



BSI Standards Publication

Communication networks and systems for power utility automation

Part 80-1: Guideline to exchanging
information from a CDC-based data
model using IEC 60870-5-101 or
IEC 60870-5-104

National foreword

This Published Document is the UK implementation of IEC/TS 61850-80-1:2016. It supersedes DD CLC/TS 61850-80-1:2010 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/57, Power systems management and associated information exchange.

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

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**Communication networks and systems for power utility automation –
Part 80-1: Guideline to exchanging information from a CDC-based data model
using IEC 60870-5-101 or IEC 60870-5-104**

INTERNATIONAL
ELECTROTECHNICAL
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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104

FOREWORD

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- 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.

This second edition cancels and replaces the first edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- a) IEC TS 61850-80-1:2008 is based on the definitions of IEC 61850 Edition 1. After the publication of IEC TS 61850-80-1:2008 the standard series IEC 61850 was updated to Edition 2 (almost all parts);
- b) In particular, IEC 61850-7-3:2010 introduces new Common Data Classes (CDCs) which are currently not mapped to IEC 60870-5-101 or IEC 60870-5-104 in IEC 61850-80-1:2008. Those new CDCs are: ENS, HST, VSS, ENC, BAC, ENG, ORG, TSG, CUG, VSG, CSG. IEC 61400-25-4, which is currently being updated, makes reference to IEC TS 61850-80-1:2008 and therefore needs to be updated according to the definitions of this second edition of IEC 61850. The following CDCs are missing in the IEC 61850-80-1:2008 and have therefore been added to this new edition for IEC 61400-25-4 Edition 2: ENS, ENC, ENG, ORG.

The text of this technical specification is based on the following documents:

Enquiry draft	Report on voting
57/1649/DTS	57/1726/RVC

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.

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 stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- 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.

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 80-1: Guideline to exchanging information from a CDC-based data model using IEC 60870-5-101 or IEC 60870-5-104

1 Scope

This part of IEC 61850, which is a 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 CDCs and services (for example IEC 61850-7) onto the already defined ASDUs 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 center(s) using a communication link over a wide area network (WAN) compliant to the definitions of IEC 60870-5-101 or IEC 60870-5-104. 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 IEC 61850 series 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.

To enable an automated database management approach, which aims to ensure consistency between the databases of substations and control centers, the SCD file (substation configuration description) can be extended with IEC 60870-5-101/IEC 60870-5-104 specific information to configure the 61850 to 101/104 gateway. How the SCD file can be extended is described in Annex A.

The extended substation configuration description (SCD+) is recommended to be used to configure any gateway in a vendor independent format.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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*

IEC 60870-5-5:1995, *Telecontrol equipment and systems – Part 5: Transmission protocols – Section 5: Basic application functions*

IEC 60870-5-101, *Telecontrol equipment and systems – Part 5-101: Transmission protocols – Companion standard for basic telecontrol tasks*

IEC 60870-5-104:2006, *Telecontrol equipment and systems – Part 5-104: Transmission protocols – Network access for IEC 60870-5-101 using standard transport profiles*

IEC 61850 (all parts), *Communication networks and systems for power utility automation*

IEC 61850-6, *Communication networks and systems for power utility automation – 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 information and communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation – Part 7-2: Basic information and communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)*

IEC 61850-7-3:2003, *Communication networks and systems in substations – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-7-3:2010, *Communication networks and systems for power utility automation – Part 7-3: Basic communication structure – Common data classes*

IEC 61850-8-1, *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*

IEEE 754:2008, *IEEE Standard for Binary Floating-Point Arithmetic*

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

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
LN	Logical node
PI	Process image
P/N	Positive/negative
QOI	Qualifier of interrogation
QDS	Quality descriptor
RFC	Request for comments
S/E	Select/execute
SCL	Substation configuration language (defined for example in IEC 61850-6)
TI	Type Identification
TISSUE	Technical issue as part of the maintenance process of IEC 61850
WAN	Wide area network
XML	Extensible mark-up language

4 The mapping architecture

The mapping architecture consists of five parts:

- 1) conceptual architecture of a gateway device and associated use cases;
- 2) conceptual architecture of an IED directly connected to a WAN (optional);
- 3) mapping of the information model;
- 4) mapping of the data (which is in fact part of the information model);
- 5) mapping of the services.

5.1.1 General

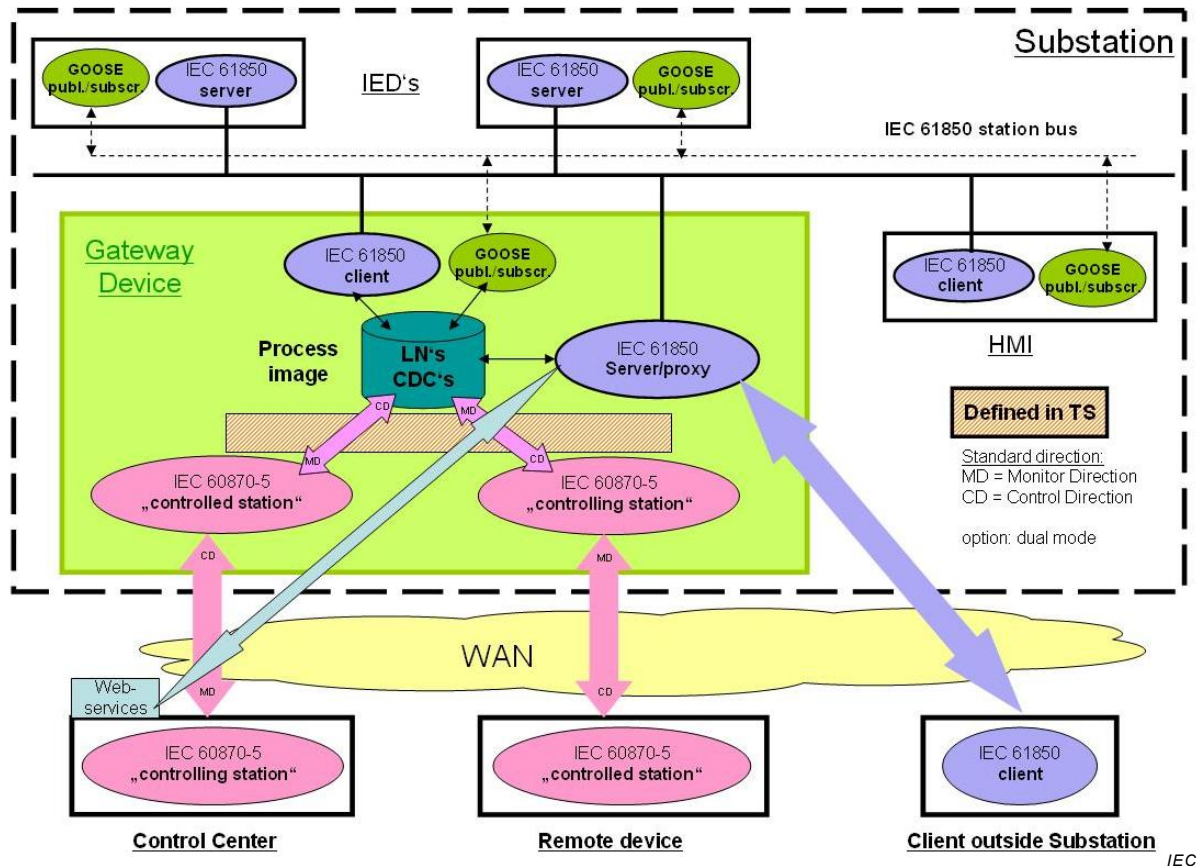


Figure 1 describes the conceptual architecture of a gateway device within a substation. The gateway device is decoupling the IEC 61850 station bus from the IEC 60870-5-101 or IEC 60870-5-104 WAN via a process image (PI). The advantage of this approach is that only services for control model interaction need to be mapped.

The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

- make process data coming from remote devices available for IEDs inside the substation;
- retrieve the data model for:
 - IEC 61850 clients inside the substation (for example HMI);
 - IEC 61850 clients outside the substation (for example future control centers);
 - existing control centers using IEC 60870-5-101 or IEC 60870-5-104 for WAN communication by using additional services (for example SCL extensions or web services).

The IEC 60870-5-101 or IEC 60870-5-104 controlled and controlling functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers or “devices on the WAN network” using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

The IEC 60870-5-101 or IEC 60870-5-104 controlling functionality inside the gateway device is used to connect “devices on the WAN network” with IEC 60870-5-101 or IEC 60870-5-104 controlled functionality to the substation.

The gateway device can optionally act as a “mediator” between the substation and all “devices on the WAN network”. When IEC 60870-5-101 or IEC 60870-5-104 “dual mode functionality” is used, the same ASDUs are used in the monitor and the control direction on the WAN.

