CONTENTS

FOREWORD....................................................................................................................... 6
1 Scope and object............................................................................................................. 8
2 Normative references .................................................................................................. 8
3 Abbreviated terms ...................................................................................................... 9
4 The mapping architecture .......................................................................................... 10
5 Conceptual architectures and associated use cases ................................................... 11
   5.1 Conceptual architecture of a gateway device ....................................................... 11
   5.2 Conceptual architecture of an IED directly connected to a WAN (optional) .... 15
6 Mapping of a device-oriented information model to IEC 60870-5-104 or
  IEC 60870-5-101 .......................................................................................................... 16
   6.1 General .................................................................................................................. 16
   6.2 Mapping of a device-oriented information model reference .................................. 16
   6.3 Logical device class mapping ............................................................................... 17
   6.4 Logical node class mapping .................................................................................. 17
7 Mapping of the common data classes (CDC) ............................................................. 17
   7.1 List of CDC, type Identifications and corresponding mappings for IEC 61850 .... 17
   7.2 CDC single point status (SPS) ............................................................................... 20
   7.3 CDC double point status (DPS) ............................................................................. 20
   7.4 CDC integer status (INS) ..................................................................................... 21
   7.5 CDC protection activated information (ACT) ...................................................... 23
   7.6 CDC directional protection activation information (ACD) .................................... 25
   7.7 CDC Security violation counting (SEC) ............................................................... 27
   7.8 CDC binary counter reading (BCR) ..................................................................... 28
   7.9 CDC measured value (MV) .................................................................................. 29
   7.10 CDC complex measured value (CMV) ............................................................... 30
   7.11 CDC Phase to ground related measured values of a three-phase system
        (WYE) ....................................................................................................................... 32
   7.12 CDC phase to phase measured values of a three phase system (DEL) ............. 32
   7.13 CDC sequence (SEQ) ........................................................................................ 33
   7.14 CDC harmonic value (HMV) ............................................................................... 34
   7.15 CDC harmonic value for WYE (HWYE) .............................................................. 35
   7.16 CDC harmonic value for DEL (HDEL) ............................................................... 35
   7.17 CDC controllable single point (SPC) ................................................................... 36
   7.18 CDC controllable double point (DPC) ................................................................. 38
   7.19 CDC controllable integer status (INC) ................................................................. 40
   7.20 CDC binary controlled step position information (BSC) .................................... 42
   7.21 CDC integer-controlled step position information (ISC) .................................... 44
   7.22 CDC controllable analogue set point information (APC) .................................... 46
   7.23 CDC Single point setting (SPG) ......................................................................... 47
   7.24 CDC integer status setting (ING) ...................................................................... 48
   7.25 CDC analogue settings (ASG) .......................................................................... 48
8 Mapping of services .................................................................................................... 48
   8.1 List of service models and corresponding mappings ............................................. 48
   8.2 Server class mapping ........................................................................................... 50
   8.3 Association class mapping ................................................................................... 50
   8.4 Logical node class mapping .................................................................................. 51
   8.5 Data class mapping ............................................................................................... 52
8.6 Setting group class mapping ................................................................. 53
8.7 Report control block class mapping ...................................................... 54
8.8 Control class mapping ........................................................................ 54
9 Protocol stack selections for IEC 60870-5-101 and IEC 60870-5-104 .............. 76
  9.1 General .............................................................................................. 76
  9.2 Structure of application data .............................................................. 76
  9.3 IEC 60870-5 interoperability ............................................................. 77

Annex A (informative) Use of SCL (substation configuration language) to include IEC 60870-5-101 or IEC 60870-5-104 information .................................................. 104

