

**DIN EN 61850-8-1**

ICS 33.040.40

Ersatz für  
DIN EN 61850-8-1:2005-11  
Siehe Anwendungsbeginn

**Kommunikationsnetze und -systeme für die Automatisierung der elektrischen Energieversorgung –  
Teil 8-1: Spezifische Abbildung von Kommunikationsdiensten (SCSM) –  
Abbildungen auf MMS (nach ISO 9506-1 und ISO 9506-2) und  
ISO/IEC 8802-3  
(IEC 61850-8-1:2011);  
Englische Fassung EN 61850-8-1:2011**

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  
(IEC 61850-8-1:2011);  
English version EN 61850-8-1:2011

Réseaux et systèmes de communication pour l'automatisation des systèmes électriques –  
Partie 8-1: Mise en correspondance des services de communication spécifiques (SCSM) –  
Mises en correspondance pour MMS (ISO 9506-1 et ISO 9506-2) et pour  
l'ISO/CEI 8802-3  
(CEI 61850-8-1:2011);  
Version anglaise EN 61850-8-1:2011

Gesamtumfang 190 Seiten

DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE

## **Anwendungsbeginn**

Anwendungsbeginn für die von CENELEC am 2011-07-22 angenommene Europäische Norm als DIN-Norm ist 2012-02-01.

Für DIN EN 61850-8-1:2005-11 gilt eine Übergangsfrist bis zum 2014-07-22.

## **Nationales Vorwort**

*Vorausgegangener Norm-Entwurf: E DIN IEC 61850-8-1:2008-02.*

Für diese Norm ist das nationale Arbeitsgremium K 952 „Netzleittechnik“ der DKE Deutsche Kommission Elektrotechnik Elektronik Informationstechnik im DIN und VDE ([www.dke.de](http://www.dke.de)) zuständig.

Die enthaltene IEC-Publikation wurde vom TC 57 „Power systems management and associated information exchange“ erarbeitet.

Das IEC-Komitee hat entschieden, dass der Inhalt dieser Publikation bis zu dem Datum (stability date) unverändert bleiben soll, das auf der IEC-Website unter „<http://webstore.iec.ch>“ zu dieser Publikation angegeben ist. Zu diesem Zeitpunkt wird entsprechend der Entscheidung des Komitees die Publikation

- bestätigt,
- zurückgezogen,
- durch eine Folgeausgabe ersetzt oder
- geändert.

Für den Fall einer undatierten Verweisung im normativen Text (Verweisung auf eine Norm ohne Angabe des Ausgabedatums und ohne Hinweis auf eine Abschnietsnummer, eine Tabelle, ein Bild usw.) bezieht sich die Verweisung auf die jeweils neueste gültige Ausgabe der in Bezug genommenen Norm.

Für den Fall einer datierten Verweisung im normativen Text bezieht sich die Verweisung immer auf die in Bezug genommene Ausgabe der Norm.

Der Zusammenhang der zitierten Normen mit den entsprechenden Deutschen Normen ergibt sich, soweit ein Zusammenhang besteht, grundsätzlich über die Nummer der entsprechenden IEC-Publikation. Beispiel: IEC 60068 ist als EN 60068 als Europäische Norm durch CENELEC übernommen und als DIN EN 60068 ins Deutsche Normenwerk aufgenommen.

Das Präsidium des DIN hat mit Präsidialbeschluss 1/2004 festgelegt, dass DIN-Normen, deren Inhalt sich auf internationale Arbeitsergebnisse der Informationsverarbeitung gründet, unter bestimmten Bedingungen allein in englischer Sprache veröffentlicht werden dürfen. Diese Bedingungen sind für die vorliegende Norm erfüllt.

Da sich die Benutzer der vorliegenden Norm der englischen Sprache als Fachsprache bedienen, wird die englische Fassung der EN 61850-8-1 veröffentlicht. Für die meisten der verwendeten Begriffe existieren keine gebräuchlichen deutschen Benennungen, da sich die deutschen Anwender in der Regel ebenfalls der englischen Benennungen bedienen. Diese Norm steht nicht in unmittelbarem Zusammenhang mit Rechtsvorschriften und ist nicht als Sicherheitsnorm anzusehen.

## **Änderungen**

Gegenüber DIN EN 61850-8-1:2005-11 wurden folgende Änderungen vorgenommen:

- a) Unterstützung von Gigabit-Ethernet;
- b) Redundanz der Verbindungsschicht;
- c) Erweiterung der Länge der Objektreferenz;
- d) Erweiterung der „Reason for Inclusion“ für umfassendes Logging;
- e) Abbildung von „Tracking Services“;
- f) zweites Abbild der Objektreferenz, wenn es im „Tracking Services“ oder als Link verwendet wird;
- g) Erweiterung der „AdditionalCause“ um zusätzliche Ursachen;

- h) Simulation von GOOSE-Telegrammen;
- i) Einführung von GOOSE-Telegrammen, die mit fester Länge kodiert sind;
- j) Entfernung des „SCL-Control-Block“;
- k) Änderung der Abbildung von ACSI-Service-Fehlercodes und ISO 9506-Fehlercodes (siehe 8.1.3.4). Eine Änderung, die beachtet werden sollte, betrifft die Behandlung von undefinierten Objekten. Der Code „object-undefined“ wurde bei vielen Rückmeldungen mit „object-non-existent“ ersetzt.

#### **Frühere Ausgaben**

DIN EN 61850-8-1: 2005-11

– Leerseite –

**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  
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pour l'automatisation des systèmes  
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services de communication spécifiques  
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(IEC 61850-8-1:2011)

This European Standard was approved by CENELEC on 2011-07-22. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

**CENELEC**

European Committee for Electrotechnical Standardization  
Comité Européen de Normalisation Electrotechnique  
Europäisches Komitee für Elektrotechnische Normung

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## Foreword

The text of document 57/1109/FDIS, future edition 2 of IEC 61850-8-1, prepared by IEC TC 57, Power systems management and associated information exchange, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61850-8-1 on 2011-07-22.

This European Standard supersedes EN 61850-8-1:2004.

The main changes with respect to EN 61850-8-1:2004 are listed below:

- the support of gigabit Ethernet,
- the link layer redundancy,
- the extension of the length of the object reference,
- the extension of the reason for inclusion type for comprehensive logging,
- the mapping of the tracking services,
- a second mapping of the objectReference when used in the tracking services, or as linking,
- the extension of the AdditionalCause enumeration,
- the simulation of GOOSE telegram,
- the so-called fixed-length encoded GOOSE,
- the removal of the SCL Control Block,
- the mappings of ACSI service error codes and ISO 9506 error codes have changed (see 8.1.3.4). One change that should be noted is the change in usage of object-undefined. The object-undefined code has been replaced by object-non-existent in many responses.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN and CENELEC shall not be held responsible for identifying any or all such patent rights.

The following dates were fixed:

- |                                                                                                                                                |       |            |
|------------------------------------------------------------------------------------------------------------------------------------------------|-------|------------|
| – latest date by which the EN has to be implemented<br>at national level by publication of an identical<br>national standard or by endorsement | (dop) | 2012-04-22 |
| – latest date by which the national standards conflicting<br>with the EN have to be withdrawn                                                  | (dow) | 2014-07-22 |

Annex ZA has been added by CENELEC.

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## Endorsement notice

The text of the International Standard IEC 61850-8-1:2011 was approved by CENELEC as a European Standard without any modification.

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## CONTENTS

|                                                                                   |    |
|-----------------------------------------------------------------------------------|----|
| INTRODUCTION .....                                                                | 12 |
| 1 Scope.....                                                                      | 13 |
| 2 Normative references.....                                                       | 13 |
| 3 Terms and definitions.....                                                      | 17 |
| 4 Abbreviations .....                                                             | 19 |
| 5 Overview .....                                                                  | 20 |
| 5.1 General.....                                                                  | 20 |
| 5.2 MMS communication profiles.....                                               | 21 |
| 5.3 Non-MMS communication profiles.....                                           | 22 |
| 5.4 MMS objects being used.....                                                   | 22 |
| 6 Communication stack.....                                                        | 22 |
| 6.1 Overview of the protocol usage.....                                           | 22 |
| 6.2 Client/server services and communication profiles.....                        | 23 |
| 6.2.1 Client/server services .....                                                | 23 |
| 6.2.2 A-Profile.....                                                              | 24 |
| 6.2.3 TCP/IP T-Profile.....                                                       | 25 |
| 6.2.4 OSI T-Profile .....                                                         | 26 |
| 6.3 GSE management and GOOSE services communication profiles .....                | 27 |
| 6.3.1 GSE mapping overview.....                                                   | 27 |
| 6.3.2 A-Profile.....                                                              | 27 |
| 6.3.3 T-Profile .....                                                             | 27 |
| 6.4 Time sync .....                                                               | 28 |
| 6.4.1 Conformance statement.....                                                  | 28 |
| 6.4.2 A-Profile.....                                                              | 29 |
| 6.4.3 T-Profile .....                                                             | 29 |
| 7 Objects of IEC 61850 .....                                                      | 30 |
| 7.1 Server.....                                                                   | 30 |
| 7.2 Logical device (LD) .....                                                     | 30 |
| 7.3 Logical node (LN).....                                                        | 30 |
| 7.3.1 General.....                                                                | 30 |
| 7.3.2 Mapping of LNReference to VariableAccessSpecifications.....                 | 32 |
| 7.3.3 DataObjects .....                                                           | 32 |
| 7.3.4 DataAttributes (DataAttr).....                                              | 33 |
| 8 Mapping of IEC 61850-7-2 and IEC 61850-7-3 data attributes .....                | 33 |
| 8.1 Mapping of Attributes specified in IEC 61850-7-2 .....                        | 33 |
| 8.1.1 BasicTypes.....                                                             | 33 |
| 8.1.2 Additional definitions of BasicType.....                                    | 34 |
| 8.1.3 Common ACSITypes .....                                                      | 35 |
| 8.2 Mapping of quality common data attribute type specified in IEC 61850-7-3..... | 51 |
| 9 Server class model .....                                                        | 52 |
| 9.1 Server mapping .....                                                          | 52 |
| 9.2 Server class attributes.....                                                  | 52 |
| 9.2.1 ServiceAccessPoint.....                                                     | 52 |
| 9.2.2 Logical devices .....                                                       | 53 |

