'utilisateur, contenues dans la ou les couches de protocole inférieures de support. De la même manière, il est facultatif dans la primitive .response. S'il est présent, il est transmis à la couche de support. Dans la

primitive `.confirm`, il peut être présent uniquement lorsque le service est confirmé à distance. Il contient alors les informations spécifiques à l'utilisateur, transportées par la ou les couches de protocole inférieures de support.

La spécification du contenu du paramètre `User_Information` n'entre pas dans le domaine d'application de la présente norme internationale. Voir aussi l'Annexe A.

Utilisation

Des exemples de séquences logiques des primitives de service COSEM-RELEASE sont présentés à la Figure 8:

- pour une libération réussie d'une AA confirmée, élément a);
- pour une libération d'une AA non confirmée, élément b), et
- pour une tentative échouée en raison d'une erreur locale, point c).

L'utilisation du service COSEM-RELEASE dépend de la valeur du paramètre `Use_RLRQ_RLRE`. Lorsqu'il est appelé avec `Use_RLRQ_RLRE == TRUE`, le service est basé sur le service A-RELEASE de l'ACSE. Sinon, l'appel du service entraîne la déconnexion de la couche de support.

La primitive `.request` est appelée par l'AP du client pour demander la libération d'une AA confirmée ou non confirmée avec un AP du serveur. À réception de l'appel de la demande avec `Use_RLRQ_RLRE == TRUE`, l'AL construit et envoie une APDU RLRQ au serveur. Sinon, il envoie une primitive `XX-DISCONNECT.request` (où XX désigne la couche de protocole inférieure de support).

La primitive `.indication` est générée par l'AL du serveur si:

- une APDU RLRQ est reçue. Si une erreur de déchiffrement se produit, l'APDU RLRQ est supprimée de manière silencieuse (aucune primitive `.indication` n'est générée); ou
- une primitive `XX-DISCONNECT.request` est reçue.

La primitive `.response` est appelée par l'AP du serveur, mais uniquement si l'AA à libérer est confirmée. À noter que l'AP de serveur ne peut pas refuser cette demande. À réception de la primitive de service `.response`, l'AL du serveur:

- envoie une APDU RLRE si le paramètre `Use_RLRQ_RLRE` est `TRUE`; ou
- envoie une primitive `XX-DISCONNECT.response`.

La primitive `.confirm` est générée par l'AL du client pour indiquer à l'AP du client si la libération demandée de l'AA est acceptée ou non:

- à distance, à réception d'une primitive `XX-DISCONNECT.cnf`. La couche de support est déconnectée; ou
- à distance, à réception d'une APDU RLRE. La couche de support n'est pas déconnectée; ou
- localement, à expiration d'un délai d'attente pour une APDU RLRE; ou
- localement, lors de l'envoi d'une APDU RLRQ pour libérer une AA non confirmée; ou
- localement, lors de la détection d'une erreur locale: paramètres manquants ou incorrects, échec de communication au niveau de la couche de protocole inférieure, etc.

Si l'APDU RLRE reçue contient une APDU xDLMS `InitiateResponse` chiffrée mais ne peut pas être déchiffrée, l'APDU RLRE doit être supprimée. C'est au client de gérer la situation.

Le protocole de libération d'une AA est indiqué en 7.2.5. Les règles spécifiques au profil de communication sont indiquées à l'Annexe A. Voir aussi 7.2.1.

6.4 Service COSEM-ABORT

Fonction

La fonction du service COSEM-ABORT est d'indiquer une déconnexion non sollicitée de la couche de support.

Sémantique

Les primitives du service COSEM-ABORT doivent spécifier des paramètres, comme indiqué dans le Tableau 13.

Tableau 13 – Paramètres de service des primitives de service COSEM-ABORT

	.indication
Diagnostics	U

Le paramètre Diagnostics est facultatif. Il doit indiquer la raison possible de la déconnexion et peut également contenir des informations dépendant de la couche de protocole inférieure. La spécification du contenu de ce paramètre n'entre pas dans le domaine d'application de la présente norme internationale.

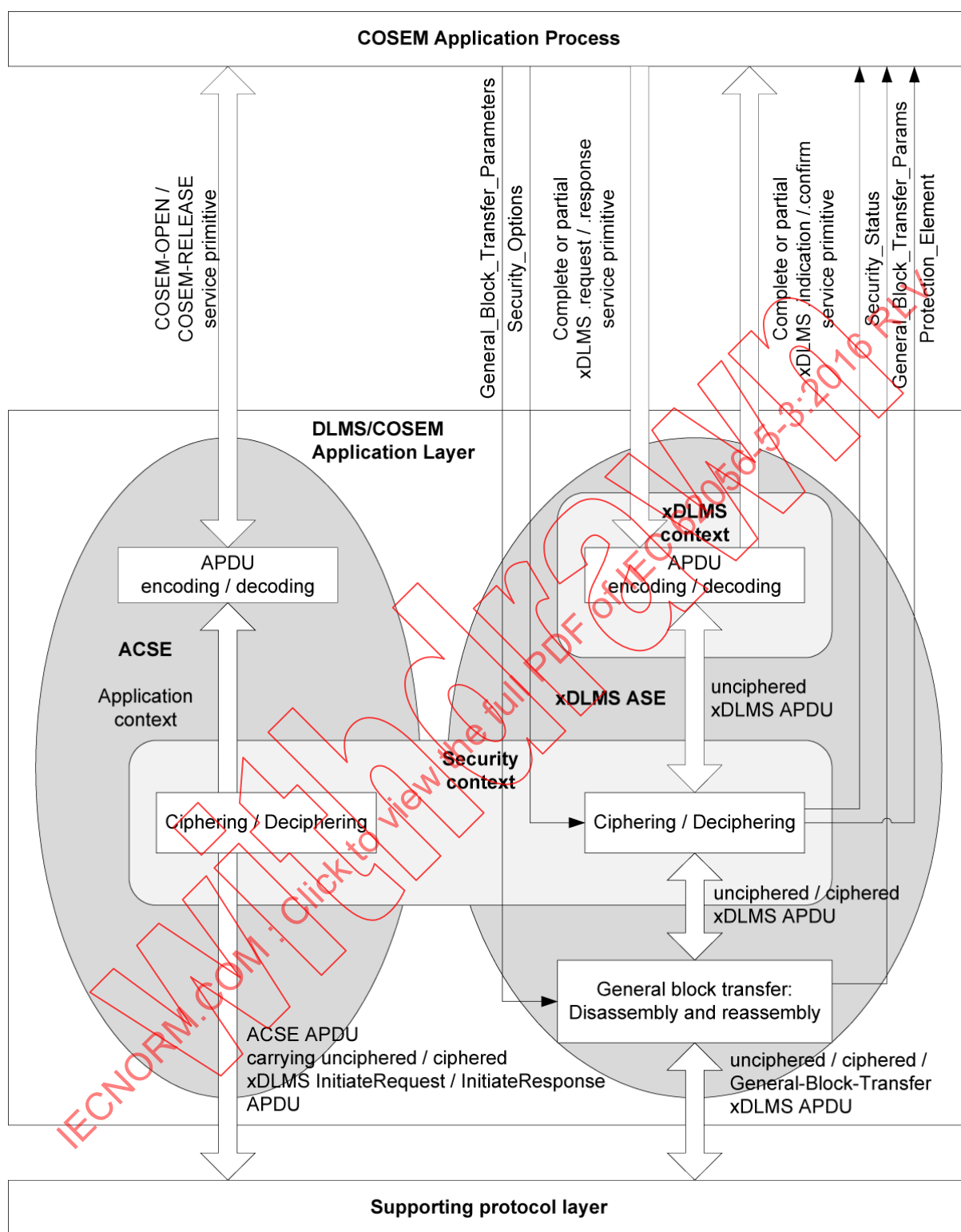
Utilisation

La primitive COSEM-ABORT.indication est générée localement du côté client et serveur pour indiquer à l'AP COSEM qu'une connexion à la couche inférieure a été fermée de manière non sollicitée. L'origine d'un tel événement peut être un événement externe (par exemple, la ligne physique est rompue) ou une action d'un AP gestionnaire des connexions à la couche de support, présente dans certains profils, lorsque la connexion à la couche de support n'est pas gérée par l'AL COSEM. Cela doit entraîner l'annulation par les AP COSEM de toutes les AA existantes, sauf celles préétablies du côté serveur.

Le protocole du service COSEM-ABORT est spécifié en 7.2.5.3.

6.5 Paramètres de protection et de transfert général de blocs

Pour contrôler la protection cryptographique des APDU xDLMS et le mécanisme GBT, des paramètres de service supplémentaires sont échangés entre l'AL et l'AP comme présenté à la Figure 9 et dans le Tableau 14.



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NOTE Pour les services initiés par le client, les primitives de services sont .request, .indication, .response et .confirm. Pour les services non sollicités (initiés par le serveur), les primitives de service sont .request et .indication.

Anglais	Français
COSEM Application Process	Processus d'application COSEM
COSEM-OPEN/ COSEM-RELEASE service primitive	Primitive de service COSEM-OPEN/ COSEM-RELEASE
Complete or partial xDLMS .request/.response service primitive	Primitive de service demande/réponse xDLMS complète ou partielle

Anglais	Français
Complete or partial xDLMS .indication/.confirm service primitive	Primitive de service indication/confirmation xDLMS complète ou partielle
DLMS/COSEM Application Layer	Couche application xDLMS/COSEM
APDU encoding/decoding	Codage/Décodage de l'APDU
xDLMS context	Contexte xDLMS
Application context	Contexte d'application
xDLMS ASE	ASE xDLMS
Unciphered xDLMS APDU	APDU xDLMS non chiffrée
Security context	Contexte de sécurité
Ciphering/deciphering	Chiffrement/Déchiffrement
Unciphered / Ciphered xDLMS APDU	APDU xDLMS chiffrée/non chiffrée
ACSE APDU carrying unciphered/ciphered xDLMS InitiateRequest/ InitiateResponse APDU	APDU ACSE transportant les APDU xDLMS non cryptées/chiffrées InitiateRequest/ InitiateResponse
General bloc transfer: disassembly and reassembly	Transfert général de blocs: désassemblage et réassemblage
Unciphered / Ciphered General-Block-Transfer xDLMS APDU	APDU xDLMS de GBT non chiffrée/ chiffrée
Supporting protocol layer	Couche de protocole de support

Figure 9 – Paramètres supplémentaires de service pour contrôler la protection cryptographique et le transfert général de blocs

Tableau 14 – Paramètres supplémentaires de service

	.request	.indication	.response	.confirm
Additional_Service_Parameters	U	–	U (=)	
Invocation_Type	M	–	M (=)	–
Security_Options	C	–	C (=)	–
General_Block_Transfer_Parameters	C	–	C (=)	–
Block_Transfer_Streaming	M	–	M (=)	–
Block_Transfer_Window	M	–	M (=)	–
Service_Parameters	M	–	M (=)	–
Additional_Service_Parameters	–	U	–	U (=)
Invocation_Type	–	U	–	U (=)
Security_Status	–	C	–	C (=)
General_Block_Transfer_Parameters	–	C	–	C (=)
Block_Transfer_Window	–	M	–	M (=)
Service_Parameters	–	M	–	M (=)
Protection_Element	–	C	–	C (=)
NOTE Les primitives de service disponibles dépendent du type de service.				

Les paramètres Additional_Service_Parameters ne sont présents que si le chiffrement ou le GBT est utilisé.

Le paramètre Invocation_Type indique si l'appel de service est complet ou partiel. Valeurs possibles: COMPLETE, FIRST-PART, ONE-PART et LAST-PART.

NOTE 1 Les appels partiels de service peuvent être utiles lorsque les paramètres de service sont longs. Cependant, il n'y a aucune relation directe entre les appels partiels de service et les APDU General-Block-Transfer (APDU GBT).

Le paramètre `Security_Options` contient des informations sur la protection à appliquer par l'AL. Voir le Tableau 15. Il n'est présent que si `Invocation_Type` = COMPLETE ou FIRST-PART.

Le paramètre `General_Block_Transfer_Parameters` fournit des informations sur les capacités de diffusion en flux du GBT:

- le paramètre `Block_Transfer_Streaming` n'est présent que dans les primitives de service `.request` et `.response`. Il est passé par l'AP à l'AL pour indiquer que l'AL est autorisée à envoyer des APDU General-Block-Transfer à l'aide de la diffusion en flux (TRUE) ou non (FALSE);
- le paramètre `Block_Transfer_Window` indique la dimension de la fenêtre prise en charge, c'est-à-dire le nombre maximal de blocs qui peuvent être reçus dans une fenêtre.

Le paramètre `General_Block_Transfer_Parameters` n'est présent que si `Invocation_Type` = COMPLETE ou FIRST-PART.

Le processus de diffusion en flux lui-même est géré par l'AL. Voir 7.3.12.

Les paramètres `Service_Parameters` sont obligatoires: ils incluent les paramètres de l'appel de service xDLMS lié à l'attribut d'objet ou à la méthode COSEM. Si `Invocation_Type` != COMPLETE, alors le type d'appel comporte une partie des paramètres de service.