Figure 1 – Conceptual architecture of a gateway device .................................. 11
Figure 2 – Use case a) for a gateway device .................................................. 12
Figure 3 – Use case b) for a gateway device ................................................... 13
Figure 4 – Use case c) for a gateway device ................................................... 14
Figure 5 – Conceptual architecture of an IED ................................................... 15
Figure 6 – Mapping architecture (conceptual) .................................................. 17
Figure 7 – Direct control with normal security with status update – positive case applied to gateway device ................................................................. 55
Figure 8 – Direct control with normal security with status update – positive case applied to IED ................................................................. 56
Figure 9 – Direct control with normal security in general – negative case a) applied to gateway device ................................................................. 56
Figure 10 – Direct control with normal security in general – negative case a) applied to IED ................................................................. 57
Figure 11 – Direct control with normal security in general – negative case b) applied to gateway device ................................................................. 57
Figure 12 – Direct control with normal security in general – negative case b) applied to IED ................................................................. 58
Figure 13 – Direct control with normal security with status update – negative case c) applied to gateway device ................................................................. 58
Figure 14 – Direct control with normal security with status update – negative case c) applied to IED ................................................................. 59
Figure 15 – Direct control with normal security without status update – positive case applied to gateway device ................................................................. 59
Figure 16 – Direct control with normal security without status update – positive case applied to IED ................................................................. 60
Figure 17 – Direct control with enhanced security – positive case applied to gateway device ................................................................. 62
Figure 18 – Direct control with enhanced security – positive case applied to IED ................................................................. 63
Figure 19 – Direct control with enhanced security – negative case c) applied to gateway device ................................................................. 64
Figure 20 – Direct control with enhanced security – negative case c) applied to IED ................................................................. 64
Figure 21 – Direct control with enhanced security – negative case d) applied to gateway device ................................................................. 65
Figure 22 – Direct control with enhanced security – negative case d) applied to IED ................................................................. 65
Figure 23 – SBOw control – positive case applied to gateway device .................. 67
Figure 24 – SBOw control – positive case applied to IED .................................. 67
Figure 25 – SBOw control – negative case a) applied to gateway device .............. 68
Figure 26 – SBOw control – negative case a) applied to IED ............................. 68
Figure 27 – SBOw control – negative case b) applied to gateway device .............................................. 69
Figure 28 – SBOw control – negative case b) applied to IED .............................................................. 69
Figure 29 – SBOw control – negative case c) applied to gateway device ............................................ 70
Figure 30 – SBOw control – negative case c) applied to IED .............................................................. 70
Figure 31 – SBO with enhanced security – positive case applied to gateway device ...................... 71
Figure 32 – SBO with enhanced security – positive case applied to IED .............................................. 72
Figure 33 – SBO with enhanced security – negative case a) applied to gateway device .............. 72
Figure 34 – SBO with enhanced security – negative case a) applied to IED ........................................ 73
Figure 35 – SBO with enhanced security – negative case b) applied to gateway device ........ 73
Figure 36 – SBO with enhanced security – negative case b) applied to IED ........................................ 74