|        |                                                                            |    |
|--------|----------------------------------------------------------------------------|----|
| 9.2.3  | Files .....                                                                | 53 |
| 9.2.4  | Client associations .....                                                  | 53 |
| 9.3    | Server class service GetServerDirectory .....                              | 53 |
| 10     | Association model .....                                                    | 54 |
| 10.1   | Association relation to communication profiles .....                       | 54 |
| 10.2   | Two party association model for client/server communication profile .....  | 55 |
| 10.2.1 | Association mapping .....                                                  | 55 |
| 10.2.2 | Association services .....                                                 | 55 |
| 10.3   | Two party association model for GSE management communication profile ..... | 56 |
| 10.4   | Two party association model for time sync .....                            | 56 |
| 10.5   | Multicast association model .....                                          | 56 |
| 11     | Logical device model .....                                                 | 56 |
| 12     | Logical node model .....                                                   | 57 |
| 12.1   | GenLogicalNodeClass .....                                                  | 57 |
| 12.2   | GenLogicalNodeClass attributes .....                                       | 57 |
| 12.3   | GenLogicalNodeClass services .....                                         | 58 |
| 12.3.1 | GetLogicalNodeDirectory .....                                              | 58 |
| 12.3.2 | GetAllDataValues .....                                                     | 59 |
| 13     | DataObject, DataAttribute, SubDataAttribute model .....                    | 59 |
| 13.1   | GenDataObjectClass .....                                                   | 59 |
| 13.2   | GenDataAttributeClass .....                                                | 60 |
| 13.3   | GenSubDataAttributeClass .....                                             | 60 |
| 13.4   | GenDataObjectClass services .....                                          | 60 |
| 13.4.1 | GetDataValues .....                                                        | 60 |
| 13.4.2 | SetDataValues .....                                                        | 60 |
| 13.4.3 | GetDataDirectory .....                                                     | 61 |
| 13.4.4 | GetDataDefinition .....                                                    | 61 |
| 14     | Data set class model .....                                                 | 61 |
| 14.1   | Data set class .....                                                       | 61 |
| 14.2   | Data set attributes .....                                                  | 61 |
| 14.3   | Data set services .....                                                    | 62 |
| 14.3.1 | GetDataSetValues .....                                                     | 62 |
| 14.3.2 | SetDataSetValues .....                                                     | 62 |
| 14.3.3 | CreateDataSet .....                                                        | 62 |
| 14.3.4 | DeleteDataSet .....                                                        | 63 |
| 14.3.5 | GetDataSetDirectory .....                                                  | 63 |
| 15     | ServiceTracking model .....                                                | 64 |
| 15.1   | General .....                                                              | 64 |
| 15.2   | Common Service Tracking – CST .....                                        | 64 |
| 15.3   | Mapping of the Buffered Report Tracking Service – BTS .....                | 66 |
| 15.4   | Mapping of the Unbuffered Report Tracking Service – UTS .....              | 67 |
| 15.5   | Mapping of the Log Control Block Tracking Service Tracking – LTS .....     | 67 |
| 15.6   | Mapping of the Log Tracking Service – OTS .....                            | 68 |
| 15.7   | Mapping of the GOOSE Control Block Tracking Service – GTS .....            | 68 |
| 15.8   | Mapping of the Setting Group Control Block Tracking Service – STS .....    | 68 |
| 15.9   | Mapping of the tracking service for MSVCB control block – MTS .....        | 69 |
| 15.10  | Mapping of the tracking service of the USVCB control block – NTS .....     | 69 |
| 16     | Setting group control class model .....                                    | 70 |

|        |                                                          |    |
|--------|----------------------------------------------------------|----|
| 16.1   | Setting group control block definition.....              | 70 |
| 16.2   | Setting group control class services.....                | 70 |
| 16.2.1 | SelectActiveSG.....                                      | 70 |
| 16.2.2 | SelectEditSG.....                                        | 70 |
| 16.2.3 | SetEditSGValue.....                                      | 70 |
| 16.2.4 | ConfirmEditSGValues.....                                 | 70 |
| 16.2.5 | GetEditSGValue.....                                      | 71 |
| 16.2.6 | GetSGCBValues.....                                       | 71 |
| 17     | Reporting and logging class model.....                   | 71 |
| 17.1   | Report model – Report control blocks.....                | 71 |
| 17.1.1 | Functional Constraint for Report Control Blocks.....     | 71 |
| 17.1.2 | Buffered report control block.....                       | 71 |
| 17.1.3 | Unbuffered report control block.....                     | 73 |
| 17.2   | Reporting services.....                                  | 74 |
| 17.2.1 | Report service.....                                      | 74 |
| 17.2.2 | GetBRCBValues.....                                       | 76 |
| 17.2.3 | SetBRCBValues.....                                       | 76 |
| 17.2.4 | GetURCBValues.....                                       | 76 |
| 17.2.5 | SetURCBValues.....                                       | 76 |
| 17.3   | Log model.....                                           | 76 |
| 17.3.1 | General.....                                             | 76 |
| 17.3.2 | Mapping of log control class.....                        | 76 |
| 17.3.3 | Mapping of log class.....                                | 76 |
| 17.3.4 | Mapping of log and log control services.....             | 80 |
| 17.3.5 | Conformance.....                                         | 82 |
| 18     | Mapping of the generic substation event model (GSE)..... | 82 |
| 18.1   | Generic object oriented substation event (GOOSE).....    | 82 |
| 18.1.1 | GOOSE control definition.....                            | 82 |
| 18.1.2 | GOOSE services.....                                      | 84 |
| 19     | Transmission of sampled values class model.....          | 91 |
| 20     | Control class model.....                                 | 91 |
| 20.1   | General.....                                             | 91 |
| 20.2   | Control service parameters.....                          | 91 |
| 20.3   | Mapping of control objects and CO_CtrlObjectRef.....     | 92 |
| 20.4   | Mapping of control services.....                         | 93 |
| 20.5   | Select.....                                              | 93 |
| 20.5.1 | Select service parameter mapping.....                    | 93 |
| 20.5.2 | Mapping of the select service.....                       | 94 |
| 20.5.3 | Select request.....                                      | 94 |
| 20.5.4 | Select response+.....                                    | 94 |
| 20.5.5 | Select response–.....                                    | 94 |
| 20.6   | SelectWithValue.....                                     | 94 |
| 20.6.1 | SelectWithValue service parameter mapping.....           | 94 |
| 20.6.2 | Mapping of the SelectWithValue service.....              | 95 |
| 20.6.3 | SelectWithValue request.....                             | 96 |
| 20.6.4 | SelectWithValue response+.....                           | 96 |
| 20.6.5 | SelectWithValue response–.....                           | 96 |
| 20.7   | Cancel.....                                              | 96 |

|         |                                                                             |     |
|---------|-----------------------------------------------------------------------------|-----|
| 20.7.1  | Cancel service parameter mapping.....                                       | 96  |
| 20.7.2  | Mapping of the Cancel service.....                                          | 97  |
| 20.7.3  | Cancel request.....                                                         | 98  |
| 20.7.4  | Cancel response+ .....                                                      | 98  |
| 20.7.5  | Cancel response–.....                                                       | 98  |
| 20.8    | Operate.....                                                                | 98  |
| 20.8.1  | Operate service parameter mapping.....                                      | 98  |
| 20.8.2  | Mapping of the Operate service .....                                        | 99  |
| 20.8.3  | Operate request .....                                                       | 100 |
| 20.8.4  | Operate response+.....                                                      | 100 |
| 20.8.5  | Operate response–.....                                                      | 100 |
| 20.9    | CommandTermination.....                                                     | 100 |
| 20.9.1  | CommandTermination service parameter mapping.....                           | 100 |
| 20.9.2  | Mapping of the CommandTermination service .....                             | 100 |
| 20.10   | TimeActivatedOperate.....                                                   | 101 |
| 20.10.1 | TimeActivatedOperate service parameter mapping .....                        | 101 |
| 20.10.2 | Mapping of the TimeActivatedOperate service.....                            | 102 |
| 20.10.3 | Mapping of the TimeActivatedOperateTermination service.....                 | 103 |
| 20.11   | AdditionalCauseDiagnosis in negative control service responses.....         | 104 |
| 21      | Time and time synchronization model .....                                   | 106 |
| 22      | Naming conventions.....                                                     | 106 |
| 23      | File transfer.....                                                          | 107 |
| 23.1    | File transfer model .....                                                   | 107 |
| 23.2    | File services .....                                                         | 108 |
| 23.2.1  | GetFile .....                                                               | 108 |
| 23.2.2  | SetFile .....                                                               | 110 |
| 23.2.3  | DeleteFile.....                                                             | 112 |
| 23.2.4  | GetFileAttributeValues .....                                                | 112 |
| 24      | Conformance.....                                                            | 113 |
| 24.1    | Notation .....                                                              | 113 |
| 24.2    | PICS.....                                                                   | 113 |
| 24.2.1  | Profile conformance.....                                                    | 113 |
| 24.2.2  | MMS conformance.....                                                        | 114 |
| 24.3    | PICS Statement .....                                                        | 125 |
| 24.3.1  | General .....                                                               | 125 |
| 24.3.2  | Logical device.....                                                         | 125 |
| 24.3.3  | GOOSE Services.....                                                         | 125 |
| 24.3.4  | Substation configuration language.....                                      | 126 |
| 25      | Substation Configuration Language (SCL).....                                | 126 |
| 25.1    | SCL file and SCL extensions .....                                           | 126 |
| 25.2    | General .....                                                               | 126 |
| 25.3    | SCSM specific address element definitions .....                             | 126 |
| 25.3.1  | Client/server addressing – element “address” .....                          | 126 |
| 25.3.2  | GOOSE addressing .....                                                      | 127 |
| 25.3.3  | GSSE definition.....                                                        | 127 |
| 25.4    | Subnetwork protocol type.....                                               | 127 |
| 25.5    | SCSM NameSpace.....                                                         | 128 |
| Annex A | (normative) Application protocol specification for GOOSE and GSE management | 129 |

