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**Title:**

Communication networks and systems for power utility automation – Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

(Titre) :

Introductory note

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## CONTENTS

FOREWORD.....	11
1 Scope.....	14
2 Normative references .....	14
3 Terms and definitions .....	18
4 Abbreviations .....	19
5 Overview .....	21
5.1 General.....	21
5.2 IEC 61850 server object .....	22
5.3 MMS communication profiles.....	23
5.4 Non-MMS communication profiles .....	23
5.5 MMS objects being used .....	23
6 Communication stack .....	24
6.1 Overview of the protocol usage .....	24
6.2 Client/server services and communication profiles .....	25
6.2.1 Client/server services .....	25
6.2.2 A-Profile .....	26
6.2.3 TCP/IP T-Profile .....	27
6.2.4 OSI T-Profile .....	29
6.3 GSE management and GOOSE services communication profiles.....	29
6.3.1 GSE mapping overview .....	29
6.3.2 A-Profile .....	30
6.3.3 T-Profile .....	30
6.4 Time sync.....	31
6.4.1 A-Profile .....	31
6.4.2 T-Profile .....	31
7 Objects of IEC 61850 .....	32
7.1 Server .....	32
7.2 Logical device (LD) .....	32
7.3 Logical node (LN).....	32
7.3.1 General .....	32
7.3.2 Mapping of LNReference to VariableAccessSpecifications.....	34
7.3.3 Data .....	34
7.3.4 Data Attributes (DataAttr) .....	35
8 Mapping of IEC 61850-7-2 and IEC 61850-7-3 data attributes .....	35
8.1 Mapping of Attributes specified in IEC 61850-7-2 .....	35
8.1.1 Basic data attribute types .....	35
8.1.2 Additional definitions of basic data type.....	35
8.1.3 Common data types.....	36
8.2 Mapping of quality common data attribute type specified in IEC 61850-7-3.....	39
9 Server class model .....	40
9.1 Server mapping.....	40
9.2 Server class attributes.....	40
9.2.1 ServiceAccessPoint.....	40
9.2.2 Logical devices.....	41
9.2.3 Files .....	41
9.2.4 Client associations .....	41
9.3 Server class service GetServerDirectory .....	41

10	Association model .....	43
10.1	Association relation to communication profiles .....	43
10.2	Two party association model for client/server communication profile .....	43
10.2.1	Association mapping .....	43
10.2.2	Association services .....	43
10.3	Two party association model for GSE management communication profile .....	44
10.4	Two party association model for time sync .....	44
10.5	Multicast association model .....	45
11	Logical device model .....	45
12	Logical node model .....	45
12.1	Logical node class .....	45
12.2	Logical node class attributes .....	45
12.3	Logical node class services .....	46
12.3.1	GetLogicalNodeDirectory .....	46
12.3.2	GetAllDataValues .....	47
13	Data class model .....	47
13.1	Data class .....	47
13.2	Data class services .....	48
13.2.1	GetDataValues .....	48
13.2.2	SetDataValues .....	48
13.2.3	GetDataDirectory .....	48
13.2.4	GetDataDefinition .....	49
14	Data set class model .....	49
14.1	Data set class .....	49
14.2	Data set attributes .....	49
14.3	Data set services .....	49
14.3.1	GetDataSetValues .....	49
14.3.2	SetDataSetValues .....	50
14.3.3	CreateDataSet .....	50
14.3.4	DeleteDataSet .....	51
14.3.5	GetDataSetDirectory .....	52
15	Substitution model .....	53
16	Setting group control class model .....	53
16.1	Setting group control class definition .....	53
16.2	Setting group control class services .....	53
16.2.1	SelectActiveSG .....	53
16.2.2	SelectEditSG .....	53
16.2.3	SetSGValues .....	53
16.2.4	ConfirmEditSGValues .....	54
16.2.5	GetSGValues .....	54
16.2.6	GetSGCBValues .....	54
17	Reporting and logging class model .....	54
17.1	Report model .....	54
17.1.1	Report control blocks .....	54
17.2	Reporting services .....	56
17.2.1	Report service .....	56
17.2.2	GetBRCBValues .....	58
17.2.3	SetBRCBValues .....	58
17.2.4	GetURCBValues .....	58

17.2.5	SetURCBValues .....	58
17.3	Log model .....	59
17.3.1	General .....	59
17.3.2	Mapping of log control class .....	59
17.3.3	Mapping of log class .....	59
17.3.4	Mapping of log and log control services .....	63
17.3.5	Conformance .....	65
18	Mapping of the generic substation event model (GSE) .....	65
18.1	Generic object oriented substation event (GOOSE) .....	65
18.1.1	GOOSE control definition .....	65
18.1.2	GOOSE services .....	66
19	Transmission of sampled values class model .....	75
20	Control class model .....	75
20.1	Control service parameters .....	75
20.2	Mapping of control objects .....	76
20.3	Mapping of control services .....	77
20.4	Select .....	78
20.4.1	Select request .....	78
20.4.2	Select response+ .....	78
20.4.3	Select response- .....	78
20.5	SelectwithValue .....	78
20.5.1	SelectwithValue request .....	78
20.5.2	SelectwithValue response+ .....	78
20.5.3	SelectwithValue response- .....	79
20.6	Cancel .....	79
20.6.1	Cancel request .....	79
20.6.2	Cancel response+ .....	79
20.6.3	Cancel response- .....	80
20.7	Operate .....	80
20.7.1	Operate request .....	80
20.7.2	Operate response+ .....	81
20.7.3	Operate response- .....	81
20.8	AdditionalCauseDiagnosis in negative control service responses .....	81
20.9	CommandTermination .....	83
21	Time and time synchronization model .....	83
22	Naming conventions .....	83
23	File transfer .....	84
23.1	File transfer model .....	84
23.2	File services .....	86
23.2.1	GetFile .....	86
23.2.2	SetFile .....	87
23.2.3	DeleteFile .....	88
23.2.4	GetFileAttributeValues .....	88
24	Conformance .....	89
24.1	Notation .....	89
24.2	PICS .....	89
24.2.1	Profile conformance .....	89
24.2.2	MMS conformance .....	90
24.3	PICS Statement .....	102

24.3.1	Logical device .....	102
24.3.2	GOOSE Services .....	102
24.3.3	Substation configuration language .....	103
25	Substation Configuration Language (SCL) .....	103
25.1	SCL file and SCL extensions .....	103
25.1.1	SCSM specific address element definitions .....	103
25.1.2	Subnetwork protocol type .....	104
Annex A (normative)	Application protocol specification for GOOSE and GSE management .....	105
Annex B (informative)	Multicast address selection .....	107
Annex C (normative)	Overview of ISO/IEC 8802-3 frame structure for GSE management and GOOSE .....	108
Annex D (informative)	SCL conformance .....	111
D.1	General .....	111
D.2	SCL control block .....	112
D.2.1	validate .....	112
D.2.2	valState .....	113
D.2.3	activate .....	113
D.3	SCL support within devices .....	113
D.3.1	File directory structure for SCL files .....	113
D.3.2	Retrieval of an SCL file from an implementation .....	113
D.3.3	Remote creation of a SCL file .....	113
D.3.4	Local validation of an SCL file .....	114
Annex E (normative)	Specialized CDCs for control service mapping .....	115
E.1	General .....	115
E.2	Mapping specific logical device name space extension .....	115
E.3	Mapping specific common data classes .....	116
E.3.1	Extended common data class controllable single point (SPC) .....	116
E.3.2	Extended common data class controllable double point (DPC) .....	116
E.3.3	Extended common data class controllable integer status (INC) .....	118
E.3.4	Extended common data class binary controlled step position information (BSC) .....	118
E.3.5	Extended common data class integer controlled step position information (ISC) .....	119
E.3.6	Extended common data class controllable analogue set point information (APC) .....	119
E.4	Mapping specific common data attribute types .....	120
E.4.1	SBOw .....	120
E.4.2	Oper .....	120
E.4.3	Cancel .....	121
E.4.4	ctIVal .....	121
E.5	Conditions for attribute inclusion .....	121
E.6	Data attribute semantic .....	122
Annex F (informative)	Time scales and epochs .....	123
F.1	General .....	123
F.2	The MMS TimeOfDay epoch began at 0 hours on 1 January 1984 (MJD 40 587). Times measured are designated in this standard as MMS TimeOfDay milli-seconds GMT and TimeOfDay days GMT, and represent offsets from the epoch. Standard time sources .....	123

Annex G (normative) Type extensions to ISO 9506-1 (2003) and ISO 9506-2 (2003) .....	126
G.1 General .....	126
G.2 ISO 9506-1 (Service definitions) .....	126
G.2.1 Add Reference for UTC time type definition .....	126
G.2.2 Add UTC as a new time type .....	126
G.2.3 Add, at the end of Subclause 14.2.2.4.1, the following new text:.....	126
G.3 ISO 9506-2 (Protocol specification) .....	127
G.3.1 Add UTC as a new time type .....	127
G.3.2 Enlarge the MMS Identifier size .....	127
G.3.3 Allow application-dependent use of MMSString data type .....	127
Annex H (normative) Example SCL File .....	129
Annex I (normative) Generic Substation State Event (GSSE) .....	147
I.1 GSSE Service and communication profile .....	147
I.1.1 GSSE mapping overview .....	147
I.1.2 A-Profile .....	147
I.1.3 T-Profile .....	148
I.2 GSSE control definition .....	149
I.3 GSSE services .....	151
I.3.1 GetGsReference .....	151
I.3.2 GetGSSEDataOffset.....	154
I.3.3 GetGsCBValues .....	155
I.3.4 SetGsCBValues .....	155
I.3.5 SendGSSEMessage .....	155
I.4 Conformance.....	160
I.4.1 PICS Statement for GSSE services .....	160
Figure 1 – Overview of functionality and profiles .....	22
Figure 2 – OSI reference model and profiles .....	24
Figure 3 –Ordered list of functional constraints .....	33
Figure 4 – Relationship of LCB attributes to IEC 61850-7-2 log definitions .....	59
Figure 5 – GetGoReference- service primitives .....	66
Figure 6 – GetGOOSEElementNumber service primitives .....	69
Figure 7 – Transmission time for events .....	71
Figure 8 – SendGooseMessage message service primitives .....	71
Figure 9 – Publisher state machine for GOOSE service .....	72
Figure 10 – Subscriber state machine for GOOSE service .....	73
Figure 11 – Mapping of ACSI GetFile to MMS FileOpen, FileRead, FileClose .....	86
Figure 12 – Mapping of ACSI SetFile service .....	87
Figure C.1 – ISO/IEC 8802-3 frame format .....	108
Figure C.2 – Virtual LAN tag .....	109
Figure I.1 – GetGsReference service primitives .....	152
Figure I.2 – GetGSSEDataOffset service primitives.....	154
Figure I.3 – GSSE service primitives.....	156
Figure I.4 – Client state machine for GSSE service.....	157
Figure I.5 – Server state machine for GSSE service .....	157
Table 1 – MMS objects and services in use within this SCSSM .....	24
Table 2 – Services requiring client/server Communication Profile .....	25

Table 3 – Service and protocols for client/server communication A-Profile .....	26
Table 4 – Service and protocols for client/server TCP/IP T-Profile .....	27
Table 5 – Service and protocols for client/server OSI T-Profile .....	29
Table 6 – Services requiring GSE Management and GOOSE communication profile .....	30
Table 7 – Service and protocols for GSE Management and GOOSE communication A-Profile .....	30
Table 8 – GOOSE/GSE T-Profile .....	30
Table 9 – Time sync A-Profile .....	31
Table 10 – Time sync T-Profile .....	31
Table 11 – Mapping of ACSI data types .....	35
Table 12 – Encoding of IEC 61850-7-2 TimeQuality .....	38
Table 13 – Encoding of IEC 61850-7-3 quality .....	40
Table 14 – ServiceError mapping for GetServerDirectory for non-files .....	42
Table 15 – ServiceErrors mapping of ACSI GetServerDirectory for files .....	42
Table 16 – Association model versus communication profiles .....	43
Table 17 – Associate service error mappings .....	44
Table 18 – Release service error mappings .....	44
Table 19 – GetNameList classes for GetLogicalNodeDirectory service .....	46
Table 20 – MMS AccessResult mapping to ACSI ServiceError .....	47
Table 21 – Mapping of GetDataValues service parameters .....	48
Table 22 – Mapping of SetDataValues service parameters .....	48
Table 23 – Mapping of GetDataDirectory service parameters .....	49
Table 24 – ServiceError Mappings for GetDataDirectory service .....	49
Table 25 – Mapping of GetDataSetValues service parameters .....	50
Table 26 – Mapping of SetDataSetValues service parameters .....	50
Table 27 – Mapping of CreateDataSet service parameters .....	51
Table 28 – ServiceError mapping for CreateDataSet .....	51
Table 29 – Mapping of DeleteDataSet service parameters .....	51
Table 30 – ServiceError mapping for DeleteDataSet .....	52
Table 31 – Mapping of GetDataSetDirectory service parameters .....	52
Table 32 – ServiceError mapping for GetDataSetDirectory .....	52
Table 33 – Mapping of ACSI ServiceError for SelectActiveSG .....	53
Table 34 – Mapping of BRCB to MMS type definition .....	54
Table 35 – Mapping of OptFlds within Bitstring .....	55
Table 36 – Mapping of URCB to MMS type definition .....	55
Table 37 – Order of AccessResults for variableListName report .....	56
Table 38 – Definition of an MMS log control block .....	60
Table 39 – Mapping of values for LogEna .....	60
Table 40 – Mapping of ACSI LogEntries .....	61
Table 41 – General mappings of ACSI log model services .....	63
Table 42 – Mapping of QueryLogByTime request parameters .....	64
Table 43 – Mapping of response parameters .....	64
Table 44 – ServiceError mappings for Log services .....	64
Table 45 – Mapping of QueryLogAfter request parameters .....	64

Table 46 – Log conformance requirements .....	65
Table 47 – MMS TypeDescription definition for GoCB MMS structure .....	65
Table 48 – DstAddress structure .....	66
Table 49 – Mapping of GetGoReference service .....	67
Table 50 – GetGoReference .....	67
Table 51 – Mapping of GetGOOSEElementNumber service .....	69
Table 52 – GetGOOSEElementNumber.....	70
Table 53 – GOOSE service parameter mapping .....	73
Table 54 – Controllable service parameters .....	75
Table 55 – Service parameters .....	76
Table 56 – Mapping of IEC 61850-7-2 control model to MMS control components.....	76
Table 57 – Mapping of control services .....	77
Table 58 – Select service parameter mapping.....	78
Table 59 – SelectWithValue service parameter mapping.....	78
Table 60 – Select, Oper and Cancel AccessResult specification .....	79
Table 61 – Cancel service parameter mapping.....	79
Table 62 – Operate service parameter mapping.....	80
Table 63 – Control with TimeActivation service parameter mapping.....	81
Table 64 – Definition of LastApplError variable structure.....	82
Table 65 – Mapping of ACSI AddCause values .....	83
Table 66 – Mapping of ACSI file class to MMS file object.....	84
Table 67 – Mappings of MMS File ServiceErrors to ACSI Service Errors.....	85
Table 68 – Reserved file suffixes .....	85
Table 69 – Mapping of ACSI GetFile service parameters .....	87
Table 70 – Mapping of ACSI SetFile parameters .....	88
Table 71 – Mapping of ACSI DeleteFile service .....	88
Table 72 – Mapping of ACSI GetFileAttributeValues parameters.....	89
Table 73 – Mapping of ACSI ListOfDirectoryEntry .....	89
Table 74 – PICS for A-Profile support .....	90
Table 75 – PICS for T-Profile support .....	90
Table 76 – MMS InitiateRequest general parameters .....	91
Table 77 – MMS InitiateResponse general parameters .....	91
Table 78 – MMS service supported conformance table .....	92
Table 79 – MMS Parameter CBB .....	95
Table 80 – GetNameList conformance statement .....	95
Table 81 – AlternateAccessSelection conformance statement.....	96
Table 82 – VariableAccessSpecification conformance statement .....	96
Table 83 – VariableSpecification conformance statement.....	97
Table 84 – Read conformance statement.....	97
Table 85 – Write conformance statement.....	97
Table 86 – InformationReport conformance statement .....	98
Table 87 – GetVariableAccessAttributes conformance statement.....	98
Table 88 – DefineNamedVariableList conformance statement.....	98
Table 89 – GetNamedVariableListAttributes conformance statement.....	99

Table 90 – DeleteNamedVariableList conformance statement .....	99
Table 91 – ReadJournal conformance statement .....	100
Table 92 – JournalEntry conformance statement .....	100
Table 93 – InitializeJournal conformance statement .....	101
Table 94 – FileDirectory conformance statement .....	101
Table 95 – FileOpen conformance statement .....	101
Table 96 – FileRead conformance statement .....	101
Table 97 – FileClose conformance statement .....	102
Table 98 – GOOSE conformance statement .....	102
Table 99 – Allowed P-Type definitions for client/server addressing .....	103
Table 100 – Definitions for GSE SCL .....	104
Table B.1 – Recommended multicast addressing example .....	107
Table C.1 – Default virtual LAN IDs and priorities .....	109
Table C.2 – Assigned Ethertype values .....	110
Table D.1 – SCL conformance degrees .....	111
Table D.2 – Supported ACSI services for SCL.2 and SCL.3 .....	111
Table D.3 – Additional MMS services for SCL.2 and SCL.3 .....	112
Table D.4 – Definition of SCL control block .....	112
Table E.1 – Name space attributes .....	115
Table E.2 – Extended common data class controllable single point .....	116
Table E.3 – Extended common data class controllable double point .....	117
Table E.4 – Extended common data class controllable integer status .....	118
Table E.5 – Extended common data class binary controlled step position information .....	118
Table E.6 – Extended common data class integer controlled step position information .....	119
Table E.7 – Extended common data class controllable analogue set point information .....	119
Table E.8 – SBOw .....	120
Table E.9 – Oper .....	120
Table E.10 – Cancel .....	121
Table E.11 – ctIVal .....	121
Table E.12 – Conditions for attribute inclusion .....	121
Table E.13 – Semantics of data attributes .....	122
Table F.1 – Relationships between timescales .....	124
Table F.2 – Examples of timescale correspondence .....	125
Table I.1 – Service requiring GSSE communication profile .....	147
Table I.2 – Service and protocols for GSSE communication A-Profile .....	147
Table I.3 – GSSE T-Profile .....	148
Table I.4 – MMS TypeDescription Definition for GSSE control block MMS structure .....	149
Table I.5 – Mapping of LSentData .....	150
Table I.6 – Definition of integer values of PhsID .....	151
Table I.7 – Definition of double-bit GSSE values .....	151
Table I.8 – Mapping of GetGsReference service .....	152
Table I.9 – GetGsReference .....	153
Table I.10 – Mapping of GetGSEDataOffset service .....	154
Table I.11 – GetGSSEDataOffset .....	155

Table I.12 – GSSE service ..... 158  
Table I.13 – Mapping of test values to bit-pair values..... 159  
Table I.14 – GSSE conformance statement..... 160

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –****Part 8-1: Specific Communication Service Mapping (SCSM) –  
Mappings to MMS (ISO 9506-1 and ISO 9506-2)  
and to ISO/IEC 8802-3**

## FOREWORD

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International Standard IEC 61850-8-1 has been prepared by IEC technical committee 57: Power systems management and associated information exchange.

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

FDIS	Report on voting
57/692/FDIS	57/712/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.

IEC 61850 consists of the following parts, under the general title *Communication networks and systems in substations*:

- Part 1: Introduction and overview
- Part 2: Glossary
- Part 3: General requirements
- Part 4: System and project management
- Part 5: Communication requirements for functions and device models
- Part 6: Configuration description language for communication in electrical substations related to IEDs
- Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models
- Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)
- Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes
- Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes
- Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3
- Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link
- Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3
- Part 10: Conformance testing <sup>1</sup>

This document specifies in Annex E specialized CDCs (Common Data Classes) based on CDCs defined in IEC 61850-7-3:2003.

TC57, WG10 is currently preparing the second edition of IEC 61850. During the recent WG meeting, it was decided to circulate in a first step the following parts as CD: Part 6, 7-2, 7-3, 7-4, 8-1 and 9-2. The purpose of these CDs is, to give the national committees a first possibility to comment on the principle direction of Edition 2. There may still be some missing elements in these CDs.

It is intended, to circulate by the end of 2007 a CDV of Edition 2. For that CDV, other parts, in particular part 1, 5 and 7-1 will be prepared as well.

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<sup>1</sup> Under consideration.

## INTRODUCTION

This document is part of a set of specifications which details layered substation communication architecture.

This part of IEC 61850 is intended to provide inter-device operation of a variety of substation and feeder devices to achieve interoperability providing detailed information on how to create and exchange concrete communication messages that implement abstract services and models specified in IEC 61850-7-4, IEC 61850-7-3, and IEC 61850-7-2.

The mapping allows for data exchange over ISO/IEC 8802-3 Local Area Networks between all kinds of substation devices. Some of the protocol stacks used within this document are routable. Therefore the actual communications path may not be restricted to the LAN. Data exchange consists of real-time monitoring and control data, including measured values, to name just a few.

NOTE This part of IEC 61850 does not provide tutorial material. It is recommended that IEC 61850-5 and IEC 61850-7-1 be read in conjunction with IEC 61850-7-2.

### Editor's Note:

This document is based on the experiences made after the publication of the first Edition of this standard. The crucial changes made are according to the Tissues (Technical Issues) posted at the Tissue database ([www.tissue.iec61850.com](http://www.tissue.iec61850.com)).

### **The following tissues have been solved in this CD**

Tissues for clauses 1-6 – General, Communication stack:

122 235 290 292 299 430 459

Tissues for clause 7-8, 11-14 and Annex E (Data Model)

109 110 111 112 115 116 119 120 123 128 144 165 168 183 222 314 368 377 422 433

Tissues for clause 16 (Setting Group)

33 34 36 37 38 39 40 41 52 53 172 333 417

Tissues for clause 17 (Reporting model)

114 177 198 344 438

Tissues for clause 18-Annex A (GOOSE)

117 121 224 227 231 237 279 323 365 419

Tissues for clause 20 (Control model)

143 196 246 262 528

Tissues for clause 22 (File transfer)

118 260 576

Harmonization with 7-2 and 7-3

103 141 146 149 173 246 453 456 457

## COMMUNICATION NETWORKS AND SYSTEMS IN SUBSTATIONS –

### Part 8-1: Specific Communication Service Mapping (SCSM) – Mappings to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

#### 1 Scope

This part of IEC 61850 specifies a method of exchanging time-critical and non-time-critical data through local-area networks by mapping ACSI to MMS and ISO/IEC 8802-3 frames.

MMS services and protocol are specified to operate over full OSI and TCP compliant communications profiles. The use of MMS allows provisions for supporting both centralized and distributed architectures. This standard includes the exchange of real-time data indications, control operations, report notification.

This part of IEC 61850 specifies the mapping of the objects and services of the ACSI (Abstract Communication Service Interface, IEC 61850-7-2) to MMS (Manufacturing Message Specification, ISO 9506) and ISO/IEC 8802-3 frames.

This standard also specifies the mapping of time-critical information exchanges to non-MMS protocol. The protocol semantics are defined in IEC 61850-7-2. This standard contains the protocol syntax, definition, mapping to ISO/IEC 8802-3 frame formats, and any relevant procedures specific to the use of ISO/IEC 8802-3.

This mapping of ACSI to MMS defines how the concepts, objects, and services of the ACSI are to be implemented using MMS concepts, objects, and services. This mapping allows interoperability across functions implemented by different manufacturers.

This part of the standard defines a standardized method of using the ISO 9506 services to implement the exchange of data. For those ACSI services, defined in IEC 61850-7-2 that are not mapped to MMS, this part defines additional protocols. This standard describes real substation devices with respect to their external visible data and behaviour using an object oriented approach. The objects are abstract in nature and may be used to a wide variety of applications. The use of this mapping goes far beyond the application in the substation communications.

This part of IEC 61850 provides mappings for the services and objects specified within IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

#### 2 Normative references

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

IEC 60874-10-1:1997, *Connectors for optical fibres and cables – Part 10-1: Detail specification for fibre optic connector type BFOC/2,5 terminated to multimode fibre type A1*

IEC 60874-10-2:1997, *Connectors for optical fibres and cables – Part 10-2: Detail specification for fibre optic connector type BFOC/2,5 terminated to single-mode fibre type B1*

IEC 60874-10-3:1997, *Connectors for optical fibres and cables – Part 10-3: Detail specification for fibre optic connector type BFOC/2,5 for single and multimode fibre*

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Part 7-1: Principles and models*

IEC 61850-7-2, *Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3, *Communication networks and systems in substations – Part 7-3: Basic communication structure for substation and feeder equipment – Common data classes*

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

IEC 61850-9-1, *Communication networks and systems in substations – Part 9-1: Specific Communication Service Mapping (SCSM) – Sampled values over serial unidirectional multidrop point to point link*

IEC 61850-9-2, *Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

*IEC 62351-6, Data and Communication Security Part 6: Security for IEC 61850*

ISO/IEC 7498-1:1994, *Information technology – Open Systems Interconnection – Basic Reference Model: The Basic Model*

ISO/IEC 7498-3:1997, *Information technology – Open Systems Interconnection – Basic Reference Model: Naming and addressing*

ISO/IEC 8072:1996, *Information technology – Open systems interconnection – Transport service*

ISO/IEC 8073:1997, *Information technology – Open Systems Interconnection – Protocol for providing the connection-mode transport service definition*

ISO/IEC 8326:1996, *Information processing system – Open Systems Interconnection – Session service definition*

ISO/IEC 8327-1:1997, *Information technology – Open Systems Interconnection – Connection-oriented session protocols: Protocol specification*

ISO/IEC 8348:2002, *Information technology – Open Systems Interconnection – Network service definition*

ISO/IEC 8473-1:1998, *Information technology – Protocol for providing the connectionless-mode network service: Protocol specification*

ISO/IEC 8473-2:1996, *Information technology – Protocol for providing the connectionless-mode network service – Part 2: Provision of the underlying service by an ISO/IEC 8802 subnetwork*

ISO/IEC 8602:1995, *Information technology – Protocol for providing the OSI connectionless-mode transport service*

ISO/IEC 8649:1996, *Information technology – Open Systems Interconnection – Service definition for the Associated Control Service Element*

ISO/IEC 8650-1:1996, *Information technology – Open Systems Interconnection – Connection-oriented protocol for the Association Control Service Element: Protocol specification*

ISO/IEC 8802-2:1998, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 2: Logical link control*

ISO/IEC 8802-3:2001, *Information technology – Telecommunications and information exchange between systems – Local and metropolitan area networks – Specific requirements – Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*

ISO/IEC 8822:1994, *Information technology – Open Systems Interconnection – Presentation service definition*

ISO/IEC 8823-1:1994, *Information technology – Open Systems Interconnection – Connection-oriented presentation protocol: Protocol specification*

ISO/IEC 8824-1:1999, *Information technology – Abstract Syntax Notation One (ASN. 1): Specification of basic notation*  
Amendment 1 (2000)  
Amendment 2 (2000)

ISO/IEC 8825-1:2000, *Information technology – ASN.1 encoding rules: Specification of Basic Encoding Rules (BER), Canonical Encoding Rules (CER) and Distinguished Encoding Rules (DER)*

ISO/IEC 8877:1992, *Information technology – Telecommunications and information exchange between systems – Interface connector and contact assignments for ISDN Basic Access Interface located at reference points S and T*

ISO/IEC 9542:1988, *Information processing systems – Telecommunications and information exchange between systems – End system to Intermediate system routing exchange protocol for use in conjunction with the Protocol for providing the connectionless-mode network service (ISO 8473)*

ISO/IEC 9548-1:1996, *Information technology – Open Systems Interconnection – Connectionless Session protocol: Protocol specification*

ISO/IEC 9576-1:1995, *Information technology – Open Systems Interconnection – Connectionless Presentation protocol: Protocol specification*

ISO/IEC 10035-1:1995, *Information technology – Open Systems Interconnection – Connectionless protocol for the Association Control Service Element: Protocol specification*  
Amendment 1 (1998)

ISO/IEC ISP 10608-1:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service – Part 1: General overview and subnetwork-independent requirements*

ISO/IEC ISP 10608-2:1992, *Information technology – International Standardized Profile TAnnnn – Connection-mode Transport Service over Connectionless-mode Network Service –*

*Part 2: TA51 profile including subnetwork-dependent requirements for CSMA/CD Local Area Networks (LANs)*

*ISO/IEC ISP 11188-1:1995, Information technology – International Standardized Profile – Common upper layer requirements – Part 1: Basic connection oriented requirements*

*ISO/IEC ISP 11188-3:1996, Information technology – International Standardized Profile – Common upper layer requirements – Part 3: Minimal OSI upper layer facilities*

*ISO 9506-1:2003, Industrial automation systems – Manufacturing Message Specification – Part 1: Service definition*

*ISO 9506-2:2003, Industrial automation systems – Manufacturing Message Specification – Part 2: Protocol specification*

*ISO/ISP 14226-1:1996, Industrial automation systems – International Standardized Profile AMM11: MMS General Applications Base Profile – Part 1: Specification of ACSE, Presentation and Session protocols for use by MMS*

*ISO/ISP 14226-2:1996, Industrial automation systems – International Standardized Profile AMM11: MMS General Applications Base Profile – Part 2: Common MMS requirements*

*ISO/ISP 14226-3:1996, Industrial automation systems – International Standardized Profile AMM11: MMS General Applications Base Profile – Part 3: Specific MMS requirements*

*IEEE C37.111:1999, IEEE Standard for Common Format for Transient Data Exchange (COMTRADE) for Power Systems*

*IEEE 754:1985, IEEE Standard for Binary Floating-Point Arithmetic*

*IEEE 802.1Q:1998, IEEE Standards for Local and Metropolitan Networks: Virtual Bridged Local Area Networks*

*RFC 542, File Transfer Protocol for the ARPA Network, IETF, available at <<http://www.ietf.org>>*

*RFC 768, User Datagram Protocol, IETF, available at <<http://www.ietf.org>>*

*RFC 791, Internet Protocol – DARPA Internet Program Protocol Specification, IETF, available at <<http://www.ietf.org>>*

*RFC 792, Internet Control Message Protocol – DARPA Internet Program Protocol Specification, IETF, available at <<http://www.ietf.org>>*

*RFC 793, Transmission Control Procedure – DARPA Internet Program Protocol Specification, IETF, available at <<http://www.ietf.org>>*

*RFC 826, An Ethernet Address Resolution Protocol or Converting Network Protocol Addresses to 48.bit Ethernet Address for Transmission on Ethernet Hardware, IETF, available at <<http://www.ietf.org>>*

*RFC 894, A Standard for the Transmission of IP datagrams over Ethernet Networks, IETF, available at <<http://www.ietf.org>>*

*RFC 919, Broadcasting Internet Datagrams, IETF, available at <<http://www.ietf.org>>*

RFC 922 *Broadcasting Internet Datagrams in the presence of subnets*, IETF, available at <<http://www.ietf.org>>

RFC 950, *Internet Standard Subnetting Procedure*, IETF, available at <<http://www.ietf.org>>

RFC 959, *File Transfer Protocol (FTP)*, IETF, available at <<http://www.ietf.org>>

RFC 1006 *ISO transport services on top of TCP: Version 3*, IETF, available at <<http://www.ietf.org>>

RFC 1112, *Host Extensions for IP Multicasting*, IETF, available at <<http://www.ietf.org>>

RFC 1122, *Requirements for Internet Hosts – Communication Layers*, IETF, available at <<http://www.ietf.org>>

RFC 1123, *Requirements for Internet Hosts – Application and Support*, IETF, available at <<http://www.ietf.org>>

RFC 2030, *Simple Network Time Protocol (SNTP) Version 4*, IETF, available at <<http://www.ietf.org>>

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61850-2 as well as the following apply.

#### 3.1

##### **(n)-layer**

any specific layer

[ISO/IEC 7498-1, 3.1]

#### 3.2

##### **(n)-protocol data unit**

unit of data specified in an (n)-protocol and consisting of (n)-protocol-control-information and possibly (n)-user-data

[ISO/IEC 7498-1, 5.6.1.3]

#### 3.3

##### **(n)-protocol**

set of rules and formats (semantic and syntactic) which determines the communication behavior of (N)-entities in the performance of (n)-functions

[ISO/IEC 7498-1, 5.2.1.9]

#### 3.4

##### **class**

description of a set of objects that share the same attributes, services, relationships, and semantics

[IEC 61850-7-2, 3.1]

#### 3.5

##### **client**

entity that requests a service from a server and that receives unsolicited messages from a server

[IEC 61850-7-2, 3.2]

**3.6****device**

entity that performs control, actuating and/or sensing functions and interfaces to other such entities within an automation system

[IEC 61850-7-2, 3.3]

NOTE Devices alone do not perform energy transport functions.

**3.7****logical device**

entity that represents a set of typical substation functions

[IEC 61850-7-2, 3.6]

**3.8****logical node**

entity that represents a typical substation function

[IEC 61850-7-2, 3.7]

**3.9****physical device**

entity that represents the physical parts of a device (hardware and operating system, etc.)

[IEC 61850-7-2, 3.8]

NOTE Physical devices host logical devices.

**3.10****Application and Transport Profiles (A-Profile and T-Profile)**

set of protocols for a specific purpose

**3.11****attribute**

named element of data which has a specific type

**3.12****data**

meaningful structured information of applications located in an automation device which can be read or written.

NOTE This definition is in accordance with the Data definition of IEC 61850-7-2. The MMS use of Data refers to data types and potential instantiations of MMS variables. The reader of this part of IEC 61850 shall be careful of the context in which "data" is being used.

**3.13****ISO/IEC 8802-3**

communication technology according to ISO/IEC 8802-3

**3.14****server**

entity that provides services to clients or issues unsolicited messages

**4 Abbreviations**

A	Application
ACSE	Association Control Service Element
ACSI	Abstract Communication Service Interface
APPID or AppID	Application Identification

BRBC	Buffered Report Control Block
CBB	Conformance Building Block
CDC	Common Data class
CL	Connectionless
Client-CR	Client Conformance Requirement
CO	Connection Oriented
DNA	Dynamic Namespace Attribute
F/S	Functional Standard.
FC	Functional Constraint
FCD	Functionally Constrained Data
GPS	Global Positioning System
GOOSE	Generic Object Oriented Substation Event
GSE	Generic Substation Event
GSSE	Generic Substation Status Event
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IP	Internet Protocol
ISO	International Standardization Organization
LAN	Local Area Network
LCB	Log Control Block
LD	Logical Device
LLC	Logical Link Control
LN	Logical Node
LPDU	Link Protocol Data Unit
M or m	Mandatory. Indicates that the service, parameter, or attribute shall be supported within an implementation
M= or m=	Mandatory information that shall be equal the original information supplied in the request
MAC	Media Access Control
MJD	Modified Julian Day
MMS	Manufacturing Message Specification (ISO 9506)
o	Optional: Indicates that the service, parameter, or attribute may be supported within an implementation
OSI	Open Systems Interconnection
PDU	Protocol Data Unit
PICS	Protocol Implementation Conformance Statement
PIXIT	Protocol Implementation Extra Information
r	Mandates that the item is readable. The ability to write the item is a local issue.
RFC	Request for Comments
rw	Mandates that the item is both readable and writeable.
S	Server specified parameter
SAP	Service Access Point. The Service Access Point represents a logical

	construct through which a peer selects a communication protocol or access to an applications. The selection of the entire seven layers of SAPs represents a communication profile
SBO	Select Before Operate
SCL	substation automation System Configuration Language (IEC 61850-6)
SNTP	Simple Network Time Protocol
SCSM	Specific Communication Service Mapping
Server-CR	Server Conformance Requirement
SG	Setting Group
SNTP	Simple Network Time Protocol
SV	Sampled Values
Sync	Synchronization
T	Transport or Timestamp
TAI	Temps Atomique International
TCP	Transmission Control Protocol
TPID	Priority Tagging Identification (for IEEE 802.1Q networks) = 0x8100
UCA	Utility Communication Architecture
u or U	User-specific: Indicates that the service, parameter, or attribute can be defined by an implementation
u= or U=	User-specific information that shall be equal the original information supplied in the request
UTC	coordinated universal time
VARSPEC	Variable Specification
V-GET	Virtual Get Function. Defined in ISO 9506-1
VID	VLAN Identifier
VLAN	Virtual LAN
VMD	Virtual Manufacturing Device
V-PUT	Virtual Put Function. Defined in ISO 9506-1
w	Mandates that the item is writeable. The ability to read the item is a local issue.

## 5 Overview

### 5.1 General

The purpose of IEC 61850-8-1 is to provide detailed instructions/specification as to the mechanisms and rules required to implement the services, objects, and algorithms specified in IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4 while making use of ISO 9506 (all parts) (Manufacturing Message Specification), SNTP, and other application protocols (see Figure 1). This Clause is intended to provide an overview of the methodology to provide the mapping from IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4 into MMS.