5.1.2 Use case a) for a gateway device

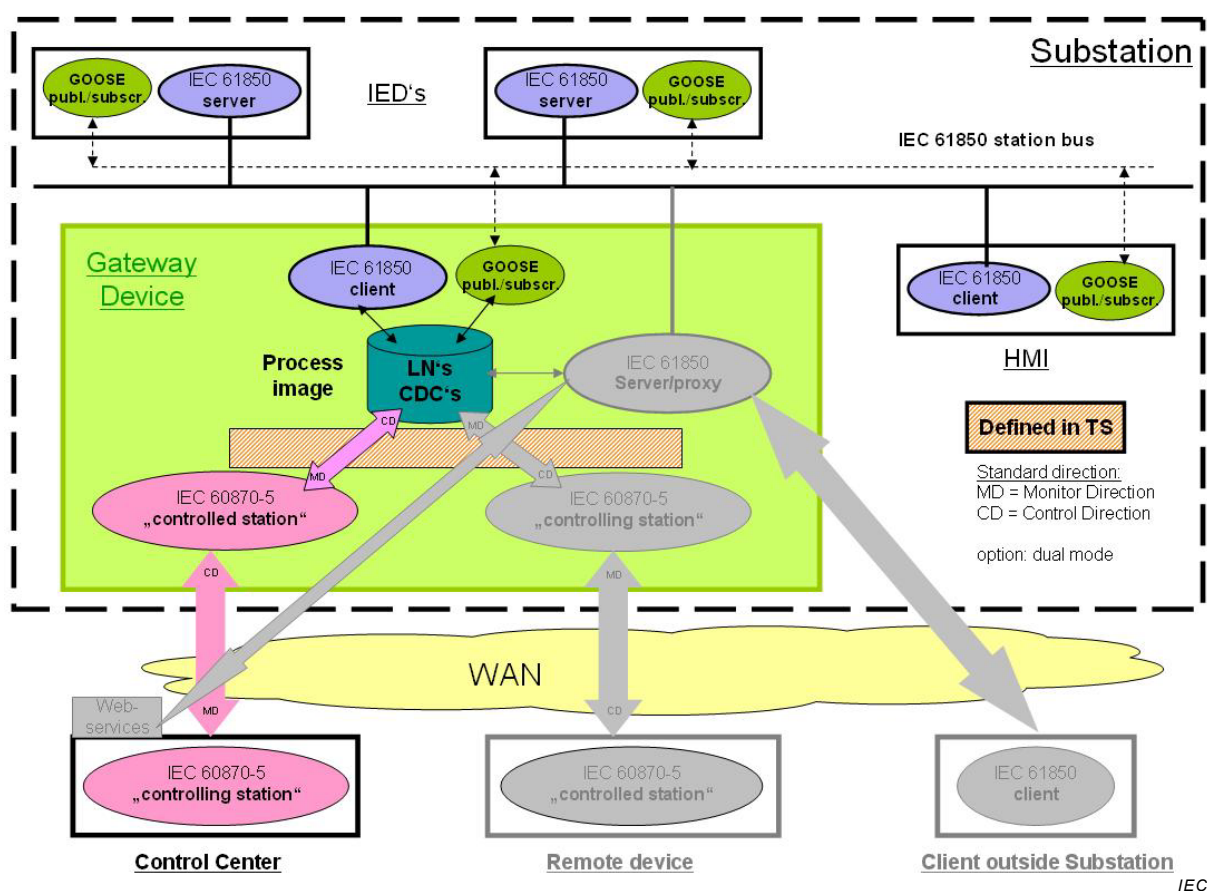


Figure 2 – Use case a) for a gateway device

Figure 2 describes use case a) using a subset of functions of the conceptual architecture. The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 60870-5-101 or IEC 60870-5-104 controlled functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

5.1.3 Use case b) for a gateway device

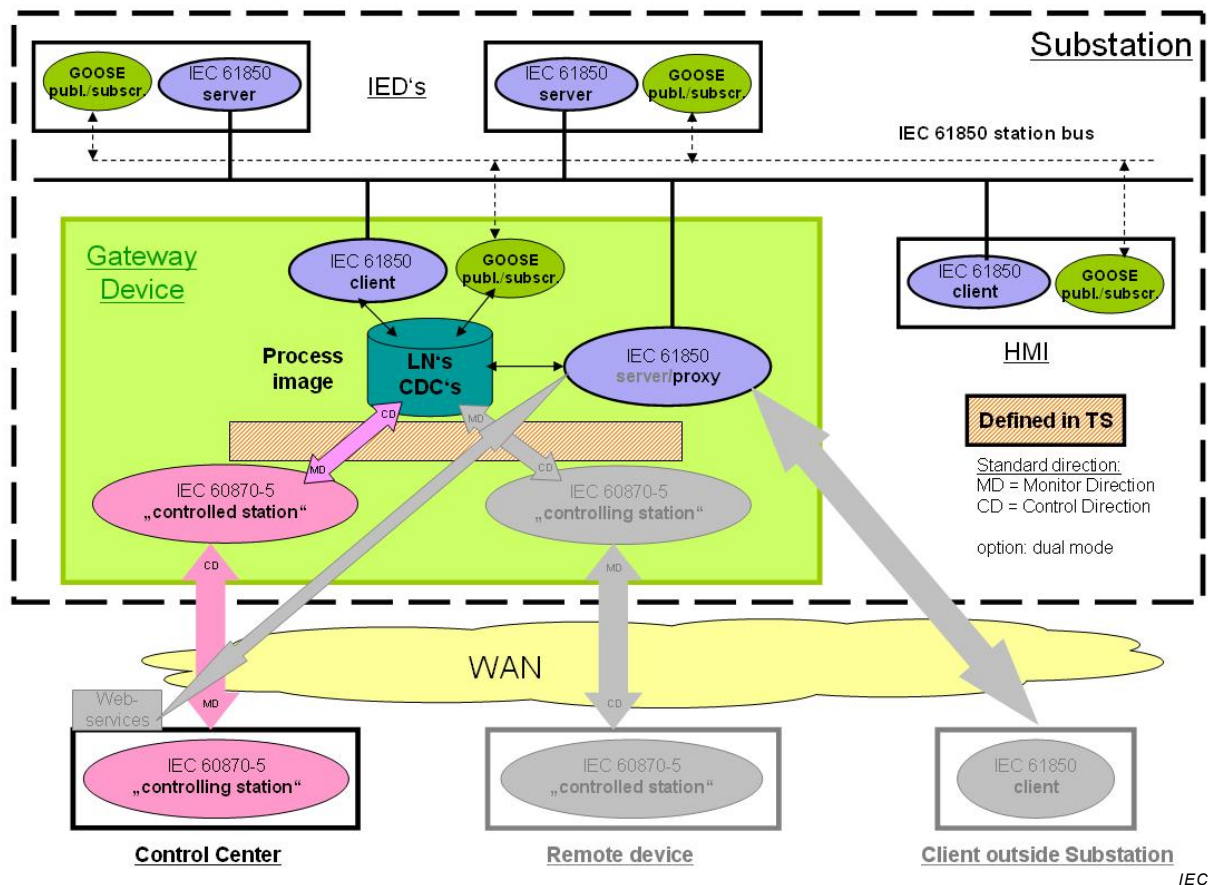


Figure 3 – Use case b) for a gateway device

Figure 3 describes use case b) using an extended subset of functions of the conceptual architecture.

The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 61850 proxy is used to retrieve the data model for IEC 61850 clients inside the substation (for example HMI).

The IEC 60870-5-101 or IEC 60870-5-104 controlled functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