|                                                                                                                              |     |
|------------------------------------------------------------------------------------------------------------------------------|-----|
| Annex B (informative) Multicast address selection.....                                                                       | 135 |
| Annex C (normative) Overview of ISO/IEC 8802-3 frame structure for GSE management and GOOSE.....                             | 136 |
| Annex D (informative) SCL conformance.....                                                                                   | 143 |
| Annex E (informative) Time scales and epochs.....                                                                            | 144 |
| Annex F (normative) Type extensions to ISO 9506-1:2003 and ISO 9506-2:2003 .....                                             | 147 |
| Annex G (informative) Example SCL File .....                                                                                 | 150 |
| Annex H (informative) Generic Substation State Event (GSSE) .....                                                            | 168 |
| Annex I (informative) Certificate management .....                                                                           | 181 |
| Annex ZA (normative) Normative references to international publications with their corresponding European publications ..... | 182 |
| Figure 1 – Overview of functionality and profiles.....                                                                       | 21  |
| Figure 2 – OSI reference model and profiles .....                                                                            | 23  |
| Figure 3 – Algorithm for logical node mapping.....                                                                           | 31  |
| Figure 4 – Ordered list of functional constraints.....                                                                       | 31  |
| Figure 5 – Relationship of LCB attributes to IEC 61850-7-2 log definitions.....                                              | 77  |
| Figure 6 – GetGoReference service primitives.....                                                                            | 84  |
| Figure 7 – GetGOOSEElementNumber service primitives .....                                                                    | 86  |
| Figure 8 – Transmission time for events.....                                                                                 | 88  |
| Figure 9 – SendGooseMessage message service primitives .....                                                                 | 88  |
| Figure 10 – Publisher state machine for GOOSE service .....                                                                  | 89  |
| Figure 11 – Subscriber state machine for GOOSE service .....                                                                 | 89  |
| Figure 12 – Mapping of ACSI GetFile to MMS FileOpen, FileRead, FileClose.....                                                | 109 |
| Figure 13 – Mapping of ACSI SetFile service.....                                                                             | 111 |
| Figure A.1 – Basic encoding rules format.....                                                                                | 131 |
| Figure A.2 – Format of the tag octets.....                                                                                   | 131 |
| Figure C.1 – ISO/IEC 8802-3 frame format.....                                                                                | 137 |
| Figure C.2 – ISO/IEC 8802-3 frame format with HSR link redundancy .....                                                      | 138 |
| Figure C.3 – ISO/IEC 8802-3 frame format with PRP link redundancy .....                                                      | 139 |
| Figure C.4 – Virtual LAN tag.....                                                                                            | 140 |
| Figure C.5 – Reserved 1 .....                                                                                                | 141 |
| Figure H.1 – Overview of functionality and profiles.....                                                                     | 168 |
| Figure H.2 – GetGsReference service primitives.....                                                                          | 173 |
| Figure H.3 – GetGSSEDataOffset service primitives.....                                                                       | 175 |
| Figure H.4 – GSSE service primitives .....                                                                                   | 177 |
| Figure H.5 – Client state machine for GSSE service.....                                                                      | 177 |
| Figure H.6 – Server state machine for GSSE service.....                                                                      | 178 |
| Table 1 – MMS objects and services in use within this SCSM .....                                                             | 22  |
| Table 2 – Services requiring client/server Communication Profile .....                                                       | 23  |
| Table 3 – Service and protocols for client/server communication A-Profile.....                                               | 24  |
| Table 4 – Service and protocols for client/server TCP/IP T-Profile .....                                                     | 25  |
| Table 5 – Service and protocols for client/server OSI T-Profile.....                                                         | 26  |

|                                                                                      |    |
|--------------------------------------------------------------------------------------|----|
| Table 6 – Services requiring GSE Management and GOOSE communication profile .....    | 27 |
| Table 7 – Service and protocols for GSE Management and GOOSE communication A-Profile | 27 |
| Table 8 – GOOSE/GSE T-Profile .....                                                  | 28 |
| Table 9 – Time sync A-Profile .....                                                  | 29 |
| Table 10 – Time sync T-Profile.....                                                  | 29 |
| Table 11 – Mapping of ACSI BasicTypes.....                                           | 33 |
| Table 12 – PHYCOMADDR structure .....                                                | 36 |
| Table 13 – Associate ACSI service error mappings .....                               | 37 |
| Table 14 – Release service error mappings.....                                       | 38 |
| Table 15 – GetNameList conflicting IEC 61850 objectClass and objectScope.....        | 38 |
| Table 16 – GetNameList service error mappings .....                                  | 39 |
| Table 17 – Read of NamedVariableList object error mappings.....                      | 40 |
| Table 18 – Write of NamedVariableList object error mappings.....                     | 40 |
| Table 19 – DefineNamedVariableList service error mappings .....                      | 41 |
| Table 20 – GetNamedVariableListAttributes service error mappings.....                | 42 |
| Table 21 – DeleteNamedVariableList service error mappings .....                      | 43 |
| Table 22 – Read service error mappings .....                                         | 44 |
| Table 23 – Write service error mappings .....                                        | 45 |
| Table 24 – GetVariableAccessAttributes service error mappings.....                   | 46 |
| Table 25 – ServiceError mappings for Log services.....                               | 46 |
| Table 26 – FileDirectory service error mappings .....                                | 47 |
| Table 27 – Mappings of ACSI ServiceErrors to ObtainFile Service Errors .....         | 47 |
| Table 28 – Mappings of ACSI ServiceErrors to FileOpen Service Errors .....           | 48 |
| Table 29 – Mappings of ACSI ServiceErrors to FileRead Service Errors .....           | 48 |
| Table 30 – Mappings of ACSI ServiceErrors to FileClose Service Errors.....           | 49 |
| Table 31 – Mappings of ACSI ServiceErrors to FileDelete Service Errors .....         | 49 |
| Table 32 – Encoding of IEC 61850-7-2 TimeQuality.....                                | 50 |
| Table 33 – Encoding of IEC 61850-7-3 quality .....                                   | 51 |
| Table 34 – Mapping of ACSI GetServerDirectory(LOGICAL DEVICE) to MMS .....           | 53 |
| Table 35 – Mapping of ACSI GetServerDirectory(FILE) to MMS.....                      | 54 |
| Table 36 – Association model versus communication profiles.....                      | 54 |
| Table 37 – Mapping of ACSI Associate service to MMS .....                            | 55 |
| Table 38 – Mapping of ACSI Release service to MMS .....                              | 56 |
| Table 39 – GetNameList classes for GetLogicalNodeDirectory service .....             | 58 |
| Table 40 – Mapping of ACSI GetLogicalNodeDirectory(DataObject) service to MMS.....   | 58 |
| Table 41 – Mapping of ACSI GetAllDataValues service to MMS.....                      | 59 |
| Table 42 – Mapping of GetDataValues service parameters.....                          | 60 |
| Table 43 – Mapping of SetDataValues service parameters.....                          | 60 |
| Table 44 – Mapping of GetDataDirectory service parameters .....                      | 61 |
| Table 45 – Mapping of GetDataSetValues service parameters.....                       | 62 |
| Table 46 – Mapping of SetDataSetValues service parameters .....                      | 62 |
| Table 47 – Mapping of CreateDataSet service parameters .....                         | 63 |
| Table 48 – Mapping of DeleteDataSet service parameters .....                         | 63 |

|                                                                                   |    |
|-----------------------------------------------------------------------------------|----|
| Table 49 – Mapping of GetDataSetDirectory service parameters .....                | 63 |
| Table 50 – Mapping of CDC CST to MMS type definition .....                        | 64 |
| Table 51 – Mapping of ACSI ServiceType values .....                               | 64 |
| Table 52 – Mapping of ACSI ServiceError values.....                               | 66 |
| Table 53 – Mapping of CDC BTS to MMS type definition.....                         | 66 |
| Table 54 – Mapping of CDC UTS to MMS type definition .....                        | 67 |
| Table 55 – Mapping of CDC LTS to MMS type definition .....                        | 67 |
| Table 56 – Mapping of CDC GTS to MMS type definition .....                        | 68 |
| Table 57 – Mapping of CDC STS to MMS type definition .....                        | 68 |
| Table 58 – Mapping of CDC MTS to MMS type definition .....                        | 69 |
| Table 59 – Mapping of CDC NTS to MMS type definition .....                        | 69 |
| Table 60 – Mapping of SGCB to MMS type definition .....                           | 70 |
| Table 61 – Mapping of BRCB to MMS type definition.....                            | 71 |
| Table 62 – Mapping of OptFlds within Bitstring .....                              | 72 |
| Table 63 – Mapping of URCB to MMS type definition .....                           | 73 |
| Table 64 – Order of AccessResults for variableListName report .....               | 74 |
| Table 65 – Definition of an MMS log control block.....                            | 77 |
| Table 66 – Mapping of values for LogEna .....                                     | 78 |
| Table 67 – Mapping of ACSI LogEntries.....                                        | 79 |
| Table 68 – General mappings of ACSI log model services .....                      | 80 |
| Table 69 – Mapping of QueryLogByTime request parameters.....                      | 81 |
| Table 70 – Mapping of response parameters .....                                   | 81 |
| Table 71 – Mapping of QueryLogAfter request parameters.....                       | 82 |
| Table 72 – Log conformance requirements.....                                      | 82 |
| Table 73 – MMS TypeDescription definition for GoCB MMS structure.....             | 82 |
| Table 74 – DstAddress structure .....                                             | 83 |
| Table 75 – Mapping of GetGoReference service .....                                | 84 |
| Table 76 – GetGoReference .....                                                   | 85 |
| Table 77 – Mapping of GetGOOSEElementNumber service .....                         | 86 |
| Table 78 – GetGOOSEElementNumber.....                                             | 87 |
| Table 79 – GOOSE service parameter mapping.....                                   | 90 |
| Table 80 – Controllable service parameters.....                                   | 92 |
| Table 81 – Mapping of IEC 61850-7-2 control model to MMS control components ..... | 92 |
| Table 82 – Mapping of control services.....                                       | 93 |
| Table 83 – Select service parameter mapping .....                                 | 94 |
| Table 84 – Mapping of the Select service.....                                     | 94 |
| Table 85 – SelectWithValue service parameter mapping.....                         | 95 |
| Table 86 – Mapping of the SelectWithValue service .....                           | 95 |
| Table 87 – SelectWithValue, Oper and Cancel AccessResult specification .....      | 96 |
| Table 88 – Cancel service parameter mapping .....                                 | 97 |
| Table 89 – Mapping of the Cancel service.....                                     | 97 |
| Table 90 – Operate service parameter mapping.....                                 | 98 |
| Table 91 – Mapping of the Operate service .....                                   | 99 |