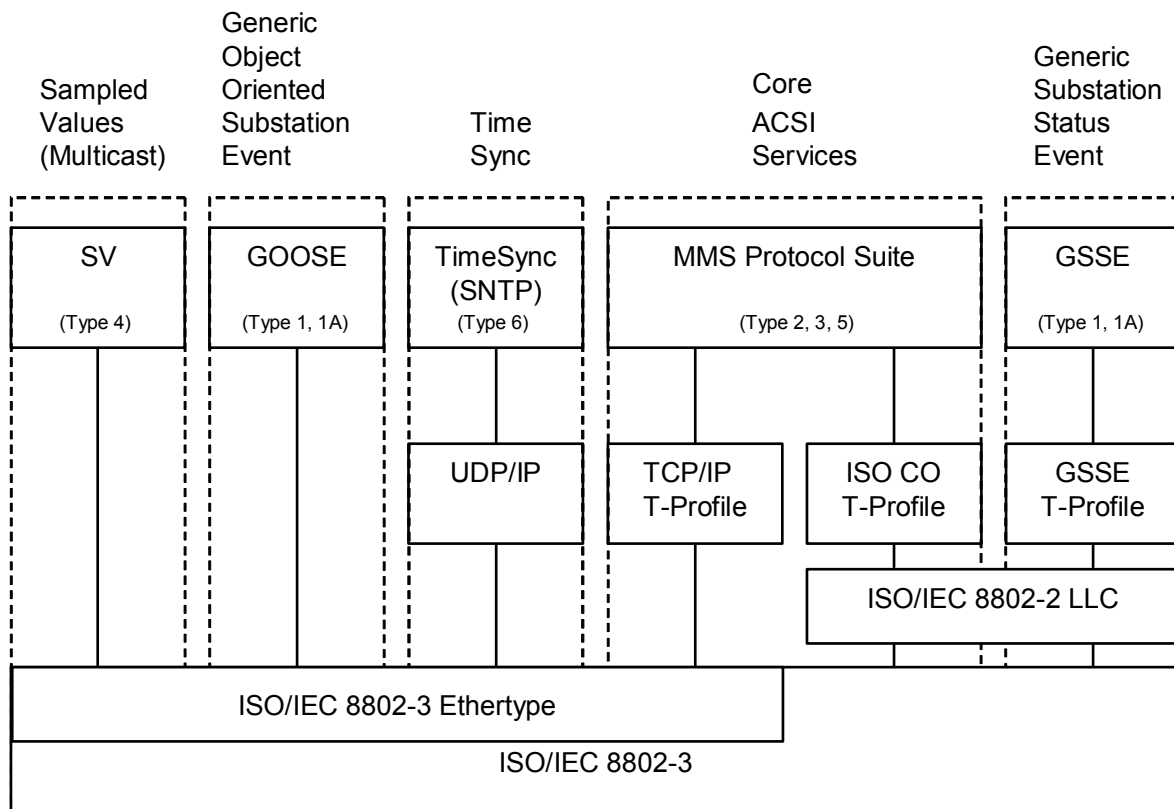
The communication requirements for substations (listed in IEC 61850-5) are met by the profiles shown in Figure 1.

The message types and performance classes specified in IEC 61850-5 are mapped as shown in Figure 1:

- Type 1 (Fast messages)
- Type 1A (Trip)
- Type 2 (Medium speed messages)
- Type 3 (Low speed messages)
- Type 4 (Raw data messages)
- Type 5 (File transfer functions)
- Type 6 (Time synchronisation messages)

Messages of Type 1 and Type 1A are mapped to distinct Ethertypes to optimise decoding of received messages.

Messages of Type 2, 3, and 5 require message oriented services. The MMS standard provides exactly the information modelling methods and services required by the ACSI.



IEC 136/04

(Type x) is the Message type and performance class defined in IEC 61850-5

**Figure 1 – Overview of functionality and profiles**

Further details pertaining to the use and actual specification of each profile may be found in Clause 6.

**5.2 IEC 61850 server object**

An instance of an IEC 61850-7-2 Server class is mapped one-to-one to an MMS Virtual Manufacturing Device (VMD) object. The MMS VMD is that portion of an application task that makes available (for control, monitoring, or both) a set of resources and functionality associated with one or more devices. Each VMD is assigned one or more communication addresses that create Service Access Points (SAPs) through which MMS services can be exchanged. The format of the address is determined by the communication profile that is

being used. It is through MMS services that MMS objects can be manipulated. Within this mapping to MMS, a VMD represents the capabilities provided by an IEC 61850-7-2 server on the network.

The server also is specified to contain other objects. These objects are:

- files
- client associations

### **5.3 MMS communication profiles**

The VMD's service address format is determined through the communication profile being used. However, ISO has recognized the existence of Application Profiles (A-Profiles) and Transport Profiles (T-Profiles). A-Profiles represent the protocols and agreements in regards to the upper 3 layers of the OSI Reference Model (ISO/IEC 7498-1). The T-Profiles represent the protocols and agreements in regards to the lower 4 layers of the OSI reference model.

For the purpose of this document, there are 2 A-Profiles: Connection Oriented OSI and Connectionless OSI. Additionally, there are 3 T-Profiles: Connection Oriented TCP, Connection Oriented OSI, and Connectionless OSI. The ConnectionOriented A-Profile shall only be used over the connection oriented T-Profiles.

### **5.4 Non-MMS communication profiles**

There are several services, specified in IEC 61850-7-2, that have been intentionally mapped to application protocols and communication profiles that do not make use of ISO 9506 as the application layer protocol. Other communication profiles are used to accomplish time synchronization, via IETF Simple Network Time Protocol (SNTP), sampled values, and GOOSE/GSSE messages.

### **5.5 MMS objects being used**

ISO 9506 (MMS) specifies several MMS objects that could be used as part of this SCSM. However, all objects are not required in order to perform the mapping of IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4. Table 1 shows the MMS objects and services that shall be used within this SCSM.

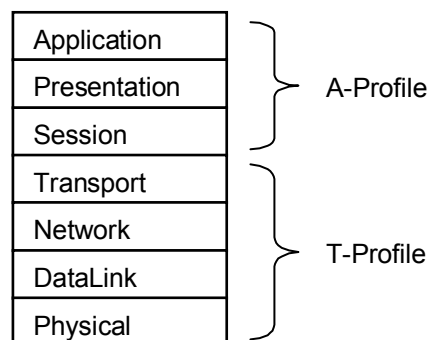
**Table 1 – MMS objects and services in use within this SCSM**

MMS OBJECT	IEC 61850 OBJECT	MMS SERVICES IN USE
Application Process VMD	Server	Initiate Conclude Abort Reject Cancel Identify <sup>1</sup>
Named Variable Objects	Logical Nodes and Data	Read Write InformationReport GetVariableAccessAttribute GetNameList
Named Variable List Objects	Data Sets	GetNamedVariableListAttributes GetNameList DefineNamedVariableList DeleteNamedVariableList GetNameList Read Write InformationReport
Journal Objects	Logs	ReadJournal InitializeJournal GetNameList
Domain Objects	Logical Devices	GetNameList GetDomainAttributes StoreDomainContents
Files	Files	FileOpen FileRead ObtainFile FileClose FileDirectory FileDelete
<sup>1</sup> Required by ISO 9506 for conformance.		

## 6 Communication stack

### 6.1 Overview of the protocol usage

The OSI Reference Model (ISO/IEC 7498-1) details a model based upon the concept of layering of communication functionality. The model details 7 layers and details the functional requirements, for each layer, in order to achieve a robust communication system. The model does not specify the protocols to be used to achieve the functionality, nor does it restrict the solution to be a single set of protocols.



IEC 137/04

**Figure 2 – OSI reference model and profiles**

The use of ISO Application (A-Profile) and Transport (T-Profile) Profiles (see Figure 2) describes the various stack profiles. An ISO A-Profile is the set of specifications and

agreements relating to the upper 3 layers of the ISO OSI reference model (e.g. the layers of application, presentation, and session). An ISO T-Profile is the set of specifications and agreements relating to the lower 4 layers of the ISO OSI reference model (e.g. the layers of transport, network, DataLink and physical).

Various combinations of A-Profiles and T-Profiles can be combined in order to allow certain types of information/services to be exchanged. The services, as specified in IEC 61850-7-2, are mapped into 4 different combinations of A- and T- profiles. The four different combinations are used for:

- Client/server services (see Figure 1 Core ACSI Services). See 6.2 for further details.
- GOOSE/GSE Management Services. See 6.3 for further details.
- GSSE Services. See Annex I.3 for further details.
- Time Sync. See 6.4 for further details.

## 6.2 Client/server services and communication profiles

### 6.2.1 Client/server services

The client/server communication profile shall be used for any implementation claiming conformance to this standard and declaring support for one of the IEC 61850-7-2 services shown in Table 2.

**Table 2 – Services requiring client/server Communication Profile**

IEC 61850-7-2 model	IEC 61850-7-2 service
Server	GetServerDirectory
Association	Associate
	Abort
	Release
Logical Device	GetLogicalDeviceDirectory
Logical Node	GetLogicalNodeDirectory
	GetAllDataValues
	GetDataValues
	SetDataValues
Data	GetDataDirectory
	GetDataDefinition
	GetDataSetValues
	SetDataSetValues
	CreateDataSet
Data Set	DeleteDataSet
	GetDataSetDirectory
	GetDataValues
	SetDataValues
Substitution	SelectActiveSG
	SelectEditSG
Setting Group Control Block	SetSGValues
	ConfirmEditSGValues
	GetSGValues
	GetSGCBValues

IEC 61850-7-2 Model	IEC 61850-7-2 Service
Report Control Block	Report
	GetBRCBValues
	SetBRCBValues
	GetURCBValues
LOG Control Block	SetURCBValues
	GetLCBValues
	SetLCBValues
	GetLogStatusValues
GOOSE	QueryLogByTime
	QueryLogAfter
	GetGoCBValues
GSSE	SetGoCBValues
	GetGsCBValues
Control	SetGsCBValues
	Select
	SelectWithValue
	Cancel
	Operate
	CommandTermination
FILE transfer	TimeActivatedOperate
	GetFile
	SetFile
	DeleteFile
	GetFileAttributeValues

### 6.2.2 A-Profile

Services and protocols of the A-Profile client/server shall be as shown in Table 3.

**Table 3 – Service and protocols for client/server communication A-Profile**

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Application	Manufacturing Message Specification	ISO 9506-1:2003	ISO 9506-2:2003	m
	Association Control Service Element	ISO/IEC 8649:1996	ISO/IEC 8650:1996	m
Presentation	Connection Oriented Presentation	ISO/IEC 8822:1994	ISO/IEC 8823-1:1994	m
	Abstract Syntax	ISO/IEC 8824-1:1999	ISO/IEC 8825-1	m
Session	Connection Oriented Session	ISO/IEC 8326:1996	ISO/IEC 8327-1:1997	m

There are 2 T-Profiles that may be used by the client/server A-Profile: TCP/IP or OSI. An implementation that claims conformance to this standard shall implement the TCP/IP profile as a minimum.

### Implementation agreements

This A-Profile shall conform to the agreements specified in ISO/ISP 14226-1, ISO/ISP 14226-2, ISO/ISP 14226-3, ISO/IEC ISP 11188-1 and ISO/IEC ISP 11188-3.

### 6.2.3 TCP/IP T-Profile

Table 4 shows services and protocols of the TCP/IP T-Profile client/server.

**Table 4 – Service and protocols for client/server TCP/IP T-Profile**

OSI Model Layer	Specification			m/o
	Name	Service specification	Protocol specification	
Communication	Requirement for internet host	RFC 1122		m
Transport	ISO Transport on top of TCP	RFC 1006		m
	Internet Control Message Protocol (ICMP)	RFC 792		m
	Transmission Control Protocol (TCP)	RFC 793		m
Network	Internet Protocol	RFC 791		m
	An Ethernet Address Resolution Protocol (ARP)	RFC 826		m
DataLink	Standard for the transmission of IP datagrams over Ethernet networks	RFC 894		m
	Carrier Sense Multiple Access with collision detection (CSMA/CD)	ISO/IEC 8802-3:2001		m
Physical (option 1)	10Base-T/100Base-T	ISO/IEC 8802-3:2001		c1
	Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup>	ISO/IEC 8877:1992		
Physical (option 2)	Fibre optic transmission system 100Base-FX	ISO/IEC 8802-3:2001		c1
	Basic Optical Fibre Connector. <sup>b</sup>	IEC 60874-10-1, IEC 60874-10-2 and IEC 60874-10-3		
<p><sup>a</sup> This is the specification for the 10BaseT connector.</p> <p><sup>b</sup> This is the specification for the ST connector.</p> <p>c1 It is recommended to implement at least one of the two Physical interfaces. Additional or future technologies may be used.</p>				

### **Implementation agreements**

#### **TCP\_KEEPALIVE**

The TCP\_KEEPALIVE function according to RFC 1122 shall be implemented. The value of the TCP\_KEEPALIVE shall be configurable. The range of allowed values shall be specified in the PIXIT declaration of the implementation. The value of the TCP shall be specified in seconds.

NOTE It is recommended that the minimum-maximum value of the allowable range should be no greater than 20 s. It is also recommended that the TCP\_KEEPALIVE be configurable to a minimum of 1 s. This results in a recommended range of 1 to 20. The value of the TCP\_KEEPALIVE is not intended to be changed via SCL since the impact of the parameter is IED wide. Additionally, the PIXIT shall declare if the TCP\_KEEPALIVE can be used to indicate Application functionality<sup>2</sup>.

<sup>2</sup> There are implementation strategy where the MMS/stack user is a separate process from the MMS provider/TCP stack. In such implementations, the use of TCP\_KEEPALIVE may not yield an appropriate indication that the MMS User is still executing.

**Transport selector**

The Transport Selector size shall be limited to a maximum of 4 octets.

## 6.2.4 OSI T-Profile

Table 5 shows services and protocols of the OSI T-Profile client/server.

**Table 5 – Service and protocols for client/server OSI T-Profile**

OSI Model Layer	Specification			m/o
	Name	Service specification	Protocol specification	
Transport	Connection Oriented Transport	ISO/IEC 8072:1996	ISO/IEC 8073:1997	m
Network	Connectionless Network	ISO/IEC 8348:2002	ISO/IEC 8473-1:1998 ISO/IEC 8473-2:1996	m
	End System to Intermediate System (ES/IS)	ISO/IEC 9542:1988		m
DataLink	Logical Link Control	ISO/IEC 8802-2:1998		m
	Carrier Sense Multiple Access with collision detection (CSMA/CD)	ISO/IEC 8802-3:2001		m
Physical (option 1)	10Base-T/100Base-T	ISO/IEC 8802-3:2001		c1
	Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup>	ISO/IEC 8877:1992		
Physical (option 2)	Fibre optic transmission system 100Base-FX	ISO/IEC 8802-3:2001		c1
	Basic Optical Fibre Connector. <sup>b</sup>	IEC 60874-10-1, IEC 60874-10-2 and IEC 60874-10-3		
<sup>a</sup> This is the specification for the 10BaseT connector. <sup>b</sup> This is the specification for the ST connector. c1 It is recommended to implement at least one of the two Physical interfaces. Additional or future technologies may be used.				

### **Implementation agreements**

The OSI T-Profile shall conform to the agreements as specified in ISO/IEC ISP 10608-1 and ISO/IEC ISP 10608-2.

### **Naming and addressing**

The naming and addressing, of this profile, shall be as specified in ISO/IEC 7498-3. The addressing shall be further constrained to support, at a minimum, the ISO DCC (39 hexadecimal) and Local (49 hexadecimal) AFI values found in ISO/IEC 7498-3.

### **Transport selector**

The Transport Selector size shall be limited to a maximum of 4 octets.

### **LLC type**

This profile shall use Class 1 LLC as specified in ISO/IEC 8802-2.

## **6.3 GSE management and GOOSE services communication profiles**

### **6.3.1 GSE mapping overview**

The GSE communication profile shall be used for any implementation claiming conformance to this standard and declaring support for one of the IEC 61850-7-2 services shown in Table 6.

**Table 6 – Services requiring GSE Management and GOOSE communication profile**

Model	IEC 61850-7-2 service
Generic Substation Event	GetReference GetGOOSEElementNumber SendGOOSEMessage

### 6.3.2 A-Profile

Table 7 shows services and protocols of the A-Profile GSE Management and GOOSE services.

**Table 7 – Service and protocols for GSE Management and GOOSE communication A-Profile**

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Application	GSE/GOOSE protocol	See Annex A		m
Presentation	Abstract Syntax	NULL		m
Session				

The presentation layer encoding shall be Basic Encoding Rules as defined in ISO/IEC 8824-1 and ISO/IEC 8825-1 to encode the grammar referenced.

### 6.3.3 T-Profile

The T-Profile for GSE and GOOSE Services shall be as shown in Table 8.

**Table 8 – GOOSE/GSE T-Profile**

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Transport				
Network				
DataLink	Priority Tagging/ VLAN	IEEE 802.1Q		m
	Carrier Sense Multiple Access with collision detection (CSMA/CD).	ISO/IEC 8802-3:2001		m
Physical (option 1)	10Base-T/100Base-T	ISO/IEC 8802-3:2001		c1
	Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup>	ISO/IEC 8877:1992		
Physical (option 2)	Fibre optic transmission system 100Base-FX	ISO/IEC 8802-3:2001		c1
	Basic Optical Fibre Connector. <sup>b</sup>	IEC 60874-10-1, IEC 60874-10-2 and IEC 60874-10-3		

<sup>a</sup> This is the specification for the 10BaseT connector.

<sup>b</sup> This is the specification for the ST connector.

c1 It is recommended to implement at least one of the two physical interfaces. Additional or future technologies may be used.

**Implementation agreements****T-DATA service**

The T-DATA service shall be mapped directly to the M\_UNITDATA service of the DataLink.

**Link layer: MAC – sublayer**

See Annex C for definitions.

The T-DATA destination address for a GOOSE message shall contain a multicast MAC address. The T-DATA source address for a GOOSE message shall contain a unicast MAC address.

The T-DATA destination address for a GSE management messages shall contain a unicast MAC address. The T-DATA source address for a GSE Management messages shall contain a unicast MAC address.

**Link Layer: Priority tagging/Virtual LAN**

See Annex C.

**6.4 Time sync**

This communication profile shall be used for any implementation claiming conformance to this standard and declaring support for objects containing an attribute of type TIMESTAMP.

**6.4.1 A-Profile**

The A-Profile for Time Sync Services shall be as shown in Table 9.

**Table 9 – Time sync A-Profile**

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Application	Simple Network Time Protocol	RFC 2030		m
Presentation				
Session				

**Implementation agreements**

This A-Profile shall conform to the agreements specified in RFC 1122 and RFC 1123.

Mode 3, 4 of SNTP time synchronization shall be supported.

**6.4.2 T-Profile**

The T-Profile for Time Sync Services shall be as shown in Table 10.

**Table 10 – Time sync T-Profile**

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Transport	Internet Control Message Protocol (ICMP)	RFC 792		m
	User Datagram Protocol (UDP)	RFC 768		m
Network	Internet Protocol	RFC 791		m

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
	An Ethernet Address Resolution Protocol (ARP)	RFC 826		m
	Broadcasting Internet Datagrams	RFC 922 RFC 950 RFC 919		m
	Host Extensions for IP Multicasting	RFC 1112		m
DataLink	Standard for the transmission of IP datagrams over Ethernet networks	RFC 894		m
	Carrier Sense Multiple Access with collision detection (CSMA/CD)	ISO/IEC 8802-3:2001		m
Physical (option 1)	10Base-T/100Base-T	ISO/IEC 8802-3:2001		c1
	Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup>	ISO/IEC 8877:1992		
Physical (option 2)	Fibre optic transmission system 100Base-FX	ISO/IEC 8802-3:2001		c1
	Basic Optical Fibre Connector. <sup>b</sup>	IEC 60874-10-1, IEC 60874-10-2 and IEC 60874-10-3		
<sup>a</sup> This is the specification for the 10BaseT connector. <sup>b</sup> This is the specification for the ST connector. c1 – It is recommended to implement at least one of the two Physical interfaces.				

## 7 Objects of IEC 61850

### 7.1 Server

For details, see 5.2.

### 7.2 Logical device (LD)

An instance of a IEC 61850-7-2 logical device class shall be represented by an MMS domain object. The IEC 61850-7-2 server object shall contain one or more MMS domain objects. An MMS domain represents a collection of information associated with a specific name. The domain object provides both an unambiguous name space for its subordinate objects (they need only be uniquely named within the scope of the domain). Within this mapping to MMS, the domain is used to represent the collection of objects and services that constitute a logical device.

Each physical device shall have one domain that represents the physical resources of the MMS VMD. This domain shall contain at least a LLN0 and a LPHD logical node.

Example IEC 61850-7-1 shows an example of a physical device that proxies other physical devices. This example can be extended to a single physical device with slotted CPU capability. Each CPU, and its associated Logical Devices, would have their own LPHD information. The entire box needs a set of independent LPHD and LLNO.

### 7.3 Logical node (LN)

#### 7.3.1 General

The construction of the contents of a logical node, that need mapping, are defined in IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

Each instance of a IEC 61850 Logical node maps to a single MMS NamedVariable. The MMS NamedVariable name is a local issue, but shall be named in accordance with the naming conventions set forth in IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

The MMS NamedVariable shall have a hierarchical MMS complex MMS type description. The general hierarchy of the MMS TypeDescription consists of multiple levels of components. The algorithm for the creation of the TypeDescription is specified in Equation 1.

```

For each functional constraint ( c ) found in Figure 33

    For each DATA ( d ) in the LN

        If the FCD generated from d,c is not empty, then add a component of
        ComponentName ( d ) of the ComponentType determined by the FCD to structure (
        s ).

    End For

If the structure ( s ) is not empty then add a component of ComponentName ( c ) of the
ComponentType ( s ) to the TypeDescription being generated.

End For

```

### Equation 1: Algorithm for logical node mapping

The order of the resulted components is recommended to be as shown in Figure 1.

MX
ST
CO
CF
DC
SP
SG
RP
LG
BR
GO
GS
SV
SE
MS
SC (SCL)
US
EX

IEC 138/04

### Figure 3 –Ordered list of functional constraints

NOTE FCs are defined as follows: RP – unbuffered report control blocks; LG – log control blocks; BR – buffered report control blocks; GO – GOOSE control blocks; GS – GSSE control blocks; SV – substituted values; SE – Setting group editing; MS – Multicast Sampled Values control block (from IEC 61850-9-2); US – Unicast Sampled Values control block (from IEC 61850-9-1); and EX – extension.

<sup>3</sup> The recommended ordering provides compatibility with existing UCA 2.0 implementations.

If there is no DATA (d) that instantiates a specific functional constraint, that functional constraint shall not appear as part of the NamedVariable TypeDescription.

Within a MMS component, representing a functional constraint, the order of the MMS components is determined by the order of the names of the compatible data classes (see IEC 61850-7-4) whose data attributes have the specific functional constraint.

Within a MMS component, representing IEC 61850-7-4 DATA, the order of MMS components is determined by the order of the names of the common data classes as defined in IEC 61850-7-3 or IEC extensions of it (e.g. Annex E.3). For private CDCs, or private Extensions, the order of attributes within the MMS component shall be identical to the order within the SCL ICD file describing the data model.

Common data classes, which have a single attribute, shall be mapped to a MMS primitive data type, unless otherwise specified. The component name shall be the attribute name from IEC 61850-7-3 unless otherwise specified.

Custom or proprietary extensions to data or data attributes shall be added to the end of the MMS TypeDescription structures. These components shall be named according to the data or data attribute names in the order given by the extended name space document.

This algorithm and mapping produces a MMS NamedVariable whose components are accessible through the use of MMS variable specification of an alternate access type. Additionally, there shall be a mapping to a set of flattened MMS named variables. The names of the flattened MMS named variables shall be created through the concatenation of the MMS named variable component names separated by “\$”. The nesting of the concatenation shall be constrained by the maximum MMS NamedVariable identifier size.

These two methods of creating a MMS variable specification shall be referred to as a 8-1 VARSPEC.

### **7.3.2 Mapping of LNReference to VariableAccessSpecifications**

An ACSI LNRef may be mapped to a MMS VariableAccessSpecification, when appropriate. The VariableSpecification of such a mapping shall be of type name (e.g. an MMS ObjectName). The scope of the ObjectName is determined by the ACSI LNReference parameter. If a LogicalDevice name is present within the LNReference, the scope of the MMS request shall be Domain-Specific. If an “@” is present, the scope shall be AA-Specific. If neither is present, the scope shall be VMD-Specific.

For a domain-specific scoped request, then the name of the ObjectName’s DomainID shall be the name of the LogicalDevice specified within the LNRef.

The ObjectName identifier for the MMS NamedVariable shall be the name of the LogicalNode contained within the LNRef.

An alternate specification shall be supported. This specification references the MMS named variable that has been mapped into a NamedVariable substituting the “\$” character for the ASCII “.” character.

### **7.3.3 Data**

Logical Nodes, according to IEC 61850-7-2, consist of one or more data. The names of data will be based upon the hierarchically named component of the data found within the MMS named variable. Each level of hierarchy will be delimited through the use of a “\$” within the MMS named variable that represents the data.

The data of an instance of LOGICAL-NODE shall be decomposed into multiple MMS NamedComponents

Example <LNVariableName>\${FC}\${LNDDataName1} (e.g. XCBR\$ST\$Pos).

#### 7.3.4 Data Attributes (DataAttr)

The logical node data attributes DataAttr map in a similar manner to the Data. However, the attribute name is also included within the hierarchy.

Example <LNVariableName>\${FC}\${LNDDataName1}\${AttributeName1}  
(e.g. XCBR\$ST\$Pos\$ctlVal).

## 8 Mapping of IEC 61850-7-2 and IEC 61850-7-3 data attributes

### 8.1 Mapping of Attributes specified in IEC 61850-7-2

#### 8.1.1 Basic data attribute types

The mapping of basic types of IEC 61850-7-2 shall be as defined in Table 11.

**Table 11 – Mapping of ACSI data types**

IEC 61850-7-2 type name	MMS data type	MMS value range	Comment
BOOLEAN	Boolean		
INT8	Integer	–128 to 127	
INT16	Integer	–32 768 to 32 767	
INT32	Integer	–2 147 483 648 to 2 147 483 647	
INT128	Integer	–2**127 to (2**127)–1	
INT8U	Unsigned	0 to 255	
INT16U	Unsigned	0 to 65 535	
INT32U	Unsigned	0 to 4 294 967 295	
FLOAT32	Floating-point	Range of values and precision as specified by IEEE 754 single precision floating point	
FLOAT64	Floating-point	Range of values and precision as specified by IEEE 754 double precision floating point	
ENUMERATED	Integer	Ordered set of values, defined where type is used	See 8.1.2.2
CODED ENUM	Bit-string	Ordered set of values, defined where type is used	See 8.1.2.3
OCTET STRING	Octet-string	Max length shall be defined where type is used	See 8.1.2.4
VISIBLE STRING	Visible-string	Max length shall be defined where type is used	See 8.1.2.5
UNICODE STRING	MMS string	Max length shall be defined where type is used	See 8.1.3.10

#### 8.1.2 Additional definitions of basic data type

##### 8.1.2.1 General

For the purposes of this standard, the reference to bitstring shall indicate the use of an MMS bitstring type. According to this definition, Bit(0) is mapped to the most significant bit of the value.

The amount of bits conveyed by a sent variable length bit-string shall always be equal to the maximum length of the defined variable length bit-string at the sender side.

NOTE The attempt to write in an attribute a value that is not supported by the application will lead to a write negative response with a `DataAccessError=object-value-invalid` (for instance: writing a not supported Enumerated, writing a longer `VisibleString/bitString` than defined, etc.).

#### **8.1.2.2 ENUMERATED**

The IEC 61850-7-2 ENUMERATED shall map to a value represented by a MMS integer value. Values that are 0 or greater shall be reserved for values standardized within IEC 61850. Values that are less than 0 shall be considered private values. The range of allowed values are specified in IEC 61850-7-2 and IEC 61850-7-3. The size of the MMS data type shall be the minimum size required to contain the maximum standardized value.

The first ordered value, of the standardized enumerated values, shall be assigned the value of zero(0).

Enumerated values outside the standardized range of values but within the MMS integer size, shall be assumed to be value extensions and shall not cause a protocol error.

NOTE For IEC 61850 enumerated values, where the actual numeric values are specified, the integer values within the context of IEC 61850-8-1 shall be the same as the numeric values specified.

#### **8.1.2.3 CODED ENUM**

The IEC 61850-7-2 CODED ENUM is represented by a bit-string. The size of the bit-string shall be the number of bits required to represent the maximum enumerate value defined in IEC 61850-7-2 and IEC 61850-7-3. The value of a particular bit-string shall be the unsigned integer encoding of the enumerated values in the order specified in IEC 61850-7-2 and IEC 61850-7-3.

For the purposes of IEC 61850-8-1, CODED ENUMs that appear within a PACKED LIST or an array of other CODED ENUMs are treated as special cases.

#### **8.1.2.4 OCTET-STRING**

The IEC 61850-7-2 OCTET-STRING shall map to a value represented by a MMS variable length octet-string. The maximum size of the MMS octet-string shall be the size as specified in IEC 61850-7-2 and IEC 61850-7-3.

#### **8.1.2.5 VISIBLE-STRING**

The IEC 61850-7-2 VISIBLE-STRING shall map to a value represented by a MMS variable length `MMSString`. The maximum size of the MMS visible-string shall be the size as specified in IEC 61850-7-2 and IEC 61850-7-3.

The character set, of `MMSString`, shall be constrained to `ISO646String`.

### **8.1.3 Common data types**

#### **8.1.3.1 OBJECTNAME**

This type never appears within the context of IEC 61850-8-1. Therefore it is not mapped.

#### **8.1.3.2 OBJECTREFERENCE**

The IEC 61850-7-2 `ObjectReference` maps to a variable length MMS visible-string. The maximum size of the visible-string shall be 129 octets. The value is the fully MMS scope qualified name of the MMS object. The value shall be constructed as:

– AA-specific scope objects:           @<MMS Object Name>

- Domain specific: <MMS Domain Name>/<MMS Object Name>
- VMD-specific: /<MMS Object Name>

The maximum MMS Object Name and Domain Name size shall be constrained by the MMS maxidentifier size of 64 (see Annex G) clause G.3.2.

The construction of MMS object names from IEC 61850 names is defined in 7.3.

The allowed character set is defined as the MMS Identifier and the “/” and “@” characters.

#### **8.1.3.3 ServiceError**

The ServiceError encoding is specified in the description of the individual services. Default mapping of a SCSI error is ACSI service error “failed-due-to-communications-constraint”.

#### **8.1.3.4 EntryID**

The ACSI EntryID type shall be mapped to an 8 octet fixed length MMS OCTETSTRING. The contents of the OCTETSTRING are IEC 61850 server specific. It is suggested that the format of the contents be documented as part of the implementation’s PIXIT statement.

The reserved value for EntryID is zero (0) is the MMS OCTETSTRING “00000000”, where all octet have a value (0).

#### **8.1.3.5 PACKED LIST**

A PACKED LIST type shall be mapped to a variable length MMS Bit-string. The minimum size of the bit-string shall be determined by the number of bits required to encode the members of the PACKED LIST. The order of the bits, in the bit-string, shall be that the first member of the PACKED LIST shall be mapped to Bit(0). The other members shall be mapped in consecutive bits in the order specified by IEC 61850-7-2 and IEC 61850-7-3.

Bitstrings shall support at least the number of bits required to represent the maximum enumerated value defined. Bits that are returned in excess of that number of bits may be ignored.

Bit 0 shall be the leftmost (most significant) bit of the first octet. Bit 7 shall be the rightmost (least significant) bit of the first octet. Bit 8 shall be the leftmost (most significant) bit of the second octet. Bit 15 shall be the rightmost (least significant) bit of the second octet. This shall be continued in that way in further octets.

There are special cases that are individually mapped and do not conform to the general rule. These are the timestamp type and quality type. For detailed mapping information, see 8.2 and 8.1.3.6.

#### **8.1.3.6 TIMESTAMP**

Extensions to the Data syntax of ISO 9506-2 are given in Annex G.

The quality flags are located in the eighth octet. These flags are defined in Table 12.



Bit 2 quality-change  
Bit 3 data-update  
Bit 4 integrity  
Bit 5 general-interrogation  
Bit 6 includeAll  
Bit 7 Reserved (reserved for future use – as long as the bit is reserved, the application shall ignore it).

#### **8.1.3.10 UNICODE-STRING**

Extensions to the Data syntax of ISO 9506-2 are given in Annex G.

#### **8.1.3.11 Array**

The IEC 61850-7-2 Array maps to a MMS array.

### **8.2 Mapping of quality common data attribute type specified in IEC 61850-7-3**

The definition, found in IEC 61850-7-3 of the Quality common data attribute, specifies a combination of PACKED LISTs, CODED ENUMs, and BOOLEAN values. The mapping of this data attribute shall be as prescribed in this Clause.

An IEC 61850-7-3 value of the type quality, shall be represented by an MMS DataType of BIT-STRING. The BIT-STRING shall be encoded as variable length bit-string. Bits that are not conveyed shall assume a DEFAULT value as specified in this Subclause.

The bit-string bit values shall be as defined in Table 13.

Future versions of the standard may add additional bits. The maximum allowed bit number shall be 15.

**Table 13 – Encoding of IEC 61850-7-3 quality**

Bit(s)	IEC 61850-7-3		Bit-String	
	Attribute name	Attribute value	Value	Default
0-1	Validity	Good	0 0	0 0
		Invalid	0 1	
		Reserved	1 0	
		Questionable	1 1	
2	Overflow		TRUE	FALSE
3	OutOfRange		TRUE	FALSE
4	BadReference		TRUE	FALSE
5	Oscillatory		TRUE	FALSE
6	Failure		TRUE	FALSE
7	OldData		TRUE	FALSE
8	Inconsistent		TRUE	FALSE
9	Inaccurate		TRUE	FALSE
10	Source	Process	0	0
		Substituted	1	
11	Test		TRUE	FALSE
12	OperatorBlocked		TRUE	FALSE

## 9 Server class model

### 9.1 Server mapping

The ACSI Server, specified in IEC 61850-7-2, shall be mapped to at least one MMS VMD.

### 9.2 Server class attributes

#### 9.2.1 ServiceAccessPoint

There are 5 ServiceAccessPoints (e.g. communication interfaces) that may be supported by an IEC 61850-8-1 implementation. The access points/communication interfaces that shall be supported are determined by the service support declared by the implementation.

#### 1) Client/server profile

Implementations that use the client/server profile shall support at least one Presentation Address that makes use of the TCP/IP T-Profile. More than one PresentationAddress may be supported.

Additionally, one or more PresentationAddresses that uses the OSI T-Profile may also be supported.

#### 2) GSE management

Implementations that support the GSE management profile shall support as least one ServiceAccessPoint for the GSE management services. An access point shall be defined as an L-Address. The L-Address shall be the combination of the physical MAC address, ETHERTYPE, and APPID specified by the profile for GSE management (see 6.3.3).

The destination ServiceAccessPoint shall be another L-Address specifying the same ETHERTYPE.

#### 3) GOOSE services

Implementations that support the GOOSE profile shall support as least one ServiceAccessPoint for transmitting GOOSE services. The access point shall be defined as an L-Address. The L-Address shall be the combination of the physical MAC address, ETHERTYPE, and APPID specified by the profile for GOOSE (see 6.3.3).

The destination ServiceAccessPoint shall be another L-Address specifying the same ETHERTYPE. The destination MAC address shall be an address that has the multicast bit set.

#### 4) GSSE services

Implementations that support the GSSE profile shall support at least ServiceAccessPoint for transmitting GSSE services. The access point shall be a PresentationAddress. (see I.1)

The destination ServiceAccessPoint shall be another PresentationAddress, as constrained by the profile. The destination ServiceAccessPoint shall be another L-Address specifying the same LLC. The destination MAC address shall be an address that has the multicast bit set.

#### 5) Transmission of sampled values services

Shall be as specified in IEC 61850-9-1 and IEC 61850-9-2.

### 9.2.2 Logical devices

Logical devices are mapped to MMS domain objects. For each logical device instance there shall be a single MMS domain. The domain name shall be the name of the logical device instance.

Further mapping information regarding logical devices is found in Clause 11.

### 9.2.3 Files

Files are mapped to MMS file objects. Further mapping information regarding files is found in Clause 23.

### 9.2.4 Client associations

See Clause 10.

## 9.3 Server class service GetServerDirectory

The GetServerDirectory service shall be mapped based upon the ACSI class being requested within the ServerDirectory service. There are 2 ACSI classes allowed: LOGICAL-DEVICE and FILE.

**LOGICAL-DEVICE class**

The ACSI request maps to an MMS GetNameList request. The GetNameList object class shall have a value of domain. The MMS GetNameList service, if constrained by the negotiated mmsPDU size limitation, may segment the process by returning a subset of file names and a flag (moreFollows) indicating the need to request the next subset. The client shall then post another request, this time specifying the position in the list at which the server should continue with name retrieval. Due to this constraint, the mapping of the ACSI service is actually a sequence of GetNameList services (until moreFollows=FALSE).

The ACSI ServiceErrors “failed-due-to-server-constraint” shall map to the Reject Code as detailed in Table 14. The ACSI ServiceErrors are mapped to MMS reject reasons. ACSI ServiceError values that do not appear in the table are not mapped.