Table 1 – Mapping structure CDC onto ASDU type ........................................................................... 18
Table 2 – CDC: Single point status (SPS) ........................................................................................... 20
Table 3 – CDC: Single point status (SPS) mapping ............................................................................ 20
Table 4 – CDC: Double point status (DPS) ......................................................................................... 20
Table 5 – CDC: Double point status (DPS) mapping .......................................................................... 21
Table 6 – CDC: Integer status (INS) .................................................................................................. 21
Table 7 – CDC: Integer status (INS) mapping ..................................................................................... 22
Table 8 – CDC: Protection activated information (ACT) ................................................................... 23
Table 9 – CDC: Protection activated information (ACT) mapping ..................................................... 24
Table 10 – CDC: Protection activated information (ACD) ................................................................. 25
Table 11 – CDC: Directional protection activated information (ACD) mapping ............................ 26
Table 12 – CDC: Security violation counting (SEC) ........................................................................... 27
Table 13 – CDC: Security violation counting (SEC) mapping ............................................................ 27
Table 14 – CDC: Binary counter reading (BCR) ............................................................................... 28
Table 15 – CDC: Binary counter reading (BCR) mapping ................................................................. 28
Table 16 – CDC: Measured value (MV) .............................................................................................. 29
Table 17 – CDC: Measured value (MV) mapping ............................................................................... 29
Table 18 – CDC: Complex measured value (CMV) ......................................................................... 30
Table 19 – CDC: Complex measured value (CMV) mapping ............................................................. 31
Table 20 – CDC: Phase to ground related measured values of a three-phase system (WYE) ............ 32
Table 21 – CDC: Phase to phase measured values of a three phase system (DEL) ....................... 33
Table 22 – CDC: Sequence (SEQ) .................................................................................................... 33
Table 23 – CDC: Harmonic value (HMV) .......................................................................................... 34
Table 24 – CDC: Harmonic value (HMV) mapping ........................................................................... 34
Table 25 – CDC: Harmonic value for WYE (HWYE) ...................................................................... 35
Table 26 – CDC: Harmonic value for DEL (HDEL) ............................................................................ 35
Table 27 – CDC: Controllable single point (SPC) .............................................................................. 36
Table 28 – CDC: Controllable single point (SPC) mapping ............................................................... 37
Table 29 – CDC: Controllable double point (DPC) .......................................................................... 38
Table 30 – CDC: Controllable double point (DPC) mapping ............................................................ 39
Table 31 – CDC: Controllable integer status (INC) .......................................................................... 40
Table 32 – CDC: Controllable integer status (INC) mapping .................................................. 41
Table 33 – CDC: Binary controlled step position information (BSC) ....................................... 42
Table 34 – CDC: Binary controlled step position information (BSC) mapping of data attributes of the functional constraint ST ................................................................. 42
Table 35 – CDC: Binary controlled step position information (BSC) mapping of data attributes of the functional constraint CO ................................................................. 43
Table 36 – CDC: Integer-controlled step position information (ISC) ....................................... 44
Table 37 – CDC: Integer-controlled step position information (ISC) mapping of data attributes of the functional constraint ST ................................................................. 45
Table 38 – CDC: Integer-controlled step position information (ISC) mapping of data attributes of the functional constraint CO ................................................................. 46
Table 39 – CDC: Controllable analogue set point information (APC) ..................................... 46
Table 40 – CDC: Controllable analogue set point information (APC) mapping of data attributes of the functional constraint MX ................................................................. 46
Table 41 – CDC: Controllable analogue set point information (APC) mapping of data attributes of the functional constraint SP ................................................................. 47
Table 42 – CDC: Single point setting (SPG) .......................................................................... 47
Table 43 – CDC: Integer status setting (ING) ....................................................................... 48
Table 44 – CDC: Analogue settings (ASG) ............................................................................ 48
Table 45 – Services requiring client/server communication profile ......................................... 49
Table 46 – Server services mapping ..................................................................................... 50
Table 47 – Association services mapping .............................................................................. 50
Table 48 – Logical nodes services mapping ........................................................................... 51
Table 49 – Data services mapping ........................................................................................ 51
Table 50 – Setting group services mapping .......................................................................... 52
Table 51 – Report control block services mapping ................................................................ 53
Table 52 – Direct control with normal security services mapping ......................................... 54
Table 53 – Direct control with enhanced security services mapping .................................... 54
Table A.1 – Extension of the "P" element types to hold IEC 60870-5-101 information ............. 133
Table A.2 – Extension of the "P" element types to hold IEC 60870-5-104 information ............. 135
Table A.3 – Extension of the "P" element types using redundancy groups ............................. 136
FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.

2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.

3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.

4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.

5) IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with an IEC Publication.

6) All users should ensure that they have the latest edition of this publication.

7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.

8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.

9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. In exceptional circumstances, a technical committee may propose the publication of a technical specification when

- the required support cannot be obtained for the publication of an International Standard, despite repeated efforts, or
- the subject is still under technical development or where, for any other reason, there is the future but no immediate possibility of an agreement on an International Standard.

Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC 61850-80-1, which is a technical specification, has been prepared by IEC technical committee 57: Power systems management and associated information exchange.
The text of this technical specification is based on the following documents:

<table>
<thead>
<tr>
<th>Enquiry draft</th>
<th>Report on voting</th>
</tr>
</thead>
<tbody>
<tr>
<td>57/916/DTS</td>
<td>57/969/RVC</td>
</tr>
</tbody>
</table>

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

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

The bold characters in some tables are used to highlight the most essential terms or functions inside the figures to improve readability. Shading of parts of the figures is used for the same purpose.