|                                                                                     |     |
|-------------------------------------------------------------------------------------|-----|
| Table 92 – Mapping of the CommandTermination service .....                          | 100 |
| Table 93 – TimeActivatedOperate service parameter mapping.....                      | 101 |
| Table 94 – Mapping of the TimeActivatedOperate service .....                        | 102 |
| Table 95 – Mapping of the TimeActivatedOperate_Termination service .....            | 103 |
| Table 96 – Definition of LastApplError variable structure.....                      | 104 |
| Table 97 – Mapping of ACSI AddCause values .....                                    | 106 |
| Table 98 – Mapping of ACSI file class to MMS file object .....                      | 107 |
| Table 99 – Reserved file suffixes.....                                              | 108 |
| Table 100 – Mapping of ACSI GetFile service parameters.....                         | 109 |
| Table 101 – Mapping of ACSI GetFile service.....                                    | 110 |
| Table 102 – Mappings of GetFile ServiceErrors to MMS Service Errors .....           | 110 |
| Table 103 – Mapping of ACSI SetFile parameters .....                                | 111 |
| Table 104 – Mapping of ACSI DeleteFile service.....                                 | 112 |
| Table 105 – Mapping of ACSI GetFileAttributeValues parameters .....                 | 112 |
| Table 106 – Mapping of ACSI ListOfDirectoryEntry.....                               | 113 |
| Table 107 – PICS for A-Profile support .....                                        | 113 |
| Table 108 – PICS for T-Profile support.....                                         | 114 |
| Table 109 – MMS InitiateRequest general parameters .....                            | 114 |
| Table 110 – MMS InitiateResponse general parameters.....                            | 115 |
| Table 111 – MMS service supported conformance table.....                            | 115 |
| Table 112 – MMS Parameter CBB .....                                                 | 118 |
| Table 113 – GetNameList conformance statement.....                                  | 119 |
| Table 114 – AlternateAccessSelection conformance statement.....                     | 119 |
| Table 115 – VariableAccessSpecification conformance statement.....                  | 120 |
| Table 116 – VariableSpecification conformance statement.....                        | 120 |
| Table 117 – Read conformance statement.....                                         | 120 |
| Table 118 – Write conformance statement.....                                        | 121 |
| Table 119 – InformationReport conformance statement .....                           | 121 |
| Table 120 – GetVariableAccessAttributes conformance statement .....                 | 121 |
| Table 121 – DefineNamedVariableList conformance statement.....                      | 122 |
| Table 122 –GetNamedVariableListAttributes conformance statement .....               | 122 |
| Table 123 – DeleteNamedVariableList conformance statement.....                      | 122 |
| Table 124 – ReadJournal conformance statement .....                                 | 123 |
| Table 125 – JournalEntry conformance statement .....                                | 123 |
| Table 126 – InitializeJournal conformance statement.....                            | 124 |
| Table 127 – FileDirectory conformance statement .....                               | 124 |
| Table 128 – FileOpen conformance statement .....                                    | 124 |
| Table 129 – FileRead conformance statement .....                                    | 125 |
| Table 130 – FileClose conformance statement.....                                    | 125 |
| Table 131 – GOOSE conformance statement.....                                        | 125 |
| Table 132 – Allowed P-Type definitions for client/server addressing.....            | 126 |
| Table 133 – Definitions for GSE SCL .....                                           | 127 |
| Table A.1 – Encoding allData in Fixed-length GOOSE message – the GOOSE Header ..... | 132 |

|                                                                                        |     |
|----------------------------------------------------------------------------------------|-----|
| Table A.2 – Encoding allData in Fixed-length GOOSE message – the basic data types..... | 132 |
| Table A.3 – Encoding example for Data .....                                            | 133 |
| Table B.1 – Recommended multicast addressing example .....                             | 135 |
| Table C.1 – Default virtual LAN IDs and priorities .....                               | 140 |
| Table C.2 – Assigned Ethertype values.....                                             | 141 |
| Table D.1 – SCL conformance degrees.....                                               | 143 |
| Table D.2 – Supported ACSI services for SCL.2 .....                                    | 143 |
| Table E.1 – Relationships between timescales .....                                     | 145 |
| Table E.2 – Examples of timescale correspondence.....                                  | 145 |
| Table H.1 – Service requiring GSSE communication profile .....                         | 168 |
| Table H.2 – Service and protocols for GSSE communication A-Profile .....               | 169 |
| Table H.3 – GSSE T-Profile.....                                                        | 169 |
| Table H.4 – MMS TypeDescription Definition for GSSE control block MMS structure .....  | 170 |
| Table H.5 – Mapping of LSentData.....                                                  | 171 |
| Table H.6 – Definition of integer values of PhsID .....                                | 172 |
| Table H.7 – Definition of double-bit GSSE values .....                                 | 172 |
| Table H.8 – Mapping of GetGsReference service.....                                     | 173 |
| Table H.9 – GetGsReference.....                                                        | 173 |
| Table H.10 – Mapping of GetGSEDataOffset service.....                                  | 175 |
| Table H.11 – GetGSSEDataOffset.....                                                    | 175 |
| Table H.12 – GSSE service .....                                                        | 178 |
| Table H.13 – Mapping of test values to bit-pair values.....                            | 179 |
| Table H.14 – GSSE conformance statement.....                                           | 180 |

## INTRODUCTION

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

This part of IEC 61850 is intended to provide inter-device operation of a variety of 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 utility 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.

## 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

#### 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.

It 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. It 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 IEC 61850 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. It describes real utility 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 utility 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.

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Amendment 1<sup>1</sup>

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### 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, definition 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, definition 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, definition 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, definition 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, definition 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, definition 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, definition 3.6]

### 3.8

#### **logical node**

entity that represents a typical substation function

[IEC 61850-7-2, definition 3.7]

### 3.9

#### **physical device**

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

[IEC 61850-7-2, definition 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

#### **data attribute**

named element of data object which has a specific type

### 3.12

#### **data object**

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

NOTE This definition is in accordance with the DataObject definition of IEC 61850-7-2. The MMS use of DataObject refers to data types and potential instantiations of MMS variables.

### 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

### 3.15

#### **V-Put**

the V-Put function is used to set one or more values within a MMS Variable. The V-Put function executes the MMS variable's access method using the value transferred with the MMS WriteRequest and generates an access-result indicating success or failure. A single MMS WriteRequest invokes the V-Put Function for each MMS Variable referenced in the request

### 3.16

#### V-Get

the V-Get function is used to obtain one or more values from a MMS Variable. The V-Get function executes the MMS variable's access method and generates an access-result indicating failure or upon success the value. A single MMS ReadRequest invokes the V-Get Function for each MMS Variable referenced in the request

## 4 Abbreviations

|                |                                                                                                            |
|----------------|------------------------------------------------------------------------------------------------------------|
| A              | Application                                                                                                |
| ACSE           | Association Control Service Element                                                                        |
| ACSI           | Abstract Communication Service Interface                                                                   |
| APPID or AppID | Application Identification                                                                                 |
| BRCB           | 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                                                                            |
| HSR            | High-availability Seamless Redundancy                                                                      |
| 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                                                                                        |
| MMPM           | Manufacturing Message Protocol Machine                                                                     |
| 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                                                                                                                                                                                                             |
| PRP1      | Parallel Redundancy Protocol Version 1                                                                                                                                                                                                                |
| r         | Mandates that the item is readable. The ability to write the item is a local issue.                                                                                                                                                                   |
| RBAC      | Role Base Access                                                                                                                                                                                                                                      |
| 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                                                                                                                                                        |
| URCB      | Unbuffered Report Control Block                                                                                                                                                                                                                       |
| 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/specifications 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.

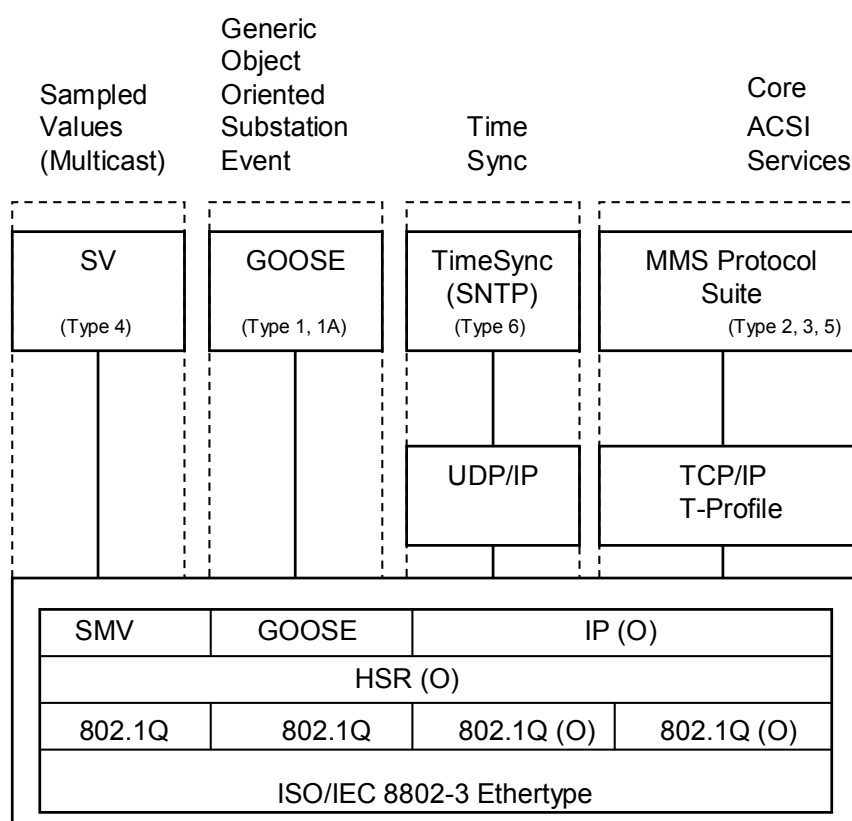
The communication requirements for utilities (listed in IEC 61850-5) are met by the profiles shown in Figure 1.

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 the same Ethertype. However, to optimise decoding of received messages they will use different ranges of the APPID (see Annex C).

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.



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

IEC 811/11

**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 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.

### 5.3 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.

### 5.4 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<br>VMD                         | Server                    | Initiate<br>Conclude<br>Abort<br>Reject<br>Cancel<br>Identify                                                                             |
| Named Variable Objects                             | Logical Nodes<br>and Data | Read<br>Write<br>InformationReport<br>GetVariableAccessAttribute<br>GetNameList                                                           |
| Named Variable List<br>Objects                     | Data Sets                 | GetNamedVariableListAttributes<br>GetNameList<br>DefineNamedVariableList<br>DeleteNamedVariableList<br>Read<br>Write<br>InformationReport |
| Journal Objects                                    | Logs                      | ReadJournal<br>InitializeJournal<br>GetNameList                                                                                           |
| Domain Objects                                     | Logical Devices           | GetNameList<br>GetDomainAttributes<br>StoreDomainContents                                                                                 |
| Files                                              | Files                     | FileOpen<br>FileRead<br>ObtainFile<br>FileClose<br>FileDirectory<br>FileDelete                                                            |
| <sup>a</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.