**Table 14 – ServiceError mapping for GetServerDirectory for non-files**

ACSI service error	MMS reject	
	Reject reason	Reject code
failed-due-to-server-constraint	confirmed-requestPDU	other, unrecognized-service, max-serv-oustanding-exceeded

**FILE class**

The ACSI request maps to an MMS FileDirectory request. The MMS FileDirectory service, if constrained by the negotiated mmsPDU size limitation, may segment the process by returning a subset of file names and a flag (moreFollows) indicating the need to request the next subset. The Client shall then post another request, this time specifying the position in the list at which the server should continue with name retrieval. Due to this constraint, the mapping of the ACSI service is actually a sequence of FileDirectory services (until moreFollows=FALSE).

The ACSI ServiceErrors shall map to Error Class/Error Code or Reject Code as detailed in Table 15. The ACSI ServiceErrors are mapped to either MMS ServiceErrors or MMS Reject reasons. ACSI ServiceError values that do not appear in the table are not mapped.

If the Filename (for instance MMS FileSpecification) is not present in the FileDirectory.request, then the responding server shall return the Filenames present in the root directory. For servers that have logical devices, 23.1 specifies the root directory. The names of the files returned shall be the filenames of the files present in the LD directory. For servers that have no logical devices (for instance possibly a file server), the root directory shall be a local issue.

**Table 15 – ServiceErrors mapping of ACSI GetServerDirectory for files**

ACSI service error	MMS ServiceError	
	Error class	Error code
parameter-value-inappropriate	file	filename-syntax-error
parameter-value-inconsistent	file	filename-ambiguous
	MMS reject	
	Reject reason	Reject code
failed-due-to-server-constraint	confirmed-requestPDU	other, unrecognized-service, max-serv-oustanding-exceeded

## 10 Association model

### 10.1 Association relation to communication profiles

There are two types of application associations specified in IEC 61850-7-2. These are:

- two-party associations;
- multicast associations.

There are several communication profiles specified in this document. An implementation-claiming conformance to any one of the given profiles shall implement the association model required for that profile, as defined in Table 16.

**Table 16 – Association model versus communication profiles**

Communication profile	ACSI association model(s) supported
Client/server	Two party
GSE Management	Two party
GOOSE	Multicast
GSSE	Multicast
Time Sync	Two party or multicast

### 10.2 Two party association model for client/server communication profile

#### 10.2.1 Association mapping

The client/server profile shall map the ACSI two party association model to the MMS environment as specified in ISO 9506-1.

NOTE The MMS environment, as specified in ISO 9506-1, is brought into existence through the establishment of a single application-to-application association that is created and maintained via a connection-oriented communication profile. The addressing and procedures for this may be found in ISO 9506-1. However, the MMS environment consists, additionally, of the negotiation of application capabilities through the exchange of the MMS initiate service.

#### AssociationID

The AssociationID shall be a local issue. However, there shall be a one-to-one correspondence between an AssociationID and an MMS environment, including negotiated parameters.

NOTE Security, authentication is a future work item and is pending the development of a common IEC Technical Committee 57 security mechanism. This mechanism may restrict the visibility of objects within the MMS Environment. These efforts are underway within IEC Technical Committee 57 Working Groups 7 and 15.

### 10.2.2 Association services

#### 10.2.2.1 Associate

The ACSI associate request service shall map directly to the MMS initiate request service.

The ACSI associate response service shall map directly to the MMS initiate response service.

The ACSI associate response– service shall map to the MMS initiate service result(–).

The ACSI ServiceErrors shall map to Error Class/Error Code as detailed in Table 17. ACSI ServiceError values that do not appear in the table are not mapped.

**Table 17 – Associate service error mappings**

ACSI service error	MMS Serviceerror		ACSE AARE
	Error class	Error code	Parameter Values
instance-not-available	application-reference	application-unreachable	
parameter-value-inappropriate	application-reference	application-reference-invalid, context-unsupported	
parameter-value-inconsistent	initiate	max-services-outstanding-calling-insufficient max-services-outstanding-called-insufficient	
failed-due-to-communications-constraint	initiate	parameter-CBB-insufficient nesting-level-insufficient	
failed-due-to-server-constraint	initiate	other	Result::=Failure

Any other MMS ServiceErrors shall be mapped to failed-due-to-server-constraint.

#### 10.2.2.2 Abort

The ACSI abort request service shall map directly to the MMS abort request service.

The ACSI Abort Indication service shall map directly to the MMS abort indication. The reason code values shall be as defined in ISO 9506 (all parts).

#### 10.2.2.3 Release

The ACSI release request service shall map directly to the MMS conclude request service.

The ACSI release response+ shall map directly to the MMS conclude response.

The ACSI release response– shall map directly to the MMS conclude error. The ACSI ServiceErrors shall map to Error Class/Error Code as detailed in Table 18. ACSI ServiceError values that do not appear in the table are not mapped.

**Table 18 – Release service error mappings**

ACSI service error	MMS ServiceError	
	Error class	Error code
instance-in-use	conclude	further-communication-required
failed-due-to-server-constraint	conclude	other

Any other MMS ServiceErrors shall be mapped to failed-due-to-server-constraint.

### 10.3 Two party association model for GSE management communication profile

Although the GSE Management communication profile does not make use of multicast, the association model shall be implemented consistent with the multicast association model.

### 10.4 Two party association model for time sync

Although the SNTP protocol does not make use of MMS, it does behave as if it were a two party association model. Please refer to RFC 2030 for the specifics.

## 10.5 Multicast association model

The association model is specified as part of the various communication profiles.

## 11 Logical device model

The ACSI request GetLogicalDeviceDirectory maps to an MMS GetNameList request. The GetNameList object class shall have a value of NamedVariable within the scope of a particular domain. The MMS GetNameList service, if constrained by the negotiated mmsPDU size limitation, may segment the process by returning a subset of object names and a flag (moreFollows) indicating the need to request the next subset. The client shall then post another request, this time specifying the position in the list at which the server should continue with name retrieval. Due to this constraint, the mapping of the ACSI service is actually a sequence of GetNameList services (until moreFollows=FALSE).

If the LDReference (e.g. the MMS Domain), in the GetLogicalDeviceDirectory does not exist within the scope of the Server, then a MMS Confirmed-ErrorPDU shall be returned. The MMS ServiceError, within the Confirmed-ErrorPDU shall be an access error whose value is "object-non-existent".

If the requested Domain exists, but there are no objects of the requested ObjectClass, then a GetNameList-Response shall be sent. The GetNameList-Response shall indicate MoreFollows=FALSE and shall contain a NULL listOfIdentifier.

The NamedVariable objects returned may contain more objects than solely logical nodes. Therefore, the MMS ObjectName will need to be filtered based upon the naming standards within this document (e.g. a NamedVariable that has no '\$' character).

## 12 Logical node model

### 12.1 Logical node class

An instance of an ACSI LogicalNode shall be mapped to a single MMS NamedVariable. The mapping algorithm shall be as specified in 7.3.

### 12.2 Logical node class attributes

#### Data

The ACSI data, associated with an instance of a logical node, shall appear as MMS named components within the NamedVariable's MMS TypeDescription.

#### DataSets

The ACSI DataSet shall be mapped to a MMS NamedVariableList object. If the DataSet is within a logical node, then the name of the NamedVariableList object shall be constructed by concatenating logical node name and DataSet name separated by a "\$" character. A DataSetRef appearing within an IEC 61850-7-2 data object shall be mapped to a MMS variable length VISIBLE-STRING. The value of the VISIBLE-STRING shall be an OBJECT-REFERENCE as specified in 8.1.3.2.

#### BufferedReportControlBlocks

See 17.1.1.1.

#### UnbufferedReportControlBlocks

See 17.1.1.2.

#### LogControlBlocks

See 17.3.2.

**SettingGroupControlBlock**

See 16.

**Log**

The mapping of the IEC 61850-7-2 Log class shall be specified in 17.3.3.

**GOOSEControlBlock**

See 18.1.1.

**GSSEControlBlock**

See Annex I.2.

**MulticastSampledValueControlBlock**

MulticastSampledValueControlBlock shall map as per the data mapping rules.

**UnicastSampledValueControlBlock**

UnicastSampledValueControlBlock shall map as per the data mapping rules.

**12.3 Logical node class services****12.3.1 GetLogicalNodeDirectory**

The GetLogicalNodeDirectory service shall map directly to the GetNameList MMS service (see Table 19).

**Table 19 – GetNameList classes for GetLogicalNodeDirectory service**

ACSI class being requested in GetLogicalNodeDirectory	GetNameList service constraints
Data	NamedVariable
DataSet	NamedVariableList
BufferedReportControlBlock	NamedVariable
UnbufferedReportControlBlock	NamedVariable
LogControlBlock	NamedVariable
SettingGroupControlBlock	NamedVariable
Log	Journal
GooseControlBlock	NamedVariable
GSSEControlBlock	NamedVariable
MulticastSampledValueControlBlock	NamedVariable
UnicastSampledValueControlBlock	NamedVariable

The ACSI request maps to an MMS GetNameList request. The GetNameList object class shall have a value as specified in Table 19. The scope of the request shall be the scope of the LogicalNode (typically within the scope of a particular domain). The MMS GetNameList service, if constrained by the negotiated mmsPDU size limitation, may segment the process by returning a subset of object names and a flag (moreFollows) indicating the need to request the next subset. The client shall then post another request, this time specifying the position in the list at which the server should continue with name retrieval. Due to this constraint, the mapping of the ACSI service is actually a sequence of GetNameList services (until moreFollows=FALSE).

The ACSI Response– maps onto the MMS ServiceError as specified in Table 14.

### 12.3.2 GetAllDataValues

#### 12.3.2.1 Request

The ACSI request shall map to an MMS read request. The mapping of the ACSI LNReference parameter shall be as per 7.3.2.

If the ACSI request contains a functional constraint parameter, the read request Variable AccessSpecification shall specify alternateAccess. The accessSelection of the alternate access specification shall specify component. The value of the component shall be the value of the functional constraint being specified.

NOTE The access to all values of a particular logical node may also be obtained through the use of a single MMS named variable, with no alternate access. The name of the variable would be <LogicalNodeName>.

#### 12.3.2.2 Response+

The ACSI GetAllDataValues response+ maps to a MMS ReadResponse where the AccessResult returns MMS data.

The ACSI GetAllDataValues response+ parameter of DataAttributeReference is not mapped nor supported within this SCSM.

The DataAttributeValue(s) shall be mapped to the MMS AccessResult of the MMS read response. There shall be only 1 AccessResult returned.

#### 12.3.2.3 Response–

The ACSI GetAllDataValues response– shall map to a MMS read response where AccessResult indicates failure. Table 20 defines the mappings.

**Table 20 – MMS AccessResult mapping to ACSI ServiceError**

ACSI service error	AccessResult Codes (DataAccessError)
instance-not-available	object-non-existent
access-violation	object-access-denied
parameter-value-inconsistent	invalid-address
instance-locked-by-other-client	temporarily-unavailable
type-conflict	type-inconsistent
failed-due-to-server-constraint	hardware-failure

NOTE An out of range access will result in an MMS DataAccessError “object-value-invalid”.

## 13 Data class model

### 13.1 Data class

Instances of IEC 61850-7-2 data shall be mapped to a IEC 61850-8-1 VARSPEC as specified in 7.3.1 data class attributes.

#### Functionally Constrained Data (FCD)

An ACSI FCD is mapped as specified in 7.3.1.

#### Functionally Constrained Data Attribute (FCDA)

An ACSI FCDA is a special case of the mapping specified in 7.3.1. The differentiation between an FCD and a FCDA is that a FCDA is specified as nesting one level below the FCD.

Once mapped to MMS, the FCDA is identical and has the same IEC 61850-8-1 VARSPEC as a data attribute access.

## 13.2 Data class services

### 13.2.1 GetDataValues

The ACSI GetDataValues service shall be mapped to the MMS read service. The mapping of the ACSI service parameters shall be as defined in Table 21.

**Table 21 – Mapping of GetDataValues service parameters**

GetDataValues parameters	MMS service or parameter	Constraint
Request	Read request service	
Reference	variableAccessSpecification	Maps to a 8-1VARSPEC
Response+	Read response service	
DataAttributeValue[1..n]	listOfAccessResult	
Response–	Read response service	
ServiceError	listOfAccessResult	See Table 20

### 13.2.2 SetDataValues

The ACSI SetDataValues service shall be mapped to the MMS Write service. The mapping of the ACSI service parameters shall be as defined in Table 22.

**Table 22 – Mapping of SetDataValues service parameters**

SetDataValues service parameters	MMS service or parameter	Constraint
Request	Write request service	
Reference	variableAccessSpecification	Mapped to 8-1VARSPEC
DataAttributeValue[1..n]	listOfData	
Response+	Write response service	
	success	
Response–	Write response service	
ServiceError	failure	See Table 20

### 13.2.3 GetDataDirectory

The ACSI GetDataDirectory service shall be mapped to the MMS GetVariableAccessAttributes service. The mapping of the ACSI service parameters shall be as defined in Table 23.

**Table 23 – Mapping of GetDataDirectory service parameters**

GetDataDirectory service parameters	MMS service or parameter	Constraint
Request	GetVariableAccessAttributes request	
DataReference	Name	The name is created from the reference as per 7.3.2
Response+	GetVariableAccessAttributes Response	
DataAttributeName[1..n]	typeDescription	
Response–		
ServiceError	MMS ServiceError	See Table 24

**Table 24 – ServiceError Mappings for GetDataDirectory service**

ACSI service error	MMS ServiceError	
	Error class	Error code
instance-not-available	access	object-non-existent
access-violation	access	object-access-denied
Failed-due-to-communications-constraint	Any class	Any error code not mapped by this table
Failed-due-to-server-constraint	resource	capability-unknown

### 13.2.4 GetDataDefinition

This service shall be the same as GetDataDirectory (see 13.2.3).

## 14 Data set class model

### 14.1 Data set class

An IEC 61850-7-2 data set shall be mapped to a MMS NamedVariableList.

### 14.2 Data set attributes

#### DSName

The IEC 61850-7-2 DataSetName attribute shall be mapped to the MMS variable list name attribute of a named variable list object.

#### DSRef

The IEC 61850-7-2 DSRef attribute shall be mapped to the ObjectName of an MMS NameVariableList.

#### DSMemberRef

The list of DSMemberRef shall be a list of ACSI Functionally Constrained Data (FCD) or a Functionally Constrained Data Attribute (FCDA). See 13.2 for the mapping of FCD.

### 14.3 Data set services

#### 14.3.1 GetDataSetValues

The ACSI GetDataSetValues service shall be mapped to the MMS read service. The mapping of the ACSI service parameters shall be as defined in Table 25.

**Table 25 – Mapping of GetDataSetValues service parameters**

GetDataSetValues service parameters	MMS service or parameter	Constraint
Request	Read request service	
	specificationWithResult	Shall be TRUE
DataSetReference	variableAccessSpecification	Shall be constrained to variableListName
Response+	Read response service	
DataSetReference		Is not mapped
DataAttributeValue[1..n]	listOfAccessResult	
Response-	Confirmed-ErrorPDU	
ServiceError	access, "object-non-existent"	See Table 20

The Response+ shall return a listOfAccessResults. The values contained within this list shall indicate the success or failure of the MMS V-Get function. Note, this means that some AccessResults may return success while others return failure.

The Response- is reserved to indicate that a non-existent DataSetReference (e.g. NamedVariableList) has been requested. In this case, a MMS Confirmed-ErrorPDU shall be returned indicating errorClass="access" with the detail of "object-non-existent".

### 14.3.2 SetDataSetValues

The ACSI SetDataSetValues shall be mapped to the MMS Write Service. The mapping of the ACSI service parameters shall be as defined in Table 26.

**Table 26 – Mapping of SetDataSetValues service parameters**

SetDataSetValues parameters	MMS service or parameter	Constraint
Request	Write request service	
DataSetReference	variableAccessSpecification	Shall be constrained to variableListName
DataAttributeValue[1..n]	listOfData	
Response+	Write response service	
Result	success	
Response-	Write response service	
ServiceError	failure	See Table 20

### 14.3.3 CreateDataSet

The ACSI CreateDataSet service shall be mapped to the MMS DefineNamedVariableList Service. The mapping of the ACSI service parameters shall be as defined in Table 27 and Table 28.

There are two types of DataSets specified in IEC 61850-7-2. These are persistent and non-persistent. The persistent DataSet shall be mapped to a MMS NamedVariableList whose scope is either VMD-SCOPE or DOMAIN-SPECIFIC SCOPE. The non-persistent DataSet shall be mapped to an ASSOCIATION-SPECIFIC MMS NamedVariableList.

**Table 27 – Mapping of CreateDataSet service parameters**

CreateDataSet parameters	MMS service or parameter	Constraint
Request	DefineNamedVariableList request service	
DataSetReference	variableListName	
DSMemberRef[1..n]	listOfVariable	
Response+	DefineNamedVariableList response service	
Result		
Response–		
ServiceError	MMS ServiceError	See Table 28

**Table 28 – ServiceError mapping for CreateDataSet**

ACSI service error	MMS ServiceError	
	Error class	Error code
instance-in-use	definition	object-exists
access-violation	access	object-access-unsupported
parameter-value-inconsistent	definition	invalid-address
type-conflict	definition	
failed-due-to-communications-constraint	All classes	any unmapped error codes

#### 14.3.4 DeleteDataSet

The ACSI DeleteDataSet service shall be mapped to the MMS DeleteNamedVariableList service. The mapping of the ACSI service parameters shall be as defined in Table 29 and Table 30.

**Table 29 – Mapping of DeleteDataSet service parameters**

DeleteDataSet parameters	MMS service or parameter	Constraint
Request	DeleteNamedVariableList request service	
DataSetReference	listOfVariableListName	
Response+	DeleteNamedVariableList response service	
	numberDeleted	
Response–		
ServiceError	MMS ServiceError	See Table 30

**Table 30 – ServiceError mapping for DeleteDataSet**

ACSI service error	MMS ServiceError	
	Error class	Error code
instance-not-available	definition	object-undefined
access-violation	access	object-access-denied
failed-due-to-communications-constraint	Any class	Any unmapped error codes
failed-due-to-server-constraint	access	object-access-unsupported
instance-in-use	service	object-state-conflict
		DeleteVariableList-Error PDU
parameter-value-inappropriate		DeleteVariableList-Error
ACSI service error	MMS Service Response	
	Service	Parameters
instance-not-available	DeleteNamedVariableList.Response-	Number Matched =0
failed-due-to-server-constraint	DeleteNamedVariableList.Response-	Number Matched not equal to Number Deleted

### 14.3.5 GetDataSetDirectory

The ACSI GetDataSetDirectory service shall be mapped to the MMS GetNamedVariableList Attributes service. The mapping of the ACSI service parameters shall be as defined in Table 31 and Table 32.

**Table 31 – Mapping of GetDataSetDirectory service parameters**

GetDataSetDirectory parameter	MMS service or parameter	Constraint
Request	GetNamedVariableListAttributes request service	
DataSetReference	variableListName	variableAccessSpecification shall be constrained to a variableListName.  variableListName ObjectName shall specify the scope and name of the named variable list.
Response+	GetNamedVariableListAttributes response service	
DSMemberRef[1..n]	listOfVariable	
Response-		
ServiceError	MMS ServiceError	See Table 32

**Table 32 – ServiceError mapping for GetDataSetDirectory**

ACSI service error	MMS ServiceError	
	Error class	Error code
instance-not-available	definition	object-undefined
access-violation	access	object-access-denied
failed-due-to-communications-constraint	Any class	Any unmapped error codes

failed-due-to-server-constraint	access	object-access-unsupported
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## 15 Substitution model

The substitution model maps directly to a specialization of data. No additional mapping is required.

## 16 Setting group control class model

### 16.1 Setting group control class definition

An implementation claiming support for this model shall declare, in its PIXIT, the number of setting groups supported by each logical device. This declaration indicates that the PIXIT specified number of setting group value sets shall be maintained in a non-volatile fashion (e.g. persistent between power-cycles).

The value of EditSG, upon power-up, shall be 0.

There shall be one Setting Group Control Block (SGCB) within a LogicalDevice.

### 16.2 Setting group control class services

#### 16.2.1 SelectActiveSG

This service is a specialization of the SetDataValues service (see 13.2.2). The value of ActSG shall be set. The ACSI ServiceError shall map as defined in Table 33.

**Table 33 – Mapping of ACSI ServiceError for SelectActiveSG**

ACSI service error	AccessResult codes (DataAccessError)
instance-not-available	object-non-existent
access-violation	object-access-denied
parameter-value-inconsistent	invalid-address
instance-locked-by-other-client	temporarily-unavailable
type-conflict	type-inconsistent
failed-due-to-server-constraint	hardware-failure
instance-in-use	temporarily-unavailable

#### 16.2.2 SelectEditSG

This service is a specialization of the SetDataValues service (see 13.2.2). The value of EditSG shall be set. The ACSI ServiceError shall map as defined in Table 33.

#### 16.2.3 SetSGValues

This ACSI service is mapped to a MMS Write of the desired values. Prior to execution of this service, the appropriate edit group needs to be selected through the use of SelectEditSG service.

A value that has been successfully written shall be non-volatile as part of the setting group set.

### 16.2.4 ConfirmEditSGValues

This service is a specialization of the SetDataValues service (see 13.2.2). The value of CnfEdit shall be set TRUE. The ACSI ServiceError shall map as defined in Table 33.

The effect of when and how the non-volatile storage is updated is a local issue. The methodology should be documented. The value of CnfEdit shall return to FALSE once the storage is completed.

### 16.2.5 GetSGValues

This ACSI service is mapped to a MMS read of the desired values. Prior to execution of this service, the appropriate edit group and/or active group need to be selected through the use of SelectEditSG or SelectActiveSG service.

### 16.2.6 GetSGCBValues

This service is a specialization of the GetDataValues service (see 13.2.1).

## 17 Reporting and logging class model

### 17.1 Report model

#### 17.1.1 Report control blocks

Instances of the buffered report control block shall be of the FC “BR”. Instances of the unbuffered report control block shall be of the FC “RP”.

##### 17.1.1.1 Buffered report control block

The mapping of the BRCB class definition shall be as a MMS named component within an instance of a logical node. The MMS structure type representing the BRCB shall be of the type defined in Table 34.

**Table 34 – Mapping of BRCB to MMS type definition**

ACSI component name	MMS named component name	MMS type	Comment
RptID	RptID	See 8.1.2.5	May not be written when RptEna=TRUE
RptEna	RptEna		
DatSet	DatSet	See 8.1.3.2	May not be written when RptEna=TRUE
ConfRev	ConfRev		May not be written
OptFlds	OptFlds	See Table 35	May not be written when RptEna=TRUE
BufTm	BufTm		May not be written when RptEna=TRUE
SqNum	SqNum		May not be written
TrgOps	TrgOps	See 8.1.3.8	May not be written when RptEna=TRUE
IntgPd	IntgPd		May not be written when RptEna=TRUE
GI	GI		
PurgeBuf	PurgeBuf		May not be written when RptEna=TRUE
EntryID	EntryID	See 8.1.3.4	May not be written when RptEna=TRUE
TimeOfEntry	TimeofEntry		May not be written
ResvTms	ResvTms		May not be written when RptEna=TRUE

A write of a change of value to RptID, DatSet, BufTm, TrgOps, IntgPd, or PurgeBuf shall execute the PurgeBuf procedure described in IEC 61850-7-2.

NOTE The naming of instances of a BRCB shall be controlled by the IEC 61850-6 RCB attribute "index".

If the IEC 61850-6 RCB attribute "index" is TRUE, the BRCB instance numbering shall start with 01 and progress through 99. Two digits of instance numbering is mandatory.

If the IEC 61850-6 RCB attribute "index" is FALSE, the BRCB instance shall be with instance number of 01.

### RptEna

A V-Put of RptEna shall fail if the value of DataSet is NULL.

### DatSet

A V-Put of a DataSet that does not exist shall fail unless the value is NULL. The value of NULL shall indicate that there is no DataSet.

### OptFIds

OptFIds shall be mapped to an MMS BITSTRING according to Table 35.

**Table 35 – Mapping of OptFIds within Bitstring**

ACSI value of BRCState	MMS bit position
Reserved	0
sequence-number	1
report-time-stamp	2
reason-for-inclusion	3
data-set-name	4
data-reference	5
buffer-overflow	6
entryID	7
conf-revision	8
segmentation	9

The segmentation bit is reserved in order to keep OptFIds and ReportedOptFIds in alignment.

#### 17.1.1.2 Unbuffered report control block

The mapping of the URCB class definition shall be as a MMS named component within an instance of a logical node. The MMS structure type representing the URCB shall be of the type defined in Table 36:

**Table 36 – Mapping of URCB to MMS type definition**

ACSI component name	MMS named component name	MMS type	Comment
RptID	RptID	See 8.1.2.5	May not be written when RptEna=TRUE
RptEna	RptEna		
Resv	Resv		May not be written when RptEna=TRUE
DatSet	DatSet	See 8.1.3.2	May not be written when RptEna=TRUE
ConfRev	ConfRev		May not be written
OptFIds	OptFIds	See Table 35	May not be written when RptEna=TRUE The values of buffer-overflow and entryID shall be ignored
BufTm	BufTm		May not be written when RptEna=TRUE
SqNum	SqNum		May not be written
TrgOps	TrgOps	See 8.1.3.8	May not be written when RptEna=TRUE
IntgPd	IntgPd		May not be written when RptEna=TRUE

GI	GI		
----	----	--	--

Within the scope of a URCB, a MMS V-GET of OptFlds shall always return the buffer-overflow=FALSE and entryID=FALSE. The other values of OptFlds shall reflect the default value(s) if no V-PUT has occurred while the the URCB is reserved (e.g. Resv=TRUE). If a V-PUT has been executed while Resv=TRUE, a V-GET shall return the V-PUT values with the exceptions of buffer-overflow=FALSE and entryID=FALSE. If a V-PUT occurs while Resv=FALSE, the value returned in the V-GET is a local issue.

A transition of RptEna from FALSE to TRUE shall cause the value of SqNum to be set to zero (0).

NOTE The naming of instances of a URCB shall be controlled by the IEC 61850-6 RCB attribute "index".

If the IEC 61850-6 RCB attribute "index" is TRUE, the URCB instance numbering shall start with 01 and progress through 99. Two digits of instance numbering is mandatory.

If the IEC 61850-6 RCB attribute "index" is FALSE, the URCB instance shall be with instance number of 01.

#### **RptEna**

A V-Put of RptEna shall fail if the value of DatSet is NULL.

#### **DatSet**

A V-Put of a DataSet that does not exist shall fail unless the value is NULL. The value of NULL shall indicate that there is no DataSet.

## **17.2 Reporting services**

### **17.2.1 Report service**

A report shall be conveyed in an MMS information report that has its variableAccess specification set to indicate a variableListName. This MMS named variable list is instantaneously created, reported, and then deleted.

The variableListName ObjectName shall contain the VMD-SPECIFIC value "RPT". In addition to the variableAccessSpecification, the InformationReport shall consist of a SEQUENCE of AccessResult. The AccessResult values shall occur as described in Table 37.

**Table 37 – Order of AccessResults for variableListName report**

<b>IEC 61850-7-2 report format parameter name</b>	<b>Condition</b>
RptID	Shall always be present
Reported OptFlds	Shall always be present
SeqNum	Shall be present if OptFlds.sequence-number is TRUE
TimeOfEntry	Shall be present if OptFlds.report-time-stamp is TRUE
DatSet	Shall be present if OptFlds.data-set-name is TRUE
BufOvfl	Shall be present if OptFlds.buffer-overflow is TRUE
EntryID	Shall be present if OptFlds.entryID is TRUE
ConfRev	Shall be present if OptFlds.conf-rev is TRUE
SubSeqNum	Shall be present if OptFlds.segmentation is TRUE
MoreSegmentsFollow	Shall be present if OptFlds.segmentation is TRUE
Inclusion-bitstring	Shall be present
data-reference(s)	Shall be present if OptFlds.data-reference is TRUE
value(s)	See value(s)

ReasonCode(s)	Shall be present if OptFlds.reason-for-inclusion is TRUE
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### **AccessResult for RptID**

The AccessResult, containing the value of RptID, shall be the same MMS TypeDescription as that of the RptID component of the control block.

If the control block RptID value is NULL, then the MMS data shall contain the object reference specifying the control block which caused the report to be generated.

### **AccessResult for Reported OptFlds**

The AccessResult, containing the value of OptFlds, shall be the same MMS TypeDescription as that of the OptFlds component of the control block. The values for this result are defined in Table 35.

The segmentation bit shall be used when included in a reported. This bit shall be used to indicate the presence or absence of the SubSeqNum and the MoreSegmentsFollow access-result.

If the segmentation bit is TRUE, then the SubSeqNum and MoreSegmentsFollow AccessResults shall be present. If the segmentation bit is FALSE, the SubSeqNum and MoreSegmentsFollow AccessResults shall not be present.

### **AccessResult for SeqNum**

The AccessResult, containing the value of SeqNum, shall be the same MMS TypeDescription as that of the SeqNum component of the control block.

### **AccessResult for TimeofEntry**

The AccessResult, containing the value of TimeofEntry, shall have a MMS TypeDescription of MMS binary-time. The format shall be 6 octets.

### **AccessResult for DatSet**

The AccessResult, containing the value of DatSet, shall have the same MMS TypeDescription as the DatSet component of the control block.

### **AccessResult for bufOvfl**

The AccessResult, containing the value of bufOvfl shall be a MMS Type of BOOLEAN. The value of FALSE indicates that there is no buffer overflow.

### **AccessResult for EntryID**

The AccessResult, containing the value of EntryID, shall be the same MMS TypeDescription as that of the EntryID component of the control block.

### **AccessResult for ConfRev**

The AccessResult, containing the value of ConfRev, shall be the same MMS TypeDescription as that of the ConfRev component of the control block.

### **AccessResult for SubSeqNum**

The value conveyed in the MMS InformationReport listOfAccessResult shall be an MMS Unsigned Integer. The range of values shall be consistent with a 16 bit unsigned integer value.

### **AccessResult for MoreSegmentsFollow**

The AccessResult, containing the value of MoreSegmentsFollow shall be a MMS type of BOOLEAN. The value of TRUE indicates that there are more report sub-sequences required to complete the entire report.

**AccessResult for inclusion-bitstring**

The AccessResult, containing the value of the inclusion bitstring shall be a MMS type of bitstring. The number of used bits, within the bitstring, shall be equal to the number of members of the NamedVariableList designated as the DataSet. If a bit value is TRUE, then a value for the corresponding NamedVariableList member will be present. If OptFld.data-reference and/or OptFlds.reason-for-inclusion are TRUE, then those AccessResults shall also be present. The order of the bits, in the bitstring, shall be the order of the members of the NamedVariableList.

**AccessResult for data-reference(s)**

The AccessResult, containing the value of the data-reference shall be a MMS type of VISIBLESTRING. The value of the AccessResult shall be the ObjectReference for the NamedVariableList member whose value is being included. The order of the AccessResult(s) shall be the order of the members of the NamedVariableList.

**AccessResult for value(s)**

This set of AccessResult shall contain the MMS data corresponding to the members of the DataSet that are being reported. The order of the AccessResult(s) shall be the order of the members of the NamedVariableList.

**AccessResult for ReasonCode(s)**

The Reason-for-inclusion shall be encoded as multiple AccessResults. Each AccessResult shall be a MMS bit-string data type. The size of the AccessResult shall be the same size as the TrgOps component of the control block. The general-interrogation bit (Bit 5) shall be used to indicate that the reason is due to a general interrogation. This number of AccessResults shall be the same as the number of AccessResults of the value(s) attribute, within the InformationReport. The order of the AccessResult(s) shall be the order of the members of the NamedVariableList.

**17.2.2 GetBRCBValues**

This service shall be mapped to a MMS read service.

The ACSI FunctionalConstraint value shall be ignored. The MMS read response shall return all values of the BRCB specified by the ACSI BRCBReference. The mapping of the BRCBReference shall be as defined in 7.3.2.

The Response– service error shall be mapped as specified in Table 20.

**17.2.3 SetBRCBValues**

This service shall be mapped to a MMS write service.

The ACSI FunctionalConstraint value shall be ignored. The MMS write response shall return AccessResult of the BRCB elements specified by the ACSI request. The mapping of the BRCBReference shall be as defined in 7.3.2.

The Response– service error shall be mapped as specified in Table 20.

**17.2.4 GetURCBValues**

Shall be mapped as per 17.2.2.

**17.2.5 SetURCBValues**

Shall be mapped as per 17.2.3.

## 17.3 Log model

### 17.3.1 General

IEC 61850-7-2 specifies two major components to the Log Model: a control class and the log class itself.

### 17.3.2 Mapping of log control class

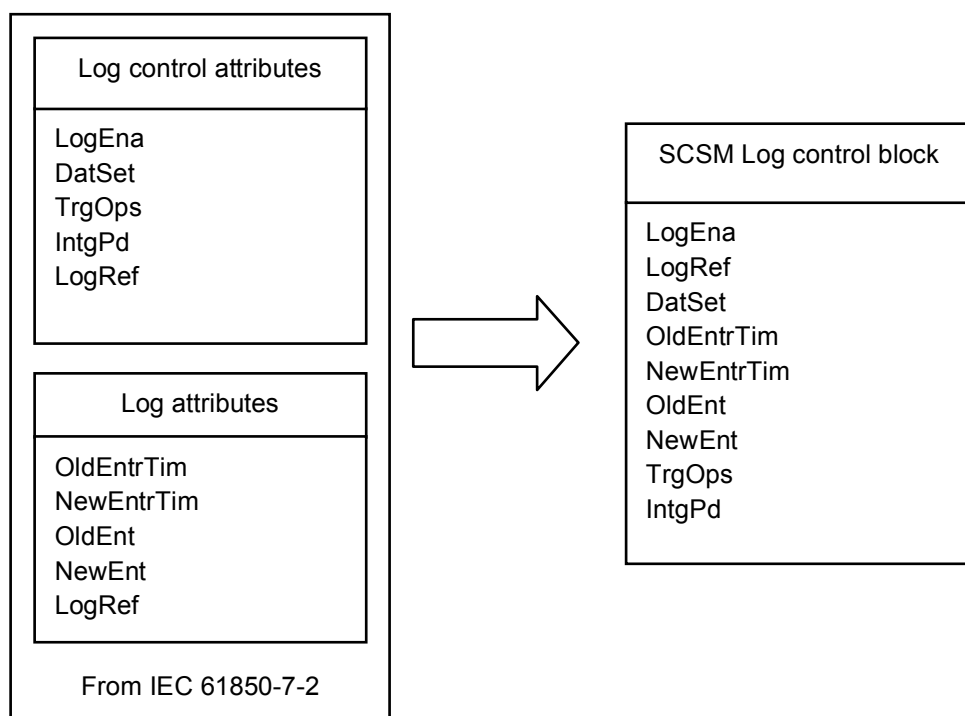
The log control class, as specified in IEC 61850-7-2, maps to structure components defined as part of the log control block (see 17.3.3). Instances of this class shall be of the FC “LG”.

### 17.3.3 Mapping of log class

The mapping of the log class maps onto two different MMS objects: a Log Control Block (LCB); and an MMS journal.

#### 17.3.3.1 Log control block

The Log Control Block (LCB) is represented as an MMS data definition that combines the attributes from the IEC 61850-7-2 log control class and other attributes from the log class (see Figure 4).



IEC 139/04

**Figure 4 – Relationship of LCB attributes to IEC 61850-7-2 log definitions**

The IEC 61850-8-1 MMS TypeDescription of an LCB is a structure with the MMS named components described in Table 38.

**Table 38 – Definition of an MMS log control block**

IEC 61850-7-2 attribute name	IEC 61850-8-1 component name	MMS TypeDescription	r/w	m/o	Comments
LogEna	LogEna	See 8.1.1	r/w	m	
LogRef	LogRef	See 8.1.3.2	r/w	m o	May not be written if LogEna=TRUE
DatSet	DatSet	See 8.1.3.2	r/w	m o	May not be written if LogEna=TRUE
OldEntrTm	OldEntrTm	See 8.1.3.7	r	m	See <sup>a)</sup>
NewEntrTm	NewEntrTm	See 8.1.3.7	r	m	See <sup>a)</sup>
OldEnt	OldEnt	See 8.1.3.4	r	m	See <sup>a)</sup>
NewEnt	NewEnt	See 8.1.3.4	r	m	See <sup>a)</sup>
OptFlds					Not mapped. This Clause forces the reasonCodes to always appear in the Log.
TrgOps	TrgOps	See 8.1.3.9	r/w	m	May not be written if LogEna=TRUE
IntgPd	IntgPd	See 8.1.1	r/w	o	May not be written if LogEna=TRUE

<sup>a)</sup> These attributes are defined as part of the Log Object in IEC 61850-7-2, but are mapped to additional attributes in the LCB within the context of this standard. The values of these attributes shall reflect the appropriate values for the Log specified by the value of LogRef.