Le paramètre `Security_Status` est conditionnel: il est présent uniquement lorsque la protection cryptographique a été appliquée. Il contient des informations sur la protection qui a été vérifiée/supprimée par l'AL. Il peut être présent dans tous les types d'appels de service. Voir le Tableau 15.

Le paramètre `Protection_Element` est conditionnel: il n'est présent que si l'APDU a été authentifiée. Voir le Tableau 15.

Tableau 15 – Paramètres de sécurité

	.request	.indication	.response	.confirm
Security_Options	C	–	C (=)	–
Security_Options_Element	M	–	M (=)	–
Security_Protection_Type	M	–	M (=)	–
Glo_Ciphering	S	–	S (=)	–
Ded_Ciphering	S	–	S (=)	–
General_Glo_Ciphering	S	–	S (=)	–
General_Ded_Ciphering	S	–	S (=)	–
System_Title	C	–	C (=)	–
Security_Control	M	–	M (=)	–
Security_Status	–	C	–	C (=)
Security_Status_Element	–	M	–	M (=)
Security_Protection_Type	–	M	–	M (=)
Glo_Ciphering	–	S	–	S (=)
Ded_Ciphering	–	S	–	S (=)
General_Glo_Ciphering	–	S	–	S (=)
General_Ded_Ciphering	–	S	–	S (=)
System_Title	–	C	–	C (=)
Security_Control	–	M	–	M (=)
Protection_Element	–	C	–	C (=)
Frame_Counter	–	M	–	M (=)
Authentication_Tag	–	M	–	M (=)
NOTE Les primitives de service disponibles dépendent du type de service.				

Le paramètre Security_Options n'est présent que si le contexte d'application est un contexte chiffré et s'il est nécessaire de chiffrer la primitive de service .request / .response. Il contient le sous-paramètre Security_Options_Element. Il n'est présent que si Invocation_Type = COMPLETE ou FIRST-PART.

Le paramètre Security_Status n'est présent que si le contexte d'application est un contexte chiffré et si la primitive de service .indication / .confirm a été chiffrée. Il contient le sous-paramètre Security_Status_Element. Il peut être présent dans tous les types d'appels de service.

Les paramètres Security_Options_Element et Security_Status_Element incluent:

- Security_Protection_Type, identifie l'APDU chiffrée qui doit être / a été utilisée:
 - Glo_Ciphering: l'APDU glo-ciphering (APDU chiffrement global) spécifique au service doit être / a été utilisée (par exemple, glo-get-response);
 - Ded_Ciphering: l'APDU ded-ciphering (APDU chiffrement dédié) spécifique au service doit être / a été utilisée (par exemple, ded-get-response);
 - General_Glo_Ciphering: l'APDU general-glo-ciphering (APDU chiffrement général global) doit être / a été utilisée;
 - General_Ded_Ciphering: l'APDU general-ded-ciphering (APDU chiffrement général dédié) doit être / a été utilisée.
- Le paramètre System_Title n'est présent qu'avec General_Glo_Ciphering et General_Ded_Ciphering. Il comporte le titre système de l'émetteur.

NOTE 2 L'inclusion du titre système de l'émetteur a pour objet d'autoriser l'autre partie à construire le vecteur d'initialisation dans lequel le titre système n'a pas été échangé d'une autre façon; voir 5.4.8.3.4.6.

- Le champ Security_Control contient l'octet de contrôle de sécurité; voir Tableau 6.

Le paramètre Protection_Element n'est présent que si l'APDU a été authentifiée. Il peut être présent dans tous les types d'appels de service, mais il peut être vide s'il n'est pas encore disponible. Il contient:

- Le Frame_Counter, comportant le champ d'appel du vecteur d'initialisation; voir 5.4.8.3.4.5.
- L'étiquette d'authentification.

6.6 Service GET

Fonction

Le service GET est utilisé avec le référencement LN. Il peut être appelé de manière confirmée ou non confirmée. Sa fonction est de lire la valeur d'un ou de plusieurs attributs d'objet d'interface COSEM. Le résultat peut être envoyé dans une seule réponse ou, s'il est trop long, dans plusieurs réponses, avec un transfert de bloc.

Sémantique

Les primitives du service GET doivent fournir des paramètres, comme indiqué dans le Tableau 16.

Tableau 16 – Paramètres de service du service GET

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	M (=)	M (=)
Request_Type	M	M (=)	–	–
COSEM_Attribute_Descriptor { COSEM_Attribute_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Attribute_Id	M	M (=)		
Access_Selection_Parameters	U	U (=)		
Access_Selector	M	M (=)		
Access_Parameters	M	M (=)		
Block_Number	C	C (=)	–	–
Response_Type	–	–	M	M (=)
Result	–	–	M	M (=)
Get_Data_Result { Get_Data_Result }	–	–	S	S (=)
Data			S	S (=)
Data_Access_Result			S	S (=)
DataBlock_G	–	–	S	S (=)
Last_Block			M	M (=)
Block_Number			M	M (=)
Result			M	M (=)
Raw_Data			S	S (=)
Data_Access_Result			S	S (=)
NOTE Pour les paramètres de sécurité, voir le Tableau 15.				

Le paramètre Invoke_Id identifie l'instance de l'appel de service.

Le paramètre Priority indique le niveau de priorité associé à l'instance de l'appel de service: normale (FALSE) ou haute (TRUE).

Le paramètre `Service_Class` indique si le service est confirmé ou non confirmé. La gestion de ce paramètre dépend du profil de communication; voir l'Annexe A.

L'utilisation des paramètres `Request_Type` et `Response_Type` est décrite dans le Tableau 17.

Tableau 17 – Types de demandes et de réponses du service GET

Type de demande		Type de réponse	
NORMAL	La valeur d'un attribut unique est demandée.	NORMAL	Le résultat complet est fourni.
		ONE-BLOCK	Un bloc du résultat est fourni.
NEXT	Le bloc de données suivant est demandé.	ONE-BLOCK	Voir ci-dessus.
		LAST-BLOCK	Le dernier bloc du résultat est fourni.
WITH-LIST	La valeur d'une liste d'attributs est demandée.	WITH-LIST	Le résultat complet est fourni.
		ONE-BLOCK	Voir ci-dessus.
NOTE Le même paramètre Response_Type peut être spécifié plusieurs fois, pour indiquer les réponses possibles pour chaque type de demande.			

Le paramètre `COSEM_Attribute_Descriptor` se rapporte à un attribut d'objet COSEM. Il est présent lorsque `Request_Type == NORMAL` ou `WITH-LIST`. Il s'agit d'un paramètre composite:

- le doublet (`COSEM_Class_Id`, `COSEM_Object_Instance_Id`) fait référence de façon non ambiguë à une seule instance d'objet COSEM;
- l'élément `COSEM_Object_Attribute_Id` identifie le ou les attributs de l'instance d'objet. `COSEM_Object_Attribute_Id == 0` référence tous les attributs publics de l'objet (fonction `Attribute_0`; voir 4.2.3.11);
- le paramètre `Access_Selection_Parameters` figure uniquement lorsque `COSEM_Object_Attribute_Id != 0` et si l'accès sélectif à l'attribut donné est disponible; voir 4.2.3.9. Les sous-paramètres `Access_Selector` et `Access_Parameters` sont définis dans les définitions d'objet d'interface COSEM; voir l'IEC 62056-6-2.

Une primitive de service GET-REQUEST-NORMAL contient un descripteur d'attribut COSEM unique. Une primitive de service GET-REQUEST-WITH-LIST contient une liste de descripteurs d'attributs COSEM; leur nombre est limité par le paramètre `server-max-receive-pdu-size`: une primitive de service GET.request doit toujours être contenue dans une seule APDU.

Le paramètre `Block_Number` est utilisé dans la primitive de service GET-REQUEST-NEXT. Il contient le numéro du dernier bloc de données reçu correctement.

Si la forme codée de la réponse passe dans une seule APDU, le paramètre `Result` est de type `Get_Data_Result`:

- le choix `Data` contient la valeur de l'attribut au moment de l'accès; ou
- le choix `Data_Access_Result` indique la raison de l'échec de lecture de cet attribut.

Une primitive de service GET-RESPONSE-NORMAL contient un seul paramètre `Get_Data_Result`. Une primitive de service GET-RESPONSE-WITH-LIST contient une liste de paramètres `Get_Data_Result`; leur nombre et leur ordre doivent être identiques à ceux des paramètres `COSEM_Attribute_Descriptor` dans la demande.

Si `COSEM_Object_Attribute_Id == 0` (`Attribute_0`), le paramètre `Data` doit être une structure contenant la valeur de tous les attributs publics dans l'ordre de leur apparition dans la spécification d'objet donnée. Pour les attributs auxquels aucun droit d'accès n'est octroyé

dans l'AA donnée ou qui ne sont pas accessibles pour toute autre raison, la valeur NULL doit être renvoyée.

Si la forme codée de la réponse ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs de données à l'aide du mécanisme spécifique au service ou du mécanisme de transfert général de blocs.

Si le mécanisme de transfert de blocs spécifique au service est utilisé, le paramètre Result est de type DataBlock_G. Il contient les informations de contrôle de transfert de bloc et l'élément raw-data:

- l'élément Last_Block indique si le bloc actuel est le dernier (TRUE) ou non (FALSE);
- l'élément Block_Number contient le numéro du bloc envoyé;
- l'élément Result (interne) contient le paramètre Raw_Data ou Data_Access_Result. Dans cette formule:
 - si la valeur d'un attribut unique a été demandée, Raw_Data contient une partie de la valeur de l'attribut (Data). Si la valeur Data ne peut pas être fournie, la réponse doit être de type GET-RESPONSE-NORMAL avec Data_Access_Result;
 - si la valeur d'une liste d'attributs a été demandée, Raw_Data contient une partie de la liste de Get_Data_Results (soit Data, soit Data_Access_Result pour chaque attribut);
 - si les données brutes ne peuvent pas être fournies, Data_Access_Result doit apporter la raison. Pour les codes d'erreur, voir 7.3.3.

Utilisation

Des exemples de séquences logiques des primitives de service GET sont présentés à la Figure 8:

- pour un GET réussi confirmé, point a);
- pour un GET non confirmé, point d); et
- pour une tentative échouée en raison d'une erreur locale, point c).

La primitive GET.request est appelée par l'AP du client pour lire la valeur d'un attribut ou de tous les attributs d'un ou de plusieurs objets COSEM de l'AP du serveur. La première demande doit toujours être définie sur le type Request_Type == NORMAL ou WITH-LIST. Une primitive de service GET-REQUEST-NEXT est appelée uniquement lorsque le serveur n'a pas pu livrer l'ensemble des données dans une seule réponse, c'est-à-dire suite à la réception d'une primitive .confirm de type Response_Type == ONE-BLOCK. À réception de la primitive .request, l'AL du client génère l'APDU Get-Request appropriée au type de demande et l'envoie au serveur.

La primitive GET.indication est générée par la couche application du serveur à réception de l'APDU Get-Request.

La primitive GET.response est appelée par l'AP du serveur, si la classe Service_Class == Confirmed, afin d'envoyer une réponse à une primitive .indication reçue. Si l'ensemble des données demandées peut être inséré dans une seule APDU, la primitive .response est appelée avec le type Response_Type == NORMAL ou WITH-LIST, selon le cas. Sinon, elle est appelée avec le type Response_Type == ONE-BLOCK, puis avec LAST-BLOCK.

La primitive GET.confirm est générée par l'AL du client pour accuser réception d'une APDU Get-Response.

Le protocole du service GET est spécifié en 7.3.3.

6.7 Service SET

Fonction

Le service SET est utilisé avec le référencement LN. Il peut être appelé de manière confirmée ou non confirmée. Sa fonction est d'écrire la valeur d'un ou de plusieurs attributs d'objets d'interface COSEM. Les données à écrire peuvent être envoyées dans une seule demande ou, si elle est trop longue pour tenir dans une seule demande, dans plusieurs demandes, grâce au transfert de bloc.

Sémantique

Les primitives de service SET doivent fournir des paramètres, comme indiqué dans le Tableau 18.

Tableau 18 – Paramètres du service SET

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	M (=)	M (=)
Request_Type	M	M (=)	–	–
COSEM_Attribute_Descriptor { COSEM_Attribute_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Attribute_Id	M	M (=)		
Access_Selection_Parameters	U	U (=)		
Access_Selector	M	M (=)		
Access_Parameters	M	M (=)		
Data {Data }	C	C (=)	–	–
DataBlock_SA	C	C (=)	–	–
Last_Block	M	M (=)		
Block_Number	M	M (=)		
Raw_Data	M	M (=)		
Response_Type	–	–	M	M (=)
Result { Result }	–	–	C	C (=)
Block_Number	–	–	C	C (=)
NOTE Pour les paramètres de sécurité, voir le Tableau 15.				

Le paramètre Invoke_Id identifie l'instance de l'appel de service.

Le paramètre Priority indique le niveau de priorité associé à l'instance de l'appel de service: normale (FALSE) ou haute (TRUE).

Le paramètre Service_Class indique si le service est confirmé ou non confirmé. La gestion de ce paramètre dépend du profil de communication; voir l'Annexe A.

L'utilisation des paramètres Request_Type et Response_Type est décrite dans le Tableau 19.