5.1.4 Use case c) for a gateway device

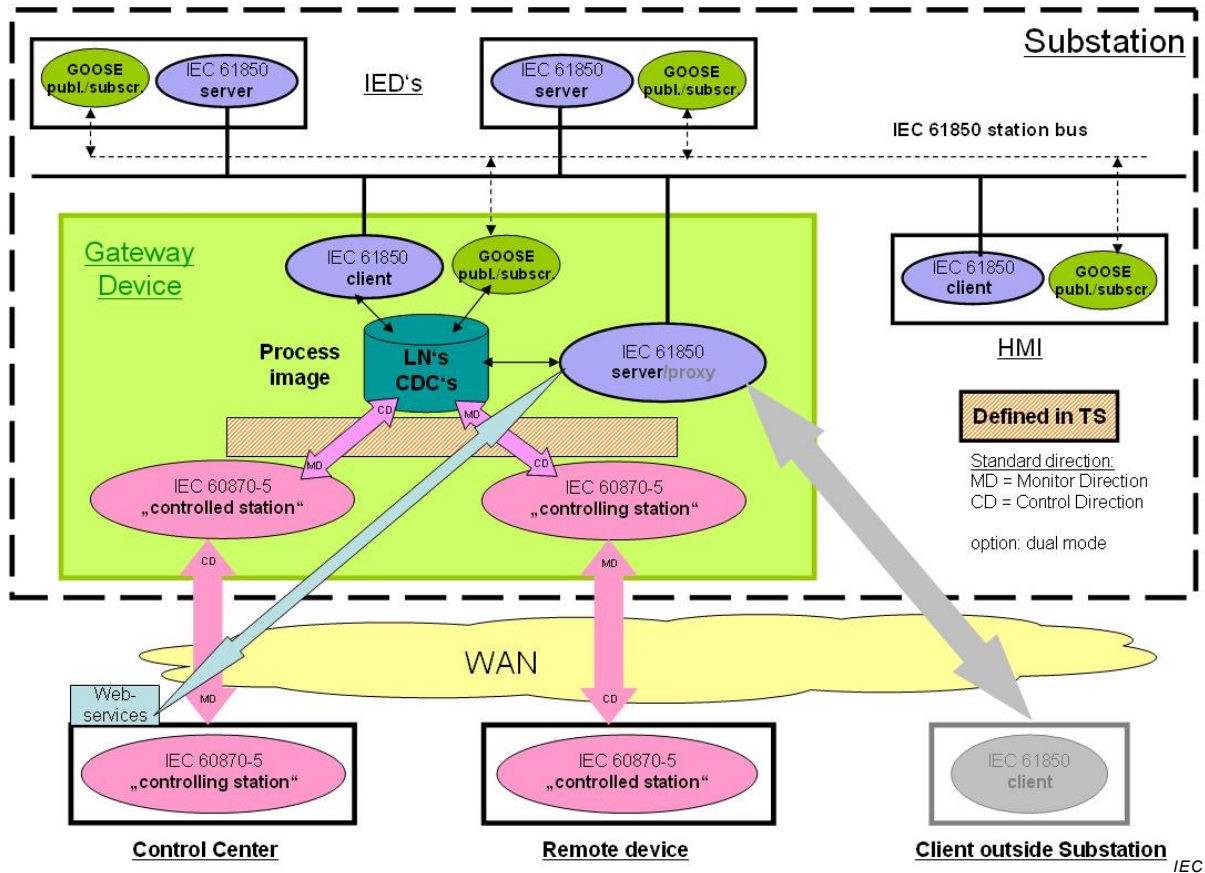


Figure 4 – Use case c) for a gateway device

Figure 4 describes use case c) using nearly all functions of the conceptual architecture. The IEC 61850 client/GOOSE subscriber is used to update the PI with process data made available by the IEDs.

The IEC 61850 server is used to:

- make process data coming from remote devices available for IEDs inside the substation;
- retrieve the data model for:
 - IEC 61850 clients inside substation (for example HMI);
 - existing control centers using IEC 60870-5-101 or IEC 60870-5-104 for WAN communication by using additional services (for example SCL extensions or web services).

The IEC 60870-5-101 or IEC 60870-5-104 controlled and controlling functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers or “devices on the WAN network” using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104 (including redundant connections).

The IEC 60870-5-101 or IEC 60870-5-104 controlling functionality inside the gateway device is used to connect “devices on the WAN network” with IEC 60870-5-101 or IEC 60870-5-104 controlled functionality to the substation.

The gateway device can optionally act as a “mediator” between the substation and all “devices on the WAN network”. When IEC 60870-5-101 or IEC 60870-5-104 “dual mode functionality” is used, the same ASDUs are used in the monitor and the control direction on the WAN.

5.2 Conceptual architecture of an IED directly connected to a WAN (optional)

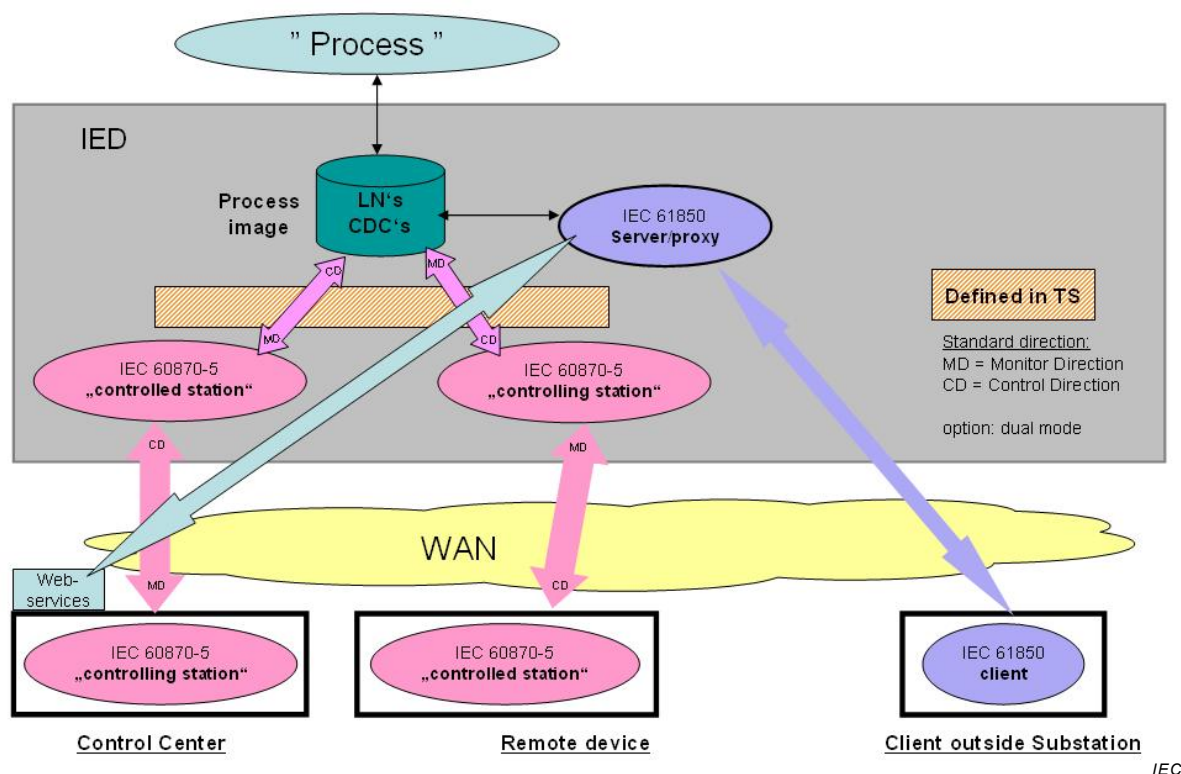


Figure 5 – Conceptual architecture of an IED

Figure 5 shows the conceptual architecture of an IED which optionally may be connected directly to a WAN compliant to IEC 60870-5-104 or IEC 60870-5-101. However, the rules and functions defined for a gateway device as a part of a substation are also valid for the mapping inside an IED.

The IED decouples the process information from the IEC 60870-5-101 or IEC 60870-5-104 WAN via a process image (PI). The advantage of this approach is that only services for control model interaction need to be mapped.

The PI is organized according the data model of IEC 61850 (LDs, LNs, CDCs).

The IEC 61850 server/proxy is used to:

- make process data coming from remote devices available for the process connected to the IED;
- retrieve the data model for:
 - IEC 61850 clients outside the substation (for example future control centers);
 - existing control centers using IEC 60870-5-101 or IEC 60870-5-104 for WAN communication by using additional services (for example SCL extensions or web services).

The IEC 60870-5-101 or IEC 60870-5-104 controlled and controlling functionality makes use of the attributes of CDCs in a defined way to build up ASDUs to communicate with control centers or “devices on the WAN network” using WAN communication based on IEC 60870-5-101 or IEC 60870-5-104.

The IEC 60870-5-101 or IEC 60870-5-104 controlling functionality inside the IED is used to connect “devices on the WAN network” with IEC 60870-5-101 or IEC 60870-5-104 controlled functionality to the IED.

The IED can optionally act as a “mediator” between the IED and all “devices on the WAN network”. When IEC 60870-5-101 or IEC 60870-5-104 “dual mode functionality” is used, the same ASDUs are used in the monitor and the control direction on the WAN.

6 Mapping of a device-oriented information model to IEC 60870-5-104 or IEC 60870-5-101

6.1 General

The defined mapping for a device-oriented information model is based on using existing functionalities in IEC 60870-5-104 or IEC 60870-5-101 by using the

- common address of ASDU (CASDU), and the
- information object address (IOA)

to accommodate the device model using LD (logical device) and LN (logical node) and transfer of real-time information (data) using standardized ASDUs. The same is applicable for the services and the basic application functions in IEC 60870-5-104 or IEC 60870-5-101.

6.2 Mapping of a device-oriented information model reference

The device-oriented information model (for example IEC 61850) shall be mapped to a hierarchical structure. The conceptual mapping is depicted in Figure 6. The device-oriented information model (for example IEC 61850) is intended to be preserved when mapped to IEC 60870-5-104 or IEC 60870-5-101. This especially means that

- the server/proxy implements the hierarchical device-oriented information model of, for example, IEC 61850 that can be retrieved by the services according to Clause 8;
- the client implements the device-oriented information model by configuration. That can be done in different ways:
 - by using the SCL file, specifying the implemented information model, mapping and addressing details according to the rules in IEC 61850-6;
 - by other configuration methods.
- the master/client station ("controlling station") accesses the hierarchical device-oriented information model of, for example, IEC 61850 through the services provided by IEC 60870-5-104 or IEC 60870-5-101 to exchange real-time data.