### 17.3.3.2 MMS TypeDescription definition for LCB MMS structure

#### 17.3.3.2.1 LogEna

The values of LogEna shall be mapped as defined in Table 39.

**Table 39 – Mapping of values for LogEna**

ACSI value	MMS value of LogEna component
enabled	TRUE
disabled	FALSE

The default value of LogEna is a local issue, however it is suggested that the default value should be FALSE.

The value of LogEna shall be non-volatile.

#### 17.3.3.2.2 LogRef

Shall be of the data type specified in 8.1.3.2. The form of the value shall be that of an ObjectReference. The DEFAULT value shall be an ObjectReference specifying the logical device (e.g. MMS domain) and the actual name of the journal. The name of the default journal shall be “GeneralLog”. Thus the default value of LogRef shall be of the form: <MMS Domain Name>/<LNName>\$GeneralLog.

Example For a LogRef within the Logical Node LLN0 of the Logical Device “LD1”, the value of LogRef would be “LD1/LLN0\$GeneralLog”.

A V-Put of a LogRef value that specifies a non-existent MMS journal shall fail.

A NULL value is reserved to indicate that no log/journal has been selected.

NOTE 1 Multiple log controls may reference the same log through having the same value of LogRef.

NOTE 2 It is recommended that implementations claiming conformance to the log model implement at least one LCB as part of LLN0.

### 17.3.3.2.3 DataSet

Shall be of the data type specified in 8.1.3.2.. A V-Put of a DataSet value that specifies a non-existent MMS NamedVariableList shall fail.

A NULL value is reserved to indicate that no DataSet has been selected.

### 17.3.3.2.4 OldEntrTim and NewEntrTim

The values, contained within the components of OldEntrTim and NewEntrTim, shall specify the Entry-Time.

If there are no journal entries within the journal, specified by LogRef, the value of these components shall be equal and the binary-time values shall be 0.

### 17.3.3.2.5 OldEnt and NewEnt

The values, contained within the components of OldEnt and NewEnt, shall be of type EntryID (see 8.1.3.4). These values shall represent the Journal entryIdentifier (see 17.3.3.3.1) values for the oldest and newest entries.

If there are no journal entries within the journal, specified by LogRef, the value of these components shall be equal, and NULL.

### 17.3.3.3 Mapping of LogEntries

The log class definition, found in IEC 61850-7-2, specifies a sequence of attributes named LogEntries. A LogEntry shall be mapped directly to ISO 9506 (all parts) journal EntryContent. The mapping shall be as defined in Table 40.

**Table 40 – Mapping of ACSI LogEntries**

IEC 61850-7-2 LogEntry attribute	ISO 9506-1	Type definition	Comment
TimeOfLog	EntryTime	See 8.1.3.7	
EntryID	Entry Identifier	See 8.1.3.4	
EntryData	Information Type Constrained to be EVENT-DATA		
DataRef, value	Journal variable		
ReasonCode	Journal variable		

LogEntries shall be non-volatile.

#### 17.3.3.3.1 ISO 9506 (all parts) entry identifier

The entry identifier shall be as specified in 8.1.2.4. The contents of the value are a local issue.

An entry identifier whose octets all have a value of 0 shall not be allowed. This value is reserved to indicate that the log is empty.

#### 17.3.3.3.2 ISO 9506 information type constraints

ISO 9506 allows the information type to be constrained to ANNOTATION, EVENT-DATA, DATA.

#### **ANNOTATION**

The use of the ANNOTATION constraint is a local issue.

## EVENT-DATA

The EVENT-DATA information type shall be used to indicate information entered into the MMS Journal due to log control block control/processing. The use of this constraint is not restricted solely to indicating LCB control, but other uses are considered to be a local issue.

The EVENT-DATA Information Type Event Transition Record shall be used for journalling transitions of the LCD LogEna value as prescribed:

- The event condition name value shall be the MMS NamedVariable ObjectName representing the log control block that caused the journal entry to be created.
- The event condition state shall be the state of the LogEna component of the log control block that caused the journal entry to be created.

The value mapping between LogEna values and event condition state values shall be:

- A value of LogEna being FALSE shall be mapped to the event condition state of DISABLED. The transition of the LogEna value from TRUE to FALSE shall cause a journal entry to be created.
- A value of LogEna being TRUE shall be mapped to either the event condition state of IDLE or ACTIVE. The IDLE state is reserved to indicate a transition of the value of LogEna from FALSE to TRUE. Only a journal entry with an event condition state value of ACTIVE shall have a list of journal variables.

For efficiency reasons, a sequence of entryDat(s) may be entered within a single MMS journal entry.

On a power-up or reset the status of the LCB's LogEna should be journaled with a value IDLE.

## DATA

DATA shall be used for logging of values from DataSets specified by an LCB.

### 17.3.3.3.3 ISO 9506 (all parts) information journal variables

MMS journal variables are represented as a sequence of a journal variable tag and data. This document maps both the LogEntry datRef/value and reasonCode to individual journal variables. These journal variables shall appear within a single information type entry and shall be in the order of: the journal variable representing the datRef/value followed by the journal variable representing the reasonCode.

Each individual journal variable is reflected as member of the listofVariables within the journal entry content (see 16.8.1 of ISO 9506-2 (2003)). Each member of the listofVariables consists of a variableTag and a valueSpecification.

The variableTag shall have a minimum-maximum size of 65 octets.

#### Journal variableTag for DatRef

A journal variable representing journal data relating to DatRef shall have a value of the form ObjectReference.

#### Journal variableTag for ReasonCode

A journal variable tag representing journal data relating to reasonCode shall have the value of "ReasonCode". The valueSpecification shall have a MMS TypeDescription of bitstring. The minimum size of the bitstring shall be 8 bits and the bit definition follow the definition of the Extended Trigger option – see 8.1.3.9.

Example The value of a journal variableTag for a reasonCode relating to a datRef, whose ObjectReference is LD1/MMXU.MX.V, would be: "LD1/MMXU.MX.V|reasonCode".

### 17.3.4 Mapping of log and log control services

#### 17.3.4.1 Overview

The ACSI log model services shall be mapped to the MMS services as described in Table 41.

**Table 41 – General mappings of ACSI log model services**

ACSI service	MMS service
GetLCBValues	Read
SetLCBValues	Write
GetLogStatusValues	Read
QueryLogbyTime	ReadJournal
QueryLogAfter	ReadJournal

##### 17.3.4.1.1 GetLCBValues

This ACSI service shall be mapped to the MMS read service. The read service shall execute a V-Get on any of the log control class attributes (see Figure 4).

The Response– shall be mapped as per the ServiceError mapping specified in Table 20.

##### 17.3.4.1.2 SetLCBValues

This ACSI service shall be mapped to the MMS write service. The write service shall execute a V-Put on any of the log control class attributes (see Figure 4). A V-Put, while the component LogEna has a value of TRUE, shall fail for the components of LogRef, DatSet, TrgOps, and IntgPd.

The Response– shall be mapped as per the ServiceError mapping specified in Table 20.

##### 17.3.4.1.3 GetLogStatusValues

This ACSI service shall be mapped to the MMS read service. The read service shall execute a V-Get on any of the log control class attributes (see Figure 4).

The Response– shall be mapped per the ServiceError mapping specified in Table 20.

##### 17.3.4.1.4 QueryLogByTime

###### 17.3.4.1.4.1 Request

The ACSI QueryLogByTime service shall be mapped to the MMS ReadJournal service. The ReadJournal-Request shall contain parameters as described in Table 42.

**Table 42 – Mapping of QueryLogByTime request parameters**

ACSI QueryLogByTime request		MMS ReadJournal-Request	
Parameter	Type	Parameter	MMS definition
LogReference	ObjectReference	journalName	ObjectName
RangeStartTime	EntryTime	startingTime	TimeOfDay
RangeStopTime	EntryTime	endingTime	TimeOfDay

**17.3.4.1.4.2 Response (QueryLogByTime and QueryLogAfter)**

The ACSI QueryLogByTime-response service shall be mapped to the MMS ReadJournal-response service. The ReadJournal-response shall contain parameters as described in Table 43.

**Table 43 – Mapping of response parameters**

ACSI QueryLogByTime response ACSI QueryLogAfter response		MMS ReadJournal-Response	
Parameter	Type	Parameter	MMS definition
ListOfLogEntries	LogEntry	listOfJournalEntry	JournalEntry

The conformance statement for JournalEntry is found in Table 92.

**17.3.4.1.4.3 Response– (QueryLogByTime and QueryLogAfter)**

The ACSI ServiceErrors shall map to Error Class/Error Code as detailed in Table 44.

**Table 44 – ServiceError mappings for Log services**

ACSI Service Error	MMS ServiceError	
	Error class	Error code
instance-not-available	access	object-non-existent
access-violation	access	object-access-denied
failed-due-to-server-constraint	all others	all others

**17.3.4.1.5 QueryLogAfter****17.3.4.1.5.1 Request**

The ACSI QueryLogAfter service shall be mapped to the MMS ReadJournal service. The ReadJournal-Request shall contain parameters as described in Table 45.

**Table 45 – Mapping of QueryLogAfter request parameters**

ACSI QueryLogAfter Request		MMS ReadJournal-Request	
Parameter	Type	Parameter	MMS definition
LogReference	ObjectReference	journalName	ObjectName
entryToStartAfter	EntryTime	timeSpecification	TimeOfDay
Entry	EntryID	entrySpecification	OCTET STRING

**17.3.4.1.5.2 Response**

The ACSI QueryLogAfter-response service shall be mapped to the MMS ReadJournal-response service. The ReadJournal-response shall be as specified in 17.3.4.1.4.2.

### 17.3.4.1.6 GetLogStatus

Shall be mapped onto the MMS read service of the log control block.

### 17.3.5 Conformance

An implementation that claims conformance to the ACSI log model shall support the services as described in Table 46.

**Table 46 – Log conformance requirements**

ACSI Service	Client-CR		Server-CR	
	Request	Response	Request	Response
GetLCBValue	m	m	m	m
SetLCBValue	o	c1	m	m
QueryLogByTime	c2	c3	m	m
QueryLogAfter	c2	c4	m	m
GetLogStatusValues	o	o	m	m
c1 – Shall be 'm' if GetLCBValue-request is supported. c2 – One of either QueryLogByTime or QueryLogAfter shall be supported. c3 – Shall be 'm' if QueryLogByTime-request is supported. c4 – Shall be 'm' if QueryLogAfter-request is supported.				

## 18 Mapping of the generic substation event model (GSE)

### 18.1 Generic object oriented substation event (GOOSE)

#### 18.1.1 GOOSE control definition

The GOOSE Control, as defined in IEC 61850-7-2, shall be mapped to an MMS GOOSE Control Block (GoCB) as defined in Table 47. All GoCB's shall be of the functional constraint "GO".

**Table 47 – MMS TypeDescription definition for GoCB MMS structure**

Component Name	MMS TypeDescription	r/w	m/o	Condition	Comments
GoEna	boolean	rw	m		
GoID	visible-string	r	m		
DatSet	visible-string	r	m		The value of this component shall be of the format of ObjectReference and shall be limited to VMD or domain scoped NamedVariableLists
ConfRev	Unsigned	r	m		
NdsCom	boolean	r	m		
DstAddress	See Table 48	r	m		

#### GoEna

Shall be as defined in IEC 61850-7-2.

#### GoID

Shall be as defined in IEC 61850-7-2. The default value of this attribute shall be the GOOSE Control Block reference.

**DatSet**

Shall be of the data type specified in 8.1.3.2. The value shall be constrained to the set of existing MMS NamedVariableLists. A V-Put of a value indicating a non-existent NamedVariableList shall fail.

**ConfRev**

This MMS component represents the IEC 61850-7-2 attribute of ConfRev. It is an Unsigned integer value whose range is 0 to 4 294 967 295.

**NdsCom**

This MMS component represents the IEC 61850-7-2 attribute of NdsCom.

**DstAddress**

This shall be a MMS structured type whose components are defined as described in Table 48.

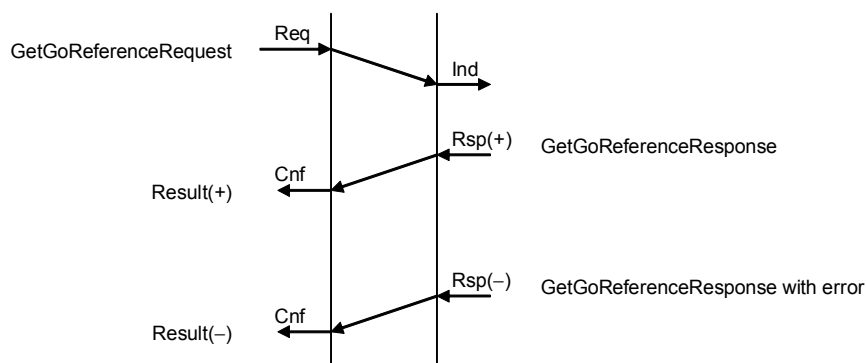
**Table 48 – DstAddress structure**

Component Name	Data Type	m/o	Comments
Addr	OCTET-STRING	m	Length is 6 Octets and contains the value of the destination Media Access Control (MAC) address to which the GOOSE message is to be sent. The address shall be an Ethernet address that has the multicast bit set TRUE.
PRIORITY	Unsigned8	m	Range of values shall be limited from 0 to 7.
VID	Unsigned16	m	Range of values shall be limited from 0 to 4 095.
APPID	Unsigned16	m	As defined in Annex C

**18.1.2 GOOSE services**

**18.1.2.1 GetGoReference**

The GetGoReference service, as specified in IEC 61850-7-2, allows a client to request the resolution of one or more element offsets. The response returns the set of requested ElementOffsets and the actual reference values. The service primitives are shown in Figure 5.



IEC 140/04

**Figure 5 – GetGoReference service primitives**

The client assigns a reference for every request and includes this reference as the StateID parameter within the request. A client that receives a GetGoReferenceResponse containing a unknown StateID shall ignore the PDU.

The application protocol specification in Annex A (with ASN.1 basic encoding rules) shall be used as the transfer syntax for the GetReference service. The GetGoReference service shall be mapped onto a GSEmngtPdu according to Table 49, and transferred using the T-DATA service as defined in 6.3.3.

**Table 49 – Mapping of GetGoReference service**

Parameter name	Transfer syntax mapping
Request	
GoCBReference	ident
MemberOffset [1..n]	offset
Response+	
GoCBReference	ident
ConfigurationRevision	confRev
DatSet	responsePositive
MemberReference [1..n]	
Response-	
ServiceError	responseNegative

Table 50 shows the parameters of the GetGoReference service primitives.

**Table 50 – GetGoReference**

Parameter Name	Req	Ind	Rsp	Cnf
Request	M	M(=)		
Destination Address	M	M(=)		
StateID	M	M(=)		
GoCBReference	U	U(=)		
MemberOffset References	M	M(=)		
Result(+)			S	S(=)
StateID			M	M(=)
ConfRev			M	M(=)
DatSet			M	M(=)
List Of Results			M	M(=)
MemberOffset Reference			M	M(=)
Result(-)			S	S(=)
StateID			M	M(=)
ErrorReason			M	M(=)

**Destination address**

The destination address shall be used to specify the address required by the T-Profile.

**StateID**

This is a client assigned value used to reference the client's state machine. The range of this value shall be –32 767 to 32 767.

**GoCBReference**

This value shall be a `VISIBLE_STRING` and shall be capable of containing a value whose size is 129 octets. The value shall correspond to the GOOSE control block for whom the lookup is being requested.

**MemberOffsets**

This is the list of elements for which the client is requesting to obtain the reference. The range of this value shall be 0 or greater. The value shall be less than 512.

**Reference**

This shall be one of the requested reference offsets requested by the client.

**ConfRev**

This parameter shall contain the configuration revision number of the GoCB at the time the request was resolved.

**DatSet**

Shall contain the value of the DataSetReference at the time the request was resolved.

**ListOfResults**

This shall be the list of elements for which the server shall return the references. The range of this value shall be 0 or greater. The value shall be between 0 and 512.

**Reference**

These values shall contain the string reference of the offset being requested or an appropriate error code as specified in Annex A.

**ErrorReason**

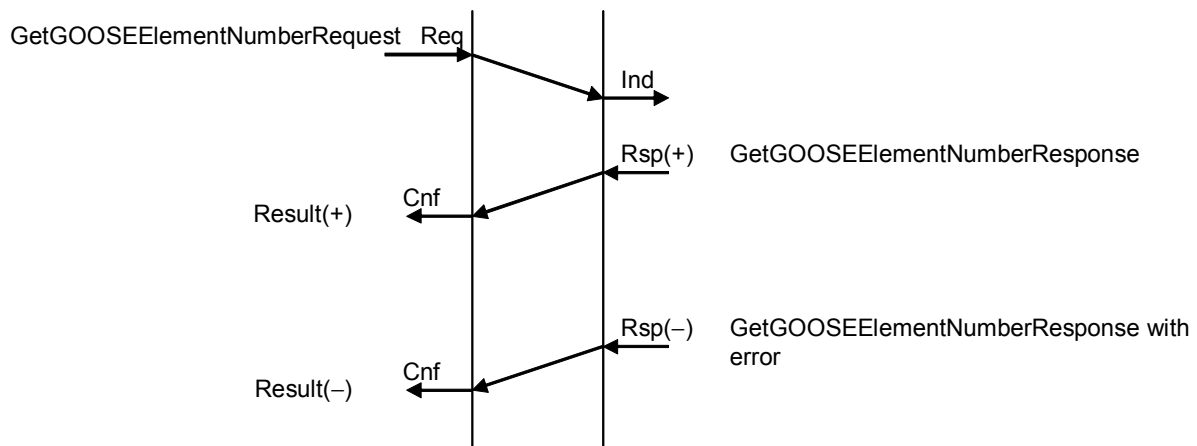
This parameter indicates an error condition that prohibits the completion of the client's request.

**T-DATA mapping**

All GSE Management PDU's shall be sent and received using the T-DATA service.

**18.1.2.2 GetGOOSEElementNumber**

The GetGOOSEElementNumber service, as specified in IEC 61850-7-2, allows a client to request the resolution of one or more reference strings to element offsets. The response returns the set of requested ElementOffsets and the actual reference values. The sequence of service primitives shall be as in Figure 6.



IEC 141/04

**Figure 6 – GetGOOSEElementNumber service primitives**

The client assigns a reference for every request and includes this reference as the StateID parameter within the request. A client that receives a GetGOOSEElementNumberResponse containing an unknown StateID shall ignore the PDU.

A server that declares support for GOOSE, and not the GetGOOSEElementNumber service, shall return a gseNotSupportedPDU if it receives a GetGOOSEElementNumberRequest.

The application protocol specification in Annex A (with ASN.1 basic encoding rules) shall be used as the transfer syntax for the GetGOOSEElementNumber service. The GetGOOSEElementNumber service shall be mapped onto a GSEMsgPdu according to Table 51.

**Table 51 – Mapping of GetGOOSEElementNumber service**

Parameter name	Transfer syntax mapping
Request	
GoCBReference	ident
MemberReference [1..n]	references
Response+	
GoCBReference	ident
ConfigurationRevision	confRev
DatSet	responsePositive
MemberOffset [1..n]	
Response-	
ServiceError	responseNegative

Table 52 shows the parameter of the GetGOOSEElementNumber service primitives.

**Table 52 – GetGOOSEElementNumber**

Parameter Name	Req	Ind	Rsp	Cnf
Request	M	M(=)		
Destination Address	M	M(=)		
StateID	M	M(=)		
GoCBReference	U	U(=)		
MemberReference ReferenceString	M	M(=)		
Result(+)			S	S(=)
StateID			M	M(=)
ConfRev			M	M(=)
DatSet			M	M(=)
MemberOffset ElementNumber			M	M(=)
Result(-)			S	S(=)
StateID			M	M(=)
ErrorReason			M	M(=)

See 18.1.2.1 for parameter definitions not defined in this Subclause.

#### **MemberReference**

This is the list of references for which the client is requesting to obtain the element offset. NULL values shall not be allowed.

#### **ReferenceString**

This shall be the string value for the Reference whose offset is being requested by the client. The value shall not be NULL.

#### **ElementNumber**

This parameter value contains the offset value for the corresponding requested ReferenceString or an error reason.

#### **T-DATA Mapping**

All GSE Management PDU's shall be sent and received using the T-Profile T-DATA service.

##### **18.1.2.3 GetGoCBValues**

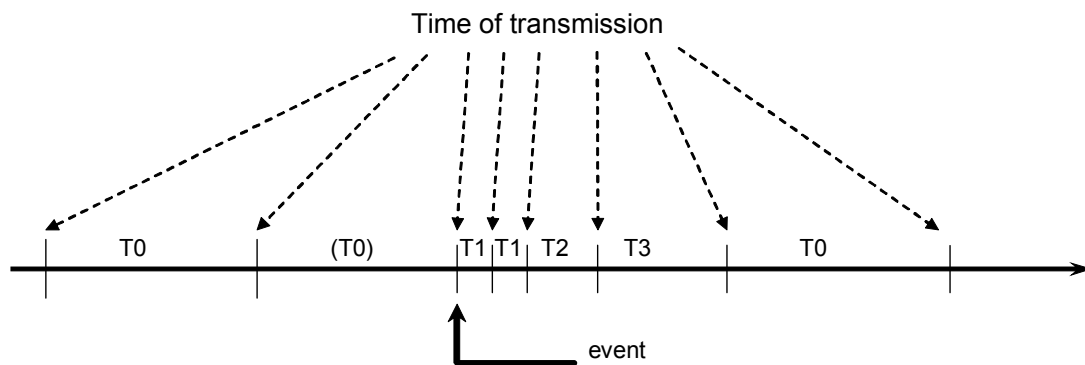
This service shall be mapped to the MMS read service.

##### **18.1.2.4 SetGoCBValues**

This service shall be mapped to the MMS write service.

**18.1.2.5 SendGOOSEMessage**

The GOOSE service model of 61850-7-2 “.. provides the possibility for a fast and reliable system-wide distribution of input and output data values.” This SCSM uses a specific scheme of re-transmission to achieve the appropriate level of reliability. When a GOOSE server generates a SendGOOSEMessage request, the current data set values are encoded in a GOOSE message and transmitted as T-DATA on the multicast association. The event that causes the server to invoke a SendGoose service is a local application issue as defined in IEC 61850-7-2. Additional reliability is achieved by re-transmitting the same data (with gradually increasing SqNum and retransmission time). How this will be done is shown in Figure 7.



- T0 retransmission in stable conditions (no event for a long time).
- (T0) retransmission in stable conditions may be shortened by an event.
- T1 shortest retransmission time after the event.
- T2, T3 retransmission times until achieving the stable conditions time.

IEC 142/04

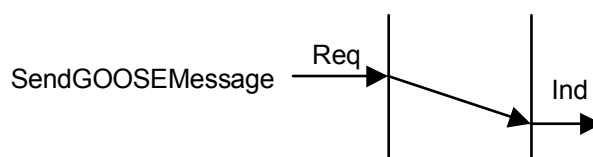
**Figure 7 – Transmission time for events**

NOTE Applications may choose to publish both transitions of transient or pulsed data attribute values. Other applications could choose to publish only on a significant event.

Each message in the retransmission sequence carries a timeAllowedToLive parameter that informs the receiver of the maximum time to wait for the next re-transmission. If a new message is not received within that time interval, the receiver shall assume that the association is lost.

The specific intervals used by any GOOSE publisher are a local issue. The timeAllowedtoLive parameter informs subscribers of how long to wait.

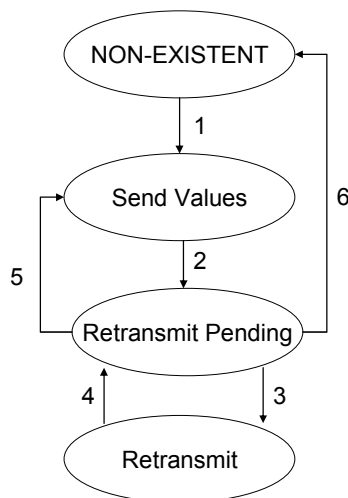
The SendGOOSEMessage service, as specified in IEC 61850-7-2, allows a publisher (e.g. server) to send variable information in an unsolicited and unconfirmed manner (see Figure 8).



IEC 143/04

**Figure 8 – SendGooseMessage message service primitives**

The publisher creates and maintains a state machine (according to Figure 9) for each enabled GoCB. The client state machine has three states (NON-EXISTENT, RETRANSMIT-PENDING, and RETRANSMIT).

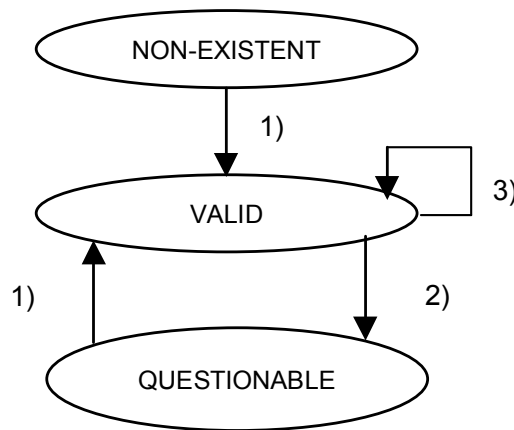


IEC 144/04

- 1) GoEna is set to TRUE.
- 2) Publisher issues GOOSE.request. A retransmission timer is started based upon publisher's timeAllowedtoLive parameter value. SqNum is set to 0. It is suggested that the retransmission timer be less than (actually half) of the timeAllowedtoLive parameter.
- 3) retransmission expiration timer indicates time for retransmission. SqNum is incremented skipping 0 on overflow.
- 4) Upon retransmission, a GOOSE.request is issued and the next retransmission interval is used. A retransmission timer is started. The selection method of retransmission intervals is a local issue. The maximum time allowed between retransmissions is a local issue. This time shall be less than 60 s.
- 5) A change of value for one of the DataSet members is detected. StNum is incremented. SqNum is set to zero.
- 6) All GOOSE messages and re-transmissions when the GoEna is set to FALSE.

**Figure 9 – Publisher state machine for GOOSE service**

The subscriber (e.g. client) shall create a state machine (according to Figure 10) consisting of three states (NON-EXISTENT, VALID, and QUESTIONABLE).



IEC 145/04

- 1) Subscriber receives GOOSE.indication. Starts timeAllowedtoLive expiration timer.
- 2) timeAllowedtoLive expiration timer expires.
- 3) Receives a valid GOOSE indication or valid retransmission.

**Figure 10 – Subscriber state machine for GOOSE service**

The handling and processing of received GOOSE messages, by the subscriber, is a local issue. It is recommended to describe the local behaviour for out-of-order state/sequence numbers in the PIXIT statement.

Table 53 shows the mapping of the parameters of the GOOSE service primitive.

**Table 53 – GOOSE service parameter mapping**

IEC 61850-7-2 parameter		Parameter name	Req	Ind
Attribute Name	Attribute Type	Argument	M	M(=)
		Destination address	U	U(=)
DatSet	ObjectReference	datSet	U	U(=)
GoID	VISIBLE STRING	goID	U	U(=)
GoCBRef	ObjectReference	gocbRef		
T	TIMESTAMP	t	U	U(=)
StNum	INT32U	stNum	U	U(=)
SqNum	INT32U	sqNum	M	M(=)
timeAllowedtoLive	INT32U	timeAllowedtoLive	U	U(=)
Test	BOOLEAN	test	U	U(=)
ConfRev	INT32U	confRev	U	U(=)
NdsCom	BOOLEAN	ndsCom	U	U(=)
GOOSEData	INT16U	numDatSetEntries	U	U(=)
	Type depends on the number and types of the members in DatSet.	allData	U	U(=)
		security <sup>(a)</sup>	U	U(=)

<sup>a)</sup> Specification of the contents of security will be found in IEC 62351-6.

**Destination address**

The destination address shall be used to specify the address of the physical node to which the query is to be issued based upon the T-Profile being used.

**DatSet**

This VisibleString shall have a maximum size of 129 octets. The value shall be the same as found in the GOOSE control block specified by GoCRef.

**GoID**

This VisibleString shall have a maximum size of 65 octets. The value shall be the same as found in the GOOSE control block specified by GoCRef.

**GoCRef**

This VisibleString shall have a maximum size of 129 octets. The value shall be the reference to the GOOSE control block that is controlling the GOOSE message.

**T**

This attribute's type has been mapped from a ENTRYTIME to TIMESTAMP in order to allow additional timestamp precision. This TIMESTAMP has a size of 8 octets. It shall have the format as specified in 8.1.3.6.

**StNum**

This INTEGER value shall have a range of 1 to 4 294 967 295.

**SqNum**

This INTEGER value shall have a range of 0 to 4 294 967 295. Following a StNum change, the counter SqNum shall be set to 0. If the counter SqNum overruns it shall be set to 1. The initial value of SqNum upon a transition of GoEna to TRUE shall be 1.

**Test**

This BOOLEAN shall have a range of TRUE, FALSE.

**ConfRev**

This INTEGER value shall have a range of 0 to 4 294 967 295.

**NdsCom**

This BOOLEAN shall have a range of TRUE, FALSE.

**numDatSetEntries**

This parameter specifies the number of members of the MMS NamedVariableList that is specified in the GOOSE control block (see 18.1.1) that controls the actual GOOSE service.

**allData**

This parameter contains a list of user defined information of the MMS NamedVariableList that is specified in the GOOSE control block (see 18.1.1).

**timeAllowedtoLive**

This INTEGER value shall have a range of 1 to 4 294 967 295. The units of the value shall be ms.

**mapping**

The GOOSE PDU shall be as defined in Annex A.

**DatSet**

The value of the DatSet parameter shall be the value of the DatSet component of the associated GoCB.

**NdsCom**

The value NdsCom parameter shall be the value of the NdsCom component of the associated GCB.

**T-DATA mapping**

All GSE Management PDU's shall be sent and received using T-Profile T-DATA service.

## 19 Transmission of sampled values class model

Shall be as specified in IEC 61850-9-2.

## 20 Control class model

The IEC 61850 control models are accessed via the MMS read and write named variable services. The common data classes (defined in IEC 61850-7-3 and specialized in Annex E of this part of IEC 61850) that allow control operations contain elements with the FC of “CO” and “SP”. The control models defined within IEC 61850-7-2 contain additional service parameters which are conveyed when executing the control. The mapping of control models and services is accomplished by combining the service parameters and the control elements into MMS structure type definitions and inserting them as components of the MMS named variable representing the common data class instance in a logical node. The services are then mapped to MMS read and write service requests of these inserted components.

### 20.1 Control service parameters

Table 54 lists the controllable service parameters, as defined within IEC 61850-7-3.

**Table 54 – Controllable service parameters**

IEC 61850-7-2 parameter	Semantic	IEC 61850-7-3 CDC
ctlVal	Control value	SPC, DPC, INC, BSC, ISC, APC
operTm	TimeStamp	SPC, DPC, INC, BSC, ISC, APC
origin	Origin	SPC, DPC, INC, BSC, ISC, APC
ctlNum	Control number	SPC, DPC, INC, BSC, ISC, APC
T	Control time stamp	SPC, DPC, INC, BSC, ISC, APC
Test	Test status	SPC, DPC, INC, BSC, ISC, APC
Check	Check condition	SPC, DPC, INC, BSC, ISC, APC

The type definitions for each of these parameters are constructed according to the rules defined in 8.1 and 7.3.2.

Table 55 lists the service parameters, as defined within IEC 61850-7-2.

**Table 55 – Service parameters**

IEC 61850-7-2 parameter	Semantic	IEC 61850-7-2 Subclause
AddCause	Additional cause diagnostic	17.5.2.6
TimOperRsp	Time activated operate response	17.5.2.7

The type definitions for each of these parameters are constructed according to the rules defined in 8.1 and 7.3.2.

## 20.2 Mapping of control objects

The data objects with controllable DataAttributes (derived from CDCs with attributes FC=CO) shall be mapped according to the rules defined in 7.3.1: the MMS named variable components representing the attributes with FC=CO of a data object have the following general reference:

<LDname>/<LNname>\$CO\$<DOname>

where the MMS type specification of the <DOname> component includes each of the attributes with FC=CO. The structures of the <DOname> component for each of the service choices shall be as defined in Table 56.

**Table 56 – Mapping of IEC 61850-7-2 control model to MMS control components**

Service choice	DataAttributes
Direct with normal security	
	Oper
	Cancel
SBO with normal security	
	SBO
	Oper
	Cancel
SBO with enhanced security	
	SBOw
	Oper
	Cancel
Direct with enhanced security	
	Oper
	Cancel

### 20.3 Mapping of control services

Table 57 gives an overview of the mapping of the control services.

**Table 57 – Mapping of control services**

ASCI service		MMS service	Variable specification	Access result
Select	Request	Read request	SBO	
	Response +	Read response	SBO	Success
	Response –	Read response	SBO = NULL	Success
SelectWithValue	Request	Write request	SBOw	
	Response +	Write response		Success
	Response –	Write response		Failure
		InformationReport (ListOfVariable)	LastApplError	
Cancel	Request	Write request	Cancel	
	Response +	Write response		Success
	Response –	Write response		Failure
		InformationReport (ListOfVariable)	LastApplError <sup>6)</sup>	
Operate or TimeActivatedOperate (operTm = 0)	Request	Write request	Oper <sup>3)</sup>	
	Response +	Write response		Success
	Response –	Write response		Failure
		InformationReport (ListOfVariable)	LastApplError <sup>6)</sup>	
TimeActivatedOperate (operTm != 0)	Request	Write request	Oper <sup>4)</sup>	
	Response (timer-activated) + <sup>1)</sup>	Write response		Success
	Response (timer-activated) – <sup>1)</sup>	Write response		Failure
		InformationReport (ListOfVariable)	LastApplError <sup>6)</sup>	
	Response (command-executed) + <sup>2)</sup>	InformationReport (ListOfVariable)	Oper	
	Response (command-executed) – <sup>2)</sup>	InformationReport (ListOfVariable)	LastApplError <sup>6)</sup>	
CommandTermination	Request + <sup>5)</sup>	InformationReport (ListOfVariable)	Oper	
	Request –	InformationReport (ListOfVariable)	LastApplError Oper	

1) Maps the first TimOper\_rsp as defined in IEC 61850-7-2.  
2) Maps the second TimOper\_rsp as defined in IEC 61850-7-2.  
3) The attribute operTm shall not be written during the operate service, otherwise it is a TimeActivatedOperate.  
4) The attribute operTm shall be written during the TimeActivatedOperate Service, otherwise it is an operate.  
5) The value of operTm shall be zero(0) within the CommandTermination message.  
6) Only for control with enhanced security

## 20.4 Select

The select service shall be performed through the use of an MMS read of the SBO attribute. The mapping of parameters is as specified in Table 58.

**Table 58 – Select service parameter mapping**

IEC 61850-7-2 parameter	Parameter name
ControlObjectReference	SBO

### 20.4.1 Select request

The IEC 61850-7-2 select request shall be performed through the use of an MMS Read.request of the SBO attribute.

### 20.4.2 Select response+

The IEC 61850-7-2 select response+ shall be performed through the use of an MMS Read.response that contains a non-NULL value for the SBO attribute.

### 20.4.3 Select response–

The IEC 61850-7-2 select response– shall be performed through the use of an MMS Read.response+ that contains a NULL value for the SBO attribute.

## 20.5 SelectwithValue

The select with value service shall be performed through the use of an MMS write to the SBOw attribute. The mapping of parameters is as specified in Table 59.

**Table 59 – SelectwithValue service parameter mapping**

IEC 61850-7-3 parameter	Parameter name
ControlObjectReference	SBOw
ctlVal	SBOw\$ctlVal
operTm	SBOw\$operTm
origin	SBOw\$origin
ctlNum	SBOw\$ctlNum
T	SBOw\$T
Test	SBOw\$Test
Check	SBOw\$Check
ctlVal type is dependant of the CDC of the object (e.g. ctlVal or ctlVal\$f)	
NOTE The definition of SBOw is given in Table E.8.	

### 20.5.1 SelectwithValue request

The IEC 61850-7-2 select request shall be performed through the use of an MMS Write.request of the SBOw structure.

### 20.5.2 SelectwithValue response+

The IEC 61850-7-2 SelectwithValue response+ shall be performed through the use of an MMS Write.response+ that contains a MMS AccessResult indicating success.

### 20.5.3 SelectwithValue response–

The IEC 61850-7-2 SelectwithValue response– maps onto two MMS PDUs. The order of the PDUs shall be an InformationReport.request with AdditionalCauseDiagnostic (see 20.8) and a MMS Write.response+ that contains an AccessResult indicating failure as defined in Table 60.

**Table 60 – Select, Oper and Cancel AccessResult specification**

Error	Conveyed By MMS AccessResult		Error condition
	Data	DataAccessError	
TEMPORARILY-UNAVAILABLE	NULL String		Control is already selected or being operated
HARDWARE-FAULT		HARDWARE-FAULT	Control may not be operated due to hardware fault
OBJECT-ACCESS-DENIED		OBJECT-ACCESS-DENIED	Access control failure
OBJECT-UNDEFINED		OBJECT-UNDEFINED	Control does not exist in this security view

## 20.6 Cancel

The cancel service shall be performed through the use of an MMS write to the cancel attribute. The mapping of parameters is as specified in Table 61.