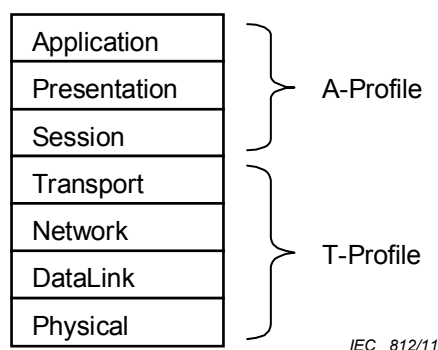


**Figure 2 – OSI reference model and profiles**

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 H.4 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          |
| Data                | GetDataValues             |
|                     | SetDataValues             |
|                     | GetDataDirectory          |
|                     | GetDataDefinition         |
| Data Set            | GetDataSetValues          |
|                     | SetDataSetValues          |
|                     | CreateDataSet             |
|                     | DeleteDataSet             |

| IEC 61850-7-2 model         | IEC 61850-7-2 service  |
|-----------------------------|------------------------|
|                             | GetDataSetDirectory    |
| Setting Group Control Block | SelectActiveSG         |
|                             | SelectEditSG           |
|                             | SetEditSGValue         |
|                             | ConfirmEditSGValues    |
|                             | GetEditSGValue         |
|                             | GetSGCBValues          |
| Report Control Block        | Report                 |
|                             | GetBRCBValues          |
|                             | SetBRCBValues          |
|                             | GetURCBValues          |
|                             | SetURCBValues          |
| LOG Control Block           | GetLCBValues           |
|                             | SetLCBValues           |
|                             | GetLogStatusValues     |
|                             | QueryLogByTime         |
|                             | QueryLogAfter          |
| GOOSE                       | GetGoCBValues          |
|                             | SetGoCBValues          |
| GSSE                        | GetGsCBValues          |
|                             | SetGsCBValues          |
| Control                     | Select                 |
|                             | SelectWithValue        |
|                             | Cancel                 |
|                             | Operate                |
|                             | CommandTermination     |
|                             | TimeActivatedOperate   |
| FILE transfer               | 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 8650-1:1996    | m   |
| Presentation    | Connection Oriented Presentation    | ISO/IEC 8822:1994     | ISO/IEC 8823-1:1994    | m   |
|                 | Abstract Syntax                     | ISO/IEC 8824-1:2008   | ISO/IEC 8825-1:2008    | 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

#### 6.2.3.1 Service and protocols

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   |
| Link Redundancy     | Parallel Redundancy Protocol and High Availability Seamless Ring                          | IEC 62439-3 – PRP1 or HSR                         |                        | o   |
|                     | Rapid Spanning Tree Protocol (RSTP)                                                       | IEEE 802.1D                                       |                        | o   |
| 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 8802-3:2000                               |                        | m   |
| Physical (option 1) | 10Base-T/100Base-T                                                                        | ISO/IEC 8802-3:2000                               |                        | 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 8802-3:2000                               |                        | c1  |
|                     | Fiber optic transmission system 1000Base-LX                                               | ISO/IEC 8802-2:1998, ISO/IEC 8802-3:2000          |                        |     |
|                     | Basic Optical Fibre Connector. <sup>b</sup>                                               | IEC 60874-10-1, IEC 60874-10-2 and IEC 60874-10-3 |                        |     |
|                     | Basic Optical Fibre Connector. <sup>c</sup>                                               | IEC 61754-22                                      |                        |     |

- <sup>a</sup> This is the specification for the 10BaseT connector.  
<sup>b</sup> This is the specification for the ST connector.  
<sup>c</sup> This is the specification for the LC connector.  
c1 It is recommended to implement at least one of the two Physical interfaces. Additional or future technologies may be used.

## 6.2.3.2 Implementation agreements

### 6.2.3.2.1 TCP\_KEEPALIVE

The TCP\_KEEPALIVE function according to RFC 1122 shall be implemented. The value of the maximum time before a lost connection is detected shall be documented in seconds in the PIXIT.

NOTE It is recommended that the minimum-maximum value of the allowable range should be no greater than 20 s. The value of the maximum time before a lost of connection is detected is not intended to be changed via SCL since the impact of the parameter is IED wide.

### 6.2.3.2.2 Transport selector

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

## 6.2.4 OSI T-Profile

### 6.2.4.1 Service and protocols

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<br>ISO/IEC 8473-2:1996 | m   |
|                                                                                                                                         | End System to Intermediate System (ES/IS)                                                 | ISO/IEC 9542:1988                                 |                                            | m   |
| Link Redundancy                                                                                                                         | Parallel Redundancy Protocol and High Availability Seamless Ring                          | IEC 62439-3 – PRP1 or HSR                         |                                            | o   |
|                                                                                                                                         | Rapid Spanning Tree Protocol (RSTP)                                                       | IEEE 802.1D                                       |                                            | o   |
| DataLink                                                                                                                                | Logical Link Control                                                                      | ISO/IEC 8802-2:1998                               |                                            | m   |
|                                                                                                                                         | Carrier Sense Multiple Access with collision detection (CSMA/CD)                          | ISO/IEC 8802-3:2000                               |                                            | m   |
| Physical (option 1)                                                                                                                     | 10Base-T/100Base-T                                                                        | ISO/IEC 8802-3:2000                               |                                            | c   |
|                                                                                                                                         | Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup> | ISO/IEC 8877:1992                                 |                                            |     |
| Physical (option 2)                                                                                                                     | Fibre optic transmission system 1000Base-LX                                               | ISO/IEC 8802-2:1998, ISO/IEC 8802-3:2000          |                                            | c   |
|                                                                                                                                         | 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.                                                                            |                                                                                           |                                                   |                                            |     |
| <sup>c</sup> It is recommended to implement at least one of the two Physical interfaces. Additional or future technologies may be used. |                                                                                           |                                                   |                                            |     |

### 6.2.4.2 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 | GetGoReference<br>GetGOOSEElementNumber<br>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                                                                                                                      |                                                                                           |                                                   |                        |     |
| Link Redundancy                                                                                                              | Parallel Redundancy Protocol and High Availability Seamless Ring                          | IEC 62439-3 – PRP1 or HSR                         |                        | o   |
|                                                                                                                              | Rapid Spanning Tree Protocol (RSTP)                                                       | IEEE 802.1D                                       |                        | o   |
| DataLink                                                                                                                     | Priority Tagging/ VLAN                                                                    | IEEE 802.1Q                                       |                        | m   |
|                                                                                                                              | Carrier Sense Multiple Access with collision detection (CSMA/CD).                         | ISO/IEC 8802-3:2000                               |                        | m   |
| Physical (option 1)                                                                                                          | 10Base-T/100Base-T                                                                        | ISO/IEC 8802-3:2000                               |                        | c   |
|                                                                                                                              | Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup> | ISO/IEC 8877:1992                                 |                        |     |
| Physical (option 2)                                                                                                          | Fibre optic transmission system 1000Base-LX                                               | ISO/IEC 8802-2:1998, ISO/IEC 8802-3:2000          |                        | c   |
|                                                                                                                              | 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.                                                                 |                                                                                           |                                                   |                        |     |
| c 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

### 6.4.1 Conformance statement

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.

### 6.4.2 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 4330              |                        | m   |
| Presentation    |                              |                       |                        |     |
| Session         |                              |                       |                        |     |

### Implementation agreements

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

Mode 3 of SNTP time synchronization shall be supported for SNTP Clients.

Mode 4 of SNTP time synchronization shall be supported for SNTP Servers.

Mode 3, 4 of SNTP time synchronization shall be supported for SNTP Clients and Servers.

### 6.4.3 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   |
|                     | An Ethernet Address Resolution Protocol (ARP)                                             | RFC 826                       |                        | m   |
|                     | Broadcasting Internet Datagrams                                                           | RFC 922<br>RFC 950<br>RFC 919 |                        | m   |
|                     | Host Extensions for IP Multicasting                                                       | RFC 1112                      |                        | m   |
| Link Redundancy     | Parallel Redundancy Protocol and High Availability Seamless Ring                          | IEC 62439-3 – PRP1 or HSR     |                        | o   |
|                     | Rapid Spanning Tree Protocol (RSTP)                                                       | IEEE 802.1D                   |                        | o   |
| 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 8802-3:2000           |                        | m   |
| Physical (option 1) | 10Base-T/100Base-T                                                                        | ISO/IEC 8802-3:2000           |                        | c   |
|                     | Interface connector and contact assignments for ISDN Basic Access Interface. <sup>a</sup> | ISO/IEC 8877:1992             |                        |     |

| OSI model layer                                                                          | Specification                               |                                                   |                        | m/o |
|------------------------------------------------------------------------------------------|---------------------------------------------|---------------------------------------------------|------------------------|-----|
|                                                                                          | Name                                        | Service specification                             | Protocol specification |     |
| Physical (option 2)                                                                      | Fibre optic transmission system 1000Base-LX | ISO/IEC 8802-2:1998, ISO/IEC 8802-3 2000          |                        | c   |
|                                                                                          | 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.                             |                                             |                                                   |                        |     |
| <sup>c</sup> It is recommended to implement at least one of the two Physical interfaces. |                                             |                                                   |                        |     |

## 7 Objects of IEC 61850

### 7.1 Server

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.

### 7.2 Logical device (LD)

An instance of an IEC 61850-7-2 GenLogicalDeviceClass 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 an IEC 61850-7-2 GenLogicalNodeClass, that need mapping, are defined in IEC 61850-7-2, IEC 61850-7-3, and IEC 61850-7-4.

Each instance of an IEC 61850 GenLogicalNodeClass 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 Figure 3.

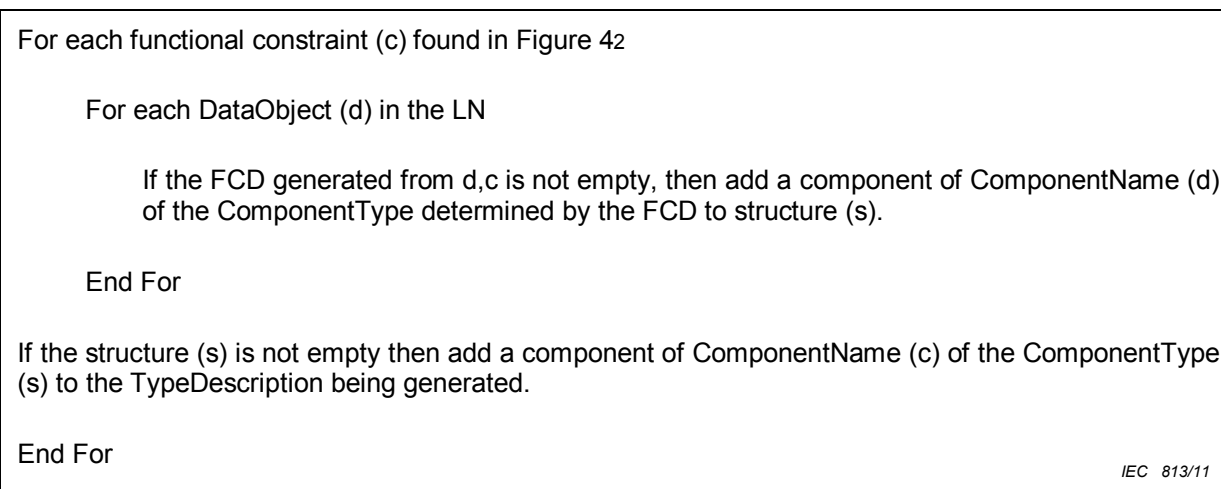


**Figure 3 – Algorithm for logical node mapping**

The order of the resulted components is recommended to be as shown in Figure 4.

|    |
|----|
| MX |
| ST |
| CO |
| CF |
| DC |
| SP |
| SG |
| RP |
| LG |
| BR |
| GO |
| GS |
| SV |
| SE |
| MS |
| US |
| EX |
| SR |
| OR |
| BL |

IEC 814/11

**Figure 4 – Ordered list of functional constraints**

<sup>2</sup> The recommended ordering provides compatibility with existing UCA 2.0 implementations.

