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Edition 1.0 2021-04

TECHNICAL REPORT

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Communication networks and systems for power utility automation – Part 7-5: IEC 61850 Modelling concepts

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-5: IEC 61850 Modelling concepts

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IEC TR 61850-7-5 has been prepared by Working Group 10 of IEC Technical Committee 57: Power systems management and associated information exchange. It is a Technical Report.

The text of this Technical Report is based on the following documents:

DTR	Report on voting
57/2253/DTR	57/2322/RVDTR

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

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available

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

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INTRODUCTION

The IEC 61850 standard series provides a very broad range of data models covering as much as possible all application functions in the range of power utility automation. The modelling both in the domains and between the domains show differences which may impact interoperability. Therefore, some informative guidelines are helpful to reach a common approach in application function modelling. A lot of basic functionality is based on the concept of IEC 61850 and is, therefore, the same for all application domains. As result, a basic cross-domain part in the form of a Technical Report is useful. Domain specific issues are addressed in the Technical Reports IEC TR 61850-7-5xx (e.g. IEC TR 61850-7-500 for substation automation).

To cover all domains in a comprehensive way would not come to a result in a reasonable time. This may be a task for future editions of this document. Therefore, this document describes in selected examples the use of logical nodes for modelling application functions and related concepts and guidelines in general independently from any application domain respectively valid for all application domains in the utility automation (substation automation, distributed energy resources, hydro power, wind power, etc.). It also includes some tutorial material where helpful.

The modelling of the use cases given in this document is based on the class model introduced in IEC 61850-7-1. The logical node and data names used in this document are defined in IEC 61850-7-4 and IEC 61850-7-3, the services applied in IEC 61850-7-2. If needed for the understanding of modelling these use cases, the application of services is also described. If different options cannot be excluded, all options may be mentioned.

If extensions are needed in the use cases, the normative naming rules for multiple instances and private, compatible extensions of Logical Node (LN) Classes and Data Object (DO) Names defined in IEC 61850-7-1 are considered.

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COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 7-5: IEC 61850 Modelling concepts

1 Scope

This part of IEC 61850, which is a technical report, establishes modelling concepts that help the user to understand how to apply the models defined in IEC 61850-7-4 and IEC 61850-7-3 to implement practical applications.

This document provides the basic concepts that are valid for all application domains using IEC 61850. Domain specific concepts are defined in other technical reports as in the document range of IEC 61850-7-5xx; as an example, IEC 61850-7-500 describes modelling concepts for functions related to substation automation.

On one side the number of potential topics for cross-domain modelling may be very high but on the other side it may be limited by domain specific restrictions often created by the historical evolution of IEC 61850 in the domains.

The first topic selected is the common control of power utility primary objects by means of the power utility automation systems based mainly on the long experience in substation automation systems. Common attributes for reliable power utility automation systems in all domains are quality and health. A special function having a broad application range in power utility automation systems is the scheduling of services as provided by the domain distributed energy resources (DER) used in smart grids, especially also for electric mobility. Not yet so much discussed in the context of IEC 61850 but very important for all IEDs is the impact of restart (power cycle) on the data model parameters. Non-agreed behaviour will raise problems for interoperability in multi-vendor systems.

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 TS 61850-2, *Communication networks and systems for power utility automation - Part 2: Glossary*

IEC 61850-7-1, *Communication networks and systems for power utility automation - Part 7-1: Basic communication structure - Principles and models*

IEC 61850-7-2:2010, *Communication networks and systems for power utility automation - Part 7-2: Basic information and communication structure - Abstract communication service interface (ACSI)*
IEC 61850-7-2:2010/AMD1:2020

IEC 61850-7-4:2010, *Communication networks and systems for power utility automation - Part 7-4: Basic communication structure - Compatible logical node classes and data object classes*
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IEC TR 61850-7-500, *Communication networks and systems for power utility automation - Part 7-500: Basic information and communication structure - Use of logical nodes for modeling application functions and related concepts and guidelines for substations*

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*

IEC 61850-8-2, *Communication networks and systems for power utility automation - Part 8-2: Specific communication service mapping (SCSM) - Mapping to Extensible Messaging Presence Protocol (XMPP)*

IEC TR 61850-90-2, *Communication networks and systems for power utility automation - Part 90-2: Using IEC 61850 for communication between substations and control centres*

IEC TR 61850-90-8, *Communication networks and systems for power utility automation - Part 90-8: Object model for E-mobility*

IEC 62351, *Power systems management and associated information exchange – Data and communications security* (all parts)

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document the terms and definitions given in IEC 61850-2 and IEC 61850-7-2 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp/ui

3.2 Abbreviated terms

EV Electric vehicle

IL Checking Interlocking

NCC Network Control Centre

CS Checking Synchronism

4 Control

4.1 Control authorization

4.1.1 Basics

Control (control commands) crosses various layers and may require authentication and authorization before it arrives at the controllable object. Figure 1 shows the various layers.