**Table 61 – Cancel service parameter mapping**

IEC 61850-7-3 Parameter	Parameter name
ControlObjectReference	Cancel
ctlVal	Cancel\$ctlVal
operTm	Cancel\$operTm
origin	Cancel\$origin
ctlNum	Cancel\$ctlNum
T	Cancel\$T
Test	Cancel\$Test
ctlVal type is dependant of the CDC of the Object (e.g. ctVal or ctIVal\$f)	
NOTE The definition of Cancel is given in Table E.10.	

### 20.6.1 Cancel request

#### 20.6.1.1 Control with normal security

The IEC 61850-7-2 cancel request shall be performed through the use of an MMS Write.request of the Cancel structure.

#### 20.6.1.2 Control with enhanced security

The IEC 61850-7-2 cancel request shall be performed through the use of an MMS Write.request of the Cancel structure.

### 20.6.2 Cancel response+

#### 20.6.2.1 Control with normal security

The IEC 61850-7-2 cancel response+ shall be performed through the use of an MMS Write.response+ that contains a MMS AccessResult indicating Success.

### 20.6.2.2 Control with enhanced security

The IEC 61850-7-2 cancel response+ shall be performed through the use of an MMS Write.response+ that contains a MMS AccessResult indicating Success.

### 20.6.3 Cancel response–

#### 20.6.3.1 Control with normal security

The IEC 61850-7-2 cancel response– maps through the use of an MMS Write.response+ that contains a MMS AccessResult indicating failure.

#### 20.6.3.2 Control with enhanced security

The IEC 61850-7-2 cancel response– maps onto two MMS PDUs. The order of the PDUs shall be an InformationReport.request with AdditionalCauseDiagnostic (see 20.8) and a MMS Write.response+ that contains an AccessResult indicating failure.

## 20.7 Operate

The operate service shall be performed through the use of an MMS Write to the oper attribute. The mapping of parameters is as specified in Table 62.

**Table 62 – Operate service parameter mapping**

IEC 61850-7-3 parameter	Parameter name
ControlObjectReference	Oper
ctlVal	Oper\$ctlVal
origin	Oper\$origin
ctlNum	Oper\$ctlNum
T	Oper\$T
Test	Oper\$Test
Check	Oper\$Check
ctlVal type is dependant of the CDC of the object (e.g. ctlVal or ctlVal\$f).	
NOTE The definition of Oper is given in Table E.9.	

### 20.7.1 Operate request

#### 20.7.1.1 Control with normal security

The IEC 61850-7-2 operate request shall be performed through the use of an MMS Write.request of the appropriate Oper structure.

#### 20.7.1.2 Control with enhanced security

The IEC 61850-7-2 operate request shall be performed through the use of an MMS Write.request of the appropriate Oper structure.

#### 20.7.1.3 Control with TimeActivation

The IEC 61850-7-2 operate request shall be performed through the use of an MMS Write.request of the appropriate Oper structure.

The operate with TimeActivation service shall be performed through the use of an MMS write to the oper attribute with the parameter OperTm present containing a valid timestamp. The

value OperTm = 0 is equivalent to control with enhanced security (i.e. without time activation). The mapping of parameters is as specified in Table 63.

**Table 63 – Control with TimeActivation service parameter mapping**

IEC 61850-7-3 parameter	Parameter name
ControlObjectReference	Oper
ctlVal	Oper\$ctlVal
operTm	Oper\$operTm
origin	Oper\$origin
ctlNum	Oper\$ctlNum
T	Oper\$T
Test	Oper\$Test
Check	Oper\$Check
ctlVal type is dependant of the CDC of the object (e.g. ctVal or ctVal\$f).	
NOTE The definition of Oper is given in Table E.9.	

### 20.7.2 Operate response+

The IEC 61850-7-2 operate response+ shall be performed through the use of an MMS Write.response+ that contains a MMS AccessResult indicating success. The second operate response+ of a time activated control (operate response(command-executed)+) maps to an information report of the oper structure.

The value of the operTm attribute, in the second response+ (operate response(command-executed)+), shall have the same value as written in the Operate request. If the OperTm value is zero(0), this shall indicate the CommandTermination.

### 20.7.3 Operate response–

#### 20.7.3.1 Control with normal security

The IEC 61850-7-2 operate response– shall be performed through the use of an MMS Write.response+ AccessResult indicating failure,

#### 20.7.3.2 Control with enhanced security

The IEC 61850-7-2 operate response– maps onto two MMS PDUs, an AdditionalCause Diagnostic (see 20.8) and a MMS Write.response+ that contains an AccessResult indicating failure.

#### 20.7.3.3 Control with TimeActivation

The IEC 61850-7-2 operate response– maps onto two MMS PDUs, an AdditionalCause diagnostic (see 20.8) and a MMS Write.response+ that contains an AccessResult indicating failure. A second operate response– (operate response(command-executed)-) differs from the first (see Table 57).

## 20.8 AdditionalCauseDiagnosis in negative control service responses

Some abstract control services supply additional application specific information in their negative responses. This information is defined by the AdditionalCauseDiagnosis (AddCause) service parameter defined in IEC 61850-7-2. The transmission of this information shall map to an MMS InformationReport service of an VMD-SPECIFIC MMS named variable “LastAppIError” of the structure defined in Table 64. This MMS named variable shall be instantaneously created, reported, and then deleted.

**Table 64 – Definition of LastApplError variable structure**

Component name	ACSI TypeDescription	r/w	m/o	Comments
CntrlObj	VISIBLESTRING	r	m	
Error	ENUMERATED	r	m	
Origin	Originator	r	m	See IEC 61850-7-3
ctlNum	INT8U	r	m	See IEC 61850-7-3
AddCause	ENUMERATED	r	m	

The value of the named variable shall represent the last detect control service application error that required additional diagnostics. The value of LastApplError shall be reported as a single MMS named variable (e.g. the structured variable shall be reported). The value of this variable shall be volatile and shall assume the specified default values upon two-party (see 10.2) association establishment.

### **CntrlObj**

CntrlObj shall be a named component that shall have VISIBLESTRING data type of the structure

```
<LDeviceName>/<LNVariableName>${FC}>${LNDataName1}>${AttributeName1}>
(see 8.1.3.2)
```

and shall have a maximum size of 129 octets. The value shall represent the control object that was operated upon that caused the additional cause to be generated.

The default value shall be NULL.

### **Error**

Error is a named component that is an ENUMERATED data type as defined in 8.1.2.2. The enumerated values for error shall be as defined as:

```
Error ::= INTEGER {
    (0) No Error
    (1) Unknown
    (2) Timeout Test Not OK
    (3) Operator Test Not OK
}
```

The default value shall be 0.

“TimeOut Test Not OK” shall be returned if a TimeActivated Control CMD is issued, with TEST=TRUE and the operation fails.

”Operator Test Not OK” shall be returned if an OPER control CMD is issued, with TEST=TRUE, and the operation fails.

### **origin**

Used to designate the client who initiated the control action.

### **ctlNum**

The control sequence number as specified by the client initiating the service.

NOTE Negative control responses mostly consist of an MMS write response+ and an additional MMS InformationReport request defined above. The transmission of the origin and ctlNum in the InformationReport request enables the client to allocate this InformationReport request to the corresponding MMS write service.

The default value shall be 0.

## AddCause

AddCause shall be a named component that is a ENUM8 data type as defined in 8.1.2.2. Table 65 defines the actual MMS values assigned to AddCause.

**Table 65 – Mapping of ACSI AddCause values**

ACSI value	MMS value
Unknown	0
Not-supported	1
Blocked-by-switching-hierarchy	2
Select-failed	3
Invalid-position	4
Position-reached	5
Parameter-change-in-execution	6
Step-limit	7
Blocked-by-Mode	8
Blocked-by-process	9
Blocked-by-interlocking	10
Blocked-by-synchrocheck	11
Command-already-in-execution	12
Blocked-by-health	13
1-of-n-control	14
Abortion-by-cancel	15
Time-limit-over	16
Abortion-by-trip	17
Object-not-selected	18

## 20.9 CommandTermination

The CommandTermination service request positive shall map to the MMS InformationReport Service of the Oper component of the MMS named variable representing the control. The CommandTermination-request+ of a Control with TimeActivation shall have an operTm attribute value of zero(0).

The CommandTermination service request negative shall map to the MMS InformationReport Service with a listOfVariable containing two MMS variables. The first variable is the MMS named variable named “LastAppIError”. The second variable is the MMS variable that represents the Oper component of the MMS named variable representing the control.

## 21 Time and time synchronization model

Time synchronization, accomplished via LAN communication, shall be accomplished through the use of SNTP (see 6.4).

Hardware synchronization mechanisms (e.g. GPS or other) are beyond the scope of this standard.

## 22 Naming conventions

See Clause 7.

## 23 File transfer

### 23.1 File transfer model

The IEC 61850-7-2 file class shall be mapped to the MMS file object. If a implementation declares support for file transfer, MMS file services shall be implemented according to this Clause. In addition, it is a local issue if the IETF File Transfer Protocol (FTP – see RFC 542) is also implemented. The conformance to the FTP RFC is out-of-scope of this standard.

The mapping is specified in Table 66.

**Table 66 – Mapping of ACSI file class to MMS file object**

IEC 61850-7-2 file class attribute name	MMS file object attribute	m/o
FileName	FileName	m
FileSize	Size	m
LastModified	LastModified	m

#### FileName

The IEC 61850-7-2 FileName attribute shall be mapped to the MMS FileName attribute. The MMS FileName shall consist of a sequence of file paths and a name-of-a-file. IEC 61850-7-2 FileNames shall be constrained to be no larger than 255 octets.

The file path specification is optional. If present, the file path specification shall consist of a sequence of file directory names. File directory names shall be constrained to be no larger than 32 octets. Directory names shall be separated by the PIXIT determined character (typically a “\” or “/”).

A server, that contains logical devices, shall have as one of its root directories a directory whose name is “LD”. Below the LD root shall be a set of directory names that represent the logical devices within the server. These file directory names shall be the same value as the logical device names (e.g. The names of the domains). Files that are specific to a logical device shall be located within the directory that represents the logical device.

NOTE Not all files may be able to be associated with a particular LD. As an example, the image file of the server itself may not be directly associated with an LD. Therefore, for files not associated with a LD, it is a local issue in regards to the directory in which such files are stored.

The minimum-maximum name-of-a-file size shall be 12 octets. It is recommended that the file specification be a maximum size of 64 octets. The maximum file specification size shall be specified in the implementation’s PIXIT statement.

FileName suffixes should be used to differentiate the content format of files. The suffix should be a maximum of 3 octets. The suffixes in Table 67 are reserved.

It is recommended that a returned MMS FileName, that is a directory on the server, should end with a delimiter of either “\” or “/”.

#### **MMS FILE ServiceError Mappings to ACSI ServiceErrors**

The ISO/IEC-9506 File services have specialized ServiceErrors that are part of MMS ServiceError errorClass=File. The following table shows the appropriate mappings between the ACSI ServiceError values and MMS ServiceErrors for File operations.

**Table 67 – Mappings of MMS File ServiceErrors to ACSI Service Errors**

ACSI ServiceError Value	MMS ServiceError ObjectClass	MMS ServiceError
parameter-value-inappropriate	file	filename-ambiguous
Instance-locked-by-other-client	file	file-busy
parameter-value-inappropriate	file	filename-syntax-error
type-conflict	file	content-type-invalid
parameter-value-inconsistent	file	position-invalid
access-violation	file	file-access-denied
instance-not-available	file	file-non-existent
instance-in-use	file	duplicate-filename
failed-due-to-server-constraint	file	insufficient-space-in-filestore

**Table 68 – Reserved file suffixes**

Suffix	Contents
Bin	Shall indicate binary format
Dtd	eXtensible Markup Language Document Type Description file of format dtd:XML
Gif	Shall indicate graphics interchange format contents
Htm	Shall indicate HTML contents
Pqd	Power Quality Data Interchange Format – PQDIF
txt	Shall indicate ASCII contents
Xml	eXtensible Markup Language file of format table-xml:XML
Xsd	eXtensible Markup Language Schema Definition file of format xsd:XML
Zip	Shall indicate zip compressed file format

FileName case sensitivity shall be declared in the implementation's PIXIT statement.

### COMTRADE FILES

IEEE C37.111(1999) (COMTRADE) files shall be contained within a file directory whose name is "COMTRADE". The file specifications shall be consistent with the naming conventions and suffixes specified in IEEE C37.111(1999).

The IEEE COMTRADE specification IEEE C37.111(1999) specifies the use of three different suffixes (e.g. hdr, cfg, and dat). In normal information/computational usage these suffixes may represent files other than COMTRADE.

If the directory contains a file with a suffix of "zip", that file shall convey the compressed contents of the COMTRADE hdr, cfg, and dat files of the files of the same name.

The COMTRADE directories shall be located in the appropriate directory path (e.g. within the LD directory or at the root level).

### FileSize

The IEC 61850-7-2 FileSize attribute shall be mapped to the MMS file size attribute. A value of 0 may be used to indicate that the file has an unknown size or that the file contains 0 octets.

The size value shall be interpreted as an estimated file size and shall not be used to determine absolute size.

NOTE Transfers from one file system to another may increase or decrease the actual size of the file.

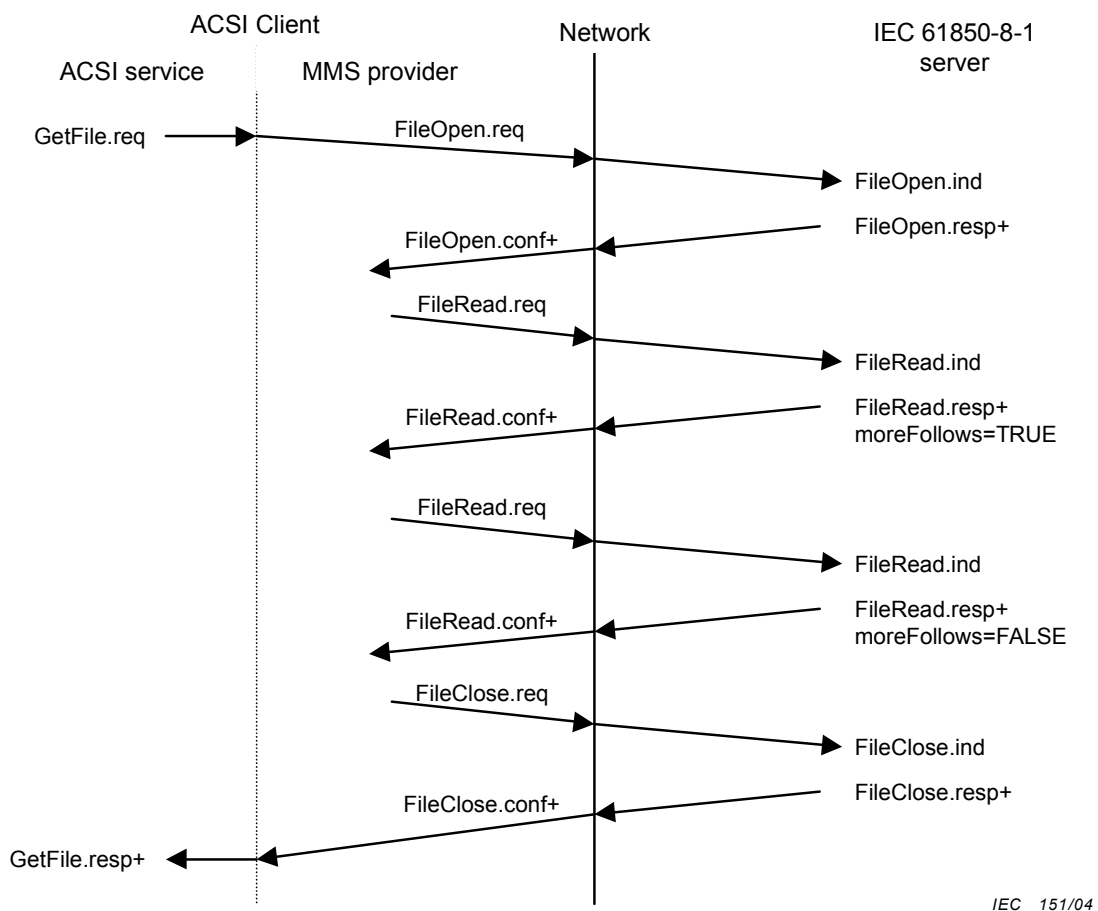
### LastModified

The IEC 61850-7-2 LastModified attribute shall be mapped to the MMS file LastModified attribute.

## 23.2 File services

### 23.2.1 GetFile

The ACSI GetFile service shall be mapped to a sequence of MMS FileOpen, FileRead, and FileClose services as specified by ISO 9506-1 and ISO 9506-2.



**Figure 11 – Mapping of ACSI GetFile to MMS FileOpen, FileRead, FileClose**

Figure 11 shows the sequence of MMS services that result from an ACSI GetFile request. An ACSI GetFile request causes an MMS FileOpen request to be generated. The initialPosition shall be 0. A FileOpen positive confirmation shall cause the first in a possible sequence of MMS FileRead requests to be generated. A FileRead positive confirmation with moreFollows=FALSE shall cause an MMS FileClose request to be issued. A FileRead positive confirmation with moreFollows=TRUE shall cause another in the sequence of FileRead requests to be issued. Upon receipt of a FileClose positive confirmation, a GetFile positive response indication shall be given.

If any MMS services return a negative confirmation, then a GetFile negative response indication shall be given.

Table 69 specifies the mapping of the ACSI GetFile service parameters.

**Table 69 – Mapping of ACSI GetFile service parameters**

ACSI parameter	MMS service and parameter	Constraint
FileName	FileOpen.request FileName	Shall be present and shall have a non-NULL value.
FileData	FileRead response FileData	

**FileName**

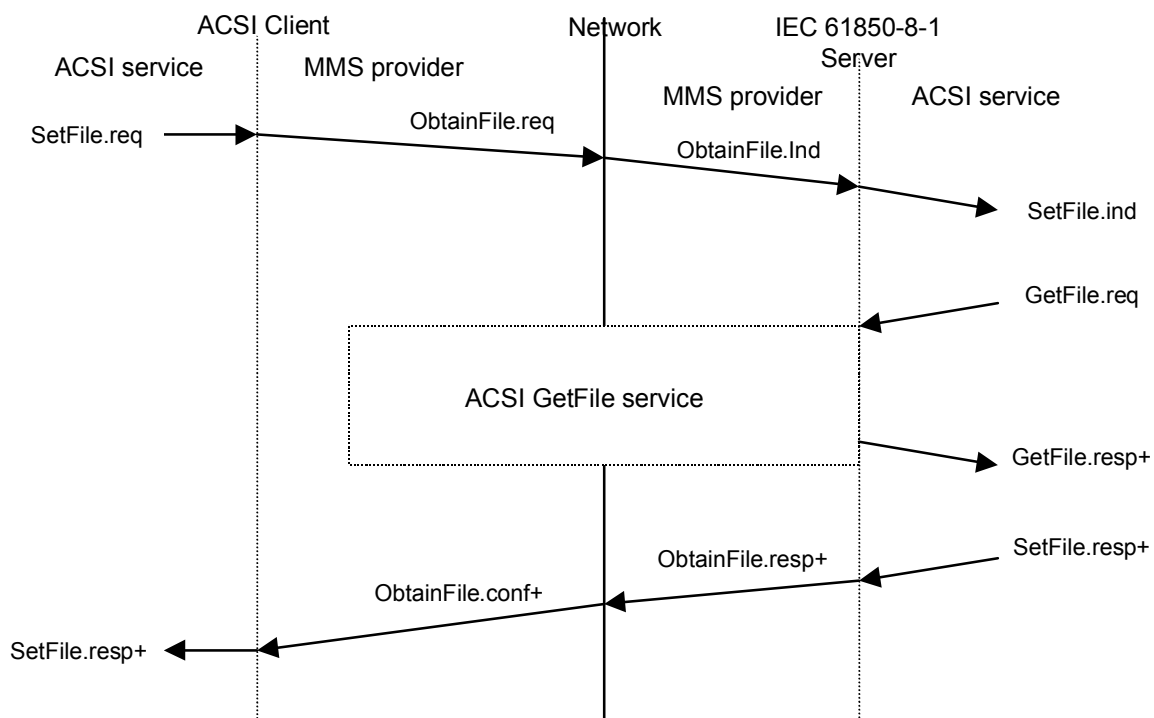
The ACSI filename parameter shall be mapped as specified in 23.1. This is a mandatory parameter that shall be present and shall have a non-NULL value.

**FileData**

The ACSI FileData shall be mapped to the sequence of FileRead response FileData returned.

**23.2.2 SetFile**

Figure 12 shows that an ACSI SetFile request shall be mapped to an MMS ObtainFile.request.



IEC 152/04

**Figure 12 – Mapping of ACSI SetFile service**

The sourceFilename parameter shall be supplied, therefore this SCSM requires a source filename parameter. Upon reception of the ObtainFile indication, the ObtainFile file transfer procedure shall be executed through the invocation of the ACSI GetFile service. Upon a GetFile response positive, an ObtainFile positive response shall be issued. Upon reception of the ObtainFile positive confirmation, a SetFile positive response shall be indicated. The mapping of the file parameters is specified in Table 70.

**Table 70 – Mapping of ACSI SetFile parameters**

ACSI parameter	MMS service and parameter	Constraint
FileName	ObtainFile request destinationFile	Shall be present and shall have a non-NULL value.
FileData	FileRead response FileData <sup>1)</sup>	
SourceFileName <sup>2)</sup>	ObtainFile request sourceFile	
<sup>1)</sup> This mapping occurs as part of the execution of the ACSI GetFile service. <sup>2)</sup> Parameter added by this SCSM.		

**FileName**

The ACSI filename parameter shall be mapped as specified in 23.1. This is a mandatory parameter that shall be present and shall have a non-NULL value.

**FileData**

The ACSI FileData shall be mapped to the sequence of FileRead response FileData returned.

**SourceFileName (added by SCSM)**

This parameter shall represent the name of the file from which FileData is to be obtained through the ACSI GetFile service. The SourceFilename parameter shall be mapped as specified in 23.1.

**23.2.3 DeleteFile**

The ACSI DeleteFile service shall map to the MMS FileDelete service as detailed in Table 71.

**Table 71 – Mapping of ACSI DeleteFile service**

ACSI service or parameter	MMS service or parameter	Constraint
FileDelete request	DeleteFile request	Shall be present and shall have a non-NULL value.
FileName	FileName	
FileDelete response+	DeleteFile response+	

**FileName**

The ACSI filename parameter shall be mapped as specified in 23.1. This is a mandatory parameter that shall be present and shall have a non-NULL value.

**23.2.4 GetFileAttributeValues**

The ACSI GetFileAttributeValues service shall be mapped to a sequence of MMS FileDirectory services. An ACSI GetFileAttributeValues request shall cause an MMS FileDirectory request to be issued. If a FileDirectory positive confirmation with moreFollows=TRUE is received, another MMS FileDirectory request shall be issued. If an MMS FileDirectory positive confirmation is received with moreFollows=FALSE, then the MMS DirectoryEntries from all MMS FileDirectory confirmations shall be indicated as part of the ACSI GetFileAttributeValues response+.

If a MMS FileDirectory negative confirmation is received, then a ACSI GetFileAttributeValues negative response shall be indicated.

The parameters of the ACSI GetFileAttributeValues service shall be mapped as detailed in Table 72.

**Table 72 – Mapping of ACSI GetFileAttributeValues parameters**

ACSI service or parameter	MMS service or parameter	Constraint
GetFileAttributeValues request	FileDirectory request	
FileName	FileSpecification	
GetFileAttributeValues response+	FileDirectory response+	
FileName		
File Attributes	listOfDirectoryEntry	
GetFileAttributeValues response–	FileDirectory response–	
ServiceError	listOfDirectoryEntry	

**FileName**

The ACSI Filename parameter shall be mapped as specified in 23.1.

**ListOfDirectoryEntry**

The ListOfDirectoryEntry parameter shall be mapped to the MMS FileDirectory service listOfDirectoryEntry. The mappings of the parameters shall be as specified in Table 73.

**Table 73 – Mapping of ACSI ListOfDirectoryEntry**

ACSI ListofDirectoryEntry parameter	MMS DirectoryEntry parameter	Constraint
FileName	FileName	
FileAttributes	FileAttributes	

The ACSI FileAttributes parameter shall be mapped as specified in 23.1.

**24 Conformance****24.1 Notation**

For the following Clause, the following definitions apply:

- m: mandatory support. The item shall be implemented.
- c: conditional support. The item shall be implemented if the stated condition exists.
- o: optional support. The implementation may decide to implement the item.
- x: excluded. The implementation shall not implement this item.
- i: out-of-scope. The implementation of the item is not within the scope of this standard.
- F/S: Functional Standard. Should be applied.
- Base: Shall be applied in any application claiming conformance to this standard.

**24.2 PICS****24.2.1 Profile conformance**

Table 74 and Table 75 define the basic conformance statement.

**Table 74 – PICS for A-Profile support**

A-Profile shortcut	Profile Description	Client		Server		Value/comment
		F/S		F/S		
A1	Client/server A-Profile	c1		c1		Refer to 6.2
A2	GOOSE/GSE management A-Profile	c2		c2		Refer to 6.3
A3	GSSE A-Profile	c3		c3		Refer to 6.4
A4	TimeSync A-Profile	c4		c4		Refer to 6.5
A5	Security for Client/server A-Profile	o		o		Refer to IEC 62351-6
A6	GOOSE/GSE management A-Profile	o		o		Refer to IEC 62351-6
c1	Shall be 'm' if support for any service specified in Table 2 are declared within the ACSI basic conformance statement.					
c2	Shall be 'm' if support for any service specified in Table 6 are declared within the ACSI basic conformance statement.					
c3	Shall be 'm' if support for any service specified in Table I.1 are declared within the ACSI basic conformance statement.					
c4	Support for at least one other A-Profile shall be declared (e.g. in A1-A3) in order to claim conformance to IEC 61850-8-1.					

**Table 75 – PICS for T-Profile support**

T-Profile	Profile Description	Client		Server		Value/Comment
		F/S		F/S		
T1	TCP/IP T-Profile	c1		c1		Refer to 6.2
T2	OSI T-Profile	c2		c2		Refer to 6.2
T3	GOOSE/GSE T-Profile	c3		c3		Refer to 6.3
T4	GSSE T-Profile	c4		c4		Refer to 6.4
T5	TimeSync T-Profile	o		o		Refer to 6.5
c1	Shall be 'm' if support for A1 is declared. Otherwise, shall be 'i'.					
c2	Shall be 'o' if support for A1 is declared. Otherwise, shall be 'i'.					
c3	Shall be 'm' if support for A2 is declared. Otherwise, shall be 'i'.					
c4	Shall be 'm' if support for A3 is declared. Otherwise, shall be 'i'.					

### 24.2.2 MMS conformance

The following conformance statements are conditional upon the support of the client/server A-Profile (e.g. A1 see profile description in Clause 6) being declared.

Except where present, MMS conformance shall be in accordance with ISO/ISP 14226-2.

#### 24.2.2.1 Character sets

##### 24.2.2.1.1 MMS identifier

The MMS Identifier shall be constrained to BasicIdentifier.

The use of ExtendedIdentifier is deprecated.

##### 24.2.2.1.2 MMSStrng

The MMSStrng shall be constrained to use the ISO646String character set. All other character sets are deprecated.

### 24.2.2.1.3 ObjectName

The MMS ObjectName shall be constrained to use BasicIdentifier. All other character sets are deprecated.

### 24.2.2.2 Environmental services

#### 24.2.2.2.1 Initiate conformance

Table 76 and Table 77 specify the conformance of the initiate service.

**Table 76 – MMS InitiateRequest general parameters**

InitiateRequest	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
InitiateRequest						
localDetailCalling	m	m		M	m	
proposedMaxServOutstandingCalling	m	m	1 or greater	M	m	1 or greater
proposedMaxServOutstandingCalled	m	m	1 or greater	M	m	1 or greater
initRequestDetail	m	m		M	m	
InitiateRequestDetail						
proposedVersionNumber	m	m	Shall be 2.1	M	m	Shall be 2.1
proposedParameterCBB	m	m	See 24.2.2.2.1.1	M	m	See 24.2.2.2.1.1
servicesSupportedCalling	m	m		M	m	
additionalSupportedCalling	c1	x		c1	x	
additionalCbbSupportedCalling	c1	x		c1	x	
privilegeClassIdentityCalling	c1	x		c1	x	
c1 Conditional upon Parameter CBB CSPI – see Table 79.						

**Table 77 – MMS InitiateResponse general parameters**

InitiateResponse	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
InitiateResponse						
localDetailCalled	m	m		M	m	
negotiatedMaxServOutstandingCalling	m	m	1 or greater	m	m	1 or greater
negotiatedMaxServOutstandingCalled	m	m	1 or greater	m	m	1 or greater
initResponseDetail	m	m		m	m	
InitiateResponseDetail						
negotiatedVersionNumber	m	m	Shall be 2.1	m	m	Shall be 2.1
negotiatedParameterCBB	m	m	See 24.2.2.2.1.1	m	m	See 24.2.2.2.1.2
servicesSupportedCalled	m	m	See 24.2.2.2.1.1	m	m	See 24.2.2.2.1.1
additionalSupportedCalled	c1	x		c1	x	
additionalCbbSupportedCalled	c1	x		c1	x	
privilegeClassIdentityCalled	c1	x		c1	x	
c1 Conditional upon Parameter CBB CSPI – see Table 79.						

### 24.2.2.2.1.1 Services supported

Table 78 defines the service support requirement, and restrictions, for this standard. Relationship to ACSI services can be found in Table 1.

**Table 78 – MMS service supported conformance table**

MMS service supported CBB	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
status	o	o		o	m	
getNameList	o	o		o	c1	
identify	o	o		m	m	
rename	o	o		o	o	
read	o	o		o	c2	
write	o	o		o	c3	
getVariableAccessAttributes	o	o		o	c4	
defineNamedVariable	o	o		o	o	
defineScatteredAccess	o	i		o	i	
getScatteredAccessAttributes	o	i		o	i	
deleteVariableAccess	o	o		o	o	
defineNamedVariableList	o	o		o	o	
getNamedVariableListAttributes	o	o		o	c5	
deleteNamedVariableList	o	o		o	c6	
defineNamedType	o	i		o	i	
getNamedTypeAttributes	o	i		o	i	
deleteNamedType	o	i		o	i	
input	o	i		o	i	
output	o	i		o	i	
takeControl	o	i		o	i	
relinquishControl	o	i		o	i	
defineSemaphore	o	i		o	i	
deleteSemaphore	o	i		o	i	
reportPoolSemaphoreStatus	o	i		o	i	
reportSemaphoreStatus	o	i		o	i	
initiateDownloadSequence	o	i		o	i	
downloadSegment	o	i		o	i	
terminateDownloadSequence	o	i		o	i	
initiateUploadSequence	o	i		o	i	
uploadSegment	o	i		o	i	
terminateUploadSequence	o	i		o	i	
requestDomainDownload	o	i		o	i	
requestDomainUpload	o	i		o	i	
loadDomainContent	o	i		o	i	
storeDomainContent	o	i		o	i	
deleteDomain	o	i		o	i	
getDomainAttributes	o	o		o	c14	
createProgramInvocation	o	i		o	i	
deleteProgramInvocation	o	i		o	i	

MMS service supported CBB	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
start	o	i		o	i	
stop	o	i		o	i	
resume	o	i		o	i	
reset	o	i		o	i	
kill	o	i		o	i	
getProgramInvocationAttributes	o	i		o	i	
obtainFile	o	c9		o	c9	
defineEventCondition	o	i		o	i	
deleteEventCondition	o	i		o	i	
getEventConditionAttributes	o	i		o	i	
reportEventConditionStatus	o	i		o	i	
alterEventConditionMonitoring	o	i		o	i	
triggerEvent	o	i		o	i	
defineEventAction	o	i		o	i	
deleteEventAction	o	i		o	i	
alterEventEnrollment	o	i		o	i	
reportEventEnrollmentStatus	o	i		o	i	
getEventEnrollmentAttributes	o	i		o	i	
acknowledgeEventNotification	o	i		o	i	
getAlarmSummary	o	i		o	i	
getAlarmEnrollmentSummary	o	i		o	i	
readJournal	o	c13		o	c13	
writeJournal	o	o		o	o	
initializeJournal	o	o		o	c12	
reportJournalStatus	o	i		o	i	
createJournal	o	i		o	i	
deleteJournal	o	i		o	i	
fileOpen	o	c8		o	c8	
fileRead	o	c8		o	c8	
fileClose	o	c8		o	c8	
fileRename	o	i		o	i	
fileDelete	o	c9		o	c9	
fileDirectory	o	c11		o	c11	
unsolicitedStatus	o	i		o	i	
informationReport	o	c7		o	c7	
eventNotification	o	i		o	i	
attachToEventCondition	o	i		o	i	
attachToSemaphore	o	i		o	i	
conclude	m	m		m	m	
cancel	o	o		o	m	
getDataExchangeAttributes	o	c10		o	c10	
exchangeData	o	c10		o	c10	
defineAccessControlList	o	c10		o	c10	
getAccessControlListAttributes	o	c10		o	c10	

MMS service supported CBB	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
reportAccessControlledObjects	o	c10		o	c10	
deleteAccessControlList	o	c10		o	c10	
alterAccessControl	o	c10		o	c10	
reconfigureProgramInvocation	o	c10		o	c10	
<p>c1 Shall be 'm' if logical device or logical node model support is declared in ACSI basic conformance statement.</p> <p>c2 Shall be 'm' if logical node model support is declared in ACSI basic conformance statement or if support for the MMS write service is declared.</p> <p>c3 Shall be 'm' if ACSI support for SetDataValues service is declared or implied.</p> <p>c4 Shall be 'm' if logical node model support is declared in ACSI basic conformance statement.</p> <p>c5 Shall be 'm' if data set support is declared in the ACSI basic conformance statement.</p> <p>c6 Shall be 'm' if support for defineNamedVariableList is declared.</p> <p>c7 Shall be 'm' if support for ACSI Report or ACSI command termination is declared.</p> <p>c8 Shall be 'm' if support for ACSI GetFile is declared.</p> <p>c9 Shall be 'm' if support for ACSI SetFile is declared.</p> <p>c10 Shall not be present since MMS minor version is declared to be 1.</p> <p>c11 Shall be 'm' if support for ACSI GetFileAttributeValues is declared.</p> <p>c12 Shall be 'm' if support for the ACSI log model is declared.</p> <p>c13 Shall be 'm' if support for the ACSI QueryLogByTime or QueryLogAfter is declared.</p> <p>c14 Shall be 'm' if support for the ACSI logical device model is declared.</p>						

#### 24.2.2.2.1.2 Parameter CBB

The specific settings for the MMS parameter CBB is specified in Table 79.

**Table 79 – MMS Parameter CBB**

MMS parameter CBB	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
STR1	o	o		o	c1	
STR2	o	o		o	o	
NEST	1	1 or greater		1	c2	
VNAM	o	o		o	c1	
VADR	o	o		o	o	
VALT	o	o		o	c1	
bit 5	x	x		x	x	
TPY	o	o		o	o	
VLIS	o	c1		o	c3	
bit 8	x	x		x	x	
bit 9	x	x		x	x	
CEI	o	i		o	i	
ACO	o	c4		o	c4	
SEM	o	c4		o	c4	
CSR	o	c4		o	c4	
CSNC	o	c4		o	c4	
CSPLC	o	c4		o	c4	
CSPI	o	c4		o	c4	

c1 Shall be 'm' if ACSI logical node model support declared.  
c2 Shall be five(5) or greater if ACSI logical node model support is declared.  
c3 Shall be 'm' if ACSI data set, reporting, GOOSE, or logging model support is declared.  
c4 Shall not be present. Receiving implementations shall assume not supported.

**24.2.2.2.2 GetNameList conformance**

Table 80 defines the conformance of the GetNameList service.

**Table 80 – GetNameList conformance statement**

GetNameList	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
ObjectClass	m	m		m	m	
ObjectScope	m	m		m	m	
DomainName	o	o	24.2.2.1.1	m	m	24.2.2.1.1
ContinueAfter	o	m	24.2.2.1.1	m	m	24.2.2.1.1
Response+						
List Of Identifier	m	m	24.2.2.1.1	m	m	24.2.2.1.1
MoreFollows	m	m		m	m	
Response-						
Error Type	m	m		m	m	

NOTE Object class 'vmd' (formerly VMDSpecific in MMS V1.0) shall not appear. If a request contains this ObjectClass, an MMS Reject shall be issued.

### 24.2.2.3 Variable access conformance

#### 24.2.2.3.1 Supporting productions

##### 24.2.2.3.1.1 AlternateAccessSelection

Table 81 defines the conformance of the alternate access selection.

**Table 81 – AlternateAccessSelection conformance statement**

AlternateAccessSelection	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
accessSelection	o	o		o	m	
component	o	o		o	m	
index	o	i		o	i	
indexRange	o	i		o	i	
allElements	o	i		o	x	
alternateAccess	o	o		o	m	
selectAccess	o	o		o	m	
component	o	o		o	m	
index	o	i		o	i	
indexRange	o	i		o	i	
allElements	o	i		o	x	

##### 24.2.2.3.1.2 VariableAccessSpecification

Table 82 defines the conformance of the variable access.