NOTE 1 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); EX – name space for model extension; SR – service tracking; CO – Control service parameters; OR – oper received; and BL for blocking.

NOTE 2 The FC “XX” defined in IEC 61850-7-2 as the wildcard FC for services only is not mapped to the MMS SC SM. Therefore any request that uses FC=“XX” will be acknowledged negatively.

If there is no DataObject (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 instantiated compatible data classes as SCL DOs (see IEC 61850-6) whose data attributes have the specific functional constraint.

NOTE 3 To maintain backward compatibility with previous version, then the ordered of the instantiated compatible data classes as SCL DOs shall meet the requirements of that previous version.

Within a MMS component, representing IEC 61850-7-4 DataObjects, the order of MMS components is determined by the order of the names of the attributes of the common data classes as defined in IEC 61850-7-2, IEC 61850-7-3 or IEC extensions to it for IEDs claiming conformance to those standards, and the SCL shall reflect the same order.

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 an 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 DataObjects**

Logical Nodes, according to IEC 61850-7-2, consist of one or more DataObjects. The DataObjects themselves can be constructed with SubDataObjects which can themselves contain SubDataObjects. The names of DataObjects, SubDataObjects 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

EXAMPLES: <LNVariableName>\$<FC>\$<LNDataObjectName1> (e.g. XCBR1\$ST\$Pos)

<LNVariableName>\${FC}\${LNDDataObjectName1}\${SubDataObjectName1} (e.g. MMXU1\$MX\$A\$phsA)

#### 7.3.4 DataAttributes (DataAttr)

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

EXAMPLES: <LNVariableName>\${FC}\${LNDDataName1}\${AttributeName1} (e.g. XCBR1\$ST\$Pos\$stVal)

<LNVariableName>\${FC}\${LNDDataName1}\${AttributeName1}\${subDataAttributeName1}

(e.g. XBCR1\$ST\$Pos\$origin\$orCat)

## 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 BasicTypes

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

**Table 11 – Mapping of ACSI BasicTypes**

| IEC 61850-7-2<br>BasicType 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                                                                                                                                                                                                  |             |
| INT64                           | Integer        | –2**63 to (2**63)–1                                                                                                                                                                                                              |             |
| INT8U                           | Unsigned       | 0 to 255                                                                                                                                                                                                                         |             |
| INT16U                          | Unsigned       | 0 to 65 535                                                                                                                                                                                                                      |             |
| INT24U                          | Unsigned       | Only used for TimeStamp type                                                                                                                                                                                                     | See 8.1.3.7 |
| 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<br><br>NOTE: The value of Not-A-Number (NaN) is valid. However, the processing of a value indicating Not-A-Number (NaN) is a local issue. |             |
| 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 8.1.2.6 |

## 8.1.2 Additional definitions of BasicType

### 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 except for the IEC 61850-7-3 Multiplier enumeration where the enumeration value delivers the multiplier value to use. The range of the allowed values is specified in IEC 61850-7-2, IEC 61850-7-3 and IEC 61850-7-4. 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 MMString. 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 MMString, shall be constrained to ISO646String.

### 8.1.2.6 UNICODE STRING

The IEC 61850-7-2 UNICODE STRING shall map to a value represented by a MMS variable length MMString. The maximum size of the MMString data type shall be the number of characters specified in

IEC 61850-7-2 and IEC 61850-7-3 divided by 4. A UNICODE STRING255 therefore maps to a MMSString data type of length 255.

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

### 8.1.2.7 Array

The IEC 61850-7-2 Array maps to an MMS array for each functional constrained Array.

### 8.1.3 Common ACSITypes

#### 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

##### 8.1.3.2.1 General

The IEC 61850-7-2 Object reference mapping to MMS depends on the context where the object reference is defined:

- Within the scope of control block attributes it is mapped to MMS address scheme as specified in 8.1.3.2.2;
- Within the scope of data attributes (Tracking CDCs,ORG) it is mapped to an ACSI reference.

In both cases, the ObjectReference maps to a variable length MMS visible string with a maximum length of 129 octets.

##### 8.1.3.2.2 Object Reference within Control Blocks

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 F.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.

##### 8.1.3.2.3 Object Reference within CDCs (Tracking, ORG).

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 ACSI scope qualified name of the MMS object. The value shall be constructed as specified in IEC 61850- 7-2.

The allowed character set is defined in IEC 61850-7-2.

The value shall be constructed as:

- Reference to a Logical Device:

<LDName>

- Reference to a Logical Node:

<LDName>/<LNName>

- Reference to a DataSet:

<LDName>/<LNName>.<DataSetName>

- Reference to a DataObject:

<LDName>/<LNName>.<DataObjectName>[.<SubDataObjectName>[. ...]]

- Reference to a DataAttribute:

<LDName>/<LNName>.<DataObjectName>[.<SubDataObjectName>[. ...]].<DataAttributeName>[(.<NumArrayElement>)].<SubDataAttributeName>[. ...]]

- Reference to a Control Block

<LDName>/<LNName>.<CBName>

### 8.1.3.3 PHYCOMADDR

The PHYCOMADDR, used by different control blocks, is mapped to the following structure (see Table 12):

**Table 12 – PHYCOMADDR 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                                                                                                                                                                                                   |

### 8.1.3.4 ServiceError

According to IEC 61850-7-2, a ServiceError is defined as:

“The service error code for negative service responses ...”

However, within the context of IEC 61850-8-1, there may be multiple possibilities for ACSI negative service responses. In general, this is caused by the processing of incoming requests by a Manufacturing Message Protocol Machine (MMPM) and then a 61850 Application. The priority of evaluation for the appropriate ServiceError response shall be the MMPM first and the 61850 application second.

Within the MMPM, an ACSI ServiceError is mapped to multiple types of MMS messages. In general the responses could be:

- A MMS Reject
- A MMS ServiceError Response
- A MMS Positive Response
- A MMS Negative Response

The following clauses specify the specifics MMPM responses for 61850 Servers given MMS Requests.

#### 8.1.3.4.1 MPPM Rejects

From ISO 9506-1:

Support for confirmed services shall be defined as the ability to receive a request indication and execute the service procedure defined for the responder role.

If a confirmed service is supported, a Reject PDU shall not be issued on receipt of that service, except in the case of a protocol error. If a confirmed service is not supported, a Reject PDU shall be issued on receipt of that service request with a reject code of "UNRECOGNIZED SERVICE".

The indication of support for a confirmed service shall be declared in the PICs/PIXIT and in the servicesSupportedCalled BITSTRING of the Initiate-Response PDU.

If the service is not supported (e.g. the appropriate bit in the servicesSupportedCalled BITSTRING is FALSE) and the MMS Client issues a well formed MMS Confirmed-Request of such a service, the MPPM shall return a Reject:

originalInvokeID: shall be present

rejectReason: shall be a reason of confirmed-requestPDU with a value of unrecognized-service

If a mal-formed PDU is received, the contents of the Reject shall be a local issue.

#### 8.1.3.4.2 MPPM Environmental Services

##### 8.1.3.4.2.1 Initiate

Within the context of IEC 61850, an Initiate-Response- is a MMS ServiceError and can contain the following information:

- Initiate parameter mismatches for the intended application: In this case the proposed parameterCBB of serviceSupported does not allow the intended IEC 61850 application to operate properly. In this instance a MMS ServiceError shall be sent indicating an errorClass of Initiate with an appropriate value.
- If the Initiate requestor is restricted from being allowed to establish a MMS Environment due to security privileges, the MPPM shall issue a MMS ServiceError indicating a errorClass = "access" with an errorCode = "object-access-denied".

Table 13 details associate ACSI service error mappings.

**Table 13 – Associate ACSI service error mappings**

| ACSI service error                      | MMS ServiceError |                                                                                                                                                                                                            | Comment          |
|-----------------------------------------|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
|                                         | Error class      | Error code                                                                                                                                                                                                 |                  |
| parameter-value-inconsistent            | initiate         | version-incompatible                                                                                                                                                                                       |                  |
| failed-due-to-communications-constraint | initiate         | parameter-CBB-insufficient<br>nesting-level-insufficient<br>max-services-outstanding-called-insufficient<br>max-services-outstanding-calling-insufficient<br>max-services-outstanding-calling-insufficient |                  |
| access-violation                        | access           | object-access-denied                                                                                                                                                                                       | Result::=Failure |
| failed-due-to-server-constraint         | Any class        | Any unmapped error codes                                                                                                                                                                                   |                  |

Any other MMS ServiceErrors pertaining to an Initiate service, not contained in Table 1, shall be mapped to the ACSI service error of failed-due-to-server-constraint

#### 8.1.3.4.2.2 Conclude

Table 14 details the mappings of ACSI to the possible service errors for a MMS Conclude-Request.

**Table 14 – 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                          |

No other MMS ServiceErrors are allowed regarding a Conclude-Request.

#### 8.1.3.4.2.3 Abort

No mappings of ACSI service errors are required for the MMS Abort Service.

#### 8.1.3.4.2.4 GetNameList

The MMS GetNameList service does not support a MMS Response- but can return a MMS ServiceError. The following MMS ServiceErrors are defined for:

- A GetNameList-Request that specifies an objectScope of domainSpecific. If the requested Domain does not exist, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A GetNameList-Request that specifies an objectScope="domainSpecific" and specifies a Domain for which the MMS Client does not have access privileges. In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A GetNameList-Request that specifies conflicting objectClass and objectScope specifications (e.g. objectClass="journal" and objectScope="aaSpecific"). . In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="service" with an errorCode="object-constraint-conflict".

Table 15 details the objectClass and objectScope specification that shall generate such a MMS Confirmed-Error PDU.