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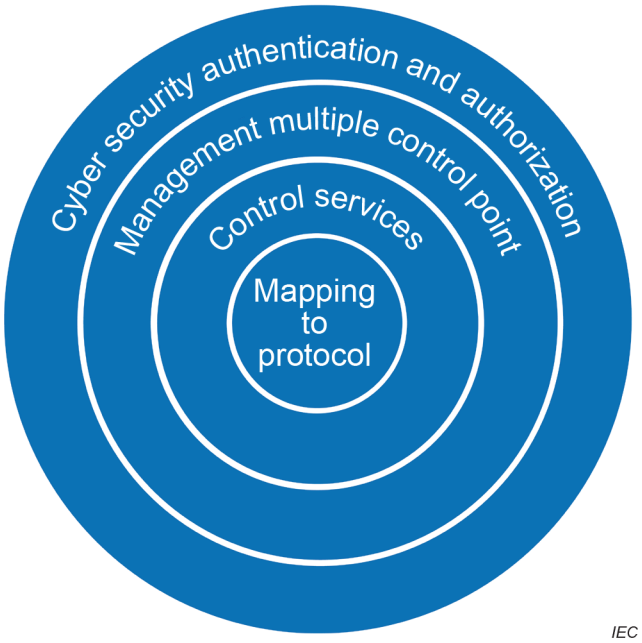

Figure 1 – Communication vs. application layer model for controls

- Mapping to protocol

  To pass a control command from a client (which issues the control) to a server (which executes the control command) both located in two different IEDs, the command needs to be mapped to a protocol. For exchanges within substations and for tunnelling through external communication systems to other substations and to the NCC a mapping to Manufacturing Message Specification (MMS) above Ethernet according to IEC 61850-8-1 is preferred. In addition, also mapping to GOOSE according to IEC 61850-8-1 may be used. For the usage outside substations beside the message tunnelling and message conversion for non-IEC 61850 communication networks especially at distribution level a mapping to web technology protocol as described in IEC 61850-8-2 may be more appropriate.

- Control services

  The flexibility of being able to choose a protocol to map to is granted thanks to the fact that controls are defined in IEC 61850-7-2 as control services of an Abstract Communication Service Interface (ACSI). These control services are tailored to the applications of the power utility automation domain.

- Management of multiple control points

  Where a control is an exclusive exchange of requests and responses between two peers, network automation systems need to also allow for applications where more than one control point may issue controls to a controllable object. The management of parallel accesses is performed on the basis of user specific rules depending on operational philosophy.

- Authentication and authorization

  The means and methods provided by the IEC 62351 series on communication network and system security will ensure that only authenticated clients may have defined access to given parts of a power utility automation system. It is furthermore up to the roles and to the permissions granted to this client whether its control request to a given controllable object is accepted.

4.1.2 Validating a control request

4.1.2.1 General

Before a control is executed, the command shall pass several steps in approval, reflecting different aspects of validation.

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4.1.2.2 Validation against the LN behaviour

The control request is forwarded to the function in charge of the controllable data object addressed in the control service. When reaching a function for control, the LN behaviour (e.g. represented by the actual value of the DO CSWI.Beh) shall decide whether the control can be processed or not, following IEC 61850-7-2. Since functions are accessible via communication in all the five states of their functional behaviour DO LN.Beh, a response has always given.

4.1.2.3 Validation against the control model

Depending on the control model which is set for the controllable object, the IED shall perform various checks against the command. The explicit order is out of the scope of the standard IEC 61850. Since the use of SBO control with enhanced security according to IEC 61850-7-2 is the common model for switchgear control, the current clause delves neither into direct operate, nor into SBO with normal security.

4.1.2.4 Test whether the conditions are met

4.1.2.4.1 General

Two kinds of tests may be performed: ‘operative test’ depending on the operative condition of the object and its process environment, and ‘dynamic test’, e.g. checking the moment of allowance for the command to the object. In its control request the client shall specify whether synchrocheck and interlocking check are to be performed. If the addressed function respectively the data object does not support these checks (not implemented, not configured), the appropriate check bits of the control request are ignored and the command is performed directly, see IEC 61850-7-2:2010, Table 110.

4.1.2.4.2 Operative test

The control hierarchy function has to be configured according to the operations requirement of the user. The control authority shall be checked by comparing the state (XXXX.Loc) of control hierarchy active in the function hosting the controllable object against the order category submitted in the actual command. Plausibility checking shall run to see whether the intended operation does not contradict to the actual position of the switchgear. To validate the switchgear control against the conditions of interlocking (IL) with the positions of other switchgear, the release output of the interlocking function CILO is taken as criteria for approval (see Table 1). The control of the switchgear shall be validated against the readiness of the equipment for an operation (consideration of EEHealth, BlkCls, supervisions through SCBR, etc.).

Table 1 – Dependence of checking Interlocking (IL) conditions on the control command and on the server configuration

LN, DO configuration →		No IL check	IL check	No IL check	IL check
↓ Control context		SwModKey = F		SwModKey = T	
from client (NCC, station HMI)	no CheckCondition	N	N	N	N
	IL CheckCondition set	N	Y	N	N
from IED level	not specified	N	Y	N	N

Then, upon SelectWithValue, the object is reserved for this actor, unless associated checks (1-out-of-n, client reservation e.g.) would lead to a rejection of the control, documented with the appropriate AddCauses. All other objects are deselected.

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