**Table 82 – VariableAccessSpecification conformance statement**

VariableAccessSpecification	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
listOfVariable	o	o		o	c1	
variableSpecification	o	o		o	c1	
alternateAccess	o	o		o	c1	
variableListName	o	o		o	c2	
c1 Shall be 'm' if ACSI support for Logical Node Model is declared.						
c2 Shall be 'm' if ACSI support for ACSI DataSets, reporting, or logging is declared.						

### 24.2.2.3.1.3 VariableSpecification

Table 83 defines the conformance of the variable specification.

**Table 83 – VariableSpecification conformance statement**

VariableSpecification	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
name	o	o		o	m	
address	o	o		o	i	
variableDescription	o	o		o	i	
scatteredAccessDescription	o	x		o	x	
invalidated	o	x		o	x	

### 24.2.2.3.2 Read

Table 84 defines the conformance of the read service.

**Table 84 – Read conformance statement**

Read	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
specificationWithResult	o	o		o	m	
variableAccessSpecification	m	m	See 24.2.2.3.1.2	m	m	See 24.2.2.3.1.2
Response						
variableAccessSpecification	o	o		o	m	
listOfAccessResult	m	m		m	m	

### 24.2.2.3.3 Write

Table 85 defines the conformance of the write service.

**Table 85 – Write conformance statement**

Write	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
variableAccessSpecification	m	m	See 24.2.2.3.1.2	m	m	See 24.2.2.3.1.2
listOfData	m	m		m	m	
Response						
failure	m	m		m	m	
success	m	m		m	m	

#### 24.2.2.3.4 InformationReport

Table 86 defines the conformance of the InformationReport service.

**Table 86 – InformationReport conformance statement**

InformationReport	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
variableAccessSpecification	m	m	See 24.2.2.3.1.2	m	m	See 24.2.2.3.1.2
listOfAccessResult	m	m		m	m	

#### 24.2.2.3.5 GetVariableAccessAttributes

Table 87 defines the conformance of the GetVariableAccessAttributes service.

**Table 87 – GetVariableAccessAttributes conformance statement**

GetVariableAccessAttributes	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
name	o	o		m	m	
address	o	o		m	x	
Response						
mmsDeletable	m	m		m	m	
address	o	x		o	x	
typeSpecification	m	m		m	m	

#### 24.2.2.3.6 DefineNamedVariableList

Table 88 defines the conformance of the DefineNamedVariableList service.

**Table 88 – DefineNamedVariableList conformance statement**

DefineNamedVariableList	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
variableListName	m	m		m	m	
listOfVariable	m	m		m	m	
variableSpecification	m	m		m	m	
alternateAccess	o	i		o	m	
Response	m	m		m	m	

### 24.2.2.3.7 GetNamedVariableListAttributes

Table 89 defines the conformance of the GetNamedVariableListAttributes service.

**Table 89 –GetNamedVariableListAttributes conformance statement**

GetNamedVariableListAttributes	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
ObjectName	m	m		m	m	
Response						
mmsDeletable	m	m		m	m	
listOfVariable	m	m		m	m	
variableSpecification	m	m		m	m	
alternateAccess	o	m		o	i	

### 24.2.2.3.8 DeleteNamedVariableList

Table 90 defines the conformance of the DeleteNamedVariableList service.

**Table 90 – DeleteNamedVariableList conformance statement**

DeleteNamedVariableList	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
Scope	m	m		m	m	
listOFVariableListName	m	m		m	m	
domainName	o	m		o	m	
Response						
numberMatched	m	m		m	m	
numberDeleted	m	m		m	m	
DeleteNamedVariableList-Error	m	m		m	m	

## 24.2.2.4 Journal management services

### 24.2.2.4.1 ReadJournal

Table 91 and Table 92 define the conformance of the ReadJournal service.

**Table 91 – ReadJournal conformance statement**

ReadJournal	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
invokeID	m	m		m	m	
journalName	m	m		m	m	
rangeStartSpecification	o	m		o	m	
startingTime	o	c1		o	m	
EntrytoStartAfter	o	o		o	m	
rangeStopSpecification	o	m		o	m	
endingTime	o	c2		o	m	
numberOfEntries	o	o		o	m	
EntryToStartAfter	o	c2		o	m	
TimeSpecification	m	m		m	m	
EntrySpecification	m	m		m	m	
Response						
invokeID	m	m		m	m	
listOfJournalEntry	m	m		m	m	
entryIdentifier	o	m		m	m	See 17.3.3.3.1
originatingApplication	m	m		m	m	
entryContent	m	m		m	m	
moreFollows	m	m		o	m	
c1 At least one shall be present.						
c2 At least one shall be present.						

**Table 92 – JournalEntry conformance statement**

Ref	Parameter	Client-CR			Server-CR		
		Base	F/S	Value/range	Base	F/S	Value/range
1	occurrenceTime	m	m		m	m	
2	additionalDetail	x	x		x	x	
3	entryForm	m	m		m	m	
4	data	o	m		o	c1	
5	event	o	m		o	o	
6	currentState	o	m		o	c2	
7	listofVariable	o	m		o	c3	
8	variableTag	o	m		o	c4	
9	valueSpecification	o	m		o	c4	
10	annotation	o	m		o	c1	
c1 Either data or annotation shall be present.							
c2 If event is present, then m.							
c3 If data is present, then m.							
c4 If listofVariable present, then m.							

**24.2.2.4.2 InitializeJournal**

Table 93 defines the conformance of the InitializeJournal service.

**Table 93 – InitializeJournal conformance statement**

InitializeJournal	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
journalName	m	m		m	m	
limitSpecification	m	m		m	m	
limitingTime	m	m		m	m	
limitingEntry	o	o		o	m	
Response+						
entriesDeleted	m	m		m	m	

**24.2.2.5 File management services****24.2.2.5.1 FileDirectory**

Table 94 defines the conformance of the FileDirectory service.

**Table 94 – FileDirectory conformance statement**

FileDirectory	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
filespecification	o	o		m	m	
continueAfter	o	o		m	m	
Response+						
listOfDirectoryEntry	m	m		m	m	
MoreFollows	m	m		m	m	

**24.2.2.5.2 FileOpen**

Table 95 defines the conformance of the FileOpen service.

**Table 95 – FileOpen conformance statement**

FileOpen	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
filename	m	m		m	m	
initialPosition	o	o		m	m	
Response+						
frsmID	m	m		m	m	
fileAttributes	m	m		m	m	

**24.2.2.5.3 FileRead**

Table 96 defines the conformance of the file read service.

**Table 96 – FileRead conformance statement**

FileRead	Client-CR	Server-CR
----------	-----------	-----------

	Base	F/S	Value/range	Base	F/S	Value/range
Request						
frsmID	m	m		m	m	
Response+						
fileData	m	m		m	m	
moreFollows	m	m		m	m	

#### 24.2.2.5.4 FileClose

Table 97 defines the conformance of the FileClose service.

**Table 97 – FileClose conformance statement**

FileClose	Client-CR			Server-CR		
	Base	F/S	Value/range	Base	F/S	Value/range
Request						
frsmID	m	m		m	m	
Response+	m	m		m	m	

### 24.3 PICS Statement

This Subclause describes the Protocol Implementation Conformation Statement Proforma (PICS). Every implementor shall complete the entire PICS. Refer to IEC 61850-7-2 ACSI basic conformance statement.

The PICS, in the following Subclauses, shall also be completed.

#### 24.3.1 Logical device

The following PICs represents the conformance requirements if support for the logical device model is declared within the ACSI basic conformance statement.

#### 24.3.2 GOOSE Services

Table 98 shall define the conformance of the GOOSE service.

**Table 98 – GOOSE conformance statement**

	Subscriber	Publisher	Value/comment
GOOSE Services	c1	c1	
SendGOOSEMessage	m	m	
GetGoReference	o	c3	
GetGOOSEElementNumber	o	c4	
GetGoCBValues	o	o	
SetGoCBValues	o	o	
GSENotSupported	c2	c5	
GOOSE Control Block (GoCB)	o	o	

	Subscriber	Publisher	Value/comment
c1			Shall be 'm' if support is declared within ACSI basic conformance statement.
c2			Shall be 'm' if ACSI basic conformance support for either GetGoReference or GetGOOSEElementNumber is declared.
c3			Shall be 'm' if support for ACSI basic conformance of GetGoReference is declared.
c4			Shall be 'm' if support for ACSI basic conformance of GetGOOSEElementNumber.
c5			Shall be 'm' if no support for ACSI basic conformance of GetGOOSEElementNumber is declared.

### 24.3.3 Substation configuration language

Conforming implementations shall support the substation configuration language as defined in IEC 61850-6 for exchange between engineering tools. Implementors that wish to provide online access and management for SCL configuration should refer to informative Annex D for guidance.

## 25 Substation Configuration Language (SCL)

### 25.1 SCL file and SCL extensions

#### 25.1.1 SCSM specific address element definitions

##### 25.1.1.1 Client/server addressing – element “address”

For the purposes of this SCSM, the SCL ConnectedAP element shall be extended. The XML Schema definition of part 6 shall be used. Table 99 defines the P-Types that are allowed for the xs:element of “Address”.

**Table 99 – Allowed P-Type definitions for client/server addressing**

P-Type designation	Description	m/o	Restrictions/comments
IP	Dotted decimal	c1	
IP-SUBNET	Subnet mask for TCP/IP profiles. Shall be dotted decimal.	c2	
IP-GATEWAY	First hop IP gateway address for TCP/IP profiles. Shall be dotted decimal.	c2	
OSI-NSAP	OSI network address	c1	Shall be limited to no more than 40 visible characters. The value shall contain an even number of visible characters. Characters shall be limited to 0 to 9 and A to F.
OSI-TSEL	OSI transport selector	m	Shall be limited to no more than 8 characters. The value shall contain an even number of visible characters. Characters shall be limited to 0 to 9 and A to F.
OSI-SSEL	OSI session selector	m	Shall be limited to no more than 16 characters. The value shall contain an even number of visible characters. Characters shall be limited to 0 to 9 and A to F.
OSI-PSEL	OSI presentation selector	m	Shall be limited to no more than 16 characters. The value shall contain an even number of visible characters. Characters shall be limited to 0 to 9 and A to F.
OSI-AP-Title	OSI ACSE AP title value	o	The value shall be quoted and per the format specified for OSI Object Identifiers. The character set shall be limited to 0 to 9 and comma(,).

P-Type designation	Description	m/o	Restrictions/comments
OSI-AP-Invoke	OSI ACSE AP invoke ID	o	Shall be limited to no more than 5 characters. Characters shall be limited to 0 to 9.
OSI-AE-Qualifier	OSI ACSE AE qualifier	o	Shall be limited to no more than 5 characters. Characters shall be limited to 0 to 9.
OSI-AE-Invoke	OSI ACSE AE invoke ID	o	Shall be limited to no more than 5 characters. Characters shall be limited to 0 to 9.
c1 One or the other shall be present for remote addressing. Both may be present for local addressing. c2 Shall be present if IP is specified			

### 25.1.1.2 GOOSE addressing

This Subclause defines the xs:string types that are allowed for the GSE GOOSE addressing as type parameters of the P element of the address element. The values and character restrictions are defined in Table 100.

**Table 100 – Definitions for GSE SCL**

P-Type designation	Description	m/o	Restrictions/comments
MAC-Address	Media access address value	m	Shall be 6 groups of 2 visible characters separated by hyphens(-). Characters shall be limited to 0 to 9 and A to F.
APPID	Application identifier	o	Shall be 4 characters. Characters shall be limited to 0 to 9 and A to F.
VLAN-PRIORITY	VLAN user priority	c1	Shall be a single character. Characters shall be limited to 0 to 7.
VLAN-ID	VLAN ID	o	Shall be 3 characters. Characters shall be limited to 0 to 9 and A to F.
c1 Shall only be present if VLAN is also present.			

### 25.1.1.3 GSSE definition

If a GSE control block shall be for GSSE protocol, then the P-Types of the “address” xs:element shall be as defined in Table 99.

### 25.1.2 Subnetwork protocol type

The protocol type for this standard shall be 8-MMS. This value shall be used as value of the subnetwork type attribute for subnetworks, where IEDs communicate according to a mapping as defined in this standard.

## Annex A (normative)

### Application protocol specification for GOOSE and GSE management

NOTE ASN.1 dictates that for parameters where the definition is on the same line, the name of that parameter begins with a lower-case letter. Therefore, correspondence of these ASN.1 parameters with parameters in the service table should be accomplished through the capitalization of the first letter.

```
IEC61850 DEFINITIONS ::= BEGIN
IMPORTS Data FROM ISO-IEC-9506-2
IEC 61850-8-1 Specific Protocol ::= CHOICE {
    gseMngtPdu          [APPLICATION 0] IMPLICIT GSEMngtPdu,
    goosePdu           [APPLICATION 1] IMPLICIT IECGoosePdu,
    ... }

GSEMngtPdu ::= SEQUENCE {
    StateID             [0] IMPLICIT INTEGER,
    Security            [3] ANY OPTIONAL, -- reserved for future definition
    CHOICE {
        requests        [1] IMPLICIT GSEMngtRequests,
        responses        [2] IMPLICIT GSEMngtResponses
    }
}

GSEMngtRequests ::= CHOICE {
    getGoReference      [1] IMPLICIT GetReferenceRequestPdu
    getGOOSEElementNumber [2] IMPLICIT GetElementRequestPdu,
    getGsReference      [3] IMPLICIT GetReferenceRequestPdu,
    getGSSEDataOffset  [4] IMPLICIT GetElementRequestPdu,
    ...
}

GSEMngtResponses ::= CHOICE {
    gseMngtNotSupported [0] IMPLICIT NULL,
    getGoReference       [1] IMPLICIT GSEMngtResponsePdu,
    getGOOSEElementNumber [2] IMPLICIT GSEMngtResponsePdu,
    getGsReference       [3] IMPLICIT GSEMngtResponsePdu,
    getGSSEDataOffset   [4] IMPLICIT GSEMngtResponsePdu,
    ...
}

GetReferenceRequestPdu ::= SEQUENCE {
    ident               [0] IMPLICIT VISIBLE-STRING,
                        -- size shall support up to 129 octets
    offset              [1] IMPLICIT SEQUENCE OF INTEGER,
    ...
}

GetElementRequestPdu ::= SEQUENCE {
    ident               [0] IMPLICIT VISIBLE-STRING,
                        -- size shall support up to 129 octets
    references          [1] IMPLICIT SEQUENCE OF VISIBLE-STRING,
    ...
}
```

```

GSEmngtResponsePdu ::= SEQUENCE {
    ident          [0] IMPLICIT VISIBLE-STRING,
                  -- echos the value of the request
    confRev       [1] IMPLICIT INTEGER OPTIONAL,
    CHOICE {
        responsePositive [2] IMPLICIT SEQUENCE {
            datSet [0] IMPLICIT VISIBLE_STRING OPTIONAL,
            result [1] IMPLICIT SEQUENCE OF RequestResults
        },
        responseNegative [3] IMPLICIT GlbErrors
    },
    ...
}

```

```

RequestResults ::= CHOICE {
    offset          [0] IMPLICIT INTEGER,
    reference       [1] IMPLICIT IA5STRING,
    error           [2] IMPLICIT ErrorReason
}

```

```

GlbErrors ::= INTEGER {
    other(0),
    unknownControlBlock(1),
    responseTooLarge(2),
    controlBlockConfigurationError (3),
    ...
}

```

```

ErrorReason ::= INTEGER {
    other (0),
    notFound (1),
    ...
}

```

```

IECGoosePdu ::= SEQUENCE {
    gocbRef          [0] IMPLICIT VISIBLE-STRING,
    timeAllowedtoLive [1] IMPLICIT INTEGER,
    datSet           [2] IMPLICIT VISIBLE-STRING,
    gold             [3] IMPLICIT VISIBLE-STRING OPTIONAL,
    t                [4] IMPLICIT UtcTime,
    stNum            [5] IMPLICIT INTEGER,
    sqNum            [6] IMPLICIT INTEGER,
    test             [7] IMPLICIT BOOLEAN DEFAULT FALSE,
    confRev          [8] IMPLICIT INTEGER,
    ndsCom           [9] IMPLICIT BOOLEAN DEFAULT FALSE,
    numDatSetEntries [10] IMPLICIT INTEGER,
    allData          [11] IMPLICIT SEQUENCE OF Data,
    security         [12] ANY OPTIONAL,
                  -- reserved for digital signature
}

```

UtcTime ::= OCTETSTRING – format and size defined in 8.1.3.6.

END

## Annex B (informative)

### Multicast address selection

In order to increase the overall performance of multicast message reception (e.g. GOOSE, GSSE, and sampled values), it is preferable to have the Media Access Control (MAC) hardware perform the filtering. The hash algorithms in the various integrated circuits do vary. It is recommended, as a system integrator, to evaluate the impact of these algorithms when assigning destination multicast addresses.

Vendors of IEC 61850-8-1 implementations that send these types of messages should provide recommendations of addressing based upon the MAC IC's hash algorithms. One such recommendation might appear as follows:

The multicast addresses (octet string of size 6) used within this standard shall have the following structure:

- The first three octets are assigned by IEEE with 01-0C-CD.
- The fourth octet shall be 01 for GOOSE, 02 for GSSE, and 04 for multicast sampled values.
- The last two octets shall be used as individual addresses assigned by the range defined in Table B.1.

**Table B.1 – Recommended multicast addressing example**

Service	Recommended address range assignments	
	Starting address (hexadecimal)	Ending address (hexadecimal)
GOOSE	01-0C-CD-01-00-00	01-0C-CD-01-01-FF
GSSE	01-0C-CD-02-00-00	01-0C-CD-02-01-FF
Multicast sampled values	01-0C-CD-04-00-00	01-0C-CD-04-01-FF



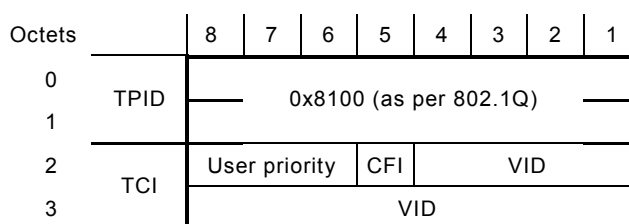
### Address fields

The destination ISO/IEC 8802-3 multicast/unicast address has to be configured for the transmission of GSE management and GOOSE. A unique ISO/IEC 8802-3 source address shall be used.

### Priority tagging/Virtual LAN

Priority tagging according to IEEE 802.1Q is used to separate time critical and high priority bus traffic for protection relevant applications from low priority busload.

The structure of the tag header is defined in Figure C.2.



IEC 154/04

**Figure C.2 – Virtual LAN tag**

TPID (Tag Protocol Identifier) Field:

Indicates the Ethertype assigned for 802.1Q Ethernet encoded frames. This value shall be 0x8100.

TCI (Tag Control Information) Fields:

User Priority: BS3; user priority value shall be set by configuration to separate sampled values and time critical protection relevant GOOSE messages from low priority busload. If the priority is not configured, then the default values of Table C.1 shall be used.

CFI (Canonical Format Indicator): BS1 [0]; a single bit flag value. For this standard the CGI bit value shall be reset (value = 0).

NOTE 1 If set (value = 1), an Embedded Resource Identification Field (E-RIF) follows the Length/Type field in the ISO/IEC 8802-3 tagged frame.

VID: The use of Virtual LAN support is optional. If this mechanism will be used the VLAN Identifier (VID) shall be set by configuration, if it is not used it shall be set to zero (0).

NOTE 2 As IEEE 802.1Q allows implementation with a restricted set of priorities, the higher priority frames should have a priority of values in the range of 4 to 7 and the lower priority should have a priority of 1 to 3. The value 1 is the priority of untagged frames, thus 0 should be avoided as it may cause unpredictable delay due to normal traffic.

Additionally, since Sampled Values need to have potentially its own bandwidth allocation, its configured VID will be different from GOOSE and GSE.

The default values for priority and VID shall be as defined in Table C.1:

**Table C.1 – Default virtual LAN IDs and priorities**

Service	Default VID	Default priority
GOOSE	0	4
GSE	0	1
Sampled Values	0	4

All implementations that send GOOSE, GSE, or Sampled Values and claim conformance to this clause of this standard, shall be capable of configuration of the VID and priority attributes.

All implementations that receive GOOSE, GSE, or Sampled Values shall be capable of receiving any VID and priority (e.g. these attributes shall not be used for Source address

matching). Additionally, such implementations shall be capable of processing incoming messages that do not contain IEEE 802.1 Q information<sup>4</sup>.

#### Ethertype and other header information

Ethertypes based on ISO/IEC 8802-3 MAC-Sublayer are registered by the IEEE authority registration. GSE, GOOSE, and sampled values shall be directly mapped to the reserved Etherbyte(s) and the Etherbyte PDU. The assigned value(s) shall be as defined in Table C.2.

**Table C.2 – Assigned Etherbyte values**

Use	Etherbyte value (hexadecimal)	APPID type
IEC 61850-8-1 GOOSE	88-B8	0 0
IEC 61850-8-1 GSE Management	88-B9	0 0
IEC 61850-9-2 Sampled Values	88-BA	0 1

APPID (application identifier): The APPID is used to select ISO/IEC 8802-3 frames containing GSE Management and GOOSE messages and to distinguish the application association. The value of APPID is the combination of the APPID Type, defined as the two most significant bits of the value (as defined in Table C.2), and the actual ID. This results in the following values:

The reserved value range for GOOSE is 0x0000 to 0x3FFF. If no APPID is configured, the default value shall be 0x0000. The default value is reserved to indicate lack of configuration. A unique, source-orientated GOOSE APPID within a system is strongly recommended. This should be enforced by the configuration system.

The GSE Management shall be the same as the APPID issued by the GOOSE for which GSE management requests are being issued. The APPID for the GSE Management response shall be the same as the one in the GSE request.

Length: Number of octets including the Etherbyte PDU header starting at APPID, and the length of the APDU (Application Protocol Data Unit). Therefore, the value of Length shall be  $8 + m$ , where  $m$  is the length of the APDU and  $m$  is less than 1492.

Frames with inconsistent or invalid length field shall be discarded.

The Reserved1 and Reserved2 are reserved for future standardized applications and shall be set to 0 as default.

The APDU octets shall be defined according to the grammar in Annex A.

<sup>4</sup> It is worthwhile to note that some Media Access Controller (MAC) ICs strip off the 802.1 Q information. Additionally, some Ethernet switches may strip or change this information.

## Annex D (informative)

### SCL conformance

#### D.1 General

Defines several degrees of conformance for which implementations may declare support of the substation configuration language.

**Table D.1 – SCL conformance degrees**

	SCL conformance	Client-CR			Server-CR		
		Base	F/S	Value/range	Base	F/S	Value/range
SCL.1	SCL file for implementation available (offline)				m	m	
SCL.2	SCL file available from implementation online	o	o		o	o	
SCL.3	SCL implementation reconfiguration supported online	o	o		o	o	

Conformance to SCL.1 is mandatory. The availability of an electronic instance of an SCL file shall be provided. This file shall be able to be parsed.

Implementations claiming conformance to SCL.2 or SCL.3 may support the ACSI services defined in Table D.2.

**Table D.2 – Supported ACSI services for SCL.2 and SCL.3**

	SCL Conformance	Client-CR			Server-CR		
		Base	F/S	Value/range	Base	F/S	Value/range
ACSI services							
	GetFileAttributeValues	o	o		o	m	
	GetFile	o	c2		o	c2	
	SetFile	o	c3		o	c3	
	DeleteFile	o	o		o	c3	
	GetDataValues	o	c1		o	c1	
	SetDataValues	o	c2		o	c2	
	SCL Control Block	i	i		o	c3	
	SCL File Structure	i	m		i	m	
	Remote Creation of SCL File	i	o		i	o	
c1 Shall be 'm' if support for SCL.2 or SCL.3 is declared. c2 Shall be 'm' if support for SCL.2 is declared. c3 Shall be 'm' if support for SCL.3 is declared.							

The additional MMS services of Table D.3 shall be supported if support for SCL.2 or SCL.3 is declared.

**Table D.3 – Additional MMS services for SCL.2 and SCL.3**

	SCL conformance	Client-CR			Server-CR		
		Base	F/S	Value/range	Base	F/S	Value/range
MMS services							
	GetCapabilityList	o	i		o	c3	
	GetDomainAttributes	o	o		o	m	
	LoadDomain	o	c1		o	c1	
	StoreDomain	o	c2		o	c2	
<p>c1 Shall be 'm' if support for SCL.3 is declared.</p> <p>c2 Shall be 'm' if support for remote creation of a SCL is declared.</p> <p>c3 An implementation that claims implementation of the GetCapabilityList service shall return the list of service capabilities that contain the list of services defined in the SCL file. Note that more capabilities are allowed to be returned than is defined in the SCL. If no capabilities are defined in the SCL file, an implementation implementing GetCapabilityList may return a NULL list of capabilities.</p>							

## D.2 SCL control block

The SCL control block shall have a functional constraint of "SC". This control block shall occur in LLN0 only.

The SCL control block shall be a structured MMS TypeDefinition that contains the ordered NamedComponents defined in Table D.4.

**Table D.4 – Definition of SCL control block**

IEC 61850-8-1 component name	MMS TypeDescription	r/w	m/o	Comments
validate	VISIBLE-STRING size of 64 octets	r w	m o	Shall be 'm' if support for remote activation of a SCL is declared.
valState	Unsigned Integer – 8 bits	r	m	(0) – NOT-VALIDATED (1) – VALIDATION-ERROR (2) – VALIDATED (3) – VALIDATION-IN-PROGRESS (4) – NOT-SUPPORTED (5) – VALIDATE-FILE-PRESENT
activate	VISIBLE-STRING size of 64 octets	r w	m o	Shall be 'm' if support for remote activation of a SCL is declared.

### D.2.1 validate

The validate attribute of the SCL control block shall contain the value of the last filename, including file directory path, that was requested to be validated.

If remote activation of an SCL file is declared to be supported, then a V-Put to this attribute shall cause a local process to start a validation process on the filename whose name was written. A V-Put to this attribute when valState = VALIDATION-IN-PROGRESS shall fail.

A successful validation, when the validated filename does not previously exist, shall cause the file to be moved from the "notvalidated" directory to the "validated" directory. If the filename previously exists, the valState shall be set to VALIDATE-FILE-PRESENT file shall not be moved.

### **D.2.2 valState**

This attribute shall contain the status of the validation phase that resulted from a V-Put to the validate attribute.

### **D.2.3 activate**

The activate attribute of the SCL control block shall contain the value of the last successfully activated SCL file.

If remote activation of an SCL file is declared to be supported, then a V-Put to this attribute shall cause a local process to:

- cause all associations to be terminated via a MMS abort service.
- shall not allow associations to be established prior to reconfiguration.
- shall reconfigure the LogicalDevice or entire device depending upon the scope of activation.
- shall allow associations to be re-established after reconfiguration is completed.

## **D.3 SCL support within devices**

This Clause standardizes the file directory structure for the storage and retrieval of SCL files. Additionally, this Clause defines a model, and control block, through which SCL files can be written to a device, validated on the device, and then activated as the current configuration of that device. It is the intent of this Clause to specify mechanisms through which the entire device (e.g. all LogicalDevices) or specific LogicalDevices may be reconfigured.

Support for SCL mandates that 3 domain attributes be supported. These attributes are named:

- SCL-Version: the value of this attribute shall indicate the version of the last SCL file that was successfully activated. If the version is unknown, the value shall be “unknown”.
- SCL-Revision: the value of this attribute shall indicate the revision of the last SCL file that was successfully activated. If the revision is unknown, the value shall be “unknown”.
- SCL-FileName: the value of this attribute shall indicate the name of the SCL that was successfully activated. If the filename is unknown, the value shall be “unknown”.

Implementations declaring support for SCL.2 shall support these domain attributes, the SCL control block, and shall support the MMS GetDomainAttributes service.

### **D.3.1 File directory structure for SCL files**

The file directory structure for SCL files shall augment the structure specified in 23.1. The root directory name shall be “SCL”. Under the root shall be two subdirectories: “notvalidated” and “validated”. SCL files may be placed (e.g. SetFile service) into the “notvalidated” directory only. The transfer of the SCL file, from “notvalidated” to “validated” shall occur when a SCL file is validated locally. This validation phase shall be accomplished through the setting of the “validate” attribute of the SCL control block. A locally created SCL file shall be created in the “validated” directory only.

### **D.3.2 Retrieval of an SCL file from an implementation**

Retrieval of an SCL file shall be per the GetFile ACSI service. This service shall be executed on the files in the directory structure specified in 23.2.1.

### **D.3.3 Remote creation of a SCL file**

The ability of a client to create a SCL file remotely can be accomplished through the MMS StoreDomainContent service.

If the StoreDomainContent service is executed on LogicalDevice LD0 (as defined in IEC 61850-7-1), then the generated SCL file shall contain the contents for the entire device. If the StoreDomainContent service is executed on a LogicalDevice, other than LD0, then the contents of the SCL file shall contain at least the SCL information pertaining to that LogicalDevice.

The file directory, into which the generated SCL file is to be placed, shall have the root of "SCL\validated". If the root is not present, or if the file already exists, the StoreDomainContent service shall fail and no SCL file shall be generated.

#### **D.3.4 Local validation of an SCL file**

The methodology for validating an SCL file is a local issue.

## Annex E (normative)

### Specialized CDCs for control service mapping

#### E.1 General

This mapping defines the control service parameters in combination with the additional control service parameters of the corresponding CDCs. The following CDCs with controllable service parameters according to IEC 61850-7-3 shall be specialized by extending the name space of common data classes:

- SPC (controllable single point);
- DPC (controllable double point);
- INC (controllable integer status);
- BSC (binary controlled step position information);
- ISC (integer controlled step position information);
- APC (controllable analogue set point information).

The additional control service parameters are mapped to data attributes of the controllable datas as

The above listed CDCs defined in IEC 61850-7-3 shall be inherited as the base definition for the specialization in this Annex.

NOTE The specializations only replace the control service parameters with FC=CO. The extensions are real extensions compared to IEC 61850-7-3; no CDC attributes have been deleted.

Table 31 of IEC 61850-7-3 shall apply to the specialized CDCs SPC, DPC, INC, BSC, and ISC.

Table 37 of IEC 61850-7-3 shall apply to the specialized CDC APC.

#### E.2 Mapping specific logical device name space extension

The name space defined in Table 12 of IEC 61850-7-3 shall be extended as shown in clause E.1.

**Table E.1 – Name space attributes**

Attribute	Application	Scope of the standard specified with the attribute	
IdNs	The DATA-ATTRIBUTE <b>IdNs</b> shall be included in the logical node LLN0 if the name space of the logical device deviates from "IEC 61850-7-4: 2003"	base name space	IEC 61850-7-4 (IEC 61850-7-3 by reference)
		extended name space	IEC 61850-7-4 (IEC 61850-7-3 by reference) (IEC 61850-8-1 by reference)

NOTE The default name space "IEC 61850-7-4:2003" (the extended name space) comprises, in addition to IEC 61850-7-4 and IEC 61850-7-3, the SCSM specific name space of the mapping defined in IEC 61850-8-1 (see clause E.3).

In the context of the mapping according to this part of IEC 61850, the common data classes defined in this part of IEC 61850 shall be applied instead of those defined in IEC 61850-7-3.

### E.3 Mapping specific common data classes

#### E.3.1 Extended common data class controllable single point (SPC)

The common data class “controllable single point” shall be as defined in Table E.2.

**Table E.2 – Extended common data class controllable single point**

SPC class					
Attribute name	Attribute type	FC	TrgOp	Value/value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
<i>control</i>					
SBO	VISIBLE STRING129	CO			AC_CO_SBO_N_M
SBOw	SBOw	CO			AC_CO_SBOW_E_M
Oper	Oper	CO			AC_CO_M
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M and AC_CO_N_O and AC_CO_E_O
<i>inherited data attributes</i>					
All DataAttributes shall be inherited from the SPC class defined in IEC 61850-7-3.					
NOTE The control service parameters in IEC 61850-7-3 with FC=CO are inherited as defined in Table E.8, Table E.9, Table E.10 when the associated control model to the Data Object requires it.					

#### E.3.2 Extended common data class controllable double point (DPC)

The common data class “controllable double point” shall be as defined in Table E.3.

**Table E.3 – Extended common data class controllable double point**

<b>DPC class</b>					
<b>Attribute name</b>	<b>Attribute type</b>	<b>FC</b>	<b>TrgOp</b>	<b>Value/value range</b>	<b>M/O/C</b>
DataName	Inherited from Data Class (see IEC 61850-7-2)				
<b>DataAttribute</b>					
<i>control</i>					
SBO	VISIBLE STRING129	CO			AC_CO_SBO_N_M
SBOw	SBOw	CO			AC_CO_SBOW_E_M
Oper	Oper	CO			AC_CO_M
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M and AC_CO_N_O and AC_CO_E_O
<i>inherited data attributes</i>					
All DataAttributes shall be inherited from the DPC class defined in IEC 61850-7-3.					
NOTE The control service parameters in IEC 61850-7-3 with FC=CO are inherited as defined in Table E.8, Table E.9, Table E.10 when the associated control model to the Data Object requires it.					

### E.3.3 Extended common data class controllable integer status (INC)

The common data class “controllable double point” shall be as defined in Table E.4.

**Table E.4 – Extended common data class controllable integer status**

INC class					
Attribute name	Attribute type	FC	TrgOp	Value/value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
<i>Control</i>					
SBO	VISIBLE STRING129	CO			AC_CO_SBO_N_M
SBOw	SBOw	CO			AC_CO_SBOW_E_M
Oper	Oper	CO			AC_CO_M
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M and AC_CO_N_O and AC_CO_E_O
<i>inherited data attributes</i>					
All DataAttributes shall be inherited from the INC class defined in IEC 61850-7-3.					
NOTE The control service parameters in IEC 61850-7-3 with FC=CO are inherited as defined in Table E.8, Table E.9, Table E.10 when the associated control model to the Data Object requires it.					

### E.3.4 Extended common data class binary controlled step position information (BSC)

The common data class “binary controlled step position information” shall be as defined in Table E.5a.

**Table E.5 – Extended common data class binary controlled step position information**

BSC class					
Attribute name	Attribute type	FC	TrgOp	Value/value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
<i>Control</i>					
SBO	VISIBLE STRING129	CO			AC_CO_SBO_N_M
SBOw	SBOw	CO			AC_CO_SBOW_E_M
Oper	Oper	CO			AC_CO_M
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M and AC_CO_N_O and AC_CO_E_O
<i>inherited data attributes</i>					
All DataAttributes shall be inherited from the BSC class defined in IEC 61850-7-3.					
NOTE The control service parameters in IEC 61850-7-3 with FC=CO are inherited as defined in Table E.8, Table E.9, Table E.10 when the associated control model to the Data Object requires it..					

**E.3.5 Extended common data class integer controlled step position information (ISC)**

The common data class “integer controlled step position information” shall be as defined in Table E.6.

**Table E.6 – Extended common data class integer controlled step position information**

ISC class					
Attribute name	Attribute type	FC	TrgOp	Value/value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
<i>Control</i>					
SBO	VISIBLE STRING129	CO			AC_CO_SBO_N_M
SBOw	SBOw	CO			AC_CO_SBOW_E_M
Oper	Oper	CO			AC_CO_M
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M and AC_CO_N_O and AC_CO_E_O
<i>inherited data attributes</i>					
All DataAttributes shall be inherited from the ISC class defined in IEC 61850-7-3.					
NOTE The control service parameters in IEC 61850-7-3 with FC=CO are inherited as defined in Table E.8, Table E.9, Table E.10 when the associated control model to the Data Object requires it.					

**E.3.6 Extended common data class controllable analogue set point information (APC)**

The common data class “controllable analogue set point information” shall be as defined in Table E.7.

**Table E.7 – Extended common data class controllable analogue set point information**

APC class					
Attribute Name	Attribute type	FC	TrgOp	Value/value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
<i>Setpoint</i>					
SBO	VISIBLE STRING129	CO			AC_CO_SBO_N_M
SBOw	SBOw	CO			AC_CO_SBOW_E_M
Oper	Oper	CO			AC_CO_M
Cancel	Cancel	CO			AC_CO_SBO_N_M and AC_CO_SBOW_E_M and AC_CO_TA_E_M and AC_CO_N_O and AC_CO_E_O
<i>inherited data attributes</i>					
All DataAttributes shall be inherited from the APC class defined in IEC 61850-7-3.					
NOTE The control service parameters in IEC 61850-7-3 with FC=CO are inherited as defined in Table E.8, Table E.9, Table E.10 when the associated control model to the Data Object requires it.					

## E.4 Mapping specific common data attribute types

### E.4.1 SBOw

The SBOw type shall be as defined in Table E.8.