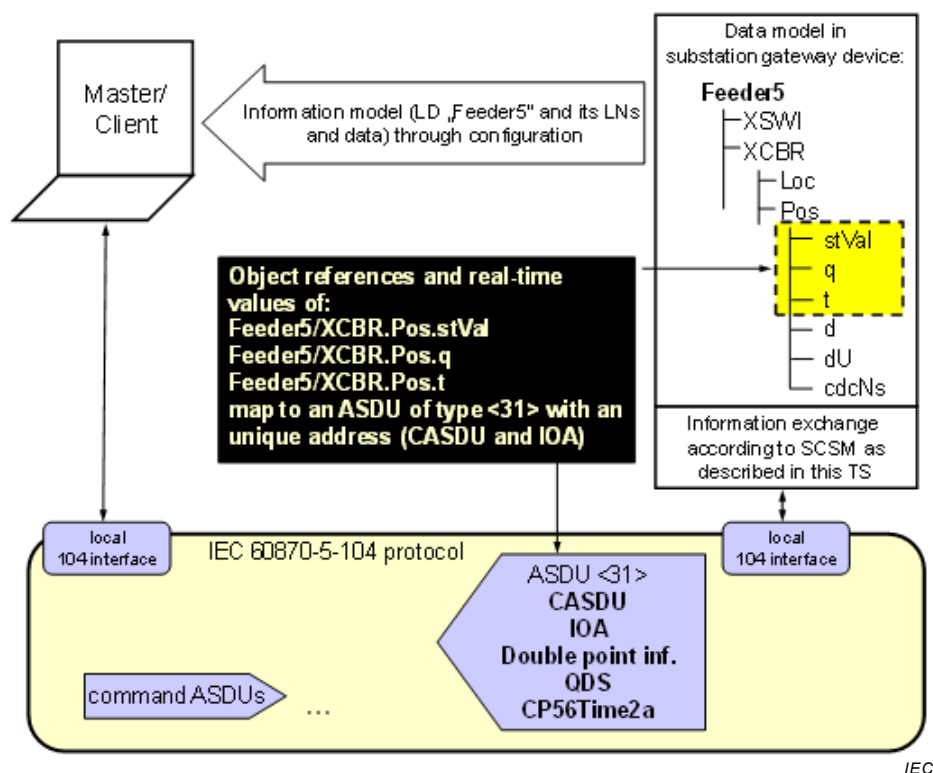


Figure 6 – Mapping architecture (conceptual)

6.3 Logical device class mapping

The logical device reference shall map to the common address of ASDU (CASDU).

The CASDU may be structured or unstructured. For example, the CASDU may identify the station ID and the logical device instance ID. It is recommended to make an addressing scheme in order to have unique address for the specific station. For example, for small stations, one CASDU can be assigned for a station, all LD will then have the same CASDU. For a large station several CASDU can be used to identify each LD. The maximum number of CASDU for one link is 65 534.

6.4 Logical node class mapping

The logical node instance ID and data attribute reference shall map to the information object address (IOA).

All attributes of the LN class are implicitly defined and visible. The IOA may be structured or unstructured. For both cases, a decimal approach for defining the IOA addresses is recommended. The maximum number of IOA addresses per CASDU is 65 536.

7 Mapping of the common data classes (CDC)

7.1 List of CDC, type Identifications and corresponding mappings for IEC 61850

Each common data class consists of one or more data attributes of a specific data type. Each data attribute shall be mapped to one specific IOA (as in 6.4). In IEC 60870-5-104 or IEC 60870-5-101, each IOA is directly related to a specific ASDU type (with or without time). Therefore, the CDC is basically mapped as in Table 1.

The mapping shown in Table 1 shall be considered as a default mapping – carefully selected out of a variety of mapping possibilities.

The requirements for the mapping of LD, LN onto CASDU, IOA can vary in different fields of application. The most suitable way of mapping should be defined on a utility or project basis depending on the specific needs. CASDU and IOA in IEC 60870-5-101 or IEC 60870-5-104 are just numbers which have to be unique within one Utility/project.

Table 1 – Mapping structure CDC onto ASDU type

CDCs defined in IEC 61850-7-3:2003	
CDC (Attribute data types)	ASDU type
SPS Single point status	<i>monitor direction (status):</i> TI<30> as event TI<1> as part of GI
DPS Double point status	<i>monitor direction (status):</i> TI<31> as event TI<3> as part of GI
INS Integer status	<i>monitor direction (status):</i> TI<35> or TI<33> or TI<30> as event TI<11> or TI<7> or TI<1> as part of GI
ACT Protection activation information	<i>monitor direction (status):</i> TI<39> as event or TI<30> as event TI<1> as part of GI
ACD Directional protection activation Information	<i>monitor direction (status):</i> TI<40> as event or TI<30> as event TI<1> as part of GI
SEC Security violation counting	<i>monitor direction (status):</i> TI<37> as event or as part of CI
BCR Binary counter reading	<i>monitor direction (status):</i> TI<37> as event or as part of CI
MV Measured value	<i>monitor direction (status):</i> TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
CMV Complex measured value	<i>monitor direction (status):</i> TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
WYE Phase to ground related measured values in a three phase system	<i>monitor direction (status):</i> via CMV to TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
DEL Phase to phase related measured values in a three phase system	<i>monitor direction (status):</i> via CMV to TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
SEQ Sequence	<i>monitor direction (status):</i> via CMV to TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
HMV Harmonic value	<i>monitor direction (status):</i> according IEC 61850-7-3:2003 TI<36> as event TI<13> as part of GI according IEC 61850-7-3:2010 via CMV TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
HWYE Harmonic value for WYE	<i>monitor direction (status):</i> according IEC 61850-7-3:2003 similar as HMV (Ed.1) to TI<36> as event TI<13> as part of GI according IEC 61850-7-3:2010 similar as HMV (Ed.2) to TI<36> or TI<35> as event TI<13> or TI<11> as part of GI

CDCs defined in IEC 61850-7-3:2003	
CDC (Attribute data types)	ASDU type
HDEL Harmonic value for DEL	<i>monitor direction (status):</i> according IEC 61850-7-3:2003 similar as HMV (Ed.1) to TI<36> as event TI<13> as part of GI according IEC 61850-7-3:2010 similar as HMV (Ed.2) to TI<36> or TI<35> as event TI<13> or TI<11> as part of GI
SPC Controllable single point	<i>monitor direction (status):</i> TI<30> as event TI<1> as part of GI <i>control direction (command):</i> TI<45> (without time tag) or TI<58> (with time tag)
DPC Controllable double point	<i>monitor direction (status):</i> TI<31> as event TI<3> as part of GI <i>control direction (command):</i> TI<46> (without time tag) or TI<59> (with time tag)
INC Controllable integer status	<i>monitor direction (status):</i> TI<35> as event TI<11> as part of GI <i>control direction (command):</i> TI<49> (without time tag) or TI<62> (with time tag)
BSC Binary controlled step position information	<i>monitor direction (status):</i> TI<32> as event TI<5> as part of GI <i>control direction (command):</i> TI<47> (without time tag) or TI<60> (with time tag)
ISC Integer-controlled step position information	<i>monitor direction (status):</i> TI<32> as event TI<5> as part of GI <i>control direction (setpoint):</i> TI<49> (without time tag) or TI<62> (with time tag)
APC Controllable analogue set point information	<i>monitor direction (status):</i> TI<36> as event TI<13> as part of GI <i>control direction (command):</i> TI<50> (without time tag) or TI<63> (with time tag)
SPG Single point setting	<i>control direction (command):</i> TI<45> (without time tag) or TI<58> (with time tag)
ING Integer status setting	<i>control direction (setpoint):</i> TI<49> (without time tag) or TI<62> (with time tag)
ASG Analogue setting	<i>control direction (setpoint):</i> TI<50> (without time tag) or TI<63> (with time tag)
Additional CDCs defined in IEC 61400-25-2	
CDC (Attribute data types)	ASDU type
STV Status value	Mapped via CDC INS Integer status
SPV Setpoint value	Mapped via CDC APC Controllable analogue set point information
ALM Alarm	Mapped via CDC INS Integer status for Data Attribute actVal CDC SPC Controllable single point for Data Attribute almAck
CMD Command	Mapped via CDC INC Controllable integer status
CTE Event counting	Mapped via CDC INS Integer status for DataAttribute actCtVal CDC SPC Controllable single point for DataAttribute manRs

Additional CDCs defined in IEC 61400-25-2	
CDC (Attribute data types)	ASDU type
TMS State timing	Mapped via CDC SPC Controllable single point for DataAttribute manRs CDC INS Integer status for DataAttribute actTmVal and for DataAttribute oldTmVal
TI:= Type Identification GI:= General Interrogation or station interrogation ASDU TI<100> CI:= Counter interrogation ASDU TI<101>	

Common data classes CURVE, DPL, LPL, CSD and SAV from IEC 61850-7-3:2003 and AST (former ASS) from IEC 61400-25-4 cannot be mapped to ASDUs of IEC 60870-5-104 or IEC 60870-5-101.

Additional CDCs defined in IEC 61850-7-3:2010	
CDC (Attribute data types)	ASDU type
ENS Enumerated status	<i>monitor direction (status):</i> TI<35> or TI <30> TI<11> or TI<1> as part of GI
HST Histogramm	<i>monitor direction (status):</i> TI<35> or TI <33> TI<11> or TI<7> as part of GI
ENC Controllable enumerated status	<i>monitor direction (status):</i> TI<35> or TI <30> TI<11> or TI<1> as part of GI <i>control direction (command):</i> TI<49> (without time tag) or TI<62> (with time tag) or TI<45> (without time tag) or TI<58> (with time tag)
ENG Enumerated status setting	<i>control direction (setpoint):</i> TI<49> (without time tag) or TI<62> (with time tag) or TI<45> (without time tag) or TI<58> (with time tag)
BAC Binary controlled analog process value	<i>monitor direction (status):</i> TI<36> as event TI<13> as part of GI <i>control direction (command):</i> TI<47> (without time tag) or TI<60> (with time tag)
CSG Curve shape setting	<i>control direction (setpoint):</i> TI<50> (without time tag) or TI<63> (with time tag)
TI:= Type Identification GI:= General Interrogation or station interrogation ASDU TI <100> CI:= Counter interrogation ASDU TI <101>	

The Common data classes VSS, ORG, TSG, CUG and VSG from IEC 61850-7-3:2010 cannot be mapped to ASDUs of IEC 60870-5-104 or IEC 60870-5-101.