**Table 15 – GetNameList conflicting IEC 61850 objectClass and objectScope**

| ObjectClass | objectScope             |
|-------------|-------------------------|
|             | <b>Parameter Values</b> |
| domain      | domainSpecific          |
| journal     | aaSpecific              |
| domain      | aaSpecific              |

Table 16 defines the mapping the MMS Confirmed-Error PDU contents to the appropriate ACSI ServiceError.

**Table 16 – GetNamedList service error mappings**

| ACSI service error                      | MMS ServiceError |                            | Comments |
|-----------------------------------------|------------------|----------------------------|----------|
|                                         | Error class      | Error code                 |          |
| instance-not-available                  | access           | object-non-existent        |          |
| access-violation                        | access           | object-access-denied       |          |
| parameter-value-inconsistent            | service          | object-constraint-conflict |          |
| failed-due-to-communications-constraint | Any class        | Any unmapped error codes   |          |

For other GetNamedList requests that are processed and no matching MMS Objects are located, a GetNamedList-Response+ shall be returned with the listOfIdentifiers being NULL and moreFollows set to FALSE.

If the GetNamedList request specifies objectClass="domain" with objectScope="vmdSpecific", for implementations claiming conformance to IEC 61850, the GetNamedList-Response+ shall not be NULL.

#### **8.1.3.4.3 MPPM NamedVariableList Services**

##### **8.1.3.4.3.1 General**

The MMS NamedVariableList objects are used by IEC 61850 as DataSets. The following clauses define the ACSI ServiceError mappings for DataSets.

##### **8.1.3.4.3.2 Read**

A MMS Read service for a NamedVariableList object returns either a Response+ or MMS ServiceError. This clause details the mappings for the MMS error responses for errors that can occur when the MPPM is performing a MMS Read service on a NamedVariableList object. This clause, together with 8.1.3.4.4.1, details the errors that shall be returned.

The following MPPM processing shall occur prior to processing per 8.1.3.4.4.1.

- A Read-Request of NamedVariableList object that specifies an objectScope="domainSpecific" and specifies a Domain for which the MMS Client does not have access privileges. In this case, the MPPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A Read-Request that specifies a NamedVariableList object that does not exist, the MPPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A Read-Request that specifies a NamedVariableList object, whose response encoding exceeds the negotiated MMSPdu size, shall return a MMS Confirmed-ErrorPDU with an errorClass="service" with an errorCode="pdu-size".

All other errors/processing shall be per 8.1.3.4.4.1.

See Table 17 for Read of NamedVariableList object error mappings.

**Table 17 – Read of NamedVariableList object error mappings**

| ACSI service error                           | MMS ServiceError |                      | Comments                                                                                          |
|----------------------------------------------|------------------|----------------------|---------------------------------------------------------------------------------------------------|
|                                              | Error class      | Error code           |                                                                                                   |
| instance-not-available                       | access           | object-non-existent  |                                                                                                   |
| access-violation                             | access           | object-access-denied |                                                                                                   |
| failed-due-to-communications-constraint      | service          | pdu-size (3)         | In ISO 9506 (1990) (the value of (3) was pdu-size. In ISO 9506 (2003), the (3) value is reserved. |
| NOTE For other error codes, see 8.1.3.4.4.1. |                  |                      |                                                                                                   |

### 8.1.3.4.3.3 Write

A MMS Write service for a NamedVariableList object returns either a Response+ or MMS ServiceError. This clause details the mappings for the MMS ServiceError responses for errors that can occur when the MMPM is performing a MMS Write service on a NamedVariableList object. This clause, together with 8.1.3.4.4.2, details the errors that shall be returned.

The following MMPM processing shall occur prior to processing per 8.1.3.4.4.2.

- A Write-Request that exceeds the negotiated MMSPdu size shall cause the MMPM to return a Reject with a rejectPDUType="confirmed-requestPDU" and a rejectCode="value-out-of-range". This shall be mapped to the ACSI ServiceError of failed-due-to-communications-constraint.
- A Write-Request of NamedVariableList object that specifies an objectScope="domainSpecific" and specifies a Domain for which the MMS Client does not have access privileges. In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A Write-Request that specifies a NamedVariableList object does not exist, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".

All other errors/processing shall be per 8.1.3.4.4.2.

See Table 18 for Write of NamedVariableList object error mappings.

**Table 18 – Write of NamedVariableList object error mappings**

| ACSI service error                           | MMS ServiceError     |                      | Comments |
|----------------------------------------------|----------------------|----------------------|----------|
|                                              | Error class          | Error code           |          |
| instance-not-available                       | access               | object-non-existent  |          |
| access-violation                             | access               | object-access-denied |          |
| ACSI service error                           | MMS Reject           |                      | Comments |
|                                              | Reject PDU Type      | Reject Code          |          |
| failed-due-to-communications-constraint      | Confirmed-requestPDU | Value-out-of-range   |          |
| NOTE For other error codes, see 8.1.3.4.4.2. |                      |                      |          |

**8.1.3.4.3.4 DefineNamedVariableList**

The MMS DefineNamedVariableList service returns either a Response+ or MMS ServiceError. This clause details the mappings for the MMS ServiceError responses for errors that can occur when the MMPM is performing the DefineNamedVariableList service request:

- A DefineNamedVariableList-Request that specifies an objectScope of domainSpecific. If the requested Domain does not exist, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A DefineNamedVariableList-Request that specifies an objectScope="domainSpecific" and specifies a Domain for which the MMS Client does not have access privileges. In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A DefineNamedVariableList-Request that contains a variableSpecification for which the specification specifies a non-existent object (e.g. if the MMS NamedVariable does not exist). In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="definition" with an errorCode="object-undefined".
- A DefineNamedVariableList-Request that contains an variableListName whose ObjectName already exists (e.g. the specific NamedVariableList already exists). In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="definition" with an errorCode="object-exists".
- A DefineNamedVariableList-Request that contains a List of Variables whose number exceeds the maximum allowed. In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="resource" with an errorCode="capability-unavailable". This shall be mapped to the ACSI ServiceError of failed-due-to-server-constraint.
- A DefineNamedVariableList-Request that exceeds the negotiated MMSPdu size shall cause the MMPM to return a Reject with a rejectPDUType="confirmed-requestPDU" and a rejectCode="value-out-of-range". This shall be mapped to the ACSI ServiceError of failed-due-to-communications-constraint.

See Table 19 for DefineNamedVariableList service error mappings.

**Table 19 – DefineNamedVariableList service error mappings**

| ACSI service error                      | MMS ServiceError     |                          | Comments |
|-----------------------------------------|----------------------|--------------------------|----------|
|                                         | Error class          | Error code               |          |
| instance-not-available                  | access               | object-non-existent      |          |
| access-violation                        | access               | object-access-denied     |          |
| instance-in-use                         | definition           | object-exists            |          |
| parameter-value-inconsistent            | definition           | object-undefined         |          |
| failed-due-to-server-constraint         | resource             | capability-unavailable   |          |
| failed-due-to-communications-constraint | Any class            | Any unmapped error codes |          |
| ACSI service error                      | MMS Reject           |                          | Comments |
|                                         | Reject PDU Type      | Reject Code              |          |
| failed-due-to-communications-constraint | Confirmed-requestPDU | Value-out-of-range       |          |

**8.1.3.4.3.5 GetNamedVariableListAttributes**

The MMS GetNamedVariableListAttributes service returns a Response or MMS ServiceError. This clause details the mappings for the MMS responses regarding errors that can occur when the MMPM is performing the GetNamedVariableListAttributes service request:

- A GetNamedVariableListAttributes-Request with an ObjectName that specifies an objectScope of domainSpecific. If the specified Domain does not exist, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A GetNamedVariableListAttributes-Request that specifies an ObjectName whose objectScope exists, but the actual MMS Variable does not exist, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A GetNamedVariableListAttributes-Request that specifies ObjectName whose objectScope of domainSpecific and specifies a Domain for which the MMS Client does not have access privileges. In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A GetNamedVariableListAttributes-Request that causes a Response+ that exceeds the negotiated MMSPdu size shall cause the MMPM to return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU, shall be errorClass="service" with an errorCode="pdu-size". This shall be mapped to the ACSI ServiceError of failed-due-to-communications-constraint.

See Table 20 for GetNamedVariableListAttributes service error mappings.

**Table 20 – GetNamedVariableListAttributes service error mappings**

| ACSI service error                      | MMS ServiceError |                          | Comments                                                                                     |
|-----------------------------------------|------------------|--------------------------|----------------------------------------------------------------------------------------------|
|                                         | Error class      | Error code               |                                                                                              |
| instance-not-available                  | access           | object-non-existent      |                                                                                              |
| access-violation                        | access           | object-access-denied     |                                                                                              |
| failed-due-to-communications-constraint | service          | pdu-size (3)             | In ISO 9506 Version1, the value of (3) is pdu-size. In Version 2, the (3) value is reserved. |
| failed-due-to-communications-constraint | Any class        | Any unmapped error codes |                                                                                              |

#### 8.1.3.4.3.6 DeleteNamedVariableList

The MMS DeleteNamedVariableList service returns a Response+, Error, or MMS ServiceError. This clause details the mappings for the MMS responses regarding errors that can occur when the MMPM is performing the DeleteNamedVariableList service request:

- A DeleteNamedVariableList-Request that specifies an objectScope of domainSpecific and specifies a domainName that is non-existent. If the requested Domain does not exist, the MMPM shall return a a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A DeleteNamedVariableList-Request that specifies an objectScope of domainSpecific and specifies a domainName for which the client does not have sufficient privilege for the service. The MMPM shall return a a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A DeleteNamedVariableList-Request that specifies an objectScope (e.g. VMD, Domain, or AA-Specific) and none of the listOfVariableListName objects exist. In this instance the MMPM shall return a Response+ with the numberMatched=0.
- A DeleteNamedVariableList-Request that attempts to delete one or more NamedVariableLists that do not have the attribute of MMSDeletable=TRUE. In this instance the MMPM shall return a Response+ with the appropriate numberMatched value and appropriate numberDeleted value.

- A DeleteNamedVariableList-Request that attempts to delete a NamedVariableList whose MMSDeletable=TRUE, and the MMPM is unable to delete the object. For example when a NamedVariableList is used in a Report Control Block. In this case the MMPM shall return a Response- with the number of NamedVariableLists that were successfully deleted.

See Table 21 for DeleteNamedVariableList service error mappings.