**Table E.8 – SBOw**

SBOw type definition			
Attribute name	Attribute type	Value/value range	M/O/C
ctlVal	Attribute type from base CDC		M for SPC, DPC, INC, BSC, ISC, and APC
operTm	TimeStamp		AC_CO_TA_E_M
origin	Originator	See 6.8 of IEC 61850-7-3	M
ctlNum	INT8U	0..255	M for SPC, DPC, INC, BSC, and ISC; attribute is not applicable for APC
T	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
Test	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
Check	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
c1 Only one attribute f or i shall be present at a given time for APC. Where <xxxx> is the appropriate CDC (e.g. ctlVal or setMag\$f).			

### E.4.2 Oper

The Oper type shall be as defined in Table E.9.

**Table E.9 – Oper**

Oper type definition			
Attribute name	Attribute type	Value/value range	M/O/C
ctlVal	Attribute type from base CDC		M for SPC, DPC, INC, BSC, ISC, and APC
operTm	TimeStamp		AC_CO_TA_E_M
origin	Originator	See 6.8 of IEC 61850-7-3	M
ctlNum	INT8U	0..255	M for SPC, DPC, INC, BSC, and ISC; attribute is not applicable for APC
T	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
Test	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
Check	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
c1 Only one attribute f or i shall be present at a given time for APC. Where <xxxx> is the appropriate CDC (e.g. ctlVal or setMag\$f).			

### E.4.3 Cancel

The cancel type shall be as defined in Table E.10.

**Table E.10 – Cancel**

Cancel Type Definition			
Attribute Name	Attribute Type	Value/Value Range	M/O/C
ctlVal	Attribute type from base CDC		M for SPC, DPC, INC, BSC, ISC, and APC
operTm	TimeStamp		AC_CO_TA_E_M
origin	Originator	See 6.8 of IEC 61850-7-3	M
ctlNum	INT8U	0..255	M for SPC, DPC, INC, BSC, and ISC; attribute is not applicable for APC
T	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M
Test	See 17.5.2 of IEC 61850-7-2	See 17.5.2 of IEC 61850-7-2	M

Where <xxxx> is the appropriate CDC (e.g. ctlVal or setMag\$f).

### E.4.4 ctlVal

The ctlVal type shall be context sensitive and shall be as defined in Table E.11.

**Table E.11 – ctlVal**

Control attribute definition					
CDC name	Control attribute name	Control attribute type	TrgOp	Value/value range	M/O/C
SPC	ctlVal	Boolean		off (FALSE)   on (TRUE)	M
DPC	ctlVal	Boolean		off (FALSE)   on (TRUE)	M
INC	ctlVal	INT8, INT16, INT32		CtxInt; the range depends on the definition of the DO that are INC	M
BSC	ctlVal	CODED ENUM		stop   lower   higher   reserved	M
ISC	ctlVal	INT8		-64 ... 63	M
APC	ctlVal	AnalogueValue			M

### E.5 Conditions for attribute inclusion

The conditions for attribute inclusion shall be as defined in Table E.12.

**Table E.12 – Conditions for attribute inclusion**

Abbreviation	Condition
AC_CO_SBO_N_M	Attribute is mandatory, if the control model SBO with normal security is used
AC_CO_SBOW_E_M	Attribute is mandatory, if the control model SBO with enhanced security is used
AC_CO_TA_E_M	Attribute is mandatory, if time activated control and enhanced security are used
AC_CO_M	Attribute is mandatory, if the controllable status class supports control

Abbreviation	Condition
AC_CO_N_O	Attribute is optional, if the control model direct with normal security is used (without time activated)
AC_CO_E_O	Attribute is optional, if the control model direct with enhanced security is used (without time activated)

## E.6 Data attribute semantic

The data attributes used in Annex E shall have semantics as defined in Table E.13.

**Table E.13 – Semantics of data attributes**

Data attribute name	Semantics
SBO	Select – returns ACSI name of control
SBOw	SelectWithValue – receives service parameters
Oper	Operate – receives service parameters and controls value
Cancel	Cancel – receives service parameters and controls value

## Annex F (informative)

### Time scales and epochs

#### F.1 General

TAI (Temps Atomique International) time base maintained by the Bureau International des Poids et Mesures is the international standard for time based on the second. TAI is implemented by a suite of atomic clocks and forms the timekeeping basis for other time scales in common use. Of these, UTC is the time scale of most engineering and commercial interest. The UTC representation is specified in ISO 8601 as YYYY-MM-DD for the date and hh:mm:ss for the time in each day.

The rate at which UTC time advances is identical to the rate of TAI. UTC time differs from the TAI time by a constant offset. This offset is modified on occasion by adding or subtracting leap seconds.

Starting on 1 January 1972 – which is MJD (Modified Julian Day)<sup>5</sup> 41 317 –, the world's standard time systems began the implementation of leap seconds to allow only integral second correction between UTC seconds (offset TAI) and conventional civil UTC time expressed in days, hours, minutes and seconds. Leap second corrections are made preferably following second 23:59:59 of the last day of June or December. The first such correction, a single positive leap second correction, was made following 23:59:59 on 30 June 1972.

The MMS UTC epoch began at 0 hours on 1 January 1970 (MJD 40 587). Times measured are designated in this standard as MMS UTC seconds. MMS UTC Time is represented in terms of seconds and fraction of seconds. The seconds representation would overflow in 136 years or roughly January of the year 2106.

The MMS Btime6 (TimeOfDay) type shall be an OCTET STRING. A value of the TimeOfDay type may contain either 4 or 6 octets. The first form specifies the time as the number of milliseconds since midnight on the current date (the date is not contained in the value), while the second form contains the time and a date, expressed as the relative day since 1 January 1984. The first four octets shall contain a value indicating the number of milliseconds since midnight for the current date in both forms.

#### **F.2 The MMS TimeOfDay epoch began at 0 hours on 1 January 1984 (MJD 40 587). Times measured are designated in this standard as MMS TimeOfDay mili-seconds GMT and TimeOfDay days GMT, and represent offsets from the epoch. Standard time sources**

There are two standard time sources of particular interest in implementing systems for which MMS UTC time is required by the application.

The first are systems implementing the SNTP protocol widely used in synchronizing computer systems within a network. The SNTP-servers themselves are synchronized to timeservers traceable to international standards. UTC time accuracy from SNTP systems is usually in the millisecond range. SNTP uses the same time format as NTP. While SNTP provides time

---

<sup>5</sup> The Julian Date, JD, is the Julian Day Number, JDN, followed by the fraction of the day elapsed since the preceding noon (1200 UTC). The Julian Day Number is a day count with the origin, JD = 0, at 1200 UTC on 1 January 4713 b.c. The Modified Julian Date, MJD, is the Julian Date less 2 400 000,5 which shifts the origin to midnight on 17 November 1858. For example: at 0 hours on 1 January 1900, JD = 2 415 020,5; JDN = 2 415 020, 16:57:44 and MJD = 15 020.

synchronization within one network, NTP allows a global time synchronization on the internet. SNTP provides the current time, the current number of leap seconds, and the warning flags marking the introduction of a leap second correction. SNTP corrects the number of SNTP Seconds since the NTP epoch whenever a leap second correction is made. The NTP epoch is 0 hours on 1 January 1900. NTP was set at 0 hours on 1 January 1972 to 2 272 060 800,0 to agree with UTC. Currently, NTP represents seconds as a 32 bit unsigned integer. NTP therefore rolls over every  $2^{32} \text{ s} = 136 \text{ years}$  with the first such rollover occurring in approximately the year 2036.

The second system of interest is the global positioning satellite system, GPS, maintained by the U.S. Department of Defense. UTC time accuracy from the GPS system is usually in the 100 ns range. GPS system transmissions represent the time as {GPS Weeks, GPS SecondsInLastWeek}, the number of weeks since the GPS epoch and the number of seconds since the beginning of the current week. From this, GPS s, the number of seconds since the GPS epoch may be computed. GPS provides the current time, the current number of leap seconds, and the warning flags marking the introduction of a leap second correction. From GPS time, MMS UTC and Btime6 times may be computed using the information contained in the GPS transmissions. The GPS epoch began at 0 hours on 6 January 1980 (MJD 44 244). GPS weeks are represented years in the satellite transmissions modulo 1 024 weeks = 19,7 years. The first such rollover occurred between the weeks of 15 August and 22 August 1999.

Relationships between the timescales discussed and examples of times in each system for interesting instants are given in Table F.1 and Table F.2.

**Table F.1 – Relationships between timescales**

To=> From	NTP =	MMS_UTC =	BTime6 =
NTP	NTP	NTP - 2 208 988 800	day= $(\text{NTP} - 2\,650\,752\,000) / 86\,400$ ms = (remainder of $(\text{NTP} - 2\,650\,752\,000) / 86\,400$ ) x 1 000
MMS_UTC	MMS_UTC - 2 208 988 800	MMS_UTC	day= $(\text{MMS\_UTC} - 441\,763\,200) / 86\,400$ ms=(remainder of $(\text{MMS\_UTC} - 441\,763\,200) / 86\,400$ ) x 1000
BTime6	$\text{BTime6.day} \times 86\,400 +$ $\text{Btime6.ms} / 1\,000 +$ 2 650 752 000	$\text{BTime6.day} \times 86\,400 +$ $\text{Btime6.ms} / 1\,000 +$ 441 763 200	BTime6
NOTE 1 The conversion from NTP or MMS_UTC to Btime6 will lead to an error in case of a leap second insertion. The correction during a leap second will be if (Leap_Second) {Btime6.day= Btime6.day-1; Btime6.ms = Btime6.ms + 86 400 000}.			
NOTE 2 MMS_UTC and NTP are handled here as fixed-point real numbers.			

**Table F.2 – Examples of timescale correspondence**

<b>Time/MJD</b>	<b>UTC</b>	<b>Leap seconds</b>	<b>MMS UTC</b>	<b>NTP</b>	<b>MMS BTime6</b>	<b>GPS</b>
00:00:00 15 020	00:00:00 01. Jan 00			(NTP epoch) 0		
00:00:00 40 587	00:00:00 01. Jan 70		(MMS_UTC epoch) 0	2 208 988 800		
00:00:00 41 317	00:00:00 01. Jan 72	10 (leap second corr start)	63 072 000	2 272 060 800		
00:00:00 44 244	00:00:00 06. Jan 80	19	315 964 800	2 524 953 600		(GPS epoch) 0
00:00:00 45 700	00:00:00 01. Jan 84	22	441 763 200	2 650 752 000	(BTime6 epoch) 0 ms 0 d	125 798 403
23:59:60 48 256	23:59:60 31. Dec 90	25 (leap)	662 688 000	2 871 676 800	86 400 000 ms 2556 d	346 723 206
00:00:00 48 257	00:00:00 01. Jan 91	26	662 688 000	2 871 676 800	0 ms 2 557 d	346 723 207
00:00:01 48 257	00:00:01 01. Jan 91	26	662 688 001	2 871 676 801	1 000 ms 2 557 d	346 723 208
21:44:58 51 354	21:44:58 25. Jun 99	32	930 347 098	3 139 335 898	78 298 000 ms 5654 d	614 382 311
16:57:44 51 357	16:57:44 28. Jun 99	32	930 589 064	3 139 577 864	61 064 000 ms 5 657 d	614 624 277

## Annex G (normative)

### Type extensions to ISO 9506-1 (2003) and ISO 9506-2 (2003)

#### G.1 General

This annex specifies three type extensions to MMS: ISO 9506-1:2003 and ISO 9506-2:2003. They are required to harmonize IEC 61850-8-1 and MMS.

The following extension applies to ISO 9506-1:2003:

- a) a new simple type (UTC time type) for use in the Variable Access Service model (ISO 9506-1, Clause 14).

The following extensions apply to ISO 9506-2:2003:

- a) a new simple type (UTC time type) for use in the Variable Access Service model (ISO 9506-2, Clause 14);
- b) enlarged MMS maxIdentifier size from 32 to 64 (ISO 9506-2, Clause 14);
- c) replace MMSString data type in Data production with UTF8 string[0-255].

#### G.2 ISO 9506-1 (Service definitions)

##### G.2.1 Add Reference for UTC time type definition

Add the following new reference to Clause 2:

RFC 1305,1992: *Network Time Protocol (Version 3) Specification, Implementation and Analysis*

##### G.2.2 Add UTC as a new time type

Insert, in Subclause 14.2.1, below the line

```
mMSString [16] Integer32 -- MMS String
```

the following next text:

```
utc-time [17] IMPLICIT NULL -- UTC Time
```

##### G.2.3 Add, at the end of Subclause 14.2.2.4.1, the following new text:

n) UTC Time – This type represents the Coordinated Universal Time (UTC) which describes a time scale, based on the second (SI), as defined and recommended by the International Radio Consultative Committee (CCIR), and maintained by the Bureau International des Poids et Mesures (BIPM). The definition of UTC is contained in CCIR Recommendation 460-4 (1986). The UTC time type represents the elapsed number of whole seconds since GMT midnight January 1, 1900 along with the elapsed fractional portion of a second. This standard (IEC 61850-8-1) uses the identical time representation except the epoch begins at GMT midnight January 1, 1970.

### G.3 ISO 9506-2 (Protocol specification)

#### G.3.1 Add UTC as a new time type

Insert, in Subclause 14.4.2, below the line

```
mMSString [16] MMSString
```

the following new text

```
utc-time [17] IMPLICIT UtcTime --UTC Time
```

Add, at the end of Subclause 14.4.2.3, the following new subclause:

##### 14.4.2.4 UTC Time

The UtcTime type shall be an OCTET STRING of length eight (8) octets. The value shall be encoded as defined in RFC 1305. The format of the value is as a 64-bit fixed point number. The integer part contains: elapsed number of whole seconds since GMT midnight January 1, 1970(s). The fractional part contains the portion of a second elapsed since the last whole second.

The integer seconds since January 1, 1970 shall be contained within the most significant four (4) octets (e. g., octets 0 through 3). The value of the time field shall be derived by numbering the bits of these octets, starting with the least significant bit of the last octet as bit zero and ending the numbering with the most significant bit of the first octet as bit thirty one. Each bit shall be assigned a numerical value of  $2^{**N}$ , where N is the position of the bit in this numbering sequence. The value of the time shall be obtained by summing the numerical values assigned to each bit for those bits which are set to one.

The fraction of second value shall be contained in the least significant four octets (e.g. octets 4 through 7). The value of the fraction field shall be derived by numbering the bits of these octets, starting with the most significant bit of octet 4 as bit one and ending the numbering with the least significant bit of octet 7 as bit 32. Each bit shall be assigned a numerical value of  $2^{*-N}$ , where N is the position of the bit in this numbering sequence. The value of the time shall be obtained by summing the numerical values assigned to each bit for those bits which are set to one (1).

NOTE This representation corresponds to the format which is commonly used in many contexts such as Internet protocols and GPS satellite time services. For most real implementations in the foreseeable future, the least significant octet of the fraction of a second value (fractional parts below  $2^{*-24}$ ) are beyond the limits of time accuracy. Some time protocol standards recommend setting the values of these fractional bits to random values. Other standards may make use of these least significant bits to meet other application requirements (for example source of the time stamp, clock quality information, etc.). Use of these least significant 8 bits of the fractional part for any other purpose should be under local agreement and is beyond the scope of this standard.

#### G.3.2 Enlarge the MMS Identifier size

Replace, in Subclause 7.5.2, the line

```
maxIdentifier INTEGER ::= 32
```

by the following new text

```
maxIdentifier INTEGER ::= 64
```

#### G.3.3 Allow application-dependent use of MMSString data type

Replace, in Subclause 14.4.2, the line

```
mMSString [16] MMSString
```

by the following new text

```
IF ( char )
    mMSString [16]      MMSString
ELSE
    mMSString [16]      UTF8 string[0-255]
ENDIF
```

---

## **Annex H**

(normative)

### **Example SCL File**

The following text represents an example of a possible SCL file. This file, and its contents should not be used for anything more than education since the example may not be updated to match the current SCL Schema. The actual SCL examples, and Schema, can be found in IEC 61850-6.

```
<?xml version="1.0" encoding="UTF-8"?>
<SCL xmlns="http://www.iec.ch/61850/2003/SCL" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="http://www.iec.ch/61850/2003/SCL&#xD;&#xA;SCL.xsd">
  <Header id="SCL Example T1-1" nameStructure="IEDName" />
  <Substation name="S12" desc="Baden">
    <VoltageLevel name="D1">
      <PowerTransformer name="T1" type="PTR">
        <LNode InInst="1" InClass="PDIF" IdInst="F1" iedName="D1Q1BP2" />
        <LNode InInst="1" InClass="TCTR" IdInst="C1" iedName="D1Q1SB1" />
        <TransformerWinding name="W1" type="PTW">
          <Terminal connectivityNode="S12/D1/Q1/L1" substationName="S12" voltageLevelName="D1" bayName="Q1" cNodeName="L1" />
        </TransformerWinding>
        <TransformerWinding name="W2" type="PTW">
          <Terminal connectivityNode="S12/E1/Q2/L3" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L3" />
        </TransformerWinding>
      </PowerTransformer>
      <Voltage multiplier="k" unit="V">220</Voltage>
      <Bay name="Q1">
        <LNode InInst="1" InClass="PDIS" IdInst="F1" iedName="D1Q1BP3" />
        <ConductingEquipment name="I1" type="CTR">
          <Terminal connectivityNode="S12/D1/Q1/L1" substationName="S12" voltageLevelName="D1" bayName="Q1" cNodeName="L1" />
          <SubEquipment name="R" phase="A">
            <LNode InClass="TCTR " iedName="D1Q1BP2" IdInst="F1" InInst="1" />
          </SubEquipment>
          <SubEquipment name="S" phase="B">
            <LNode InClass="TCTR " iedName="D1Q1BP2" IdInst="F1" InInst="2" />
          </SubEquipment>
          <SubEquipment name="T" phase="C">
            <LNode InClass="TCTR " iedName="D1Q1BP2" IdInst="F1" InInst="3" />
          </SubEquipment>
          <SubEquipment name="IO" phase="N">
            <LNode InClass="TCTR " iedName="D1Q1BP2" IdInst="F1" InInst="4" />
          </SubEquipment>
        </ConductingEquipment>
        <ConnectivityNode name="L1" pathName="S12/D1/Q1/L1" />
      </Bay>
    </VoltageLevel>
    <VoltageLevel name="E1">
```

```

<Voltage multiplier="k" unit="V">132</Voltage>
<Bay name="Q1">
  <LNode InInst="1" InClass="MMXU" IdInst="C1" iedName="E1Q1SB1" />
  <LNode InInst="1" InClass="PDIS" IdInst="F1" />
  <LNode InInst="1" InClass="PDIF" IdInst="F1" />
  <ConductingEquipment name="QA1" type="CBR">
    <LNode InInst="1" InClass="CSWI" IdInst="C1" iedName="E1Q1SB1" />
    <Terminal connectivityNode="S12/E1/Q1/L1" substationName="S12" voltageLevelName="E1" bayName="Q1" cNodeName="L1" />
    <Terminal connectivityNode="S12/E1/Q1/L2" substationName="S12" voltageLevelName="E1" bayName="Q1" cNodeName="L2" />
  </ConductingEquipment>
  <ConductingEquipment name="QB1" type="DIS">
    <LNode InInst="2" InClass="CSWI" IdInst="C1" iedName="E1Q1SB1" />
    <LNode InInst="1" InClass="CILO" IdInst="C1" iedName="D1Q1SB4" />
    <Terminal connectivityNode="S12/E1/Q4/B1" substationName="S12" voltageLevelName="E1" bayName="Q4" cNodeName="B1" />
    <Terminal connectivityNode="S12/E1/Q1/L1" substationName="S12" voltageLevelName="E1" bayName="Q1" cNodeName="L1" />
  </ConductingEquipment>
  <ConductingEquipment name="U1" type="VTR">
    <Terminal connectivityNode="S12/E1/Q1/L2" substationName="S12" voltageLevelName="E1" bayName="Q1" cNodeName="L2" />
    <SubEquipment name="A" phase="A">
      <LNode InClass="TVTR" iedName="E1Q1SB1" IdInst="C1" InInst="1" desc="VT phase L1" />
    </SubEquipment>
  </ConductingEquipment>
  <ConductingEquipment name="I1" type="CTR">
    <Terminal connectivityNode="S12/E1/Q1/L3" substationName="S12" voltageLevelName="E1" bayName="Q1" cNodeName="L3" />
    <Terminal connectivityNode="S12/E1/Q1/L2" substationName="S12" voltageLevelName="E1" bayName="Q1" cNodeName="L2" />
  </ConductingEquipment>
  <ConnectivityNode name="L1" pathName="S12/E1/Q1/L1" />
  <ConnectivityNode name="L2" pathName="S12/E1/Q1/L2" />
  <ConnectivityNode name="L3" pathName="S12/E1/Q1/L3" />
</Bay>
<Bay name="Q2" desc="Turgi">
  <ConductingEquipment name="QA1" type="CBR">
    <LNode InInst="1" InClass="CSWI" IdInst="C1" />
    <Terminal connectivityNode="S12/E1/Q2/L0" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L0" />
    <Terminal connectivityNode="S12/E1/Q2/L1" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L1" />
  </ConductingEquipment>
  <ConductingEquipment name="QB1" type="DIS">
    <LNode InInst="2" InClass="CSWI" IdInst="C1" />
    <LNode InInst="2" InClass="CILO" IdInst="C1" iedName="D1Q1SB4" />
    <Terminal connectivityNode="S12/E1/Q4/B1" substationName="S12" voltageLevelName="E1" bayName="Q4" cNodeName="B1" />

```

```
<Terminal connectivityNode="S12/E1/Q2/L0" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L0" />
</ConductingEquipment>
<ConductingEquipment name="I1" type="CTR">
  <Terminal connectivityNode="S12/E1/Q2/L1" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L1" />
  <Terminal connectivityNode="S12/E1/Q2/L2" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L2" />
</ConductingEquipment>
<ConductingEquipment name="U1" type="VTR">
  <Terminal connectivityNode="S12/E1/Q2/L1" substationName="S12" voltageLevelName="E1" bayName="Q2" cNodeName="L1" />
</ConductingEquipment>
<ConnectivityNode name="L0" pathName="S12/E1/Q2/L0" />
<ConnectivityNode name="L1" pathName="S12/E1/Q2/L1" />
<ConnectivityNode name="L2" pathName="S12/E1/Q2/L2" />
</Bay>
<Bay name="Q3" desc="London">
  <LNode InInst="1" InClass="MMXU" IdInst="LD0" />
  <LNode InInst="1" InClass="PDIS" IdInst="LD0" />
  <LNode InInst="1" InClass="PDIF" IdInst="LD0" />
  <ConductingEquipment name="QA1" type="CBR">
    <LNode InInst="1" InClass="CSWI" IdInst="C1" />
    <Terminal connectivityNode="S12/E1/Q3/L1" substationName="S12" voltageLevelName="E1" bayName="Q3" cNodeName="L1" />
    <Terminal connectivityNode="S12/E1/Q3/L2" substationName="S12" voltageLevelName="E1" bayName="Q3" cNodeName="L2" />
  </ConductingEquipment>
  <ConductingEquipment name="QB1" type="DIS">
    <Terminal connectivityNode="S12/E1/Q4/B1" substationName="S12" voltageLevelName="E1" bayName="Q4" cNodeName="B1" />
    <Terminal connectivityNode="S12/E1/Q3/L1" substationName="S12" voltageLevelName="E1" bayName="Q3" cNodeName="L1" />
  </ConductingEquipment>
  <ConductingEquipment name="U1" type="VTR">
    <Terminal connectivityNode="S12/E1/Q3/L2" substationName="S12" voltageLevelName="E1" bayName="Q3" cNodeName="L2" />
  </ConductingEquipment>
  <ConductingEquipment name="I1" type="CTR">
    <Terminal connectivityNode="S12/E1/Q3/L3" substationName="S12" voltageLevelName="E1" bayName="Q3" cNodeName="L3" />
    <Terminal connectivityNode="S12/E1/Q3/L2" substationName="S12" voltageLevelName="E1" bayName="Q3" cNodeName="L2" />
  </ConductingEquipment>
  <ConnectivityNode name="L1" pathName="S12/E1/Q3/L1" />
  <ConnectivityNode name="L2" pathName="S12/E1/Q3/L2" />
  <ConnectivityNode name="L3" pathName="S12/E1/Q3/L3" />
</Bay>
<Bay name="Q4">
  <ConnectivityNode name="B1" pathName="S12/E1/Q4/B1" />
```

```
</Bay>
</VoltageLevel>
</Substation>
<Communication>
  <SubNetwork name="W01" type="8-MMS">
    <Text>Station bus</Text>
    <BitRate unit="b/s">10</BitRate>
    <ConnectedAP iedName="D1Q1SB4" apName="S1">
      <Address>
        <P type="IP" xsi:type="tP_IP">10.0.0.11</P>
        <P type="IP-SUBNET" xsi:type="tP_IP-SUBNET">255.255.255.0</P>
        <P type="IP-GATEWAY" xsi:type="tP_IP-GATEWAY">10.0.0.101</P>
        <P type="OSI-TSEL" xsi:type="tP_OSI-TSEL">00000001</P>
        <P type="OSI-PSEL" xsi:type="tP_OSI-PSEL">01</P>
        <P type="OSI-SSEL" xsi:type="tP_OSI-SSEL">01</P>
      </Address>
      <GSE IdInst="C1" cbName="SyckResult">
        <Address>
          <P type="MAC-Address">01-0C-CD-01-00-02</P>
          <P type="APPID">3001</P>
          <P type="VLAN-PRIORITY">4</P>
        </Address>
      </GSE>
      <PhysConn type="Plug">
        <P type="Type">FOC</P>
        <P type="Plug">ST</P>
      </PhysConn>
    </ConnectedAP>
    <ConnectedAP iedName="E1Q1SB1" apName="S1">
      <Address>
        <P type="IP">10.0.0.1</P>
        <P type="IP-SUBNET">255.255.255.0</P>
        <P type="IP-GATEWAY">10.0.0.101</P>
        <P type="OSI-TSEL">00000001</P>
        <P type="OSI-PSEL">01</P>
        <P type="OSI-SSEL">01</P>
      </Address>
      <GSE IdInst="C1" cbName="ItIPositions">
        <Address>
          <P type="MAC-Address">01-0C-CD-01-00-01</P>