The mapping of all CDC's defined for service tracking in IEC 61850-7-2:2010 – CTS, BTS, UTS, LTS, GTS, MTS, NTS, and STS – cannot be mapped to IEC 60870-5-101 or IEC 60870-5-104.

NOTE The mappings shown include the timestamp and are applicable for the monitor information if sent as an event. If the information is sent as part of GI (general interrogation/station interrogation) or CI (counter interrogation), the complete mapping is applicable, apart from the timestamp. All GI and CI data is sent excluding a timestamp.

7.2 CDC single point status (SPS)

The data attributes of the common data class SPS depicted in Table 2 shall be mapped as shown in Table 3.

Table 2 – CDC: Single point status (SPS)

SPS class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
Data attribute					
Status					
stVal	BOOLEAN	ST	dchg	TRUE FALSE	M
q	Quality	ST	qchg	Quality	M
t	TimeStamp	ST		Time value	M

The signal [stVal + q + t] shall map to the ASDU TI<30> "Single point information with time tag CP56Time2a" as specified in Table 3.

Table 3 – CDC: Single point status (SPS) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
SPS		TI<30>	
Attribute name	Attribute type	information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	BOOLEAN	SIQ	SPI: <0> OFF = FALSE <1> ON = TRUE
q	Quality		validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

7.3 CDC double point status (DPS)

The data attributes of the common data class DPS depicted in Table 4 shall be mapped as shown in Table 5.

Table 4 – CDC: Double point status (DPS)

DPS class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	CODED ENUM	ST	dchg	intermediate state off on bad state	M
q	Quality	ST	qchg	Quality	M
t	TimeStamp	ST		Time	M

The signals [stVal + q + t] shall map to the ASDU TI<31> "Double point information with time tag CP56Time2a" as specified in Table 5.

Table 5 – CDC: Double point status (DPS) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
DPS		TI<31>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	CODED ENUM	DIQ	DPI <0> intermediate state = intermediate-state <1> determined state OFF = OFF <2> determined state ON = ON <3> indeterminate = bad.state
q	Quality		validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

7.4 CDC integer status (INS)

The DataAttributes of the common data class INS depicted in Table 6 shall be mapped as shown in Table 7.

Table 6 – CDC: Integer status (INS)

INS class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
stVal	INT32	ST	dchg, dupd		M
q	Quality	ST	qchg	Quality	M
t	TimeStamp	ST		Time	M
configuration, description and extension					
units	Unit	CF	dchg	See Annex A of IEC 61850-7-3:2010	O

The signals [stVal + q + t] shall map to either ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a" or optionally ASDU TI<33> "Bitstring of 32 bits with time tag CP56Time2a" as specified in Table 7.

For the special use case that the attribute EEHealth of a logical node with the CDC INS (IEC 61850-7-4:2003) has to be mapped onto one single status to meet the requirements of existing control center systems, the signals [stVal + q + t] shall map to ASDU TI<30> "Single point information with time tag CP56Time2a".

The mapping of CDC INS to ASDU TI<33> (binary state information) is optional. It may be used if the value range for the default mapping to ASDU TI<35> (scaled value) is not sufficient.

In IEC 61850-7-3:2010 the configuration attribute "units" of type "Unit" was added to the CDC INS. The TrgOp of the attribute "units" was defined as "dchg". Furthermore the TrgOp "dupd" was added for the attribute "stVal".

The type "Unit" consists of two attributes – "SIUnit" (as mandatory) and "multiplier" (as optional), both of type ENUMERATED.

That means that optionally the attribute "units.multiplier", which might have an influence on the mapping of the value of stVal, can be mapped to ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a".

Table 7 – CDC: Integer status (INS) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INS		TI <35>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	INT32	SVA = Scaled value	SVA $16 \times 2^{15} \dots + 2^{15} - 1$ 0 map on 0 Valid range for INT32 is $<-2^{15} \dots + 2^{15} - 1>$
q	Quality	QDS = Quality descriptor	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg, qchg or dupd
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INS		TI<33>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	INT32	BSI = Binary state information	BSI:= 32BS1[1..32]<0,1>
q	Quality	QDS = Quality descriptor	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg, qchg or dupd

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
INS		TI<30>	
Attribute nme	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
stVal	INT32	SIQ	stVal:= <1> ok -> SPI:=<0> OFF = FALSE stVal:= <3> Alarm -> SPI:= <1> ON = TRUE
q	Quality		validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg, qchg or dupd

7.5 CDC protection activated information (ACT)

The data attributes of the common data class ACT depicted in Table 8 shall be mapped as shown in Table 9.

Table 8 – CDC: Protection activated information (ACT)

ACT class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status					
general	BOOLEAN	ST	dchg	TRUE FALSE	M
phsA	BOOLEAN	ST	dchg	TRUE FALSE	O
phsB	BOOLEAN	ST	dchg	TRUE FALSE	O
phsC	BOOLEAN	ST	dchg	TRUE FALSE	O
neut	BOOLEAN	ST	dchg	TRUE FALSE	O
q	Quality	ST	qchg	Quality	M
t	TimeStamp	ST		Time value	M

The signals [general + phsA + phsB + phsC + neut + q + t] shall map to the ASDU TI<39> "Packed start events of protection equipment with time tag CP56Time2a" or multiple ASDUs TI<30> "Single point information with time tag CP56time 2a" as specified in Table 9.

Table 9 – CDC: Protection activated information (ACT) mapping

a) Mapping to ASDU TI <39>			
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACT		TI<39>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	SPE	GS = general start of operation:= BS1[1]<0..1> FALSE = <0>:= no general start of operation TRUE = <1>:= general start of operation
phsA	BOOLEAN	SPE	SL1 = start of operation phase L1:= BS1[2]<0..1> FALSE = <0>:= no start of operation L1 TRUE = <1>:= start of operation L1
phsB	BOOLEAN	SPE	SL2 = start of operation phase L2:= BS1[3]<0..1> FALSE = <0>:= no start of operation L2 TRUE = <1>:= start of operation L2
phsC	BOOLEAN	SPE	SL3 = start of operation phase L3:= BS1[4]<0..1> FALSE = <0>:= no start of operation L3 TRUE = <1>:= start of operation L3
neut	BOOLEAN	SPE	SIE = start of operation IE (earth current) FALSE = <0>:= no start of operation IE TRUE = <1>:= start of operation IE
q	Quality	QDP	validity -> IV good invalid -> valid invalid questionable -> NT EI not used:= set to zero . = elapsed time valid source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

b) Mapping to ASDU TI<30>			
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACT		TI<30>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
phsA	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
phsB	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
phsC	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
neut	BOOLEAN	SIQ	SPI <0> OFF = FALSE <1> ON = TRUE
q	Quality	SIQ	validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

Each attribute maps to one ASDU TI<30> "Single point information with time tag CP56Time2a" as specified in Table 3 using consecutive indices:

IOA n := general

IOA n+1 := phsA (Optional)

IOA n+2 := phsB (Optional)

IOA n+3 := phsC (Optional)

IOA n+4 := neut (Optional)

7.6 CDC directional protection activation information (ACD)

The data attributes of the common data class ACD depicted in Table 10 shall be mapped as shown in Table 11.

Table 10 – CDC: Protection activated information (ACD)

ACD class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
status					
general	BOOLEAN	ST	dchg	TRUE FALSE	M
dirGeneral	ENUMERATED	ST	dchg	unknown forward backward both	M
phsA	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(1)
dirPhsA	ENUMERATED	ST	dchg	unknown forward backward	GC_2(1)
phsB	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(2)
dirPhsB	ENUMERATED	ST	dchg	unknown forward backward	GC_2(2)
phsC	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(3)
dirPhsC	ENUMERATED	ST	dchg	unknown forward backward	GC_2(3)
neut	BOOLEAN	ST	dchg	TRUE FALSE	GC_2(4)
dirNeut	ENUMERATED	ST	dchg	unknown forward backward	GC_2(4)
q	Quality	ST	qchg	Quality	M
t	TimeStamp	ST		Time value	M

The signals [general + phsA + phsB + phsC + neut + q + t] shall map to the ASDU TI<40> "Packed output circuit information of protection equipment with time tag CP56Time2a" or multiple ASDUs TI<30> "Single point information with time tag CP56time 2a as specified in Table 11.