**Table 21 – DeleteNamedVariableList service error mappings**

| ACSI service error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | MMS ServiceError |                          | Comments |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|--------------------------|----------|
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 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 unmapped error codes |          |
| ACSI service error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | MMS Response+    |                          | Comments |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Parameter        | value                    |          |
| instance-not-available                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | numberMatched    | 0                        |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | numberDeleted    | 0                        |          |
| failed-due-to-server-constraint                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | numberMatched    | non-zero                 |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | numberDeleted    | Less than numberMatched. |          |
| ACSI service error                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | MMS Response-    |                          | Comments |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Parameter        | value                    |          |
| failed-due-to-server-constraint                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | numberDeleted    | any value                |          |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                  |                          |          |
| Note: There are two (2) mappings to failed-due to-server-constraint. These mappings are due to the service procedures defined in ISO/IEC 9506-1. The relevant section of the service procedure follows: "If a error occurs in the deletion of any of the specifiedobjects, then a negative response shall be issued with the NumberDeleted parameter indicating the number of objects that were deleted. Failure to delete an object with the MMS Deletable attribute equal to false shall not be deemed an error." |                  |                          |          |

#### 8.1.3.4.4 MMPM NamedVariable Services

##### 8.1.3.4.4.1 Read

The MMS Read service returns a Response+ or MMS ServiceError. Within a Response+ there is a sequence of AccessResults that indicate the success or failure of the VGET function on the individual VariableSpecifications in the request.

For the purposes of this section, the errors are specified based upon the appropriate ListOfVariable VariableSpecification or Variable List Name Specified.

The following are the definitions of the possible errors that can be returned:

- A Read-Request that causes a Response that exceeds the negotiated MMSPdu size shall cause the MMPM to return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU, shall be errorClass="service" with an errorCode="pdu-size". This shall be mapped to the ACSI ServiceError of failed-due-to-communications-constraint.
- A Read-Request of a VariableAccessSpecification that specifies an object for which the MMS Client does not have access privileges. In this case, the MMPM shall return a failure within the Write-Response+ indicating DataAccessError="object-access-denied" or DataAccessError="object-non-existent".
- A Read-Request of VariableAccessSpecification that specifies an object which the does not exists. The MMPM shall return an AccessResult indicating failure within the Read-Response+ indicating DataAccessError="="object-non-existent".

See Table 22 for read service error mappings.

**Table 22 – Read service error mappings**

| ACSI service error                      | MMS ServiceError           |                          | Comments                                                                                     |
|-----------------------------------------|----------------------------|--------------------------|----------------------------------------------------------------------------------------------|
|                                         | Error class                | Error code               |                                                                                              |
| failed-due-to-communications-constraint | service                    | pdu-size (3)             | In ISO 9506:1990 the value of (3) was pdu-size. In ISO 9506:2003, the (3) value is reserved. |
| failed-due-to-communications-constraint | Any class                  | Any unmapped error codes |                                                                                              |
| ACSI service error                      | MMS Response+              |                          | Comments                                                                                     |
|                                         | DataAccessError            |                          |                                                                                              |
| access-violation                        | object-access-denied       |                          |                                                                                              |
| instance-not-available                  | object-non-existent        |                          |                                                                                              |
| failed-due-to-communications-constraint | Any other DataAccessErrors |                          |                                                                                              |

#### 8.1.3.4.4.2 Write

The MMS Write service returns a Response+ or MMS ServiceError. Within a Response+ there is a sequence of results that indicate the success or failure of the VPUT function on the individual VariableSpecifications in the request.

For the purposes of this section, the errors are specified based upon the appropriate ListOfVariable VariableSpecification or Variable List Name Specified.

The following are the definitions of the possible errors that can be returned:

- A Write-Request that exceeds the negotiated MMSPdu size shall cause the MMPM to return a Reject with a rejectPDUType="pdu-error" and a rejectCode="invalid-pdu". This shall be mapped to the ACSI ServiceError of parameter-value-inconsistent".
- A Write-Request of VariableAccessSpecification that specifies an object for which the MMS Client does not have access privileges. In this case, the MMPM shall return a Write-Response+. The MMPM shall return a failure within the Write-Response+ indicating dataAccessError="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".
- A Write-Request of VariableAccessSpecification that specifies an object which does not exist. In this case, the MMPM shall return a Write-Response+. The MMPM shall return a failure within the Write-Response+ indicating dataAccessError="object-non-existent".
- A Write-Request of a VariableAccessSpecification that specifies an object which has been reserved by another MMS Client (e.g. a ControlBlock or control structure) or the writability/accessability of the object depends on the value of another object (e.g. Setting group values). In this case, the MMPM shall return a Write-Response+. The MMPM shall return a failure within the Write-Response+ indicating dataAccessError="temporarily-unavailable".
- MMS Data Type issues. There are several issues that are associated with VPUTs of MMS Data and their Data Type Definitions:
  - For V-PUTs of fixed size MMS Data Types, where the Data provided does not match the defined size. The MMPM shall return a failure within the Write-Response+ indicating dataAccessError="type-inconsistent".
  - For V-PUTs of variable length size MMS Data Types, where the Data provided does exceed the maximum defined size. The MMPM shall return a failure within the Write-Response+ indicating dataAccessError="type-inconsistent".

- For V-PUTs of variable length size, and extensible, MMS Data Types (e.g. BITSTRINGS), where the Data provided does exceeds the maximum defined size. The MMPM shall not generate a `dataAccessError` for this condition. The IEC 61850 application may not generate a `dataAccessError` for this situation.
- A Write-Request of a `VariableAccessSpecification` whose V-PUT fails due to the being read-only, shall result in a Write-Response+ indicating a `dataAccessError="object-access-denied"`. This `dataAccessError` shall be returned if the entire `VariableAccessSpecification` is read-only or one or more of its sub-components is read-only (e.g. a structure component or array element),
- A V-PUT to an IEC 61850-7-2 ENUMERATION requires processing by the MMPM and the IEC 61850 application. ENUMERATIONS are mapped to some size of a MMS Integer DataType. If the V-PUT contains a value that is valid for the MMS DataType, the MMPM shall not generate an error. However, if the value is beyond the defined set of values allowed for the ENUMERATION, the IEC 61850 application shall return a `DataAccessError` of `object-value-invalid`.

NOTE This shall apply to both the defined positive and supported negative ranges of enumerated values.

See Table 23 for write service error mappings.

**Table 23 – Write service error mappings**

| ACSI service error                      | MMS ServiceError                        |                          | Comments |
|-----------------------------------------|-----------------------------------------|--------------------------|----------|
|                                         | Error class                             | Error code               |          |
| failed-due-to-communications-constraint | Any class                               | Any unmapped error codes |          |
| ACSI service error                      | MMS Response+                           |                          | Comments |
|                                         | DataAccessError                         |                          |          |
| access-violation                        | object-access-denied                    |                          |          |
| instance-not-available                  | object-non-existent                     |                          |          |
| instance-locked-by-other-client         | temporarily-unavailable                 |                          |          |
| type-conflict                           | type-inconsistent                       |                          |          |
| parameter-value-inconsistent            | object-value-invalid                    |                          |          |
| failed-due-to-communications-constraint | Any other <code>DataAccessErrors</code> |                          |          |
| ACSI service error                      | MMS Reject                              |                          | Comments |
|                                         | Reject PDU Type                         | Reject Code              |          |
| parameter-value-inconsistent            | pdu-error                               | Invalid-pdu              |          |
|                                         |                                         |                          |          |

#### 8.1.3.4.4.3 GetVariableAccessAttributes

The MMS `GetVariableAccessAttributes` service returns a Response+ or MMS ServiceError. This clause details the mappings for the MMS responses regarding errors that can occur when the MMPM is performing the `GetVariableAccessAttributes` service request:

- A `GetVariableAccessAttributes-Request` that specifies an `ObjectName` whose `objectScope` of `domainSpecific`. If the specified Domain does not exist, the MMPM shall return a a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be `errorClass="access"` with an `errorCode="object-non-existent"`.
- A `GetVariableAccessAttributes-Request` that specifies `ObjectName` whose `objectScope` of `domainSpecific` and specifies a Domain for which the MMS Client does not have access privileges. In this case, the MMPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be `errorClass="access"` with an `errorCode="object-access-denied"` or `errorClass="access"` with an `errorCode="object-non-existent"`.

- A GetVariableAccessAttributes-Request that causes a Response+ that exceeds the negotiated MMSPdu size shall cause a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU, shall be errorClass="service" with an errorCode="pdu-size". This shall be mapped to the ACSI ServiceError of failed-due-to-communications-constraint.

See Table 24 for GetVariableAccessAttributes service error mappings.

**Table 24 – GetVariableAccessAttributes service error mappings**

| ACSI service error                      | MMS ServiceError |                      | Comments                                                                                      |
|-----------------------------------------|------------------|----------------------|-----------------------------------------------------------------------------------------------|
|                                         | Error class      | Error code           |                                                                                               |
| instance-not-available                  | access           | object-non-existent  |                                                                                               |
| access-violation                        | access           | object-access-denied |                                                                                               |
| failed-due-to-communications-constraint | service          | pdu-size (3)         | In ISO 9506 Version 1, the value of (3) is pdu-size. In Version 2, the (3) value is reserved. |

#### 8.1.3.4.5 MPPM Journal Services

##### 8.1.3.4.5.1 ReadJournal

The MMS ReadJournal service returns a Response+ or MMS ServiceError. This clause details the mappings for the MMS responses regarding errors that can occur when the MPPM is performing the ReadJournal service request:

- A ReadJournal-Request that specifies a JournalName objectScope of domainSpecific. If the specified Domain does not exist, the MPPM shall return a a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-non-existent".
- A JournalRead-Request that specifies JournalName for which the MMS Client does not have access privileges. In this case, the MPPM shall return a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="access" with an errorCode="object-access-denied" or errorClass="access" with an errorCode="object-non-existent".

See Table 25 for ServiceError mappings for Log services.

**Table 25 – ServiceError mappings for Log services**

| ACSI service error              | MMS ServiceError |                          | Comments |
|---------------------------------|------------------|--------------------------|----------|
|                                 | Error class      | Error code               |          |
| instance-not-available          | access           | object-non-existent      |          |
| access-violation                | access           | object-access-denied     |          |
| failed-due-to-server-constraint | Any class        | Any unmapped error codes |          |

#### 8.1.3.4.6 MPPM File Services

##### 8.1.3.4.6.1 FileDirectory

The MMS FileDirectory service returns a Response+ or MMS ServiceError. This clause details the mappings for the MMS responses regarding errors that can occur when the MPPM is performing the FileDirectory service request:

- A FileDirectory-Request that specifies a directory that does not exist, the MPPM shall return a a MMS Confirmed-Error PDU. The ServiceError, within the Confirmed-ErrorPDU shall be errorClass="file" with an errorCode="file-non-existent".