Tableau 19 – Types de demandes et de réponses du service SET

Type de demande		Type de réponse	
NORMAL	La référence d'un attribut unique et l'ensemble des données à écrire sont envoyés.	NORMAL	Le résultat est fourni.
FIRST-BLOCK	La référence d'un attribut unique et le premier bloc de données à écrire sont envoyés.	ACK-BLOCK	La bonne réception du bloc est confirmée.
ONE-BLOCK	L'un des blocs de données à écrire est envoyé.		
LAST-BLOCK	Le dernier bloc de données à écrire est envoyé.	LAST-BLOCK	La bonne réception du dernier bloc est confirmée et le résultat est fourni.
		LAST-BLOCK-WITH-LIST	La bonne réception du dernier bloc est confirmée et la liste des résultats est fournie.
WITH-LIST	La référence d'une liste d'attributs et l'ensemble des données à écrire sont envoyés.	WITH-LIST	La liste des résultats est fournie.
FIRST-BLOCK-WITH-LIST	La référence d'une liste d'attributs et le premier bloc des données à écrire sont envoyés.	ACK-BLOCK	La bonne réception du bloc est confirmée.
NOTE Le même type de réponse (Response_Type) peut figurer plusieurs fois, pour indiquer les réponses possibles pour chaque demande.			

Le paramètre COSEM_Attribute_Descriptor se rapporte à un attribut d'objet COSEM. Il est présent lorsque le type Request_Type == NORMAL, FIRST-BLOCK, WITH-LIST et FIRST-BLOCK-WITH-LIST. Il s'agit d'un paramètre composite:

- le doublet (COSEM_Class_Id, COSEM_Object_Instance_Id) fait référence de façon non ambiguë à une seule instance d'objet COSEM;
- COSEM_Object_Attribute_Id identifie le(s) attribut(s) de l'instance d'objet. COSEM_Object_Attribute_Id == 0 référence tous les attributs publics de l'objet (fonction Attribute_0; voir 4.2.3.11);
- le paramètre Access_Selection_Parameters figure uniquement lorsque COSEM_Object_Attribute_Id != 0 et si l'accès sélectif à l'attribut donné est disponible; voir 4.2.3.9. Les sous-paramètres Access_Selector et Access_Parameters sont définis dans les définitions d'objet d'interface COSEM de l'IEC 62056-6-2.

Une primitive de service SET-REQUEST-NORMAL ou SET-REQUEST-WITH-FIRST-BLOCK contient un seul descripteur d'attribut COSEM. Une primitive de service SET-REQUEST-WITH-LIST ou SET-REQUEST-FIRST-BLOCK-WITH-LIST contient une liste de descripteurs d'attributs COSEM; leur nombre est limité par le paramètre server-max-receive-pdu-size: tous les descripteurs d'attributs COSEM ainsi qu'une partie des données à écrire doivent être contenus dans une seule APDU.

Le paramètre Data contient les données requises pour écrire la valeur des attributs référencés. Le nombre et l'ordre des paramètres Data doivent être identiques à ceux des paramètres COSEM_Attribute_Descriptor.

Si COSEM_Object_Attribute_Id == 0 (Attribute_0), le paramètre Data envoyé doit être une structure des attributs publics respectant leur ordre d'apparition dans la spécification d'objet donnée et contenant pour chacun des attributs une valeur ou la valeur NULL, indiquant que l'attribut donné n'a pas besoin d'être défini.

Si la forme codée du paramètre Data ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs à l'aide du mécanisme spécifique au service ou du mécanisme de transfert général de blocs.

Si le mécanisme de transfert de blocs spécifique au service est utilisé, le paramètre DataBlock_SA contient les informations de contrôle de transfert de bloc et l'élément raw-data:

- l'élément Last_Block indique si le bloc actuel est le dernier (TRUE) ou non (FALSE);
- l'élément Block_Number contient le numéro du bloc envoyé;
- l'élément Raw_Data contient une partie des données à écrire.

Les paramètres Result figurent dans la primitive .response de type Response_Type != ACK-BLOCK. Leur nombre et leur ordre doivent être identiques à ceux des paramètres COSEM_Attribute_Descriptor de la demande. Chaque paramètre Result doit contenir l'information «réussite» (success) ou la raison de l'échec d'écriture de l'attribut référencé (Data_Access_Result). Dans la primitive .request COSEM_Object_Attribute_Id == 0 (Attribute_0), le paramètre Result doit contenir une liste de résultats, soit l'information «réussite» (success), soit la raison de l'échec d'écriture de l'attribut (Data_Access_Result), pour chaque attribut public, dans l'ordre où ils apparaissent dans la spécification d'objet correspondante.

Le paramètre Block_Number doit être présent lorsque le paramètre Response_Type == ACK-BLOCK, LAST-BLOCK ou LAST-BLOCK-WITH-LIST. Il contient le numéro du dernier bloc de données reçu correctement.

Utilisation

Des exemples de séquences logiques des primitives de service SET sont présentés à la Figure 8:

- pour un SET réussi confirmé, point a),
- pour un SET non confirmé, point d); et
- pour une tentative échouée en raison d'une erreur locale, point c).

La primitive SET.request est appelée par l'AP du client pour écrire la valeur d'un ou de tous les attributs d'un ou de plusieurs objets COSEM de l'AP du serveur. Si l'ensemble des données à envoyer peut être contenue dans une seule APDU, la primitive .request doit être appelée avec le type Request_Type == NORMAL ou WITH-LIST, selon le cas. Sinon, elle doit être appelée avec le type Request_Type == FIRST-BLOCK ou FIRST-BLOCK-WITH-LIST, puis avec le type Request_Type == ONE-BLOCK et enfin avec LAST-BLOCK, selon le cas. À réception de la primitive .request, l'AL du client génère l'APDU Set-Request correspondant au Request_Type et l'envoie au serveur.

La primitive SET.indication est générée par l'AL du serveur à réception de l'APDU Set-Request.

La primitive SET.response est appelée par l'AP du serveur, si la classe Service_Class == Confirmed, afin d'envoyer une réponse à une primitive .indication reçue. Si les données ont été envoyées dans une seule APDU, la primitive .response est appelée avec Response_Type == NORMAL ou WITH-LIST, selon le cas. Sinon, elle est appelée avec le type Response_Type == ACK-BLOCK, puis avec LAST-BLOCK ou LAST-BLOCK-WITH-LIST, selon le cas.

La primitive SET.confirm est générée par l'AL du client pour accuser réception d'une APDU Set-Response.

Le protocole du service SET est spécifié en 7.3.4.

6.8 Service ACTION

Fonction

Le service ACTION est utilisé avec le référencement LN. Il peut être appelé de manière confirmée ou non confirmée. Sa fonction est d'appeler une ou plusieurs méthodes d'objets d'interface COSEM. Il se décompose en deux phases:

- lors de la première phase, le client envoie la ou les références de la/des méthode(s) à appeler, avec les paramètres d'appel de méthode requis;
- lors de la seconde phase, après l'appel des méthodes, le serveur renvoie le résultat et les paramètres de retour générés par l'appel des méthodes, le cas échéant.

Si les paramètres d'appel de méthode sont trop longs pour être insérés dans une seule demande, ils sont envoyés en plusieurs demandes (transfert de blocs du client vers le serveur). Si les paramètres de résultat et de retour sont trop longs pour être insérés dans une seule réponse, ils sont renvoyés en plusieurs réponses (transfert de blocs du client vers le serveur).

Sémantique

Les primitives du service ACTION doivent fournir des paramètres, comme indiqué dans le Tableau 20.

Tableau 20 – Paramètres du service ACTION

	.request	.indication	.response	.confirm
Invoke_Id	M	M (=)	M (=)	M (=)
Priority	M	M (=)	M (=)	M (=)
Service_Class	M	M (=)	M (=)	M (=)
Request_Type	M	M (=)	–	–
COSEM_Method_Descriptor { COSEM_Method_Descriptor }	C	C (=)	–	–
COSEM_Class_Id	M	M (=)		
COSEM_Object_Instance_Id	M	M (=)		
COSEM_Object_Method_Id	M	M (=)		
Method_Invocation_Parameters { Method_Invocation_Parameters }	U	U (=)	–	–
Response_Type	–	–	M	M (=)
Action_Response { Action_Response }	–	–	M	M (=)
Result			M	M (=)
Response_Parameters			U	U (=)
Data			S	S (=)
Data_Access_Result			S	S (=)
DataBlock_SA	C	C (=)	C	C (=)
Last_Block	M	M (=)	M	M (=)
Block_Number	M	M (=)	M	M (=)
Raw_Data	M	M (=)	M	M (=)
Block_Number	C	C (=)	C	C (=)
NOTE Pour les paramètres de sécurité, voir le Tableau 15.				

Le paramètre Invoke_Id identifie l'instance de l'appel de service.

Le paramètre Priority indique le niveau de priorité associé à l'instance de l'appel de service: normale (FALSE) ou haute (TRUE).

Le paramètre Service_Class indique si le service est confirmé ou non confirmé. La gestion de ce paramètre dépend du profil de communication; voir l'Annexe A.

L'utilisation des paramètres Request_Type et Response_Type est décrite dans le Tableau 21.

Tableau 21 – Types de demandes et de réponses du service ACTION

Type de demande		Type de réponse	
NORMAL	La référence de méthode unique et le paramètre d'appel de méthode complet sont envoyés.	NORMAL	Le résultat et le paramètre de retour complet sont envoyés.
		ONE-BLOCK	Un bloc du résultat et du paramètre de retour est envoyé.
NEXT	Le bloc de données suivant est demandé.	ONE-BLOCK	Voir ci-dessus.
		LAST-BLOCK	Le dernier bloc du (des) résultat(s) et du (des) paramètre(s) de retour est envoyé.
FIRST-BLOCK	La référence d'une méthode unique et le premier bloc des paramètres d'appel de méthode sont envoyés.	NEXT	La bonne réception du bloc est confirmée.
ONE-BLOCK	Un bloc de paramètres d'appel de méthode est envoyé.		
LAST-BLOCK	Le dernier bloc des paramètres d'appel de méthode est envoyé.	NORMAL	Voir ci-dessus.
		ONE-BLOCK	Voir ci-dessus.
WITH-LIST	La référence d'une liste des méthodes et la liste complète des paramètres d'appel de méthode sont envoyées.	WITH-LIST	La liste complète des résultats et des paramètres de retour est envoyée.
		ONE-BLOCK	Voir ci-dessus.
WITH-LIST-AND-FIRST-BLOCK	La référence d'une liste de méthodes et le premier bloc des paramètres d'appel de méthode sont envoyés.	NEXT	La bonne réception du bloc est confirmée.
NOTE Le même type de réponse (Response_Type) peut figurer plusieurs fois, pour indiquer les réponses possibles pour chaque demande.			

Le paramètre COSEM_Method_Descriptor référence une méthode d'objet COSEM. Il est présent lorsque le type Request_Type == NORMAL, FIRST-BLOCK, WITH-LIST et WITH-LIST-AND-FIRST-BLOCK. Il s'agit d'un paramètre composite:

- le doublet (COSEM_Class_Id, COSEM_Object_Instance_Id) fait référence de façon non ambiguë à une seule instance d'objet COSEM;
- COSEM_Method_Id identifie une méthode de l'objet COSEM référencé.

Une primitive de service ACTION-REQUEST-NORMAL ou ACTION-REQUEST-FIRST-BLOCK doit contenir un seul descripteur de méthode COSEM. Une primitive de service ACTION-REQUEST-WITH-LIST ou ACTION-REQUEST-WITH-LIST-AND-FIRST-BLOCK doit contenir une liste des descripteurs de méthode COSEM; leur nombre est limité par le paramètre server-max-receive-pdu-size: toutes les références de méthode COSEM – ainsi qu'une partie des paramètres d'invocation de la méthode – doivent être contenues dans une seule APDU.

Le paramètre Method_Invocation_Parameter contient le(s) paramètre(s) nécessaire(s) pour appeler la (les) méthode(s) référencée(s).

- si Request_Type == NORMAL, le paramètre Method_Invocation_Parameter est facultatif;

- si Request_Type == WITH-LIST, la primitive de service doit contenir une liste des paramètres Method_Invocation_Parameters. Le nombre et l'ordre des paramètres d'appel de méthode doivent être identiques à ceux des COSEM_Method_Descriptor-s. Si l'appel d'une méthode n'exige pas de paramètres supplémentaires, ceux-ci doivent cependant figurer, avec des données NULL.

Si la forme codée du/des descripteur(s) de méthode COSEM et du/des paramètre(s) d'appel de méthode ne peut pas être contenue dans une APDU unique, elle peut être transportée en blocs à l'aide du mécanisme spécifique au service ou du mécanisme de transfert général de blocs.

Si le mécanisme de transfert de blocs spécifique au service est utilisé, le paramètre DataBlock_SA contient les informations de contrôle de transfert de bloc et l'élément raw-data:

- l'élément Last_Block indique si le bloc actuel est le dernier (TRUE) ou non (FALSE);
- l'élément Block_Number contient le numéro du bloc réel envoyé;
- l'élément Raw_Data contient une partie des paramètres d'appel de méthode.