Table 11 – CDC: Directional protection activated information (ACD) mapping

Without using directional attribute			
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACD		TI<40>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	OCI	GC = general command to output circuit:= BS1[1]<0..1> FALSE = <0>:= no general command to output circuit TRUE = <1>:= general command to output circuit
phsA	BOOLEAN	OCI	CL1 = command to output circuit phase L1:= BS1[2]<0..1> FALSE = <0>:= no command to output circuit phase L1 TRUE = <1>:= command to output circuit phase L1
phsB	BOOLEAN	OCI	CL2 = command to output circuit phase L2:= BS1[3]<0..1> FALSE = <0>:= no command to output circuit phase L2 TRUE = <1>:= command to output circuit phase L2
phsC	BOOLEAN	OCI	CL3 = command to output circuit phase L3:= BS1[4]<0..1> FALSE = <0>:= no command to output circuit phase L3 TRUE = <1>:= command to output circuit phase L3
q	Quality	QDP	validity -> IV good invalid -> valid invalid questionable -> NT EI not used:= set to zero:= elapsed time valid source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

Use of directional attribute			
CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
ACD		TI<30>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
general	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
phsA	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
phsB	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
phsC	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
neut	BOOLEAN	SIQ	SPI <0> OFF:= FALSE <1> ON:= TRUE
q	Quality	SIQ	validity -> IV good invalid -> valid invalid questionable -> NT source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence for object

Each value of direction attribute maps to one ASDU TI<30> "Single point information with time tag CP56Time2a" as specified in Table 3 using consecutive indices:

IOA n := general + unknown
IOA n+1 := general + forward
IOA n+2 := general + backward
IOA n+3 := general + both
IOA n+4 := phsA + unknown
..

IOA n+7 := phsB + unknown
..

IOA n+10 := phsC + unknown
..

IOA n+13 := neut + unknown
..
IOA n+15 := neut + backward

7.7 CDC Security violation counting (SEC)

The data attribute of the common data class SEC depicted in Table 12 shall be mapped as shown in Table 13.

Table 12 – CDC: Security violation counting (SEC)

SEC class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Status					
cnt	INT32U	ST	dchg		M
t	TimeStamp	ST		Time value	M

The signal [cnt + t] shall map to the ASDU TI<37> "Integrated totals with time tag CP56Time2a" as specified in Table 13.

Table 13 – CDC: Security violation counting (SEC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
SEC		TI<37>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
cnt	INT32U	BCR	Counter reading ... I32 <-2 ³¹ ..+2 ³¹ -1>
t	TimeStamp		Seven octet binary time, CP56Time2a – Time of occurrence of dchg
		BCR-□sequence notation	SQ:= sequence number = set to zero CY:= carry = set to zero CA:= counter was adjusted = set to zero IV:= validity good -> valid

7.8 CDC binary counter reading (BCR)

The data attribute of the common data class BCR depicted in Table 14 shall be mapped as shown in Table 15.

Table 14 – CDC: Binary counter reading (BCR)

BCR class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from Data Class (see IEC 61850-7-2)				
DataAttribute					
Status					
actVal	INT128 / INT64	ST	dchg		M
frVal	INT128 / INT64	ST	dupd		GC_2(1)
frTm	TimeStamp	ST		Time value	GC_2(1)
q	Quality	ST	qchg	Quality	M
t	TimeStamp	ST		Time value	M
configuration, description and extension					
units	Unit	CF	dchg	See Annex A of IEC 61850-7-3:2010	O

The signal [actVal + q + t] shall map to ASDU TI<37> "Integrated totals with time tag CP56Time2a" with IOA n and the *optional* signal [frVal + frTm + q] shall map to ASDU TI<37> "Integrated totals with time tag CP56Time2a" with IOA n+1 as specified in Table 15.

The type "Unit" consists of two attributes – "SIUnit" (as mandatory) and "multiplier" (as optional), both of type ENUMERATED.

Optionally the attribute "units.multiplier", which might have an influence on the mapping of the value of actVal or frVal, can be mapped to ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a".

Table 15 – CDC: Binary counter reading (BCR) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
BCR		TI<37>	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
actVal	INT128 / INT64	BCR = Binary Counter Reading	counter reading I32 $\langle -2^{31}..+2^{31}-1 \rangle$
q	Quality	BCR-sequence notation	SQ:= sequence number = set to zero CY:= carry = set to zero CA:= counter was adjusted = set to zero IV:= validity good -> valid
t	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg
frVal	INT128 / INT64	BCR = Binary Counter Reading	counter reading I32 $\langle -2^{31}..+2^{31}-1 \rangle$
frTm	TimeStamp	CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dupd, dchg or qchg
q	Quality	BCR-sequence notation	SQ:= sequence number = set to zero CY:= carry = set to zero CA:= counter was adjusted = set to zero IV:= validity good -> valid

In IEC 61850-7-3:2010 the attribute type of "actVal" and "frVal" have been changed to INT64. The gateway or proxy shall take the least significant 31 bits plus sign extension of the value for mapping

7.9 CDC measured value (MV)

The data attributes of the common data class MV depicted in Table 16 shall be mapped as shown in Table 17.

Table 16 – CDC: Measured value (MV)

MV class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
measured attributes					
mag	AnalogueValue	MX	dchg, dupd		M
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M
configuration, description and extension					
db	INT32U	CF	dchg	0 ... 100 000	O
units	Unit	CF	dchg	See Annex A of IEC 61850-7-3:2010	O
sVC	ScaledValueConfig	CF	dchg		AC_SCAV

The signal [mag + q + t] shall map to the either ASDU TI<36> "Measured value, short floating point value with time tage CP56time2a" or ASDU <35> "Measured value, scaled value with time tag CP56time2a" as specified in Table 17.

NOTE In IEC 61850-7-3:2010 the trigger option "dupd" was added for the data attribute "mag" and the trigger option "dchg" was added for the data attribute "db".

The type "Unit" consists of two attributes – "SIUnit" (as mandatory) and "multiplier" (as optional), both of type ENUMERATED.

The type "ScaledValueConfig" consists of two attributes – "scaleFactor" and "offset", both mandatory and of type FLOAT32.

Table 17 – CDC: Measured value (MV) mapping

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
MV			TI<36> or TI<35>	
Attribute name	Attribute type	DACComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
a) mag	AnalogueValue	mag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
b) mag	AnalogueValue	mag.i INT32	SVA	$I16<-2^{15}..+2^{15}-1>$ 0 map on 0 Valid range for INT32 is $<-2^{15}+2^{15}-1>$
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

Either a) or b) shall be mapped.

Optionally the attribute “units.multiplier”, which might have an influence on the mapping of the value of mag, can be mapped to ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a".

Optionally “sVC.scaleFactor” and “sVC.offset” which also might have an influence on the mapping of the value of mag, can be mapped to ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a".

The optional configuration attribute "db" can be optionally set by ASDU TI<111> "Parameter of measured value, scaled value" or ASDU TI<112> "Parameter of measured value, short floating point value" as described in Clause 8.

If required, this parameter can be reported as part of an interrogation response.

7.10 CDC complex measured value (CMV)

The data attributes of the common data class CMV depicted in Table 18 shall be mapped as shown in Table 19.

Table 18 – CDC: Complex measured value (CMV)

CMV class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
measured attributes					
cVal	Vector	MX	dchg, dupd		M
q	Quality	MX	qchg		M
t	TimeStamp	MX			M
configuration, description and extension					
db	INT32U	CF	dchg	0 ... 100 000	O
units	Unit	CF	dchg	See Annex A of IEC 61850-7-3:2010	O
magSVC	ScaledValueConfig	CF	dchg		AC_SCAV
angSVC	ScaledValueConfig	CF	dchg		AC_SCAV

The type “Unit” consists of two attributes – “SIUnit” (as mandatory) and “multiplier” (as optional), both of type ENUMERATED.

The type “ScaledValueConfig” consists of two attributes – “scaleFactor” and “offset”, both mandatory and of type FLOAT32.

NOTE In IEC 61850-7-3:2010 the trigger option “dupd” was added for the data attribute “cVal” and the trigger option “dchg” was added for the data attribute “db”.

Table 19 defines the mapping for data attributes of common data class CMV. The data attributes [cVal + q + t] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a".

Table 19 – CDC: Complex measured value (CMV) mapping

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
CMV			TI<36> or TI<35>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
a) cVal	Vector	cVal.mag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
b) cVal	Vector	cVal.mag.i INT32	SVA	$116 < -2^{15} \dots +2^{15}-1 >$ 0 map on 0 Valid range for INT32 is $< -2^{15} \dots +2^{15}-1 >$
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence for object
a) cVal	Vector	cVal.ang.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
b) cVal	Vector	cVal.ang.i INT32	SVA	$116 < -2^{15} \dots +2^{15}-1 >$ 0 map on 0 Valid range for INT32 is $< -2^{15} \dots +2^{15}-1 >$
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg or qchg

Either a) or b) shall be mapped in both cases.

If both attributes (mag and angle) have to be mapped, two consecutive IOA addresses is recommended to be used.

IOA n := CMV.cVal.mag.f or CMV.cVal.mag.i

IOA n+1 := CMV.cVal.ang.f or CMV.cVal.ang.i

Optionally the attribute “units.multiplier”, which might have an influence on the mapping of the value of cVal, can be mapped to ASDU TI<35> “Measured value, scaled value with time tag CP56Time2a.

