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Representation of communication in power utility automation

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CONTENTS

FOREWORD 4
INTRODUCTION 6
1 Scope 7
2 Normative references 8
3 Terms, definitions and abbreviated terms 9
3.1 Terms and definitions 9
3.2 Abbreviated terms 9
4 General description of physical resource documentation 10
4.1 Secondary system documentation description 10
4.2 Target users of the documentation 10
4.3 Use cases 11
5 Documentation requirement 11
6 Physical source of communication description in tabular format 11
6.1 Sampled value presentation 11
6.1.1 General 11
6.1.2 Creation of sampled values, LPIT 12
6.1.3 Sample values publisher to subscriber 13
6.1.4 Creation of sampled values by a SAMU 15
6.2 GOOSE communication presentation 17
6.2.1 General 17
6.2.2 Publisher to subscriber 17
6.3 Client-to-server control presentation 19
6.4 Reporting 21
6.5 Time synchronization 23
6.5.1 General 23
6.5.2 SNTP time synchronization 23
6.5.3 PTP IEC/IEEE 61850-9-3 time synchronization 24
6.6 Disturbance recorder 26
6.7 Digital communication protocol gateways 28
6.8 Protection and control devices with only proprietary communication protocol 28
Annex A (informative) Representation of information concept for power utility automation 30
Bibliography 31

Figure 1 – Example of an optical instrument transformer with digital output (LPIT) 12
Figure 2 – Sample values publisher (IED 1) to subscriber (IED 2) 14
Figure 3 – Analogue transformer connected to a SAMU 15
Figure 4 – Communication scheme of publisher (IED 1) to subscriber (IED 2) 18
Figure 5 – Communication scheme of client to server 19
Figure 6 – Communication scheme of server to client 21
Figure 7 – Communication scheme of SNTP time synchronization 23
Figure 8 – Communication scheme of PTP IEC/IEEE 61850-9-3 25
Figure 9 – Communication scheme of disturbance recorder 27
Figure 10 – Communication scheme of digital communication protocol gateways 28

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Figure 11 – Communication scheme of protection and control devices with only proprietary communication protocol 29
Figure A.1 – Positioning of the RCCA within the documentation system for an IEC 61850 substation 30

Table 1 – Abbreviations 9
Table 2 – Data presentation for use in SV communication 12
Table 3 – Information about all MUs connected to the instrument transformer for data stream n 13
Table 4 – Communication between the publishing MU and the subscribing IEDs 14
Table 5 – Presentation of subscriber n to an SV stream 15
Table 6 – Data presentation for use in SV communication 16
Table 7 – Presentation of a SAMU connected to a conventional transformer 17
Table 8 – Presentation of a publisher of a GOOSE 18
Table 9 – Presentation of Subscriber to a GOOSE 19
Table 10 – Presentation of MMS client 20
Table 11 – Presentation of MMS server 21
Table 12 – Presentation of an MMS report server 22
Table 13 – Presentation of an MMS report client 23
Table 14 – Presentation of a SNTP server 24
Table 15 – Presentation of a client 24
Table 16 – Presentation of PTP GMC 25
Table 17 – Presentation of a PTP slave clock 26
Table 18 – Presentation of disturbance recorder, server 27
Table 19 – Presentation of disturbance recorder, client 27
Table 20 – Presentation of communication conversion 28
Table 21 – Presentation of protection and control device with proprietary communication protocol 29

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REPRESENTATION OF COMMUNICATION IN POWER UTILITY AUTOMATION

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

Draft	Report on voting
3/1611/DTS	3/1623/RVDTS

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 Specification 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 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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INTRODUCTION

The data communication system is a critical point in the real time operation of a power utility automation system. Information from the system is retrieved and used for reliable operation, for supervision, and for efficient maintenance work in power utility automation systems, such as hydro power plant, thermal power plant, transmission station, distribution station, industrial site, etc.; hereby referred to as substations.

Power utility automation systems, including those for substations, have been increasingly modernized thanks to their benefits to power utilities. Digital data exchange, based on IEC 61850 (all parts), among the functions in the system, replaces the copper hardwired conventional communication.

The exchange of digital information, in the form of data objects and data attributes, between intelligent electronic devices (IEDs), has become very common in utility automation and these data are essential for control and protection of the power grid, and the amount of such data exchanges is increasing.

The engineering tools available for configuration of the communication systems are typically focusing on the data exchange between tools and less on readability for human perception. Documents prepared by these tools are often comprehensive and well-structured files, for example, in XML-format, but are difficult to read and to understand and could therefore be inappropriate in some steps of the product/system life cycle. With the increasing amount of data exchanges and the increasing level of complexity, the inconsistencies and errors in the complex documentation cannot be efficiently perceived by human users. Proper visualization of data exchanges from different entities makes the maintenance and design more reliable.

This document aims to provide a structure for documentation of exchanged information that is used for testing and maintenance of devices in the substation. This standardized documentation is called "representation of communication configuration and application", abbreviated as RCCA. This reference documentation is intended to be part of the delivery documentation for an IEC 61850 substation.