Les paramètres Action_Response sont présents dans la primitive de réponse lorsque le type Response_Type == NORMAL ou WITH-LIST. Leur nombre et leur ordre doivent être identiques à ceux des descripteurs de méthode COSEM. Ils contiennent deux éléments:

- le paramètre Result. Il contient l'information «réussite» (success) ou la raison de l'échec de l'appel de la méthode référencée (Action-Result);
- le(s) paramètre(s) Response_Parameter. Chaque paramètre de réponse doit contenir les données retournées suite à l'appel de la méthode, ou une raison de l'échec du retour des paramètres (Data-Access-Result). Si l'appel de l'une des méthodes ne renvoie aucun paramètre, des données NULL doivent être retournées.

Si la réponse ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs à l'aide du mécanisme spécifique au service ou du mécanisme de transfert général de blocs.

Si le mécanisme de transfert de blocs spécifique au service est utilisé, le paramètre DataBlock_SA contient les informations de contrôle de transfert de bloc et l'élément raw-data:

- l'élément Last_Block indique si le bloc actuel est le dernier (TRUE) ou non (FALSE);
- l'élément Block_Number contient le numéro du bloc réel envoyé;
- l'élément Raw_Data contient une partie de la réponse:
 - si une seule méthode est appelée, Raw_Data contient le résultat et les paramètres Response_Parameters, le cas échéant. Si aucun paramètre Response_Parameters n'est retourné, la réponse doit être de type ACTION-RESPONSE-NORMAL;
 - Si une liste de méthodes a été appelée, Raw_Data contient une partie de la liste des réponses Action_Responses et des données facultatives.

Le paramètre Block_Number d'une primitive de service ACTION-REQUEST-NEXT doit contenir le numéro du dernier bloc de données reçu correctement en provenance du serveur.

Le paramètre Block_Number inclus dans une primitive de service ACTION-RESPONSE-NEXT doit contenir le numéro du dernier bloc de données envoyé et reçu correctement en provenance du client.

Utilisation

Des exemples de séquences logiques de primitives de service ACTION sont présentés à la Figure 8:

- pour une ACTION réussie confirmée, point a);

- pour une ACTION non confirmée point d); et
- pour une tentative échouée en raison d'une erreur locale, point c).

Lors de la première phase, la primitive ACTION.request est appelée par l'AP du client pour appeler une ou plusieurs méthodes d'un ou de plusieurs objets d'interface COSEM de l'AP du serveur. Si la liste complète des descripteurs de méthode et des paramètres d'appel de méthode COSEM est contenue dans une seule APDU, la primitive .request est appelée avec le type Request_Type == NORMAL ou WITH-LIST selon le cas. Sinon, elle est appelée avec le type Request_Type == FIRST-BLOCK ou WITH-LIST-AND-FIRST-BLOCK, selon le cas, puis avec le type Request_Type == ONE-BLOCK et enfin avec LAST-BLOCK. À réception de la primitive .request, l'AL du client génère l'APDU Action-Request correspondant au type de demande (Request_Type) et l'envoie au serveur.

La primitive ACTION.indication est générée par l'AL du serveur à réception de l'APDU Action-Request.

Lors du transfert de bloc des paramètres d'appel de la méthode, l'AP du serveur appelle la primitive ACTION.response avec le type Request_Type == NEXT jusqu'à réception du dernier bloc.

La primitive ACTION.confirm est générée par l'AL du client à réception de l'APDU Action-Response.

Une fois tous les paramètres d'appel de méthode transférés, le serveur appelle les méthodes des objets d'interface COSEM référencés, puis la deuxième phase commence.

Si la réponse complète est contenue dans une seule APDU, la primitive ACTION.response est appelée par l'AP du serveur avec le type de réponse Response_Type == NORMAL ou WITH-LIST, selon le cas. Sinon, elle est appelée avec le type Response_Type == ONE-BLOCK, puis avec LAST-BLOCK. À réception de la primitive .response, l'AL de serveur génère l'APDU Action-Response correspondant au type de réponse (Response_Type) et l'envoie au client.

La primitive ACTION.confirm est générée par l'AL du client pour confirmer la réception de l'APDU Action-Response.

Lors du transfert de bloc des paramètres de retour, l'AP du client appelle la primitive .request avec le type de demande Request_Type == NEXT jusqu'à réception du dernier bloc.

Le protocole du service ACTION est spécifié en 7.3.5.

6.9 Service DataNotification

Fonction

Le service DataNotification est un service non sollicité et non confirmé. Il est utilisé par le serveur pour pousser des données au client. Il s'agit d'un service non confirmé. Le processus Push est configuré par les objets «Push setup»; voir 5.3.8 de l'IEC 62056-6-2:—.

Sémantique

Les primitives de service DataNotification doivent fournir des paramètres tels que présentés dans le Tableau 22.

Tableau 22 – Paramètres de service des primitives de service DataNotification

	.request	.indication
Long_Invoke_Id	M	M (=)
Self_Descriptive	–	–
Processing_Option	–	–
Service_Class	–	–
Priority	M	M (=)
Date_Time	U	U (=)
Notification_Body	M	M (=)

Le paramètre Long_Invoke_Id identifie l'instance de l'appel de service.

Les paramètres Self_Descriptive, Processing_Option et Service_Class ne sont pas utilisés dans le cas de ce service.

Le paramètre Priority indique le niveau de priorité associé à l'instance de l'appel de service: normale (FALSE) ou haute (TRUE).

Le paramètre Date_Time indique le moment auquel la primitive de service DataNotification.request est appelée. Il s'agit d'une chaîne d'octets, qui peut être de longueur nulle lorsque la transmission de Date_Time n'est pas exigée.

Le paramètre Notification_Body contient les données Push.

Utilisation

Un exemple de séquence logique de primitives de service DataNotification est présenté dans la Figure 8 f) et g).

La primitive .request est appelée par l'AP du serveur pour pousser des données à l'AP du client distant. À réception de la primitive .request, l'AL du serveur construit l'APDU DataNotification.

La primitive .indication est générée par l'AL du client à réception d'une APDU DataNotification.

Le protocole du service DataNotification est spécifié en 7.3.6.

6.10 Service EventNotification

Fonction

Le service EventNotification est un service de type non-client/serveur non sollicité. Il est demandé par le serveur lorsqu'un événement se produit, afin d'informer le client de la valeur d'un attribut, comme s'il était demandé par le COSEM. Il s'agit d'un service non confirmé.

Sémantique

Les primitives du service EventNotification doivent spécifier des paramètres, comme indiqué dans le Tableau 23.

Tableau 23 – Paramètres de service des primitives du service EventNotification

	.request	.indication
Time	U	U (=)
Application_Addresses	U	U (=)
COSEM_Attribute_Descriptor	M	M (=)
COSEM_Class_Id	M	M (=)
COSEM_Object_Instance_Id	M	M (=)
COSEM_Object_Attribute_Id	M	M (=)
Attribute_Value	M	M (=)

Le paramètre facultatif Time indique l'heure à laquelle la primitive de service EventNotification.request a été émise.

Le paramètre Application_Addresses est facultatif. Il est présent uniquement lorsque le service EventNotification est appelé en dehors d'une AA établie. Dans ce cas, il contient tous les paramètres spécifiques au protocole requis pour identifier les AP de l'expéditeur et du destinataire.

Lorsque la primitive .request ne contient pas le paramètre facultatif Application_Addresses, des adresses par défaut doivent être utilisées. Il s'agit des adresses par défaut du dispositif logique de gestion de serveur et de l'AP de gestion du client. Les deux AP sont toujours présentes, et dans tout profil de protocole. Elles sont associées à des adresses connues prédéfinies.

Le triplet (COSEM_Class_Id, COSEM_Object_Instance_Id, COSEM_Object_Attribute_Id) fait référence de façon non ambiguë à un seul attribut d'une instance d'objet d'interface COSEM.

Le paramètre Attribute_Value définit la valeur de cet attribut. Des informations supplémentaires sur l'événement notifié peuvent être obtenues en interrogeant cet objet d'interface COSEM.

Si la forme codée de la demande ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs de données à l'aide du mécanisme de transfert général de blocs.

Utilisation

Un exemple de séquence logique de primitives de service EventNotification est présenté dans la Figure 8 f) et g).

La primitive .request est appelée par l'AP du serveur pour envoyer la valeur d'un attribut d'objet d'interface COSEM à l'AP de client distant. À réception de la primitive .request, l'AL du serveur construit l'APDU EventNotificationRequest.

Dans certains cas, le(s) protocole(s) de couche inférieure de support ne permet(tent) pas l'envoi réel, non sollicité d'une unité de données de protocole. Dans ces cas, il faut que le client sollicite explicitement l'envoi d'une trame EventNotification, en appelant la primitive de service Trigger_EventNotification_Sending.

La primitive EventNotification.indication est générée par l'AL du client à réception d'une APDU EventNotificationRequest.

Le protocole du service EventNotification est spécifié en 7.3.7.

6.11 Service TriggerEventNotificationSending

Fonction

La fonction du service TriggerEventNotificationSending est de déclencher l'envoi de la trame contenant l'APDU EventNotification.request sur le serveur, via le client.

Ce service est nécessaire dans le cadre de protocoles, lorsque le serveur ne peut pas envoyer une APDU EventNotification.request réelle non sollicitée.

Sémantique

La primitive de service TriggerEventNotificationSending.request doit spécifier des paramètres, comme indiqué dans le Tableau 24.

Tableau 24 – Paramètres de service de la primitive de service TriggerEventNotificationSending.request

	.request
Protocol_Parameters	M

Le paramètre Protocol_Parameters contient toutes les informations relatives à la couche de protocole inférieure, requises pour déclencher l'envoi par le serveur d'une trame en attente contenant une APDU EventNotification.request. Ces informations incluent l'identifiant de protocole et tous les paramètres de couches inférieures requis.

Utilisation

À réception d'un appel de service TriggerEventNotificationSending.request envoyé par l'AP du client, l'AL du client doit appeler le service de couche de support correspondant pour qu'il envoie un message déclencheur au serveur.

6.12 Spécification d'accès variable

Variable_Access_Specification est un paramètre des primitives de service .request et .indication suivantes: xDLMS Read / Write / UnconfirmedWrite InformationReport. Ses variantes sont présentées dans le Tableau 25:

- Variable_Name identifie une variable DLMS désignée;
- Parameterized_Access permet d'intégrer des paramètres complémentaires;
- Block_Number_Access contient un numéro de bloc;
- Read_Data_Block_Access contient les informations de contrôle de transfert de bloc et des données brutes;
- Write_Data_Block_Access contient les informations de contrôle de transfert de bloc.

L'utilisation des différentes variantes dépend du service utilisé. Elle est détaillée dans les spécifications de service SN correspondantes.

Tableau 25 – Spécification d'accès variable

Variable_Access_Specification	Read .request	Write .request	Write.request non confirmée	Rapport d'informations
Kind_Of_Access	M	M	M	M
Variable_Name	S	S	S	M
Detailed_Access	Non utilisée dans DLMS/COSEM			
Parameterized_Access	S	S	S	–
Variable_Name	M	M	M	
Selector	U	U	U	
Parameter	U	U	U	
Block_Number_Access	S	–	–	–
Block_Number	M			
Read_Data_Block_Access	S	–	–	–
Last_Block	M			
Block_Number	M			
Raw_Data	M			
Write_Data_Block_Access	–	S	–	–
Last_Block		M		
Block_Number		M		

6.13 Service Read

Fonction

Le service Read est utilisé avec le référencement SN. Il s'agit d'un service confirmé. Ses fonctions sont les suivantes:

- lire la valeur d'un ou de plusieurs attributs d'objets d'interface COSEM. Dans ce cas, la forme codée de la primitive de service .request doit être contenue dans une APDU unique. Le résultat peut être envoyé dans une seule réponse ou, s'il est trop long, dans plusieurs réponses, avec un transfert de bloc;
- appeler une ou plusieurs méthodes d'objet d'interface COSEM, lorsque des paramètres de retour sont attendus. Dans ce cas, si la primitive de service .request (y compris les références de méthode et les paramètres d'appel de méthode) ou .response (y compris les résultats et les paramètres de retour) est trop longue pour être contenue dans une seule APDU, alors le transfert par blocs, sur plusieurs demandes et/ou réponses peut être utilisé.

Le service Read est spécifié dans la norme IEC 61334-4-41:1996, 10.4 et Annexe A. Afin de fournir des informations complètes et cohérentes avec la spécification de services à l'aide du référencement LN, la spécification est reproduite ici, avec les extensions adaptées à DLMS/COSEM.

Sémantique

Les primitives du service Read doivent spécifier les paramètres de service tel qu'indiqué dans le Tableau 26.