Optionally “magSVC.scaleFactor”, “magSCV.offset” and/or “angSVC.scaleFactor” “angSVC.offset” which also might have an influence on the mapping of the value of cVal, can

be mapped to ASDU TI<36>"Measured value, short floating point value with time tag CP56Time2a".

The optional configuration attribute "db" can be optionally set by ASDU TI<111> "Parameter of measured value, scaled value" or ASDU TI<112> "Parameter of measured value, short floating point value" as described in Clause 8.

7.11 CDC Phase to ground related measured values of a three-phase system (WYE)

The data attributes of the common data class WYE depicted in Table 20 shall be mapped as multiple mappings of the common data Class CMV as shown in Table 19.

Table 20 – CDC: Phase to ground related measured values of a three-phase system (WYE)

WYE class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from Data Class (see IEC 61850-7-2)				
Data					
phsA	CMV				GC_1
phsB	CMV				GC_1
phsC	CMV				GC_1
neut	CMV				GC_1
net	CMV				GC_1
res	CMV				GC_1

Each present data attribute (of common data class CMV) shall map to the ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a". Six ASDUs of TI<36> or TI<35> is recommended to be used with consecutive IOA indices:

IOA n := CMV phsA.cVal.mag.f or CMV phsA.cVal.mag.i

IOA n+1 := CMV phsB.cVal.mag.f or CMV phsB.cVal.mag.i

IOA n+2 := CMV phsC.cVal.mag.f or CMV phsC.cVal.mag.i

IOA n+3 := CMV neut.cVal.mag.f or CMV neut.cVal.mag.i

IOA n+4 := CMV net.cVal.mag.f or CMV net.cVal.mag.i

IOA n+5 := CMV res.cVal.mag.f or CMV res.cVal.mag.i

The amount of used IOA addresses is dependent on the presence of the data attributes of CDC WYE. If all data attributes are present six IOA addresses are needed as shown in the example.

If both attributes (mag and angle) of every present data attribute of type CMV have to be mapped, two consecutive IOA addresses should be used for each present data attribute.

IOA n := CMV phsA.cVal.mag.f or CMV phsA.cVal.mag.i

IOA n+1 := CMV phsA.cVal.ang.f or CMV phsA.cVal.ang.i

IOA n+2 := CMV phsB.cVal.mag.f or CMV phsB.cVal.mag.i

IOA n+3 := CMV phsB.cVal.ang.f or CMV phsB.cVal.ang.i

IOA n+4 := CMV phsC.cVal.mag.f or CMV phsC.cVal.mag.i

IOA n+5 := CMV phsC.cVal.ang.f or CMV phsC.cVal.ang.i

IOA n+6 := CMV neut.cVal.mag.f or CMV neut.cVal.mag.i

IOA n+7 := CMV neut.cVal.ang.f or CMV neut.cVal.ang.i

IOA n+8 := CMV net.cVal.mag.f or CMV net.cVal.mag.i

IOA n+9 := CMV net.cVal.ang.f or CMV net.cVal.ang.i

IOA n+10 := CMV res.cVal.mag.f or CMV res.cVal.mag.i

IOA n+11 := CMV res.cVal.ang.f or CMV res.cVal.ang.i

The amount of used IOA addresses is dependent on the presence of the data attributes of CDC WYE. If all data attributes are present twelve IOA addresses are needed as shown in the example.

The mapping of common data class CMV is shown in detail in Table 19.

The conditional GC_1 means that at least one of the attributes shall be present for a given instance of the DataObject.

7.12 CDC phase to phase measured values of a three phase system (DEL)

The data attributes of the common data class DEL depicted in Table 21 shall be mapped as multiple mappings of the common data class CMV as shown in Table 19.

Table 21 – CDC: Phase to phase measured values of a three phase system (DEL)

DEL class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
Data					
phsAB	CMV				GC_1
phsBC	CMV				GC_1
phsCA	CMV				GC_1

Each data present attribute (of common data class CMV) shall map to the ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a". Three ASDUs of TI<36> or TI<35> is recommended to be used with consecutive IOA indices:

IOA n := CMV phsAB.cVal.mag.f or CMV phsAB.cVal.mag.i

IOA n+1 := CMV phsBC.cVal.mag.f or CMV phsBC.cVal.mag.i

IOA n+2 := CMV phsCA.cVal.mag.f or CMV phsCA.cVal.mag.i

The amount of used IOA addresses is dependent on the presence of the data attributes of CDC DEL. If all data attributes are present three IOA addresses are needed as shown in the example.

If both attributes (mag and angle) of every present data attribute of attribute type CMV have to be mapped, two consecutive IOA addresses have to be used for each present data attribute. In that case, six ASDUs of TI<36> is recommended to be used with consecutive IOA indices:

IOA n := CMV phsAB.cVal.mag.f or CMV phsAB.cVal.mag.i

IOA n+1 := CMV phsAB.cVal.ang.f or CMV phsAB.cVal.ang.i

IOA n+2 := CMV phsBC.cVal.mag.f or CMV phsBC.cVal.mag.i

IOA n+3 := CMV phsBC.cVal.ang.f or CMV phsBC.cVal.ang.i

IOA n+4 := CMV phsCA.cVal.mag.f or CMV phsCA.cVal.mag.i

IOA n+5 := CMV phsCA.cVal.ang.f or CMV phsCA.cVal.ang.i

The amount of used IOA addresses is dependent on the presence of the data attributes of CDC DEL. If all data attributes are present six IOA addresses are needed as shown in the example.

The mapping of common data class CMV is shown in detail in Table 19.

The conditional GC_1 means that at least one of the attributes shall be present for a given instance of the DataObject.

7.13 CDC sequence (SEQ)

The data attributes of the common data class SEQ depicted in Table 22 shall be mapped as multiple mappings of the common data class CMV as shown in Table 19.

Table 22 – CDC: Sequence (SEQ)

SEQ class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
Data					
c1	CMV				M
c2	CMV				M
c3	CMV				M

Each data attribute (of common data class CMV) shall map to the ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time tag CP56Time2a". Three ASDUs of TI<36> or TI<35> is recommended to be used with consecutive IOA indices:

IOA n := c1.cVal.mag.f or CMV c1.cVal.mag.i

IOA n+1 := c2.cVal.mag.f or CMV c2.cVal.mag.i

IOA n+2 := c3.cVal.mag.f or CMV c3.cVal.mag.i

If both attributes (mag and angle) of every attribute of attribute type CMV have to be mapped, two consecutive IOA addresses have to be used for each attribute. In that case, six ASDUs of TI <36> is recommended to be used with consecutive IOA indices:

IOA n := CMV c1.cVal.mag.f or CMV c1.cVal.mag.i

IOA n+1 := CMV c1.cVal.ang.f or CMV c1.cVal.ang.i

IOA n+2 := CMV c2.cVal.mag.f or CMV c2.cVal.mag.i

IOA n+3 := CMV c2.cVal.ang.f or CMV c2.cVal.ang.i

IOA n+4 := CMV c3.cVal.mag.f or CMV c3.cVal.mag.i

IOA n+5 := CMV c3.cVal.ang.f or CMV c3.cVal.ang.i

The mapping of common data class CMV is shown in detail in Table 19.

7.14 CDC harmonic value (HVM)

7.14.1 CDC HVM defined in IEC 61850-7-3:2003

The data attributes of the common data class HVM depicted in Table 23 shall be mapped as shown in Table 24.

Table 23 – CDC: Harmonic value (HVM) Ed.1

HMV class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
<i>Harmonics and interharmonics</i>					
har	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
<i>Basics</i>					
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M

Table 24 defines the mapping for data attributes of common data class HVM. The number of "har" attributes is variable ($n := 0 - \text{numHar}$). The signals [har(n).mag + q + t] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a".

Table 24 – CDC: Harmonic value (HVM) Ed.1 mapping

CDC class			IEC 60870-5-101 or IEC 60870-5-104 mapping	
HVM			TI<36>	
Attribute name	Attribute type	DAComponent	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
har	Vector	har.mag.f FLOAT32	IEEE STD 754	R32.23{Fraction,Exponent,Sign}
q	Quality		QDS	validity -> IV good invalid -> valid invalid questionable -> NT detailQual -> OV overflow -> overflow source -> SB substituted -> substituted operatorBlocked -> BL blocked -> blocked
t	TimeStamp		CP56Time2a	Seven octet binary time, CP56Time2a – Time of occurrence of dchg, dupd or qchg

Each data attribute "har" (of attribute type Vector) shall map to the ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a". The amount of ASDUs of TI<36> for the mapping is defined by the configuration attribute "numHar". The IOA addresses for all necessary ASDUs is recommended to be used with consecutive IOA indices:

IOA n := har[0].mag.f or har[0].mag.i

IOA n+1 := har[1].mag.f or har[1].mag.i

IOA n+numHar:= har[numHar].mag.f or har[numHar].mag.i

7.14.2 CDC HMV defined in IEC 61850-7-3:2010

The data attributes of the common data class HMV Ed.2 depicted in Table 25 shall be mapped via the CDC CMV as shown in Table 19.

Table 25 – CDC: Harmonic value (HMV) Ed.2

HMV class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
har	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		M

The number of "har" attributes of type CMV is variable (n:= 0 – numHar). Every data attribute "har" shall be mapped via the CDC CMV as defined in 7.10. Every signal [har(n).cVal.mag.f + har(n).q + har(n).t or har(n).cVal.mag.i + har(n).q + har(n).t] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<36> "Measured value, short floating point value with time tag CP56Time2a" or ASDU TI<35> "Measured value, scaled value with time time tag as shown in Table 19 .