```

```
<P type="APPID">3000</P>
<P type="VLAN-PRIORITY">4</P>
</Address>
</GSE>
<SMV IdInst="C1" cbName="Volt">
  <Address>
    <P type="MAC-Address">01-0C-CD-04-00-01</P>
    <P type="APPID">4000</P>
    <P type="VLAN-ID">123</P>
    <P type="VLAN-PRIORITY">4</P>
  </Address>
</SMV>
</ConnectedAP>
<ConnectedAP iedName="E1Q1BP2" apName="S1">
  <Address>
    <P type="IP">10.0.0.2</P>
    <P type="IP-SUBNET">255.255.255.0</P>
    <P type="IP-GATEWAY">10.0.0.101</P>
    <P type="OSI-TSEL">00000001</P>
    <P type="OSI-PSEL">01</P>
    <P type="OSI-SSEL">01</P>
  </Address>
</ConnectedAP>
<ConnectedAP iedName="E1Q1BP3" apName="S1">
  <Address>
    <P type="IP">10.0.0.3</P>
    <P type="IP-SUBNET">255.255.255.0</P>
    <P type="IP-GATEWAY">10.0.0.101</P>
    <P type="OSI-TSEL">00000001</P>
    <P type="OSI-PSEL">01</P>
    <P type="OSI-SSEL">01</P>
  </Address>
</ConnectedAP>
<ConnectedAP iedName="A1KA1" apName="S1">
  <!-- station level client for reporting -->
  <Address>
    <P type="IP">10.0.0.121</P>
    <P type="IP-SUBNET">255.255.255.0</P>
    <P type="IP-GATEWAY">10.0.0.101</P>
```

```
<P type="OSI-TSEL">00000001</P>
<P type="OSI-PSEL">01</P>
<P type="OSI-SSEL">01</P>
</Address>
</ConnectedAP>
</SubNetwork>
</Communication>
<IED name="E1Q1SB1">
  <Services>
    <DynAssociation />
    <GetDirectory />
    <GetDataObjectDefinition />
    <GetDataSetValue />
    <DataSetDirectory />
    <ReadWrite />
    <FileHandling />
    <ConfDataSet max="4" maxAttributes="50" />
    <ConfReportControl max="12" />
    <ReportSettings bufTime="Dyn" cbName="Conf" rptID="Dyn" dataSet="Conf" intgPd="Dyn" optFields="Conf" />
    <ConfLogControl max="1" />
    <ConfLNs fixLnInst="true" />
    <GetCBValues />
    <GOOSE max="2" />
    <GSESettings applID="Conf" cbName="Conf" dataSet="Conf" />
  </Services>
  <AccessPoint name="S1">
    <Server>
      <Authentication />
      <LDevice inst="C1">
        <LN0 InType="LN0" InClass="LLN0" inst="">
          <DataSet name="Positions">
            <FCDA IdInst="C1" prefix="" InInst="1" InClass="CSWI" doName="Pos" fc="ST" />
            <FCDA IdInst="C1" prefix="" InInst="2" InClass="CSWI" doName="Pos" fc="ST" />
          </DataSet>
          <DataSet name="Measurands">
            <FCDA IdInst="C1" prefix="" InInst="1" InClass="MMXU" doName="Amps" fc="MX" />
            <FCDA IdInst="C1" prefix="" InInst="1" InClass="MMXU" doName="Volts" fc="MX" />
          </DataSet>
          <DataSet name="smv">
            <FCDA IdInst="C1" prefix="" InClass="TVTR" InInst="1" doName="Vol" daName="instMag" fc="MX" />
          </DataSet>
        </LN0>
      </LDevice>
    </Server>
  </AccessPoint>
</IED>
```

```
</DataSet>
<ReportControl name="PosReport" rptID="E1Q1Switches" datSet="Positions" confRev="0">
  <TrgOps dchg="true" qchg="true" />
  <OptFields />
  <RptEnabled max="5">
    <ClientLN iedName="A1KA1" IdInst="LD1" InInst="1" InClass="IHMI" />
  </RptEnabled>
</ReportControl>
<ReportControl name="MeaReport" rptID="E1Q1Measurands" datSet="Measurands" intgPd="2000" confRev="0">
  <TrgOps qchg="true" period="true" />
  <OptFields reasonCode="true" />
  <RptEnabled max="5">
    <ClientLN iedName="A1KA1" IdInst="LD1" InInst="1" InClass="IHMI" />
  </RptEnabled>
</ReportControl>
<LogControl name="Log" datSet="Positions" logName="C1">
  <TrgOps dchg="true" qchg="true" />
</LogControl>
<GSEControl name="ItlPositions" datSet="Positions" appID="Itl" />
<SampledValueControl name="Volt" datSet="smv" smvID="11" smpRate="4800" nofASDU="5" multicast="true">
  <SmvOpts sampleRate="true" refreshTime="true" sampleSynchronized="true" />
</SampledValueControl>
<Log />
</LN0>
<LN InType="LPHDa" InClass="LPHD" inst="1">
  <DOI name="Proxy">
    <DAI name="stVal">
      <Val>false</Val>
    </DAI>
  </DOI>
</LN>
<LN inst="1" InClass="CSWI" InType="CSWIa" />
<LN inst="2" InClass="CSWI" InType="CSWIa" />
<LN inst="3" InClass="CSWI" InType="CSWIb" />
<LN inst="1" InClass="MMXU" InType="MMXUa">
  <DOI name="Volts">
    <SDI name="sVC">
      <DAI name="offset">
        <Val>10</Val>
      </DAI>
    </SDI>
  </DOI>
</LN>
```

```
</DAI>
<DAI name="scaleFactor">
  <Val>200</Val>
</DAI>
</SDI>
</DOI>
</LN>
<LN InType="TVTRa" InClass="TVTR" inst="1" />
</LDevice>
</Server>
</AccessPoint>
</IED>
<!-- Details of following IEDs to be defined before final allocation of LNs to Substation section -->
<IED name="E1Q1BP2">
  <AccessPoint name="S1" />
</IED>
<IED name="E1Q1BP3">
  <AccessPoint name="S1" />
</IED>
<IED name="E1Q2SB1">
  <AccessPoint name="S1" />
</IED>
<IED name="E1Q3SB1">
  <AccessPoint name="S1" />
</IED>
<IED name="E1Q3KA1">
  <AccessPoint name="S1" />
</IED>
<IED name="E1Q3KA2">
  <AccessPoint name="S1" />
</IED>
<IED name="E1Q3KA3">
  <AccessPoint name="S1" />
</IED>
<IED name="D1Q1SB1">
  <AccessPoint name="S1" />
</IED>
<IED name="D1Q1BP2">
  <AccessPoint name="S1" />
</IED>
```

```
<IED name="D1Q1BP3">
  <AccessPoint name="S1" />
</IED>
<IED name="D1Q1SB4">
  <Services>
    <DynAssociation />
    <GetDirectory />
    <GetDataObjectDefinition />
    <GetDataSetValue />
    <DataSetDirectory />
    <ReadWrite />
    <FileHandling />
    <ConfDataSet max="4" />
    <ConfReportControl max="12" />
    <ReportSettings bufTime="Dyn" cbName="Conf" rptID="Dyn" dataSet="Conf" intgPd="Dyn" optFields="Conf" />
    <ConfLogControl max="1" />
    <GetCBValues />
    <GOOSE max="2" />
    <GSESettings applID="Conf" cbName="Conf" dataSet="Conf" />
  </Services>
  <AccessPoint name="S1">
    <Server>
      <Authentication />
      <LDevice inst="C1">
        <LN0 InType="LN0" InClass="LLN0" inst="">
          <DataSet name="SyckResult">
            <FCDA IdInst="C1" prefix="" InInst="1" InClass="RSYN" doName="Rel" fc="ST" />
          </DataSet>
          <GSEControl name="SyckResult" dataSet="SyckResult" applID="SynChk" />
        </LN0>
        <LN InType="LPHDa" InClass="LPHD" inst="1">
          <DOI name="Proxy">
            <DAI name="stVal">
              <Val>false</Val>
            </DAI>
          </DOI>
        </LN>
        <LN inst="1" InClass="RSYN" InType="RSYNa" />
        <LN inst="1" InClass="CILO" InType="CILOa" />
      </LDevice>
    </AccessPoint>
  </Server>
</IED>
```

```
<LN inst="2" InClass="CILO" InType="CILOa" />
</LDevice>
</Server>
</AccessPoint>
</IED>
<IED name="A1KA1">
  <!-- station level IED - client only -->
  <AccessPoint name="S1">
    <LN inst="1" InClass="IHMI" InType="IHMIa" />
  </AccessPoint>
</IED>
<DataTypeTemplates>
  <LNNodeType id="LN0" InClass="LLN0">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myBeh" />
    <DO name="Health" type="myHealth" />
    <DO name="NamPit" type="myLN0LPL" />
  </LNNodeType>
  <LNNodeType id="LPHDa" InClass="LPHD">
    <DO name="PhyNam" type="myDPL" />
    <DO name="PhyHealth" type="myINS" />
    <DO name="Proxy" type="mySPS" />
  </LNNodeType>
  <LNNodeType id="CSWIa" InClass="CSWI">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myBeh" />
    <DO name="Health" type="myHealth" />
    <DO name="NamPit" type="myLPL" />
    <DO name="Pos" type="myPosWhitoutTimeActivation" />
  </LNNodeType>
  <LNNodeType id="CSWIb" InClass="CSWI">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myBeh" />
    <DO name="Health" type="myHealth" />
    <DO name="NamPit" type="myLPL" />
    <DO name="Pos" type="myPosWithTimeActivation" />
  </LNNodeType>
  <LNNodeType id="MMXUa" InClass="MMXU">
    <DO name="Mod" type="myMod" />
    <DO name="Beh" type="myHealth" />
```

```
<DO name="Health" type="myBeh" />
<DO name="NamPlt" type="myLPL" />
<DO name="Amps" type="myMV" />
<DO name="Volts" type="myMV" />
</NodeType>
<NodeType id="CILOa" InClass="CILO">
  <DO name="Mod" type="myHealth" />
  <DO name="Beh" type="myBeh" />
  <DO name="Health" type="myINS" />
  <DO name="NamPlt" type="myLPL" />
  <DO name="EnaOpen" type="mySPS" />
  <DO name="EnaClose" type="mySPS" />
</NodeType>
<NodeType id="TVTRa" InClass="TVTR">
  <DO name="Mod" type="myMod" />
  <DO name="Beh" type="myBeh" />
  <DO name="Health" type="myHealth" />
  <DO name="NamPlt" type="myLPL" />
  <DO name="Vol" type="mySAV" />
  <DO name="FuFail" type="mySPS" />
</NodeType>
<NodeType id="RSYNa" InClass="RSYN">
  <DO name="Mod" type="myMod" />
  <DO name="Beh" type="myBeh" />
  <DO name="Health" type="myHealth" />
  <DO name="NamPlt" type="myLPL" />
  <DO name="Rel" type="mySPS" />
</NodeType>
<NodeType id="IHMIa" InClass="IHMI">
  <DO name="Mod" type="myMod" />
  <DO name="Beh" type="myBeh" />
  <DO name="Health" type="myHealth" />
  <DO name="NamPlt" type="myLPL" />
</NodeType>
<DOType id="myMod" cdc="INC">
  <DA name="stVal" fc="ST" dchg="true" bType="Enum" type="Mod" />
  <DA name="q" fc="ST" bType="Quality" qchg="true" />
  <DA name="t" fc="ST" bType="Timestamp" dchg="true" />
  <DA name="ctlModel" fc="CF" bType="Enum" type="ctlModel" />
```

```
<DA name="Oper" fc="CO" bType="Struct" type="myModOper" />
<!-- needed for mapping according to 8-1 -->
</DOType>
<DOType id="myHealth" cdc="INS">
  <DA name="stVal" fc="ST" bType="Enum" dchg="true" type="Health" />
  <DA name="q" fc="ST" bType="Quality" qchg="true" />
  <DA name="t" fc="ST" bType="Timestamp" dchg="true" />
</DOType>
<DOType id="myBeh" cdc="INS">
  <DA name="stVal" fc="ST" bType="Enum" dchg="true" type="Beh" />
  <DA name="q" fc="ST" bType="Quality" qchg="true" />
  <DA name="t" fc="ST" bType="Timestamp" dchg="true" />
</DOType>
<DOType id="myINS" cdc="INS">
  <DA name="stVal" fc="ST" bType="INT32" dchg="true" />
  <DA name="q" fc="ST" bType="Quality" qchg="true" />
  <DA name="t" fc="ST" bType="Timestamp" dchg="true" />
</DOType>
<DOType id="myLN0LPL" cdc="LPL">
  <DA name="vendor" fc="DC" bType="VisString255">
    <Val>myVendorName</Val>
  </DA>
  <DA name="swRev" fc="DC" bType="VisString255">
    <Val>my SW revision ID</Val>
  </DA>
  <DA name="d" fc="DC" bType="VisString255" />
  <DA name="configRev" fc="DC" bType="VisString255">
    <Val>Rev 3.45</Val>
  </DA>
  <DA name="IdNs" fc="EX" bType="VisString255">
    <Val>IEC 61850-7-4:2003</Val>
  </DA>
</DOType>
<DOType id="myLPL" cdc="LPL">
  <DA name="vendor" fc="DC" bType="VisString255">
    <Val>myVendorName</Val>
  </DA>
  <DA name="swRev" fc="DC" bType="VisString255" />
  <DA name="d" fc="DC" bType="VisString255" />
</DOType>
```

```
<DOType id="myDPL" cdc="DPL">
  <DA name="vendor" fc="DC" bType="VisString255">
    <Val>myVendorName</Val>
  </DA>
  <DA name="hwRev" fc="DC" bType="VisString255">
    <Val>Rev 1.23</Val>
  </DA>
</DOType>
<DOType id="myPosWithoutTimeActivation" cdc="DPC">
  <DA name="stVal" fc="ST" bType="Dbpos" dchg="true" type="Dbpos" />
  <DA name="q" fc="ST" bType="Quality" qchg="true" />
  <DA name="t" fc="ST" bType="Timestamp" />
  <DA name="ctlModel" fc="CF" bType="Enum" type="ctlModel" />
  <Val>sbo-with-enhanced-security</Val>
</DA>
<DA name="cdcNsl" fc="EX" bType="Struct" type="VString255" />
<!-- needed for mapping according to 8-1 -->
<DA name="SBOw" fc="CO" bType="Struct" type="myOpeWithoutTimeActivation" />
<DA name="Oper" fc="CO" bType="Struct" type="myOperWithoutTimeActivation" />
<!-- needed for mapping according to 8-1 -->
<DA name="Cancel" fc="CO" bType="Struct" type="myCancelWithoutTimeActivation" />
<!-- needed for mapping according to 8-1 -->
</DOType>
<DOType id="myPosWithTimeActivation" cdc="DPC">
  <DA name="stVal" fc="ST" bType="Dbpos" dchg="true" type="Dbpos" />
  <DA name="q" fc="ST" bType="Quality" qchg="true" />
  <DA name="t" fc="ST" bType="Timestamp" />
  <DA name="ctlModel" fc="CF" bType="Enum" type="ctlModel">
    <Val>sbo-with-enhanced-security</Val>
  </DA>
  <DA name="cdcNsl" fc="EX" bType="Struct" type="VString255" />
  <!-- needed for mapping according to 8-1 -->
  <DA name="SBOw" fc="CO" bType="Struct" type="myOperWithTimeActivation" />
  <DA name="Oper" fc="CO" bType="Struct" type="myOperWithTimeActivation" />
  <!-- needed for mapping according to 8-1 -->
  <DA name="Cancel" fc="CO" bType="Struct" type="myCancelWithTimeActivation" />
  <!-- needed for mapping according to 8-1 -->
</DOType>
<DOType id="mySPS" cdc="SPS">
```

```
<DA name="stVal" fc="ST" bType="INT32" dchg="true" />
<DA name="q" fc="ST" bType="Quality" qchg="true" />
<DA name="t" fc="ST" bType="Timestamp" />
</DOType>
<DOType id="myMV" cdc="MV">
  <DA name="mag" fc="MX" bType="Struct" type="myAnalogValue" dchg="true" />
  <DA name="q" fc="MX" bType="Quality" qchg="true" />
  <DA name="t" fc="MX" bType="Timestamp" />
  <DA name="sVC" fc="CF" bType="Struct" type="ScaledValueConfig" dchg="true" />
</DOType>
<DOType id="myCMV" cdc="CMV">
  <DA name="cVal" fc="MX" bType="Struct" type="myVector" dchg="true" />
  <DA name="q" fc="MX" bType="Quality" qchg="true" />
  <DA name="t" fc="MX" bType="Timestamp" />
</DOType>
<DOType id="mySEQ" cdc="SEQ">
  <SDO name="c1" type="myCMV" />
  <SDO name="c2" type="myCMV" />
  <SDO name="c3" type="myCMV" />
  <DA name="seqT" fc="MX" bType="Enum" type="seqT" />
</DOType>
<DOType id="mySAV" cdc="SAV">
  <DA name="instMag" fc="MX" bType="Struct" type="myAnalogValue" />
  <DA name="q" fc="MX" bType="Quality" qchg="true" />
</DOType>
<DAType id="myAnalogValue">
  <BDA name="f" bType="FLOAT32" />
</DAType>
<DAType id="ScaledValueConfig">
  <BDA name="scaleFactor" bType="FLOAT32" />
  <BDA name="offset" bType="FLOAT32" />
</DAType>
<DAType id="myVector">
  <BDA name="mag" bType="Struct" type="myAnalogValue" />
  <BDA name="ang" bType="Struct" type="myAnalogValue" />
</DAType>
<DAType id="originator">
  <BDA name="orCat" bType="Enum" type="orCategory" />
  <BDA name="orIdent" bType="Octet64" />
</DAType>
```

```
<DAType id="myModOper">
  <!-- introduced and demanded by IEC 61850-8-1 -->
  <BDA name="ctlVal" bType="Enum" type="Mod" />
  <BDA name="origin" bType="Struct" type="originator" />
  <BDA name="ctlNum" bType="INT8U" />
  <BDA name="T" bType="Timestamp" />
  <BDA name="Test" bType="BOOLEAN" />
  <BDA name="Check" bType="BOOLEAN" />
</DAType>
<DAType id="myOperWithoutTimeActivation">
  <!-- introduced and demanded by IEC 61850-8-1 -->
  <BDA name="ctlVal" bType="BOOLEAN" />
  <BDA name="origin" bType="Struct" type="originator" />
  <BDA name="ctlNum" bType="INT8U" />
  <BDA name="T" bType="Timestamp" />
  <BDA name="Test" bType="BOOLEAN" />
  <BDA name="Check" bType="BOOLEAN" />
</DAType>
<DAType id="myCancelWithoutTimeActivation">
  <!-- introduced and demanded by IEC 61850-8-1 -->
  <BDA name="ctlVal" bType="BOOLEAN" />
  <BDA name="origin" bType="Struct" type="originator" />
  <BDA name="ctlNum" bType="INT8U" />
  <BDA name="T" bType="Timestamp" />
  <BDA name="Test" bType="BOOLEAN" />
</DAType>
<DAType id="myOperWithTimeActivation">
  <!-- introduced and demanded by IEC 61850-8-1 -->
  <BDA name="ctlVal" bType="BOOLEAN" />
  <BDA name="operTm" bType="Timestamp" />
  <BDA name="origin" bType="Struct" type="originator" />
  <BDA name="ctlNum" bType="INT8U" />
  <BDA name="T" bType="Timestamp" />
  <BDA name="Test" bType="BOOLEAN" />
  <BDA name="Check" bType="BOOLEAN" />
</DAType>
<DAType id="myCancelWithTimeActivation">
  <!-- introduced and demanded by IEC 61850-8-1 -->
  <BDA name="ctlVal" bType="BOOLEAN" />
```

```
<BDA name="operTm" bType="Timestamp" />
<BDA name="origin" bType="Struct" type="originator" />
<BDA name="ctlNum" bType="INT8U" />
<BDA name="T" bType="Timestamp" />
<BDA name="Test" bType="BOOLEAN" />
</DAType>
<EnumType id="ACDdir">
  <EnumVal ord="0">unknown</EnumVal>
  <EnumVal ord="1">forward</EnumVal>
  <EnumVal ord="2">backward</EnumVal>
  <EnumVal ord="3">both</EnumVal>
</EnumType>
<EnumType id="seqT">
  <EnumVal ord="0">pos-neg-zero</EnumVal>
  <EnumVal ord="1">dir-quad-zero</EnumVal>
</EnumType>
<EnumType id="Dbpos">
  <EnumVal ord="0">intermediate</EnumVal>
  <EnumVal ord="1">off</EnumVal>
  <EnumVal ord="2">on</EnumVal>
  <EnumVal ord="3">bad</EnumVal>
</EnumType>
<EnumType id="Tcmd">
  <EnumVal ord="0">stop</EnumVal>
  <EnumVal ord="1">lower</EnumVal>
  <EnumVal ord="2">higher</EnumVal>
  <EnumVal ord="3">reserved</EnumVal>
</EnumType>
<EnumType id="ctlModel">
  <EnumVal ord="0">status-only</EnumVal>
  <EnumVal ord="1">direct-with-normal-security</EnumVal>
  <EnumVal ord="2">sbo-with-normal-security</EnumVal>
  <EnumVal ord="3">direct-with-enhanced-security</EnumVal>
  <EnumVal ord="4">sbo-with-enhanced-security</EnumVal>
</EnumType>
<EnumType id="sboClass">
  <EnumVal ord="0">operate-once</EnumVal>
  <EnumVal ord="1">operate-many</EnumVal>
</EnumType>
<EnumType id="orCategory">
```

```
<EnumVal ord="0">not-supported</EnumVal>
<EnumVal ord="1">bay-control</EnumVal>
<EnumVal ord="2">station-control</EnumVal>
<EnumVal ord="3">remote-control</EnumVal>
<EnumVal ord="4">automatic-bay</EnumVal>
<EnumVal ord="5">automatic-station</EnumVal>
<EnumVal ord="6">automatic-remote</EnumVal>
<EnumVal ord="7">maintenance</EnumVal>
<EnumVal ord="8">process</EnumVal>
</EnumType>
<EnumType id="Beh">
  <EnumVal ord="1">on</EnumVal>
  <EnumVal ord="2">blocked</EnumVal>
  <EnumVal ord="3">test</EnumVal>
  <EnumVal ord="4">test/blocked</EnumVal>
  <EnumVal ord="5">off</EnumVal>
</EnumType>
<EnumType id="Mod">
  <EnumVal ord="1">on</EnumVal>
  <EnumVal ord="2">blocked</EnumVal>
  <EnumVal ord="3">test</EnumVal>
  <EnumVal ord="4">test/blocked</EnumVal>
  <EnumVal ord="5">off</EnumVal>
</EnumType>
<EnumType id="Health">
  <EnumVal ord="1">Ok</EnumVal>
  <EnumVal ord="2">Warning</EnumVal>
  <EnumVal ord="3">Alarm</EnumVal>
</EnumType>
</DataTypeTemplates>
</SCL>
```

## Annex I (normative)

### Generic Substation State Event (GSSE)

#### I.1 GSSE Service and communication profile

##### I.1.1 GSSE mapping overview

This communication profile shall be used for any implementation claiming conformance to this standard and declaring support for the IEC 61850-7-2 service (shown in Table I.1).

**Table I.1 – Service requiring GSSE communication profile**

Model	IEC 61850-7-2 Service	Comment
Generic substation event model	SendGSSEMessage	See 18.2.2.5

##### I.1.2 A-Profile

Table I.2 shows services and protocols that shall form the A-Profile GSSE.

**Table I.2 – Service and protocols for GSSE communication A-Profile**

OSI Model Layer	Specification			m/o
	Name	Service Specification	Protocol Specification	
Application	Manufacturing message specification	ISO 9506-1:2003	ISO 9506-2:2003	m
	Association control service element	ISO/IEC 8649:1996	ISO/IEC 10035-1:1995	m
Presentation	Connectionless presentation	ISO/IEC 8822:1994	ISO/IEC 9576-1:1995	m
	Abstract syntax	ISO/IEC 8824-1:1999	ISO/IEC 8825-1	m
Session	Connectionless session	ISO/IEC 8326:1996	ISO/IEC 9548-1:1996	m

### **Implementation agreements**

This A-Profile shall conform to the agreements specified in ISO/ISP 14226-1, ISO/ISP 14226-2, ISO/ISP 14226-3, ISO/IEC ISP 11188-1 and ISO/IEC ISP 11188-3.

#### **I.1.3 T-Profile**

The T-Profile for GSSE Services shall be as shown in Table I.3.

**Table I.3 – GSSE T-Profile**

OSI model layer	Specification			m/o
	Name	Service specification	Protocol specification	
Transport	Connectionless transport	ISO/IEC 8072:1996	ISO/IEC 8602:1995	m
Network	Connectionless network	ISO/IEC 8348:2002	ISO/IEC 8473-1:1998 ISO/IEC 8473-2:1996	m
	End System to Intermediate System (ES/IS)	ISO/IEC 9542:1988		m
DataLink	Logical Link Control	ISO/IEC 8802-2:1998		m
	Carrier Sense Multiple Access with collision detection (CSMA/CD)	ISO/IEC 8802-3:2001		m
Physical (option 1)	10Base-T/100Base-T	ISO/IEC 8802-3:2001		c1
	Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup>	ISO/IEC 8877:1992		
Physical (option 2)	Fibre optic transmission system 100Base-FX	ISO/IEC 8802-3:2001		c1
	Basic Optical Fibre Connector. <sup>b</sup>	IEC 60874-10-1, IEC 60874-10-2 and IEC 60874-10-3		
<sup>a</sup> This is the specification for the 10BaseT connector. <sup>b</sup> This is the specification for the ST connector. c1 It is recommended to implement at least one of the two physical interfaces. Additional or future technologies may be used.				

The destination T-DATA address for a GSSE message shall contain a multicast MAC address. The source T-DATA address for a GSSE message shall contain a unicast MAC address.

### **Implementation agreements**

The OSI T-Profile shall conform to the agreements as specified in ISO/IEC ISP 10608-1 and ISO/IEC ISP 10608-2.

#### **Naming and addressing**

The naming and addressing of this profile shall be as specified in ISO/IEC 7498-3. The addressing shall be further constrained to support, at a minimum, the ISO DCC (39 hexadecimal) and Local (49 hexadecimal) AFI values as defined in ISO/IEC 7498-3.

#### **LLC type**

This profile shall use Class 1 LLC as specified in ISO/IEC 8802-2.

## I.2 GSSE control definition

The GSSE control, as defined in IEC 61850-7-2, shall be mapped to an MMS GSSE control block (GsCB) as defined in Table I.4. The functional constraint for an GsCB shall be ‘GS’.

**Table I.4 – MMS TypeDescription Definition for GSSE control block MMS structure**

IEC 61850-7-2 control block	Component name	MMS TypeDescription	r/w	m/o	FC
GsEna	GsEna	BOOLEAN	r	m	GS
GsID	GsID	VISIBLE-STRING	r <sup>a</sup>	m	GS
Data Label	DNALabels	ARRAY OF VISIBLE-STRING	r <sup>a</sup>	m	GS
	UserSTLabels	ARRAY OF VISIBLE-STRING	r <sup>a</sup>	m	GS
LSentData	LsentData	STRUCTURE	r <sup>a</sup>	m	GS
<sup>a</sup> A V-Put to these attributes shall FAIL.					

NOTE The IEC 61850-7-2 DataLabel(s) is mapped into DNALabels and UserSTLabels.

### GsID

Shall be as defined in IEC 61850-7-2. The default value of this attribute shall be the GOOSE control block reference.

The value contained shall be unique within the substation.

### DNALabels

This is an array of the type VISIBLE-STRING. The array size shall be 32. The maximum allowed VISIBLE-STRING value shall be 65 octets.

The values contained by the VISIBLE-STRING shall represent the first 32 DataLabels as defined in IEC 61850-7-2 and correspond to the data labels assigned to the GOOSE DNA bits.

The first array entry (e.g. zero) is reserved and the value shall be “test”.

The second array entry (e.g. one) is reserved and the value shall be “ConfRev”.

### UserSTLabels

This is an array of the type VISIBLE-STRING. The maximum array size shall be 128 entries. There shall be at least 1 entry in the array. The maximum allowed VISIBLE-STRING value shall be 65 octets.

The values contained by the VISIBLE-STRING shall represent the DataLabels as defined in IEC 61850-7-2 and correspond to the data labels assigned to the GOOSE UserSt bits.

### LSentData

This component represents the data last sent in the GSSE Message. The LSentData shall be mapped to an MMS structured TypeDescription. The component names shall be as specified Table I.5.

**Table I.5 – Mapping of LSentData**

IEC 61850-7-3 Name	IEC 61850-8-1 Data type/range	IEC 61850-8-1 type specified in Subclause
GsID	VISIBLE-STRING	8.1.2.5
t	ENTRY-TIME	
SqNum	INT32U	8.1.1
StNum	INT32U	8.1.1
TAL	INT32U	8.1.1
usec	INT32U	8.1.1
PhsID	INT16U	8.1.1
DNA	BIT-STRING	8.1.1
UserSt	BIT-STRING	8.1.1

**GsID**

This value shall reflect the value of the GsCB GsID sent in the last GSSE message. The format and data type is defined in 8.1.2.5.

**t**

The ‘t’ component shall be of the type MMS BinaryTime. The value shall contain 6 octets and shall contain the time at which the last state change was detected for the data being issued by the GSSE message.

**TAL**

This INTEGER value shall have a range of 1 to 4 294 967 295. It represents the timeAllowedtoLive of the last sent message. The unit of the value shall be ms. The maximum is a local issue. This time shall be less than or equal to 60 seconds.

**usec**

The component usec shall be used to convey the microsecond component of the state change timestamp.

**PhsID**

The integer values of PhsID shall be as defined in Table I.6.

**Table I.6 – Definition of integer values of PhsID**

Value	Name
(0)	None
(1)	Phase A
(2)	Phase B
(3)	Phase C
(4)	Neutral
(5)	A to neutral
(6)	B to neutral
(7)	C to neutral
(8)	AB
(9)	BC
(10)	CA
(11)	AB to neutral
(12)	BC to neutral
(13)	CA to neutral
(14)	ABC
(15)	ABC to neutral

**DNA**

This BIT-STRING shall be 64 bits. The BIT-STRING represents an array of double-bit pair values whose meaning corresponds to the DNALabels within the GsCB. The double-bit values shall be defined in Table I.7.

**Table I.7 – Definition of double-bit GSSE values**

Bit pair values		Meaning
MSB	LSB	
FALSE	FALSE	Reserved
FALSE	TRUE	FALSE
TRUE	FALSE	TRUE
TRUE	TRUE	Invalid value

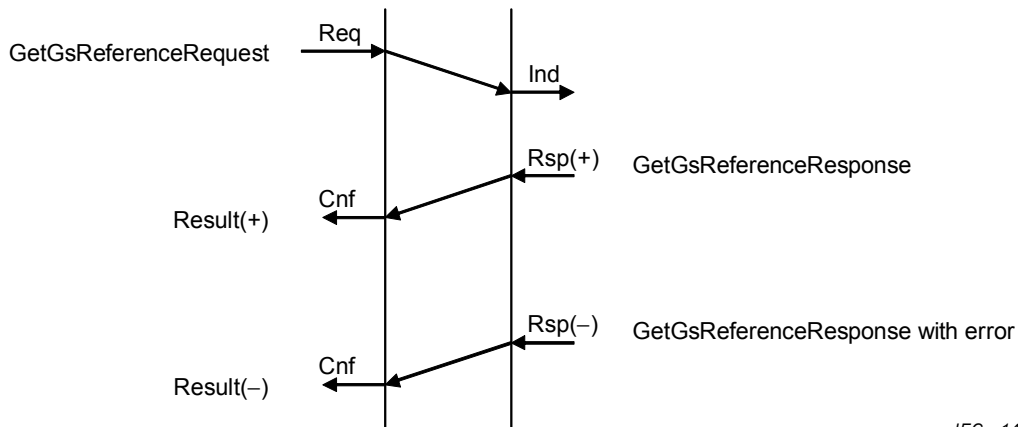
The first two bit-pairs are reserved as defined by the DNALabels.

**UserSt**

This BIT-STRING shall be at least 2 bits and a maximum of 256 bits. The BIT-STRING represents an array of double-bit pair values whose meaning corresponds to the UserSt within the GsCB. The double-bit values shall be as defined in Table I.7.

**I.3 GSSE services****I.3.1 GetGsReference**

The GetGsReference service, as specified in IEC 61850-7-2, allows a client to request the resolution of one or more element offsets. The response returns the set of requested ElementOffsets and the actual reference values. The service primitives are shown in Figure I.1.



IEC 146/04

**Figure I.1 – GetGsReference service primitives**

The client assigns a reference for every request and includes this reference as the StateID parameter within the request. A client that receives a GetGsReferenceResponse containing an unknown StateID shall ignore the PDU.

The Application protocol specification in Annex A (with ASN.1 basic encoding rules) shall be used as the transfer syntax for the GetReference service. The GetGsReference service shall be mapped onto a GSEMngtPdu according to Table I.8.

**Table I.8 – Mapping of GetGsReference service**

Parameter name	Transfer syntax mapping
Request	
GsCBReference	ident
DataOffset [1..n]	offset
Response+	
GsCBReference	ident
DataLabel [1..n]	responsePositive
Response-	
ServiceError	responseNegative

Table I.9 shows the parameters of the GetGsReference service primitives.

**Table I.9 – GetGsReference**

Parameter name	Req	Ind	Rsp	Cnf
Request	M	M(=)		
Destination address	M	M(=)		
StateID	M	M(=)		
GsID	U	U(=)		
DataOffset OffsetNumber	M	M(=)		
Result(+)			S	S(=)
StateID			M	M(=)
GsID			M	M(=)
List of results			M	M(=)
DataLabel label			M	M(=)
Result(-)			S	S(=)
StateID			M	M(=)
ErrorReason			M	M(=)

**Destination address**

The destination address shall be used to specify the address required by the T-Profile

**StateID**

This is a client assigned value used to reference the client's state machine. The range of this value shall be –32 767 to 32 767.

**GsID**

This value shall be a `VISIBLE_STRING` and shall be capable of containing a value whose size is 65 octets. The value shall correspond to the GsID for whom the lookup is being requested.

**DataOffset**

This is the list of elements for which the client is requesting to obtain the reference. The range of this value shall be 0 or greater. The value shall be less than 512.

**OffsetNumber**

This shall be one of the requested Reference offsets requested by the client.

**ListOfResults**

This is the list of elements for which the server is responding the reference. The range of this value shall be 0 or greater. The value shall be less than 512.

**Label**

These values shall contain the string reference of the offset being requested or an appropriate error code as specified in Annex A.

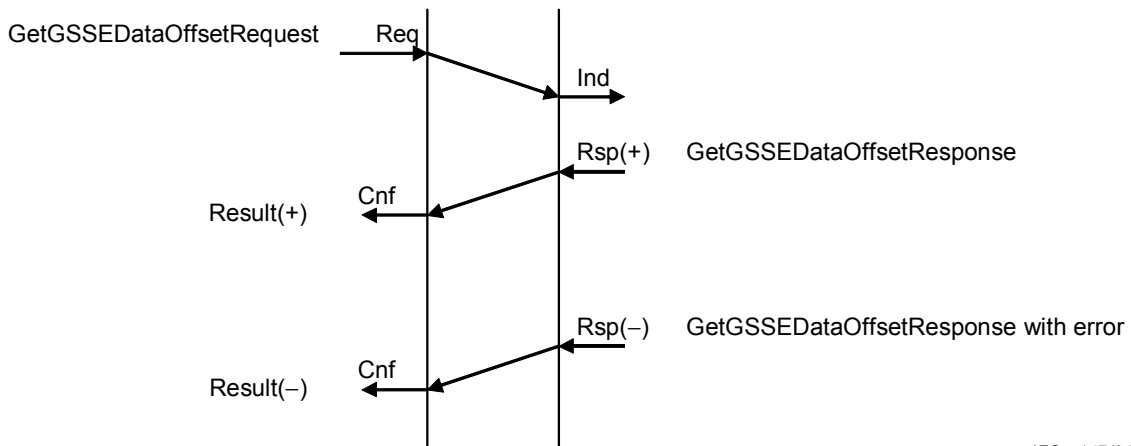
**ErrorReason**

This parameter indicates an error condition that prohibits the completion of the client's request.

All GSE Management PDU's shall be sent and received using the T-DATA service.

**I.3.2 GetGSSEDataOffset**

The GetGSSEDataOffset service, as specified in IEC 61850-7-2, allows a client to request the resolution of one or more reference strings to element offsets. The response returns the set of requested ElementOffsets and the actual reference values. The sequence of service primitives shall be as in Figure I.2.



IEC 147/04

**Figure I.2 – GetGSSEDataOffset service primitives**

The client assigns a reference for every request and includes this reference as the StateID parameter within the request. A client that receives a GetGSSEDataOffset containing an unknown StateID shall ignore the PDU.

A server that declares support for GOOSE, and not the GetGSSEDataOffset service, shall return a gseNotSupportedPDU if it receives a GetGSSEDataOffsetRequest.

The application protocol specification in Annex A (with ASN.1 basic Encoding Rules) shall be used as the transfer syntax for the GetGSEDataOffset service. The GetGSEEDataOffset service shall be mapped onto a GSEMngtPdu according to Table I.10.

**Table I.10 – Mapping of GetGSEDataOffset service**

Parameter name	Transfer syntax mapping
Request	getGSSEDataOffset
GsCBReference	gsID
DataLabel [1..n]	label
Response+	getGSSEDataOffset
GoCBReference	gsID
DataOffset [1..n]	dataOffset
Response-	getGSEEDataOffset
ServiceError	error

Table I.11 shows the parameter of the GetGSSEDataOffset service primitives.

**Table I.11 – GetGSSEDataOffset**

Parameter Name	Req	Ind	Rsp	Cnf
Request	M	M(=)		
Destination Address	M	M(=)		
StateID	M	M(=)		
GsID	U	U(=)		
MemberReference ReferenceString	M	M(=)		
Result(+)			S	S(=)
StateID			M	M(=)
GsID			M	M(=)
MemberOffset ElementNumber			M	M(=)
Result(-)			S	S(=)
StateID			M	M(=)
ErrorReason			M	M(=)

See I.3.1 for parameter definitions not defined in this Subclause.

#### **DataLabel**

This is the list of offset for which the client is requesting to obtain the label. NULL values shall not be allowed.

#### **Label**

This shall be the string value for the reference whose offset is being requested by the client. The value shall not be NULL.

#### **dataOffset**

This parameter value contains the offset value for the corresponding requested ReferenceString or an error reason.

#### **T-DATA mapping**

All GSE management PDU's shall be sent and received using the T-Profile T-DATA service.

#### **I.3.3 GetGsCBValues**

This service shall be mapped to the MMS read service.

#### **I.3.4 SetGsCBValues**

This service shall be mapped to the MMS write service.

#### **I.3.5 SendGSSEMessage**

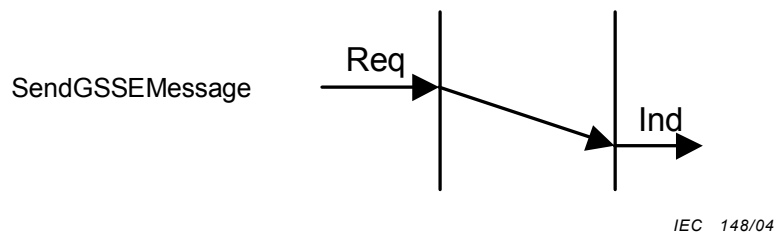
The GSSE service model of 61850-7-2 “provides the possibility for a fast and reliable system-wide distribution of input and output data values.” This SCSM uses a specific scheme of re-transmission to achieve the appropriate level of reliability. When a GSSE server generates a SendGSSEMessage request, the current data set values are encoded in a GSSE message

and transmitted as LDATA on the multicast association. The event that causes the server to invoke a SendGSSEMessage service is a local application issue as defined in IEC 61850-7-2. Additional reliability is achieved by re-transmitting the same data (with gradually increasing SqNum and retransmission time). Figure 7 shows how this will be done.

NOTE Applications may choose to publish both transitions of transient or pulsed data attribute values (e.g. a trip). Other applications could choose to publish only on a significant event (e.g. start).

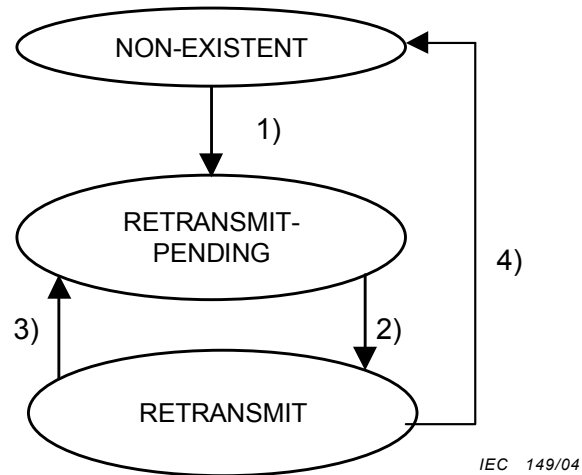
Each message in the retransmission sequence carries a timeAllowedToLive parameter that informs the receiver of the maximum time to wait for the next re-transmission. If a new message is not received within that time interval, the receiver shall assume that the association is lost.

The SendGSSEMessage service, as specified in IEC 61850-7-2, allows a publisher (e.g. server) to send variable information in an unsolicited and unconfirmed manner (see Figure I.3).



**Figure I.3 – GSSE service primitives**

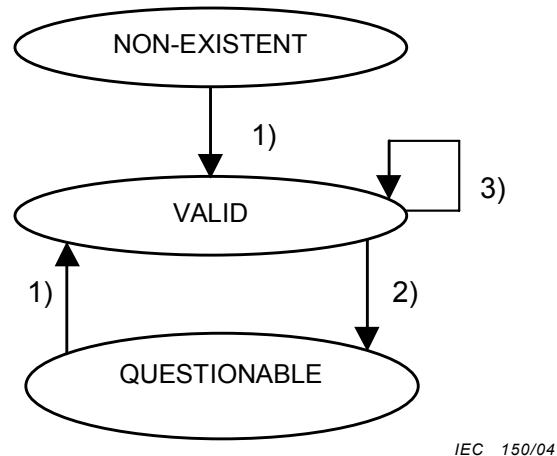
The publisher creates a state machine prior to issuing the GSSE request. The client assigns a reference for this state machine (according to Figure I.4) and includes this reference. The value of this reference is a local issue. The client state machine has three states (NON-EXISTENT, RETRANSMIT-PENDING, and RETRANSMIT).



- 1) Publisher Issues GSSE.request. A retransmission timer is started based upon publisher's HoldTim parameter value. SqNum is set to 0. It is suggested that the retransmission timer be less than (actually half) of the HoldTim.
- 2) Retransmission expiration timer indicates time for retransmission. SqNum is incremented skipping 0 on overflow.
- 3) Upon retransmission, a GSSE.request is issued and the next retransmission interval is used. A retransmission timer is started. The selection method of retransmission intervals is a local issue. The maximum time allowed between retransmissions is a local issue. This time shall be less than 60 s.
- 4) All GOOSE messages and re-transmissions when the GsEna is set to FALSE.

**Figure I.4 – Client state machine for GSSE service**

The subscriber (e.g. client) shall create a state machine (according Figure I.5) consisting of three states (NON-EXISTENT, VALID, and QUESTIONABLE).



- 1) Subscriber receives GSSE.indication. Starts HoldTim expiration timer.
- 2) HoldTim expiration timer expires.
- 3) Subscriber receives a valid GSSE indication or retransmission.

**Figure I.5 – Server state machine for GSSE service**

The handling and processing of received GOOSE messages, by the subscriber, is a local issue. It is recommended to describe the local behaviour for out-of-order state/sequence numbers in the PIXIT statement.

Table I.12 shows the parameter of the GSSE service primitives.

**Table I.12 – GSSE service**

IEC 61850-7-2 parameter name	Parameter name	Req	Ind
Argument	Argument	M	M(=)
	Destination address	U	U(=)
GsID	GsID	M	M(=)
T	t	M	M(=)
StNum	StNum	M	M(=)
SqNum	SqNum	M	M(=)
	usec	U	U(=)
	TAL	M	M(=)
PhsID	PhsID	M	M(=)
GSSEData		M	M(=)
test	DNA	U	U(=)
	Test (bit pair 0)	U	U(=)
	ConfRev (bit pair 1) bit pairs 2-31 are user assigned		
	UserSt (user assigned)		

**Destination address**

The destination address shall be used to specify the presentation address of the physical node to which the query is to be issued.

**GsID**

This VisibleString shall have a maximum size of 65 octets. The value shall be globally unique within the substation.

This value shall be mapped into the SendingIED component of the GSSE control block structure.

**t**

The ‘t’ component shall be of the type MMS BinaryTime. The value shall contain 6 octets and shall contain the time at which the last state change was detected for the data being issued by the GSSE message.

**usec**

As defined in LsentData structure.

**StNum**

This INTEGER value shall have a range of 1 to 4 294 967 295. This value shall be mapped to the StNum component of the LSentData structure.

**SqNum**

This INTEGER value shall have a range of 0 to 4 294 967 295. This value shall be mapped to the SqNum component of the LSentData structure. The value of 0 shall be reserved and used to indicate the first transmission due to a change in StNum. A rollover from the value of 4 294 967 295 shall be to a value of 1.

**PhsID**

See I.1.

**TAL**

TimeAllowed to live as defined as part of the LsentData structure.

**Test**

The value shall be mapped to the first DNA bit-pair in the LSentData. The value of the bit-pair shall be as defined in Table I.13.

**Table I.13 – Mapping of test values to bit-pair values**

Bit pair values		ACSI value
MSB	LSB	
FALSE	TRUE	no-test
TRUE	FALSE	test

**ConfRev**

This BOOLEAN value shall indicate if a configuration change has occurred to either the GoID, DNALabels, or UserSTLabels of the GCB. A value of TRUE indicates that a configuration change has been detected. Upon detection, the value shall remain TRUE for no-longer than 60 s and no less than 30 s.

The value is mapped to the second DNA bit-pair according to the bit-pair value specification in Table I.7.

**ListofData**

The ListofData shall be a set of double-bit pair values. The list shall contain a minimum of 33 such pairs, with the values as specified in Table I.7. The first 32 values shall be mapped to the DNA BIT-STRING of the PACT structure. The remaining values shall be mapped into the UserSt BIT-STRING accordingly.

If the 'test' parameter has a value of 'test' then any non-test data values shall be set to the INVALID value.

The information in the LSentData structure shall be transmitted according to the procedures specified within this Subclause. The information shall be sent in an MMS information report containing a variableAccessSpecification indicating a variableSpecification. The variable Specification choice shall be name, the ObjectName choice shall be vmd-specific, and the identifier shall have the value “GOOSE”.

NOTE This mapping maintains backward compatibility and interoperability with the UCA 2.0 GOOSE message definition.

## I.4 Conformance

### I.4.1 PICS Statement for GSSE services

This Subclause describes the Protocol Implementation Conformation Statement Proforma (PICS) extension for devices that support GSSE. Every implementor shall complete the entire PICS. Refer to IEC 61850-7-2 ACSI basic conformance statement. Table I.14 shall define the conformance of the GSSE service.

**Table I.14 – GSSE conformance statement**

	Subscriber	Publisher	Value/comment
GSSE Services	c1	c1	
SendGSSEEMessage	m	m	
GetGsReference	o	c3	
GetGSSEDataOffset	o	c4	
GetGsCBValues	o	o	
SetGsCBValues	o	o	
GSENotSupported	c2	c5	
GSSE Control Block (GsCB)	o	o	
c1 Shall be 'm' if support is declared within ACSI basic conformance statement. c2 Shall be 'm' if ACSI basic conformance support for either GetGsReference or GetGSSEDataOffset is declared. c3 Shall be 'm' if support for ACSI basic conformance of GetGsReference is declared. c4 Shall be 'm' if support for ACSI basic conformance of GetGSSEDataOffset. c5 Shall be 'm' if no support for ACSI basic conformance of GetGSSEDataOffset is declared.			