Tableau 26 – Paramètres du service Read

	.request	.indication	.response	.confirm
Variable_Access_Specification { Variable_Access_Specification }	M	M (=)		
Variable_Name	S	S (=)		
Parameterized_Access	S	S (=)	–	–
Variable_Name	M	M (=)		
Selector	U	U (=)		
Parameter	U	U (=)		
Read_Data_Block_Access	S	S (=)		
Last_Block	M	M (=)		
Block_Number	M	M (=)		
Raw_Data	M	M (=)		
Block_Number_Access	S	S (=)		
Block_Number	M	M (=)		
Result (+)			S	S (=)
Read_Result { Read_Result }	–	–	M	M (=)
Data			S	S (=)
Data_Access_Error			S	S (=)
Data_Block_Result			S	S (=)
Last_Block			M	M (=)
Block_Number			M	M (=)
Raw_Data			M	M (=)
Block_Number			S	S (=)
Result (–)			S	S (=)
Error_Type			M	M (=)
NOTE Pour les paramètres de sécurité, voir le Tableau 15.				

L'utilisation des diverses variantes du paramètre de service Variable-Access-Specification de la primitive de service Read.request et les différents choix de la primitive Read.response sont détaillés dans le Tableau 27.

Si la forme codée de la réponse ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs de données à l'aide du mécanisme de transfert général de blocs.

Tableau 27 – Utilisation des variantes du paramètre Variable_Access_Specification et des choix de Read.response

Read.request Variable_Access_Specification		CHOIX Read.response	
Variable_Name (Variable_Name)	Référence une liste ¹ d'attributs d'objets COSEM.	Data {Data}	Indique la valeur des attributs référencés.
		Data_Access_Error {Data_Access_Error}	Indique la raison de l'échec de lecture.
		Data_Block_Result	Fournit les informations de contrôle de transfert de bloc et un bloc de données brutes.
Parameterized_Access {Parameterized_Access}	Présente une liste ¹ d'attributs d'objets COSEM à lire de façon sélective.	Data {Data}	Voir ci-dessus.
		Data_Access_Error {Data_Access_Error}	
		Data_Block_Result	
	Présente une liste ¹ de méthodes d'objet COSEM, avec les paramètres d'appel de méthode.	Data {Data}	Présente les paramètres de retour d'appel de méthode. NOTE Si les paramètres sont retournés, cela veut dire que l'appel de méthode a réussi.
		Data_Access_Error {Data_Access_Error}	Indique la raison de l'échec de l'appel de méthode.
		Data_Block_Result	Voir ci-dessus.
Read_Data_Block_Access	Contient les informations de contrôle de transfert de bloc et une partie de la forme codée des références de méthode COSEM et des paramètres d'appel de méthode.	Block_Number	Contient le numéro du dernier bloc de données reçu.
Block_Number_Access	Contient le numéro du dernier bloc de données reçu.	Data_Block_Result	Voir ci-dessus.
NOTE Le choix Read.response peut figurer plusieurs fois pour afficher les réponses possibles à chaque demande.			
¹ Une liste peut contenir plusieurs éléments.			

La primitive de service Read request peut contenir un ou plusieurs paramètres Variable_Access_Specification.

- La variante Variable_Name permet de référencer un attribut d'objet COSEM complet à lire. La demande peut inclure un ou plusieurs noms de variables;
- La variante Parameterized_Access est utilisée soit:
 - pour référencer un attribut d'objet COSEM à lire de façon sélective. Dans ce cas, l'élément Variable_Name référence l'attribut d'objet COSEM, les éléments Selector et Parameter contiennent respectivement le sélecteur d'accès et les paramètres d'accès comme indiqué dans la spécification de l'attribut; soit
 - pour référencer une méthode d'objet COSEM à appeler. Dans ce cas, l'élément Variable_Name référence la méthode, l'élément Selector est égal à zéro et l'élément Parameter contient les paramètres d'appel de méthode (le cas échéant) ou des données NULL;
 - la demande peut inclure un ou plusieurs paramètres d'accès paramétré;

NOTE 1 Avec cette spécification, le service Read peut transporter des informations dans les deux directions, tout comme le service ACTION utilisé dans le référencement LN: les paramètres d'appel de méthode du client vers le serveur et les paramètres de retour du serveur vers le client.

- la variante Read_Data_Block_Access est utilisée lorsqu'une ou plusieurs méthodes d'objet COSEM sont appelées et lorsque la forme codée de la demande ne rentre pas dans une

seule APDU. La demande peut inclure un seul paramètre `Read_Data_Block_Access`. Il contient les informations de contrôle de transfert de bloc et l'élément `raw-data`:

- l'élément `Last_Block` indique si le bloc donné est le dernier (TRUE) ou non (FALSE);
- l'élément `Block_Number` contient le numéro du bloc envoyé;
- l'élément `Raw_Data` contient une partie de la forme codée de la liste des paramètres `Variable_Access_Specification` (comme en l'absence de transfert de bloc), y compris les références de méthode et les paramètres d'appel de méthode. Ici, seules les variantes `Variable_Name` et `Parameterized_Access` sont autorisées.
- la variante `Block_Number_Access` est appliquée lorsque le serveur utilise le transfert de bloc pour envoyer une réponse longue, pour confirmer la réception d'un bloc de données et pour demander le bloc de données suivant. La demande peut inclure un seul paramètre `Block_Number_Access`. Il contient le numéro du dernier bloc de données reçu correctement.

Le paramètre `Result (+)` indique que le service demandé a réussi.

Sans transfert de bloc, les primitives de service `.response` / `.confirm` contiennent un ou plusieurs paramètres `Read_Result`. Leur nombre et leur ordre doivent être identiques à ceux des paramètres `Variable_Name` / `Parameterized_Access` des primitives `.request` / `.indication`.

Si le service `Read` est utilisé pour lire des attributs, alors:

- le choix `Data` permet d'insérer la valeur de l'attribut au moment de l'accès;
- l'élément `Data_Access_Error` indique la raison de l'échec de lecture de cet attribut.

Si le service `Read` est utilisé pour appeler des méthodes, alors:

- le choix `Data` intègre les paramètres de retour (si des données sont renvoyées, cela signifie que l'appel de méthode a réussi). Si aucun paramètre de retour n'est défini, `Data` doit être NULL;

NOTE 2 Cependant, si aucune donnée de retour n'est attendue, le service `Write` est utilisé pour appeler des méthodes.

- le choix `Data_Access_Error` indique la raison de l'échec de l'appel de cette méthode.

Dans le cas d'un transfert par bloc, la primitive `.response` / `.confirm` contient un paramètre `Read_Result` unique. le choix `Data_Block_Result` contient un bloc de la réponse:

- l'élément `Last_Block` indique si le bloc donné est le dernier (TRUE) ou non (FALSE);
- l'élément `Block_Number` doit contenir le numéro du bloc envoyé;
- l'élément `Raw_Data` contient une partie de la forme codée de la liste `Read_Results`.

Si le bloc de données ne peut pas être fourni, la primitive `.response` doit contenir un seul paramètre `Result` via le choix `Data_Access_Error` contenant un message d'erreur approprié, par exemple (14) `data-block-unavailable`.

Si le numéro de bloc de la demande n'est pas celui attendu, ou si le bloc suivant ne peut pas être fourni, la primitive de service `Read.response` doit être retournée avec un seul paramètre `Read_Result`, avec le choix `Data_Access_Error`, contenant un code approprié, par exemple (19) `data-block-number-invalid`.

Le choix `Block_Number` est sélectionné lorsque le service `Read` est utilisé pour appeler une ou plusieurs méthodes; la demande est envoyée en plusieurs blocs pour confirmer la bonne réception du bloc de données et demander le bloc suivant. Il contient le numéro du dernier bloc de données reçu.

Le paramètre Result (–) indique que le service demandé précédemment a échoué. Le paramètre Error_Type indique la raison de l'échec. Dans ce cas, le serveur doit renvoyer une APDU ConfirmedServiceError au lieu d'une APDU ReadResponse.

Utilisation

Un exemple de séquence logique des primitives de service Read est présenté à la Figure 8, point a).

La primitive Read.request est appelée suite à l'appel d'une primitive .request GET ou ACTION par l'AP du client; elle la mappe sur une primitive Read.request via l'ASE SN_MAPPER. L'AL du client génère ensuite l'APDU ReadRequest et l'envoie au serveur. Pour la mise en correspondance de services LN / SN, voir 6.18.

La primitive Read.indication est générée par l'AL du serveur à réception d'une APDU ReadRequest.

La primitive Read.response est appelée par l'AP du serveur afin d'envoyer une réponse à une primitive Read.indication précédemment reçue. L'AL du serveur génère alors l'APDU ReadResponse et l'envoie au client.

La primitive Read.confirm est générée par l'AL du client après réception d'une APDU ReadResponse. Elle est ensuite mise en correspondance avec une primitive .confirm GET ou ACTION par l'ASE SN_MAPPER. La primitive .confirm GET ou ACTION est ensuite générée.

Le protocole du service Read est spécifié en 7.3.8.

6.14 Service Write

Fonction

Le service Write est utilisé avec le référencement SN. Il s'agit d'un service confirmé. Ses fonctions sont les suivantes:

- écrire la valeur d'un ou de plusieurs attributs d'objets d'interface COSEM;
- appeler une ou plusieurs méthodes d'objet d'interface COSEM, lorsqu'aucun paramètre de retour n'est attendu.

Dans les deux cas, si la forme codée de la primitive de service .request ne peut pas être contenue dans une seule APDU, elle peut alors être envoyée en plusieurs demandes avec transfert par blocs. La primitive de service .response doit toujours pouvoir être contenue dans une seule APDU.

Le service Write est spécifié dans la norme IEC 61334-4-41:1996, 10.5 et Annexe A. Afin de fournir des informations complètes et cohérentes avec la spécification de services à l'aide du référencement LN, la spécification est reproduite ici, avec les extensions adaptées à DLMS/COSEM.

Sémantique

Les primitives du service Write doivent spécifier les paramètres de service, comme indiqué dans le Tableau 28.

Tableau 28 – Paramètres du service Write

	.request	.indication	.response	.confirm
Variable_Access_Specification { Variable_Access_Specification }	M	M(=)		
Variable_Name	S	S(=)		
Parameterized_Access	S	S(=)	–	–
Variable_Name	M	M(=)		
Selector	M	M(=)		
Parameter	M	M(=)		
Write_Data_Block_Access	S	S(=)		
Last_Block	M	M(=)	–	–
Block_Number	M	M(=)		
Data { Data }	M	M(=)	–	–
Result (+)	–	–	S	S(=)
Write_Result { Write_Result }	–	–	S	S(=)
Success			S	S(=)
Data_Access_Error			S	S(=)
Block_Number			S	S(=)
Result (–)			S	S(=)
Error_Type			M	M(=)
NOTE Pour les paramètres de sécurité, voir le Tableau 15.				

L'utilisation des diverses variantes du paramètre de service Variable-Access-Specification de la primitive de service Write.request et les différents choix de primitive Write.response sont détaillés dans le Tableau 29. L'utilisation du paramètre de service Data est également expliquée.

Si la forme codée de la demande ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs de données à l'aide du mécanisme spécifique au service ou du mécanisme de transfert général de blocs.

Tableau 29 – Utilisation des variantes de Variable_Access_Specification et des choix de Write.response

Write.request Variable_Access_Specification		CHOIX Write.response	
Variable_Name {Variable_Name}	Référence une liste ¹ d'attributs d'objets COSEM.	Success {Success}	Indique que l'attribut référencé a été écrit avec succès.
	Le paramètre de service Data contient les données à écrire ou le(s) paramètre(s) d'appel de méthode.	Data_Access_Error {Data_Access_Error}	Indique la raison de l'échec d'écriture.
Parameterized_Access {Parameterized_Access}	Référence une liste ¹ d'attributs d'objet COSEM à écrire de façon sélective.	Success {Success}	Voir ci-dessus.
	Le paramètre de service Data contient les données à écrire.	Data_Access_Error {Data_Access_Error}	
Write_Data_Block_Access	Contient les informations de contrôle de transfert de bloc. Le paramètre de service Data contient les données brutes, notamment la forme codée de la liste ¹ d'attributs d'objet COSEM ou de références de méthode et la liste des données à écrire ou la liste des paramètres d'appel de méthode.	Block_Number	Contient le numéro du dernier bloc de données reçu.
NOTE Le choix Write.response peut figurer plusieurs fois pour afficher les réponses possibles à chaque demande. ¹ Une liste peut contenir un ou plusieurs éléments.			

La primitive de service Write.request peut contenir un ou plusieurs paramètres Variable_Access_Specification:

- la variante Variable_Name permet de référencer un attribut d'objet COSEM complet à écrire ou une méthode d'objet COSEM à appeler. La demande peut inclure un ou plusieurs noms de variables;
- la variante Parameterized_Access est utilisée pour référencer un attribut d'objet COSEM à écrire de façon sélective. Dans ce cas, l'élément Variable_Name référence l'attribut d'objet COSEM, les éléments Selector et Parameter contiennent respectivement le sélecteur d'accès et les paramètres d'accès comme indiqué dans la spécification de l'attribut. La demande peut inclure un ou plusieurs paramètres Parameterized_Access;

Le paramètre de service Data inclut la ou les valeurs à écrire sur le ou les attributs, ou le(s) paramètre(s) d'appel de la ou des méthodes à appeler. Le nombre et l'ordre des paramètres Data doivent être identiques à ceux des paramètres Variable_Access_Specification.