The amount of ASDUs of TI<36> for the mapping is defined by the configuration attribute "numHar". The IOA addresses for all necessary ASDUs are recommended to be used with consecutive IOA indices:

IOA n := har[0].cVal.mag.f or har[0].cVal.mag.i

IOA n+1 := har[1]. cVal.mag.f or har[1].cVal.mag.i

IOA n+numHar:= har[numHar].cVal.mag.f or har[numHar].cVal.mag.i

7.15 CDC harmonic value for WYE (HWYE)

7.15.1 CDC WYE (HWYE) defined in IEC 61850-7-3:2003

The data attributes of the common data class HWYE depicted in Table 26 shall be mapped as multiple mappings of the common data class HMV as shown in Table 24.

Table 26 – CDC: Harmonic value for WYE (HWYE) Ed.1

HWYE class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
phsAHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
phsBHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
phsCHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
neutHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
netHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
resHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
Basics					
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M

Each used data attribute of the CDC WYE (HWYE) Ed.1 shall be mapped in the same way as it is defined for the CDC HMV.

The mapping of common data class HMV is shown in detail in Table 24.

7.15.2 CDC WYE (HWYE) defined in IEC 61850-7-3:2010

The data attributes of the common data class WYE (HWYE) Ed.2 depicted in Table 27 shall be mapped as multiple mappings of the common data class HMV Ed.2 as shown in Table 25.

Table 27 – CDC: Harmonic value for WYE (HWYE) Ed.2

HWYE class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
phsAHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		M
phsBHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O
phsCHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O
neutHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O
netHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O
resHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O

Each used data attribute of the CDC WYE (HWYE) Ed.2 shall be mapped in the same way as CDC HMV Ed.2 (shown in Table 25) using multiple mappings of CDC CMV as shown in Table 19.

7.16 CDC harmonic value for DEL (HDEL)

7.16.1 CDC DEL (HDEL) defined in IEC 61850-7-3:2003

The data attributes of the common data class DEL (HDEL) Ed.1 depicted in Table 28 shall be mapped as multiple mappings of the common data class HMV Ed.1 as shown in Table 24.

Table 28 – CDC: Harmonic value for DEL (HDEL)

HDEL class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
phsABHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		M
phsBCHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
phsCAHar	ARRAY[0..numHar] OF Vector	MX	dchg, dupd		O
Basics					
q	Quality	MX	qchg	Quality	M
t	TimeStamp	MX		Time value	M

Each data attribute of the CDC DEL (HDEL) Ed.1 shall be mapped in the same way as it is defined for the CDC HMV Ed.1.

The mapping of common data class HMV Ed.1 is shown in detail in Table 24.

7.16.2 CDC DEL (HDEL) defined in IEC 61850-7-3:2010

The data attributes of the common data class DEL (HDEL) Ed.2 depicted in Table 29 shall be mapped as multiple mappings of the common data class HMV Ed.2 as shown in Table 25.

Table 29 – CDC: Harmonic value for DEL (HDEL) Ed.2

HDEL class					
Attribute name	Attribute type	FC	TrgOp	Explanation and value / Range	M/O
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
Harmonics and interharmonics					
phsABHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		M
phsBCHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O
phsCAHar	ARRAY[0..numHar] OF CMV	MX	dchg, dupd		O

Each used data attribute of the CDC DEL (HDEL) Ed.2 shall be mapped in the same way as CDC HMV Ed.2 (shown in Table 25) using multiple mappings of CDC CMV as shown in Table 19.

7.17 CDC controllable single point (SPC)

The data attributes of the common data class SPC depicted in Table 30 shall be mapped as shown in Table 3 (for the attributes with the functional constraint ST) and Table 31 (for the parameters for control services.).

Table 30 – CDC: Controllable single point (SPC)

SPC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status and control mirror					
origin	Originator	ST			AC_CO_O
stVal	BOOLEAN	ST	dchg	FALSE TRUE	AC_ST
q	Quality	ST	qchg		AC_ST
t	TimeStamp	ST			AC_ST
configuration, description and extension					
ctlModel	ctlModels	CF	dchg		M
parameter for control services					
ctlVal	BOOLEAN			off (FALSE) on (TRUE)	

Table 3 defines the mapping for the data attributes with the functional constraint ST [stVal + q + t].

Table 31 defines the mapping for data attributes of SPC for the parameters for control services.

The data attribute [ctlVal + origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<45> "Single command" or to IEC 60870-5-104 ASDU TI<58> "Single command with time tag CP56Time2a".

In IEC 61850-7-3:2003 the parameter for control services "ctlVal" was defined with the functional constraint "CO" and the condition for attribute inclusion "AC_CO_M". The TrgOp "dchg" for the data attribute "ctlModel" was added in IEC 61850-7-3:2010.

NOTE The attributes T and ctlModel are defined in Clause 17 of IEC 61850-7-2:2003 or Clause 20 of IEC 61850-7-2:2011.

Table 31 – CDC: Controllable single point (SPC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
SPC		TI<45> (without time tag) or TI<58> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	BOOLEAN	SCO	SCS (Single command state) <0> OFF:= off (FALSE) <1> ON:= on (TRUE) simple SPC -> QU <0> no additional definition other QU values are not used IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default ^a <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for parameter for control services (or FC=CO):</u> remote control <-> activation <6> *) <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>
^a If the attribute origin does not exist in the CDC the Originator Address has to be set to <0>:= default and the Cause has to be set to "activation" <6>.			

7.18 CDC controllable double point (DPC)

The data attributes of the common data class DPC depicted in Table 32 shall be mapped as shown in Table 5 (for the attributes with the functional constraint ST) and Table 33 (for the parameters for control services).

Table 32 – CDC: Controllable double point (DPC)

DPC class					
Attribute name	Attribute type	FC	TrgOp	Value/Value range	M/O/C
DataName	Inherited from data class (see IEC 61850-7-2)				
DataAttribute					
status and control mirror					
Origin	Originator	ST			AC_CO_O
stVal	CODED ENUM	ST	dchg	intermediate-state off on bad-state	M
q	Quality	ST	qchg		M
t	TimeStamp	ST			M
configuration, description and extension					
ctlModel	ctlModels	CF	dchg		M
parameter for control services					
ctlVal	BOOLEAN			off (FALSE) on (TRUE)	

Table 5 defines the mapping for data attributes of DPC with the functional constraint ST [stVal + q + t].

Table 33 defines the mapping for data attributes of DPC for the parameters for control services.

The data attribute [ctlVal+ origin] or [ctlVal + origin + T] shall map to IEC 60870-5-104 or IEC 60870-5-101 ASDU TI<46> "Double point command" " or to IEC 60870-5-104 ASDU TI<59> "Double command with time tag CP56Time2a.

In IEC 61850-7-3:2003 the parameter for control services "ctlVal" was defined with the functional constraint "CO" and the condition for attribute inclusion "AC_CO_M". The TrgOp "dchg" for the data attribute "ctlModel" was added in IEC 61850-7-3:2010.

NOTE The attributes T and ctlModel are defined in Clause 17 of IEC 61850-7-2:2003 or Clause 20 of IEC 61850-7-2:2011.

Table 33 – CDC: Controllable double point (DPC) mapping

CDC class		IEC 60870-5-101 or IEC 60870-5-104 mapping	
DPC		TI<46> (without time tag) or TI<59> (with time tag)	
Attribute name	Attribute type	Information element	IEC 60870-5-104 or IEC 60870-5-101 object group mapping
ctlVal	BOOLEAN	DCO	DCS (Double command state) <0> not permitted <1> OFF:= off (FALSE) <2> ON:= on (TRUE) <3> not permitted simple DPC -> QU <0> no additional definition other QU values may be used (see clause 8.8) IEC 60870-5-104 and IEC 60870-5-101 support the following modes of the IEC 61850 Control Model (ctlModel): direct control with normal security direct control with enhanced security S/E <0>:= direct control SBO control with enhanced security S/E <1>:= select and execute for details see Subclause 8.8
origin.orIdent	OCTET STRING64	COT	Originator Address:= UI8[9..16] <0..255> <0>:= default <1..255>:= number of originator address The number of originator address shall be mapped to attribute orIdent (OCTET STRING64). NOTE Only values of the length of one octet of orIdent can be mapped to Originator Address because of the limitation in value range.
origin.orCat	ENUMERATED	COT	Cause:= UI6[1..6] <0..63> <u>Valid for parameter for control services (or FC = CO):</u> remote control <-> activation <6> <u>Valid for FC = ST:</u> not supported <-> not used <0> remote control <-> return information caused by remote command <11> automatic-remote -> return information caused by remote command <11> bay control <-> return information caused by local command <12> station control, automatic bay, automatic station -> return information caused by local command <12> process <-> spontaneous <3> maintenance -> spontaneous <3>

7.19 CDC controllable integer status (INC)

The data attributes of the common data class INC depicted in Table 34 shall be mapped as shown in Table 7 (for the attributes with the functional constraint ST) and Table 35 (for the parameters for control services).