A list of all parts of the IEC 61850 series, published under the general title Communication networks and systems for power utility automation, can be found on the IEC website.

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

- transformed into an International standard,
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual edition of this document may be issued at a later date.
1 Scope and object

This technical specification gives a guideline on how to exchange information from a CDC-based data model (for example IEC 61850) using IEC 60870-5-101 or IEC 60870-5-104 between substation(s) and control center(s). Mostly guidelines for functions needed in a substation gateway device are given.

The goal of this technical specification is to describe standardized mapping of device-oriented data models (for example IEC 61850) with already defined attributes of CDC's and services (for example IEC 61850-7) onto the already defined ASDU's and services of IEC 60870-5-104 or IEC 60870-5-101. It is not the goal of this technical specification to add any extensions to published standards (for example IEC 61850 or IEC 60870-5-104 or IEC 60870-5-101).

After an introduction giving a basic description of the mapping, the mapping of the information model with associated data classes, and the mapping of services are described. Clause 9 shows how the mapped data and services according to the IEC 60870-5-104 and IEC 60870-5-101 protocol are marked (selected) in the interoperability sheet.

The scope of this technical specification is to achieve real-time exchange of process information required for operational purposes between a substation using a CDC-based data model (for example IEC 61850) and (a) control centre(s) using a communication link over a wide area network (WAN) compliant to the definitions of IEC 60870-5-104 or IEC 60870-5-101. The amount of real-time information provided by the substation-gateway device can vary dependent on the operational needs. Actors could be regional and nationwide control centers that receive real-time information in order to monitor and control geographically widespread processes. The described mapping can be used for several fields of application of power utilities, such as substations, hydro and wind power plants, and decentralized energy resources DER. The mapping is based on the definitions of the standard series IEC 61850 Edition 1.0 and IEC 60870-5-104:2006/IEC 60870-5-101:2003. The scope of the mapped IEC 60870-5-104 and IEC 60870-5-101 subset is given in Clause 9.

This technical specification focuses mainly on defining rules and functions of a gateway device as a part of the substation. However, the rules and functions are also valid when an IED may optionally be connected directly to a WAN compliant with IEC 60870-5-101 or IEC 60870-5-104 and therefore, the mapping has to be done inside the IED.

2 Normative references

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

IEC 60870-5-3, Telecontrol equipment and systems – Part 5: Transmission protocols – Section 3: General structure of application data

IEC 60870-5-4:1993, Telecontrol equipment and systems – Part 5: Transmission protocols – Section 4: Definition and coding of application information elements
3 Abbreviated terms

For the purposes of this document, the following abbreviated terms apply.

- ACSI Abstract communication service interface (defined for example in IEC 61850-7-2)
- ASDU Application service data unit
- CASDU Common address of ASDU
- CDC Common data class (defined for example in IEC 61850-7-3)
- CI Counter interrogation
- COT Cause of transmission
- GI General interrogation
- GOOSE Generic object oriented substation event
- HMI Human machine interface
- IED Intelligent electronic device
- IOA Information object address
- LD Logical device

IEC 61850 (all parts), Communication networks and systems in substations

IEC 61850-6, Communication networks and systems in substations – Part 6: Configuration description language for communication in electrical substations related to IEDs

IEC 61850-7-2:2003, Communication networks and systems in substations – Part 7-2: Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)

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

IEC 61850-8-1, Communication networks and systems in substations – Part 8-1: Specific Communications Service Mapping (SCSM) – Mapping to MMS (ISO 9506-1 and ISO 9506-2) and to ISO/IEC 8802-3

Document 57/963/INF: IEC 61850 – Technical issues (see www.tissue.iec61850.com)

IEC 61400-25-2, Wind turbines – Part 25-2: Communications for monitoring and control of wind power plants – Information models


RFC 2200, Internet Official Protocol Standards, Request for Comments 2200 (June 1997)