Si la primitive de service Write.request ne peut pas être contenue dans une seule APDU, le transfert par bloc peut donc être utilisé. Dans ce cas:

- la variante Write_Data_Block_Access du paramètre Variable_Access_Specification contient les informations de contrôle de transfert de blocs:
 - l'élément Last_Block indique si le bloc donné est le dernier (TRUE) ou non (FALSE);
 - l'élément Block_Number contient le numéro du bloc envoyé;
- le paramètre Data contient une partie de la liste des références d'attribut et la liste des données à écrire, ou une partie de la liste de références de méthode et la liste des paramètres d'appel de méthode.
- La demande inclut un seul paramètre Write_Data_Block_Access et un seul paramètre Data.

Le paramètre Result (+) indique que le service demandé a réussi.

Les primitives de service .response / .confirm contiennent une liste des paramètres Write_Result. Leur nombre et leur ordre doivent être identiques à ceux des paramètres Variable_Name / Parameterized_Access des primitives de service .request / .indication.

Sans transfert par bloc et avec transfert par bloc après réception du dernier bloc:

- lorsque le service Write est utilisé pour écrire un ou plusieurs attributs, chaque élément indique soit que l'accès en écriture a réussi (Success), soit la raison de l'échec d'écriture de cette variable (Data_Access_Error);
- lorsque le service Write est utilisé pour appeler une ou plusieurs méthodes, chaque élément indique soit que l'accès d'appel a réussi (Success), soit la raison de l'échec de l'appel de cette variable (Data_Access_Error).

Le choix Block_Number est utilisé lors du transfert par blocs pour confirmer la réception d'un bloc de données et pour demander le bloc suivant. Il contient le numéro du dernier bloc reçu.

Si le numéro de bloc de la demande n'est pas celui attendu, ou si le bloc n'a pas été bien reçu, la primitive de service Write.response doit être retournée avec un seul paramètre Write_Result, avec le choix Data_Access_Error, contenant un code approprié, par exemple (19) data-block-number-invalid.

Le paramètre Result (–) indique que le service demandé a échoué. Le paramètre Error_Type indique la raison de l'échec. Dans ce cas, le serveur doit retourner une APDU ConfirmedServiceError au lieu d'une APDU WriteResponse.

Utilisation

Un exemple de séquence logique des primitives de service Write est présenté à la Figure 8, point a).

La primitive Write.request est appelée suite à l'appel d'une primitive .request SET ou ACTION par l'AP du client; elle la mappe sur une primitive Write.request via l'ASE SN_MAPPER. L'AL du client génère ensuite l'APDU WriteRequest et l'envoie au serveur. Pour la mise en correspondance de services LN / SN, voir 6.18.

La primitive Write.indication est générée par l'AL du serveur à réception d'une APDU WriteRequest.

La primitive Write.response est appelée par l'AP du serveur afin d'envoyer une réponse à une primitive Write.indication reçue précédemment. L'AL du serveur génère alors l'APDU WriteResponse et l'envoie au client.

La primitive Write.confirm est générée par l'AL du client après réception d'une APDU WriteResponse. Elle est ensuite mise en correspondance avec une primitive .confirm SET ou ACTION par l'ASE SN_MAPPER. La primitive .confirm SET ou ACTION est ensuite générée.

Le protocole du service Write est spécifié en 7.3.9.

6.15 Service UnconfirmedWrite

Fonction

Le service UnconfirmedWrite est utilisé avec le référencement SN. Il s'agit d'un service non confirmé. Ses fonctions sont les suivantes:

- écrire la valeur d'un ou plusieurs attributs d'objets COSEM;

- appeler une ou plusieurs méthodes d'objet d'interface COSEM, lorsqu'aucun paramètre de retour n'est attendu.

La primitive de service UnconfirmedWrite.request doit toujours pouvoir être contenue dans une seule APDU.

Le service UnconfirmedWrite est spécifié dans l'IEC 61334-4-41:1996, 10.6 et Annexe A. Afin de fournir des informations complètes et cohérentes avec la spécification de services à l'aide du référencement LN, la spécification est reproduite ici, avec les extensions adaptées à DLMS/COSEM.

Sémantique

Les primitives du service UnconfirmedWrite doivent spécifier les paramètres de service, comme indiqué dans le Tableau 30.

Tableau 30 – Paramètres du service UnconfirmedWrite

	request	indication
Variable_Access_Specification { Variable_Access_Specification }	M	M(=)
Variable_Name	S	S (=)
Parameterized_Access	S	S (=)
Variable_Name	M	M (=)
Selector	M	M (=)
Parameter	M	M (=)
Data { Data }	M	M (=)
NOTE Pour les paramètres de sécurité, voir le Tableau 15.		

L'utilisation des diverses variantes du paramètre de service Variable-Access-Specification de la primitive de service UnconfirmedWrite.request est détaillée dans le Tableau 31. L'utilisation du paramètre de service Data est également expliquée.

Si la forme codée de la demande ne peut pas être contenue dans une seule APDU, elle peut être déplacée en blocs de données à l'aide du mécanisme de transfert général de blocs.

Tableau 31 – Utilisation des variantes de Variable_Access_Specification

UnconfirmedWrite.request Variable_Access_Specification	
Variable_Name {Variable_Name}	Référence un attribut d'objet COSEM. Le paramètre de service Data contient les données à écrire ou le(s) paramètre(s) d'appel de méthode.
Parameterized_Access {Parameterized_Access}	Référence un attribut d'objet COSEM avec accès sélectif. Le paramètre de service Data contient les données à écrire.

La primitive de service UnconfirmedWrite.request peut contenir un ou plusieurs paramètres Variable_Access_Specification.

- la variante Variable_Name permet de référencer un attribut d'objet COSEM complet à écrire ou une méthode d'objet COSEM à appeler;
- la variante Parameterized_Access est utilisée pour référencer un attribut d'objet COSEM à écrire de façon sélective. Dans ce cas, l'élément Variable_Name référence l'attribut d'objet COSEM, les éléments Selector et Parameter contiennent respectivement le sélecteur d'accès et les paramètres d'accès comme indiqué dans la spécification de l'attribut.

Le paramètre de service Data inclut la ou les valeurs à écrire sur le ou les attributs, ou le(s) paramètre(s) d'appel de la ou des méthodes à appeler. Le nombre et l'ordre des paramètres Data doivent être identiques à ceux des paramètres Variable_Access_Specification.

Utilisation

Un exemple de séquence logique des primitives de service Write est présenté à la Figure 8, point d).

La primitive UnconfirmedWrite.request est appelée suite à l'appel d'une primitive .request SET ou ACTION avec le paramètre Service_Class == Unconfirmed par l'AP du client; elle la mappe vers une primitive UnconfirmedWrite.request via l'ASE SN_MAPPER. L'AL du client génère ensuite l'APDU UnconfirmedWriteRequest et l'envoie au serveur.

La primitive UnconfirmedWrite.indication est générée par l'AL du serveur à réception d'une APDU WriteRequest.

Le protocole du service UnconfirmedWrite est spécifié en 7.3.10.

6.16 Service InformationReport

Fonction

Le service InformationReport est un service de type non-client/serveur non sollicité. Il est demandé par un serveur utilisant le référencement SN lorsqu'un événement se produit, afin d'informer le client de la valeur d'une ou plusieurs variables DLMS désignées, mises en correspondance avec des attributs d'objet d'interface COSEM, comme si les valeurs avaient été demandées par le client. Il s'agit d'un service non confirmé.

Le service InformationReport est détaillé dans l'IEC 61334-4-41:1996, 10.7 et Annexe A. Afin de fournir des informations complètes et cohérentes sur la spécification de services à l'aide du référencement LN, la spécification du service InformationReport est reproduite ici, avec les extensions adaptées aux caractéristiques DLMS/COSEM.

Sémantique

Les primitives du service InformationReport doivent spécifier des paramètres, comme indiqué dans le Tableau 32.

Tableau 32 – Paramètres du service InformationReport

	.request	.indication
Current_Time	M	M (=)
Variable_Access_Specification { Variable_Access_Specification }	M	M (=)
Variable_Name	M	M (=)
Data { Data }	M	M(=)

Le paramètre Current_Time indique l'heure à laquelle la primitive de service InformationReport.request a été émise.

Le paramètre Variable_Access_Specification du choix Variable_Name indique une ou plusieurs variables DLMS désignées – mises en correspondance sur des attributs d'objet d'interface COSEM – dont les valeurs sont envoyées par le serveur.

Le paramètre Data contient la valeur des variables DLMS désignées, qui respectent l'ordre des paramètres Variable_Access_Specification.

Le protocole du service InformationReport est spécifié en 7.3.11.

6.17 Services de gestion de couches côté client: Demande SetMapperTable.request

Fonction

La fonction du service SetMapperTable est de gérer l'ASE SN_MAPPER du client.

Sémantique

Une seule primitive est requise: .request. Elle doit spécifier les paramètres suivants (voir Tableau 33):

Tableau 33 – Paramètres de service des primitives de service SetMapperTable.request

	.request
Mapping_Table	M

Le paramètre Mapping_table est obligatoire. Il contient les éléments de l'attribut «object_list» du serveur et de l'AA demandés. La structure du contenu est définie dans l'IEC 62056-6-2.

Utilisation

Le service SetMapperTable.request est appelé par l'AP du client afin de fournir des informations de mise en correspondance avec l'ASE du client SN_MAPPER. Ce service ne déclenche pas de transmission de données entre le client et le serveur. L'AP du client utilise cette primitive de service, afin d'améliorer l'efficacité du processus de mise en correspondance si le référencement SN est utilisé.

6.18 Récapitulatif des services et de la mise en correspondance de services de transfert de données LN/SN

Les Tableaux 34 à 36 suivants récapitulent les services de couche application COSEM.

Tableau 34 – Récapitulatif des services ACSE

Côté client	Côté serveur
COSEM-OPEN.request	COSEM-OPEN.indication
COSEM-OPEN.confirm	COSEM-OPEN.response
COSEM-RELEASE.request	COSEM-RELEASE.indication
COSEM-RELEASE.confirm	COSEM-RELEASE.response
COSEM-ABORT.indication	COSEM-ABORT.indication

Tableau 35 – Récapitulatif des services xDLMS pour le référencement LN

Côté client	Côté serveur
GET.request	GET.indication
GET.confirm	GET.response
SET.request	SET.indication
SET.confirm	SET.response
ACTION.request	ACTION.indication
ACTION.confirm	ACTION.response
DataNotification.indication	DataNotification.request
EventNotification.indication	EventNotification.request
Trigger_EventNotification_Sending.request	–
NOTE Le service DataNotification peut être utilisé à la fois dans les contextes d'application utilisant le référencement SN et ceux utilisant le référencement LN.	

Tableau 36 – Récapitulatif des services xDLMS pour le référencement SN

Côté client	Côté serveur
Read.request	Read.indication
Read.confirm	Read.response
Write.request	Write.indication
Write.confirm	Write.response
UnconfirmedWrite.request	UnconfirmedWrite.indication
DataNotification.indication	DataNotification.request
InformationReport.indication	InformationReport.request
NOTE Le service DataNotification peut être utilisé à la fois dans les contextes d'application utilisant le référencement SN et ceux utilisant le référencement LN.	

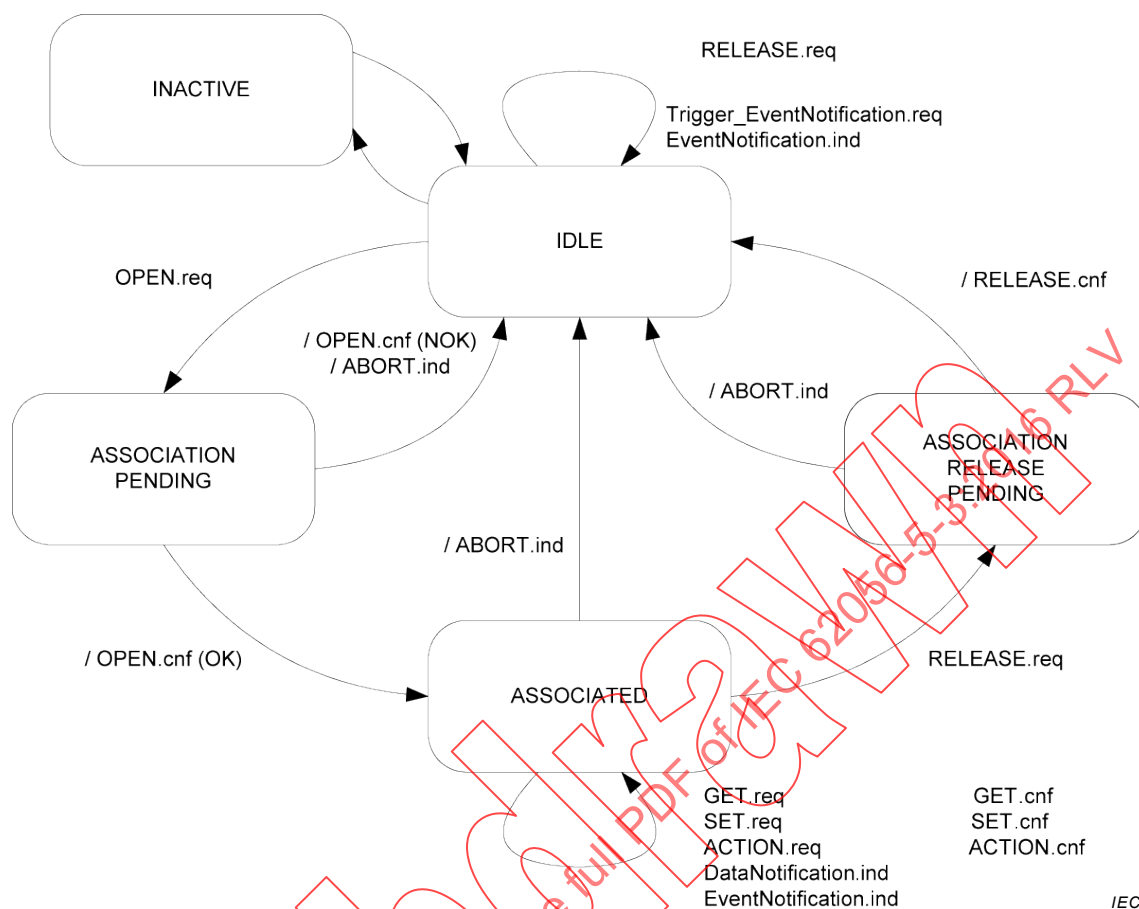
Lorsque le serveur utilise le référencement SN, une mise en correspondance entre les primitives de service utilisant le référencement LN et le référencement SN s'effectue côté client. Cette mise en correspondance est détaillée en 7.3.8, 7.3.9, 7.3.10 et 7.3.11.