As a consequence of using IEDs and digital communication in substations, the need arises for readily available, clearly presented, human-readable representation of data for reliable and convenient use by persons in the field.

The IEC 61850 series has provided the comprehensive range of International Standards covering functional, communication and engineering aspects, but not covering the presentation and visualization of these functions.

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REPRESENTATION OF COMMUNICATION IN POWER UTILITY AUTOMATION

1 Scope

This document specifies a structure for representation of exchanged information that is essential for testing and maintenance of the devices in power utility automation systems. It is mainly intended to be applied to communication equipment that communicate information in accordance with IEC 61850 (all parts) in at least one part of their communication flow.

The following communication equipment is included within the scope:

– optical instrument transformer;
– conventional instrument transformers related to IEC 61850 traffic;
– merging unit;
– stand-alone merging unit;
– protection, control and measuring devices with at least one IEC 61850 interface;
– switchgear control unit (breaker IED);
– switchgear providing IEC 61850 interface;
– IEC 61850 time synchronization device;
– IEC 61850 gateway (RTU) and station HMI;
– digital disturbance recorder / digital fault recorder;
– digital communication protocol gateways with at least one IEC 61850 interface;
– protection, control and measuring devices that utilise a proprietary protocol for communication with devices that have at least one IEC 61850 interface.

The following communication equipment, scheme and protocols are excluded from the scope:

– IEC 61850 Ethernet switches and network topology;
– PMU phasor measurement unit with at least one IEC 61850 interface;
– the full path of substation-to-substation communication;

  EXAMPLE 1: The description of R-GOOSE Publisher in substation A does not include the description of R-GOOSE Subscriber in substation B.

– functions with only hardwired communication, e.g. direct analogue copper wired connection;

  EXAMPLE 2: A current transformer connected to a protection relay with hardwired tripping of a circuit breaker.

– functions using only proprietary communication protocol systems;

  EXAMPLE 3: A dedicated system for collecting disturbance recorder files with courier protocol or path from IEC 60870-5-103 to IEC 60870-5-101 will not be presented in this document.

– protocol mappings to XMPP (IEC 61850-8-2).

This document forms a supplement to other documentation standards in power utility automation.

It also harmonizes the representation of the logical data flow structures based on IEC 61850 communication among different devices in order to provide a reference document that can be created for any IEC 61850 substation.

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This document focuses in principle on the visualization of the digital information exchanged between IEDs and control or measurement devices in a power utility automation system. The information visualization does not refer to any graphical modelling but to a tabular format of presentation. The data in tabular format can be used as a basis for other kinds of visual presentation outside the scope of this document.

For representing all kinds of substation information, a single suitable tabular form is not possible to find. This document instead presents a limited number of high visual performance representation formats.

Presentation formats described in this document provide interactive visualization that assists users in analysing data and identifying some important and essential information in a more efficient way.

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 61082-1, *Preparation of documents used in electrotechnology – Part 1: Rules*

IEC 61850-5, *Communication networks and systems for power utility automation – Part 5: Communication requirements for functions and device models*

IEC 61850-6, *Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in power utility automation systems related to IEDs*

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

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 61869-9, *Instrument transformers – Part 9: Digital interface for instrument transformers*

IEC 62439-3, *Industrial communication networks – High availability automation networks – Part 3: Parallel Redundancy Protocol (PRP) and High-availability Seamless Redundancy (HSR)*

IEC 81346-1, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 1: Basic rules*

IEC 81346-2, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 2: Classification of objects and codes for classes*

ISO 81346-10, *Industrial systems, installations and equipment and industrial products – Structuring principles and reference designations – Part 10: Power supply systems*

IEC 82045-1, *Document management – Part 1: Principles and methods*

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3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

3.1.1
substation
part of a power system, concentrated in a given place, including mainly the terminations of transmission or distribution lines switchgear and housing and which may also include transformers. It generally includes facilities necessary for system security and control (e.g. the protective devices)

Note 1 to entry: According to the nature of the system within which the substation is included, a prefix may qualify it.

EXAMPLE Transmission substation (of a transmission system), distribution substation, 400 kV substation, 20 kV substation.

[SOURCE: IEC 60050-605:1983, 605-01-01]

3.2 Abbreviated terms

For the purposes of this document, the abbreviations provided in Table 1 are used.

Table 1 – Abbreviations

Abbreviated term	Full term
ASDU	Application service data unit
FAT	Factory acceptance test
FTP	File transfer protocol
GNSS	Global navigation satellite system EXAMPLES: GPS/BDS/GLONASS/GALILEO
GMC	Grand master clock
GOOSE	Generic object oriented substation event
HMI	Human machine interface
HSR	High-availability seamless redundancy
IED	Intelligent electronic device
LPIT	Low power instrument transformer
MMS	Manufacturing messaging specification
MU	Merging unit
PLC	Power line carrier
PPS	Pulse per second
PRP	Parallel redundancy protocol
PTP	Precision time protocol
RCB	Report control block
RCCA	Representation of communication configuration and application

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