7 Spécification du protocole de couche application DLMS/COSEM

7.1 Fonction de commande

7.1.1 Définitions des états de la fonction de commande côté client

La Figure 10 montre le diagramme d'états de la CF côté client; voir également la Figure 1.



NOTE Sur les diagrammes d'états des CF côté client et serveur, les conventions suivantes sont utilisées:

- les primitives de service sans caractère initial «/» sont des «stimulants»: l'appel de ces primitives constitue l'origine du changement d'état;
- les primitives de service avec un caractère initial «/» sont des «sorties»: la génération de ces primitives s'effectue au moment du changement d'état.

Figure 10 – Diagramme d'états partiel pour la fonction de commande côté client

Les définitions d'état de la CF côté client (et de l'AL où figure la CF) sont les suivantes:

- INACTIVE** Dans cet état, la CF ne présente aucune activité: elle ne fournit aucun service à l'AP et elle n'utilise aucun service de la couche de protocole de support.
- IDLE** Dans cet état, la CF ne présente aucune AA existante en cours de libération ou d'établissement. Néanmoins, certains échanges de données entre le client et le serveur (si le canal physique a été établi précédemment) sont possibles. Dans cet état, la CF peut gérer le service EventNotification.
- NOTE Les transitions entre les états INACTIVE et IDLE sont contrôlées en dehors du protocole. Par exemple, la CF peut être considérée comme effectuant la transition de l'état INACTIVE à l'état IDLE en étant instanciée et placée en haut de la couche de protocole de support. La transition inverse s'effectue en supprimant l'instance donnée de la CF.
- ASSOCIATION PENDING** La CF quitte l'état IDLE et passe à cet état lorsque l'AP demande l'établissement d'une AA en appelant la primitive COSEM-OPEN.request (OPEN.req). La CF peut quitter cet état et passer soit à l'état ASSOCIATED, soit à l'état IDLE. Elle génère la primitive COSEM-OPEN.confirm, (/OPEN.cnf(OK)) ou (/OPEN.cnf(NOK)), en fonction du résultat de la demande d'association. La CF quitte également cet état et revient à l'état IDLE lorsqu'elle génère la primitive COSEM-ABORT.indication (/ABORT.ind).
- ASSOCIATED** La CF passe à cet état lorsque l'AA a été établie avec succès. Les services de données de type client/serveur sont disponibles dans cet état, et le service EventNotification peut être utilisé. La CF reste à cet état jusqu'à ce que l'AP demande la libération de l'AA en appelant la primitive COSEM-RELEASE.request (RELEASE.req). La CF quitte également cet état et revient à l'état IDLE lorsqu'elle génère la primitive COSEM-ABORT.indication (/ABORT.ind).

ASSOCIATION RELEASE PENDING La CF quitte l'état ASSOCIATED et passe à cet état lorsque l'AP demande la libération de l'AA en appelant la primitive COSEM-RELEASE.request (RELEASE.req). La CF reste dans cet état et attend que le serveur réponde à cette demande. Le serveur n'est pas autorisé à refuser une demande de libération. Après avoir quitté cet état, la CF passe donc toujours à l'état IDLE. La CF peut quitter cet état en générant la primitive COSEM-RELEASE.confirm après réception de la réponse envoyée par le serveur ou en la générant localement (/RELEASE.cnf). La CF quitte également cet état et revient à l'état IDLE lorsqu'elle génère la primitive COSEM-ABORT.indication (/ABORT.ind).

7.1.2 Définitions des états de la fonction de commande côté serveur

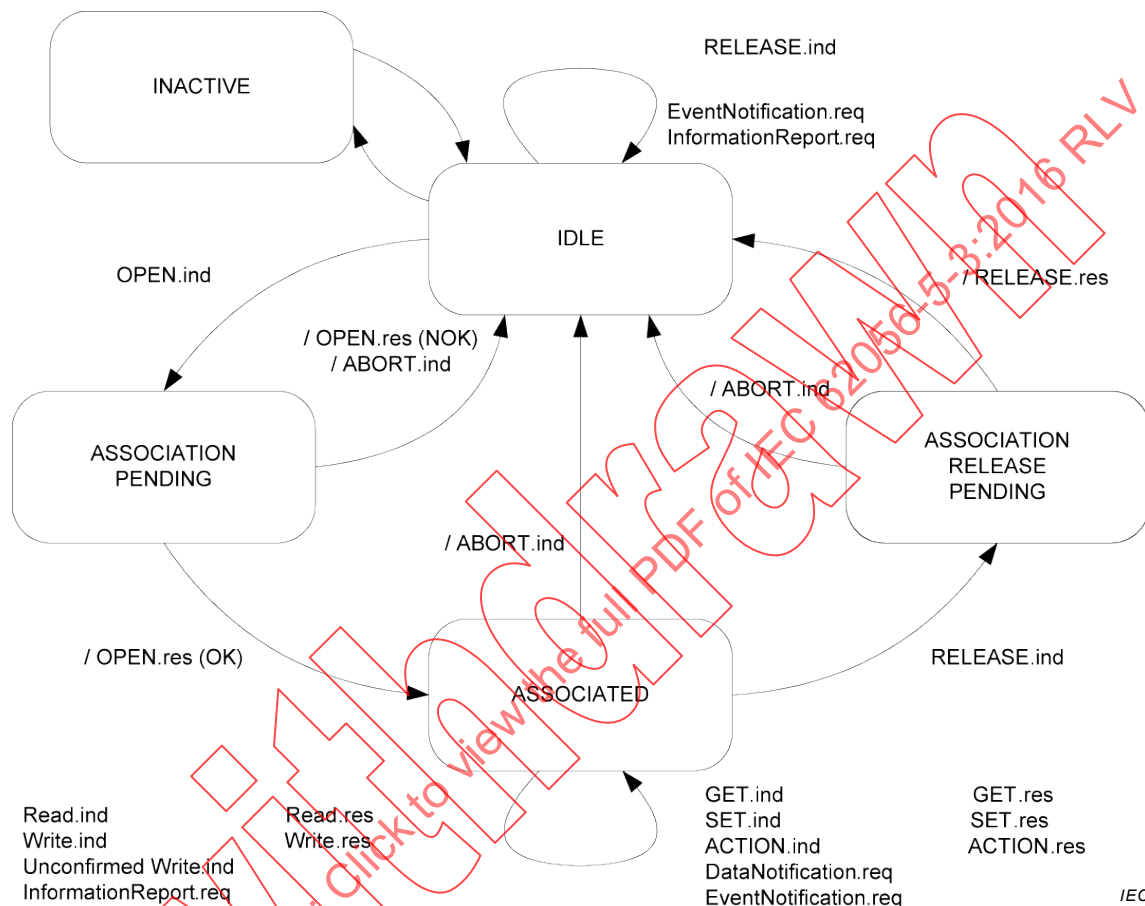


Figure 11 – Diagramme d'états partiel pour la fonction de commande côté serveur

La Figure 11 montre le diagramme d'états de la CF côté serveur; voir également la Figure 1.

INACTIVE Dans cet état, la CF ne présente aucune activité: elle ne fournit aucun service à l'AP et elle n'utilise aucun service de la couche de protocole de support.

IDLE Dans cet état, la CF ne présente aucune AA existante, ni en cours de libération ni en cours d'établissement³. Néanmoins, certains échanges de données entre le client et le serveur (si le canal physique a été établi précédemment) sont possibles. La CF peut gérer les services EventNotification / InformationReport.

ASSOCIATION PENDING La CF quitte l'état IDLE et passe à cet état lorsque le client demande l'établissement d'une AA et lorsque l'AL du serveur génère la primitive COSEM-OPEN.indication (/OPEN.ind). La CF peut quitter cet état et passer soit à l'état ASSOCIATED, soit à l'état IDLE, en fonction du résultat de la demande d'association, et appeler la primitive COSEM-OPEN.response, (/OPEN.res(OK)) ou (/OPEN.res(NOK)). La CF quitte également cet état et revient à l'état IDLE lorsqu'elle génère la primitive COSEM-ABORT.indication (/ABORT.ind).

³ À noter qu'il s'agit du diagramme d'états pour l'AL: les connexions de couche inférieure, y compris la connexion physique, ne sont pas prises en compte. D'un autre côté, l'établissement de la connexion physique s'effectue en dehors du protocole.

ASSOCIATED	La CF passe à cet état lorsque l'AA a été établie avec succès. Les services de données de type client/serveur sont disponibles dans cet état, et les services EventNotification / InformationReport peuvent être utilisés. La CF reste dans cet état jusqu'à ce que le client demande la libération de l'AA et que l'AL du serveur génère la primitive COSEM-RELEASE.ind (/RELEASE.ind). La CF quitte également cet état et revient à l'état IDLE lorsqu'elle génère la primitive COSEM-ABORT.indication (/ABORT.ind).
ASSOCIATION RELEASE PENDING	La CF quitte l'état ASSOCIATED et passe dans cet état lorsque le client demande la libération de l'AA et l'AP du serveur reçoit la primitive COSEM-RELEASE.indication (/RELEASE.ind). La CF reste dans cet état, en attendant que l'AP accepte la demande de libération. Le serveur n'est pas autorisé à refuser une demande de libération. Après avoir quitté cet état, la CF passe donc toujours à l'état IDLE. La CF peut quitter cet état lorsque l'AP accepte la libération de l'AA, puis appelle la primitive COSEM-RELEASE.response (RELEASE.res). La CF quitte également cet état et revient à l'état IDLE lorsqu'elle génère la primitive COSEM-ABORT.indication (/ABORT.ind).

7.2 Services ACSE et APDU

7.2.1 Unités fonctionnelles ACSE, services et paramètres de service

L'ACSE AL DLMS/COSEM est basé sur l'ACSE orienté connexion, comme indiqué dans les normes ISO/IEC 15953 et ISO/IEC 15954.

Les unités fonctionnelles permettent de négocier les exigences d'utilisateur ACSE lors de l'établissement de l'association. Trois unités fonctionnelles sont définies:

- unité fonctionnelle Kernel;
- unité fonctionnelle d'authentification; et
- unité fonctionnelle Application Context Negotiation.

L'AL DLMS/COSEM utilise uniquement les unités fonctionnelles Kernel et Authentication.

Les paramètres d'exigences ACSE des APDU AARQ et AARE permettent de sélectionner les unités fonctionnelles de l'association.

L'unité fonctionnelle Kernel est toujours disponible. Il s'agit de l'unité fonctionnelle par défaut.

Pour être incluse, l'unité fonctionnelle d'authentification doit être explicitement demandée sur l'APDU AARQ et être acceptée sur l'APDU AARE. Lorsque l'unité fonctionnelle d'authentification est sélectionnée, les paramètres complémentaires des APDU AARQ et AARE sont pris en charge. L'unité fonctionnelle d'authentification n'affecte pas les éléments de la procédure.

Le Tableau 37 présente les services et les paramètres associés aux unités fonctionnelles ACSE, utilisés par l'AL DLMS/COSEM. La syntaxe abstraite des APDU ACSE est spécifiée à l'Article 8.

Tableau 37 – Unités fonctionnelles ACSE, services et paramètres de service

Unité fonctionnelle	Service	APDU	Paramètre	Présence
Kernel	A-ASSOCIATE	AARQ	protocol-version	O ¹
			application-context-name	M
			called-AP-title	U
			called-AE-qualifier	U
			called-AP-invocation-identifier	U
			called-AE-invocation-identifier	U
			calling-AP-title	U
			calling-AE-qualifier	U
			calling-AP-invocation-identifier	U
			calling-AE-invocation-identifier	U
			implementation-information	O
			user-information ²⁾	M
			(contenant une APDU xDLMS InitiateRequest)	U
			dedicated-key	U
			response-allowed	U
			proposed-quality-of-service	U
			proposed-dlms-version-number	M
			proposed-conformance	M
			client-max-receive-pdu-size	M
		AARE	protocol-version	O
			application-context-name	M
			result	M
			result-source-diagnostic	M
			responding-AP-title	U
			responding-AE-qualifier	U
			responding-AP-invocation-identifier	U
			responding-AE-invocation-identifier	U
			implementation-information	O
			user-information ²	M
			(contenant une APDU xDLMS InitiateResponse)	S
			negotiated-quality-of-service	U
			negotiated-dlms-version-number	M
			negotiated-conformance	M
			server-max-receive-pdu-size	M
			vaa-name	M
			(ou contenant une APDU ConfirmedServiceError)	S
	A-RELEASE	RLRQ	reason	U
			user-information	U
		RLRE	reason	U
			user-information	U

Unité fonctionnelle	Service	APDU	Paramètre	Présence
Authentification	A-ASSOCIATE	AARQ	sender-acse-requirements	U
			mechanism-name	U
			calling-authentication-value	U
		AARE	responder-acse-requirements	U
			mechanism-name	U
			responding-authentication-value	U

¹ O: La présence est une option ACPM (Couche application COSEM).

² Selon l'ISO/IEC 15953, le paramètre user-information est facultatif. Cependant, dans l'environnement DLMS/COSEM, il est obligatoire dans les APDU AARQ / AARE.

En général, la valeur de chaque paramètre de l'APDU AARQ est déterminée par les paramètres de la primitive de service COSEM-OPEN.request. De la même façon, la valeur de chaque paramètre de l'AARE est déterminée par la primitive COSEM-OPEN.response. Le service COSEM-OPEN est spécifié en 6.2.

Les paramètres des APDU AARQ et AARE sont spécifiés ci-dessous. La gestion de ces paramètres est spécifiée en 7.2.4.1.

- **protocol-version:** l'AL COSEM utilise la valeur par défaut. Pour plus de détails, voir l'ISO/IEC 15954;
- **application-context-name:** Les noms contextuels d'application COSEM sont indiqués en 7.2.2.2;
- **called-, calling- et responding- titles, qualifieurs et invocation-identifieurs:** ces champs facultatifs contiennent la valeur des paramètres correspondants du service COSEM-OPEN. Pour plus de détails, voir l'ISO/IEC 15954;
- **implementation-information:** ce paramètre n'est pas utilisé par l'AL COSEM. Pour plus de détails, voir la norme ISO/IEC 15954;
- **user-information:** l'APDU AARQ contient une APDU xDLMS InitiateRequest où sont définis les éléments du paramètre Proposed_xDLMS_Context de la primitive de service COSEM-OPEN.request. L'APDU AARE contient une APDU xDLMS InitiateResponse où figurent les éléments du paramètre Negotiated_xDLMS_Context ou une APDU xDLMS ConfirmedServiceError où figurent les éléments du paramètre xDLMS_Initiate_Error de la primitive de service COSEM-OPEN.response.
- **sender- et responder-acse-requirements:** ce paramètre permet de sélectionner les unités fonctionnelles facultatives des APDU AARQ et AARE. Dans COSEM, seule l'unité fonctionnelle d'authentification est utilisée. Lorsqu'elle est présente, elle contient la valeur BIT STRING { authentication (0) }. Bit positionné: module d'authentification sélectionné;
- **mechanism-name:** Les noms des mécanismes d'authentification COSEM sont indiqués en 7.2.2.3;
- **calling- et responding- authentication-value:** voir 5.3;
- **result:** la valeur de ce paramètre est déterminée par l'AP COSEM (accepteur) ou l'AL COSEM (ACPM) comme indiqué ci-dessous. Elle est utilisée pour déterminer la valeur du paramètre Result de la primitive COSEM-OPEN.confirm:
 - Si l'APDU AARQ est rejetée par l'ACPM (c'est-à-dire que la primitive COSEM-OPEN.indication n'est pas émise par l'AL COSEM), la valeur «rejected (permanent)» ou «rejected (transient)» est attribuée par l'ACPM;
 - sinon, la valeur est déterminée par le paramètre Result de l'APDU COSEM-OPEN.response;

- **result-source-diagnostic**: ce paramètre contient la valeur Result source et la valeur Diagnostic. Il est utilisé pour déterminer la valeur du paramètre Failure_Type de la primitive COSEM-OPEN.confirm:
 - Valeur Result-source: si l'AARQ est rejetée par l'ACPM, (c'est-à-dire que la primitive COSEM-OPEN.indication n'est pas émise par l'AL COSEM), l'ACPM attribue la valeur «ACSE service-provider». Sinon, l'ACPM attribue la valeur «ACSE service-user»;
 - Valeur Diagnostic: Si l'AARQ est rejetée par l'ACPM, la valeur appropriée est attribuée par l'ACPM. Sinon, la valeur est déterminée par le paramètre Failure_Type de la primitive COSEM-OPEN.response. Si le paramètre Diagnostic ne figure pas dans la primitive .response, l'ACPM attribue la valeur «null».

Les paramètres des APDU RLRQ / RLRE – utilisés lorsque le service COSEM-RELEASE (voir 6.3) est appelé avec le paramètre Use_RLRQ_RLRE == TRUE – sont spécifiés ci-dessous.

- **reason**: indique la valeur adéquate, comme indiqué en 6.3;
- **user-information**: si ces informations sont présentes, elles contiennent une APDU xDLMS InitiateRequest / InitiateResponse, où figurent les éléments du paramètre Proposed_xDLMS_Context / Negotiated_xDLMS_Context, respectivement des primitives de service COSEM-RELEASE.request / .response; voir 6.3.

7.2.2 Noms COSEM enregistrés

7.2.2.1 Généralités

Dans un environnement OSI, de nombreux types d'objets réseau doivent être identifiés par des noms non ambigus au niveau mondial. Ces objets réseau sont des syntaxes abstraites, des syntaxes de transfert, des contextes d'application, des noms de mécanismes d'authentification, etc. Généralement, les noms de ces objets sont attribués par le comité qui développe la norme de base ISO particulière ou durant des ateliers pour implémenteurs. Il convient de déposer ces noms d'objets. Pour DLMS/COSEM, ces noms d'objets sont attribués par l'association DLMS User Association. Ils sont spécifiés ci-dessous.

La décision n° 1999.01846 de l'OFCOM, Suisse, attribue le préfixe suivant aux identifiants d'objet définis par l'association DLMS User Association.

{ joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) }

Pour DLMS/COSEM, les identifiants d'objet sont spécifiés afin de désigner les éléments suivants:

- Noms de contexte d'application COSEM;
- Noms de mécanismes d'authentification COSEM.

7.2.2.2 Contexte d'application COSEM

Pour établir un échange d'informations efficace à l'intérieur de l'AA, la paire d'appels AE doit être mutuellement au courant et respecter un ensemble de règles relatives à cet échange. Cet ensemble de règles communes est appelé le contexte d'application de l'AA. Le contexte d'application relatif à une AA est déterminé lors de son établissement⁴. Les méthodes possibles sont les suivantes:

- définition d'un contexte d'application préexistant;
- transfert d'une description réelle du contexte d'application.

⁴ Un seul contexte d'application est défini par AA. Cependant, l'ensemble de règles constitutives du contexte d'application d'une AA peut contenir des règles modifiant cet ensemble pour la durée de vie de l'AA.

Dans un environnement COSEM, il est prévu qu'un contexte d'application préexiste. Il est référencé sous son nom lors de l'établissement d'une AA. Le nom de contexte d'application est défini comme suit: IDENTIFIANT OBJET ASN.1. COSEM identifie le nom de contexte d'application en fonction de la valeur d'identifiant d'objet suivante:

COSEM_Application_Context_Name::=

{joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) application-context(1) context_id(x)}

La signification de ces contextes d'application COSEM généraux est la suivante:

- deux ASE sont présents dans l'appel AE, l'ACSE et le xDLMS_ASE;
- NOTE Avec les extensions COSEM sur les DLMS; voir 4.2.3.1.
- le xDLMS_ASE doit être tel que défini dans l'IEC 61334-4-41:1996;
- la syntaxe de transfert doit être de type A-XDR, spécifié dans l'IEC 61334-6.

Les ID de contexte spécifiques et l'utilisation des APDU chiffrées et non chiffrées sont indiqués dans le Tableau 38 ci-dessous:

Tableau 38 – Utilisation des APDU chiffrées et non chiffrées

Application_Context_Name	context_id	APDU non chiffrées	APDU chiffrées
Logical_Name_Referencing_No_Ciphering::=	context_id(1)	Oui	Non
Short_Name_Referencing_No_Ciphering::=	context_id(2)	Oui	Non
Logical_Name_Referencing_With_Ciphering::=	context_id(3)	Oui	Oui
Short_Name_Referencing_With_Ciphering::=	context_id(4)	Oui	Oui

Pour établir avec succès une AA, il convient que le paramètre application-context-name des APDU AARQ et AARE contienne l'un des noms «valides». Le client propose un nom de contexte d'application via le paramètre Application_Context_Name de la primitive COSEM-OPEN.request. Le serveur peut retourner toute valeur, soit la valeur proposée, soit la valeur qu'il prend en charge.

7.2.2.3 Nom de mécanisme d'authentification COSEM

L'authentification du client, du serveur ou les deux est l'un des aspects de sécurité traité par la spécification DLMS/COSEM. Trois niveaux de sécurité d'authentification sont spécifiés:

- pas de sécurité d'authentification (niveau inférieur);
- niveau de sécurité d'authentification bas basé sur un mot de passe (LLS) identifiant le client uniquement;
- niveau de sécurité d'authentification 4 passes de haut niveau (HLS) identifiant le client et le serveur.

La COSEM identifie les mécanismes d'authentification en fonction de la valeur d'identifiant d'objet générale suivante:

COSEM_Authentication_Mechanism_Name::=

{joint-iso-ccitt(2) country(16) country-name(756) identified-organization(5) DLMS-UA(8) authentication_mechanism_name(2) mechanism_id(x)}

La valeur de l'élément mechanism_id sélectionne l'un des mécanismes de sécurité spécifiés:

COSEM_lowest_level_security_mechanism_name::=

mechanism_id(0)

COSEM_low_level_security_mechanism_name::=	mechanism_id(1)
COSEM_high_level_security_mechanism_name::=	mechanism_id(2)
COSEM_high_level_security_mechanism_name_using_MD5::=	mechanism_id(3)
COSEM_high_level_security_mechanism_name_using_SHA-1::=	mechanism_id(4)
COSEM_high_level_security_mechanism_name_using_GMAC::=	mechanism_id(5)
NOTE Avec l'élément mechanism_id(2), la méthode de traitement de la demande d'accès est secrète.	

Lorsque l'élément Authentication_Mechanism_Name est présent dans le service COSEM-OPEN, l'unité fonctionnelle d'authentification du service A-ASSOCIATE doit être sélectionnée. Le processus d'authentification LLS et HLS est décrit en 5.3 et 5.4.8.4.

7.2.3 Règles de codage d'APDU

7.2.3.1 Codage de l'APDU ACSE

Les APDU ACSE doivent être codées en BER, conformément à l'ISO/IEC 8825-1. Le champ user-information de ces APDU doit contenir l'APDU xDLMS InitiateRequest / InitiateResponse / ConfirmedServiceError selon le cas, codée en A-XDR. L'OCTET STRING résultant doit être codé en BER.

Des exemples de codage d'APDU AARQ/AARE sont fournis à l'Annexe C et à l'Annexe D.

7.2.3.2 Codage des APDU xDLMS

Les APDU xDLMS doivent être codées en A-XDR, comme indiqué dans l'IEC 61334-6.

7.2.4 Protocole d'établissement d'association d'applications

7.2.4.1 Protocole d'établissement d'associations d'applications confirmées

L'établissement d'AA à l'aide du service A-Associate de l'ACSE est l'élément clé de l'interopérabilité COSEM. Les éléments d'une AA sont:

- un AP de client, qui propose les AA, et
- un AP de serveur, qui les accepte ou non.

NOTE 1 Pour prendre en charge des services de diffusion ou multidiffusion, une AA peut également être établie entre un AP de client et un groupe d'AP de serveur.

La Figure 12 indique le MSC lorsque:

- la primitive COSEM-OPEN.request demande une AA confirmée;
- la connexion de couches inférieures de support est requise pour l'établissement de cette AA.

Un AP de client souhaitant établir une AA confirmée appelle la primitive COSEM-OPEN.request de l'ASO avec le paramètre Service_Class == Confirmed. Le paramètre response-allowed de l'APDU xDLMS InitiateRequest est défini sur TRUE. L'AL de client attend une APDU AARE avant de générer la primitive .confirm, avec un résultat positif ou négatif.

La CF du client passe à l'état ASSOCIATION PENDING. Elle examine ensuite le paramètre Protocol_Connection_Parameters. S'il indique que l'établissement de la connexion à la couche de support est requis, la CF établit la connexion.

NOTE 2 La couche physique doit être connectée avant l'appel du service COSEM-OPEN.