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Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substations related to IEDs

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 6: Configuration description language for communication in electrical substations related to IEDs

FOREWORD

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International Standard IEC 61850-6 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 2004, and constitutes a technical revision.

The main changes with respect to the previous edition are as follows:

- functional extensions added based on changes in other Parts, especially Parts 7-2 and 7-3;
- functional extensions concerning the engineering process, especially for configuration data exchange between system configuration tools, added;
- provision of clarifications and corrections. Issues that require clarification are published in a database available at www.tissue.iec61850.com. Arising incompatibilities are listed in 8.2.3.

The text of this standard is based on the following documents:

FDIS	Report on voting
57/1025/FDIS	57/1041/RVD

Full information on the voting for the approval of this standard 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 the parts in the IEC 61850 series, under the general title *Communication networks and systems for power utility automation*, can be found on the IEC website. [1)]

This publication contains attached .xml and .xsd files. These files are intended to be used as a complement and do not form an integral part of this standard.

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

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this standard may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

1) It has been decided to amend the general title of the IEC 61850 series from *Communication networks and systems in substations* to *Communication networks and systems for power utility automation.* Henceforth, new editions within the IEC 61850 series will adopt this new general title.

INTRODUCTION

This part of IEC 61850 specifies a description language for the configuration of electrical substation IEDs. This language is called System Configuration description Language (SCL). It is used to describe IED configurations and communication systems according to IEC 61850-5 and IEC 61850-7-x. It allows the formal description of the relations between the utility automation system and the process (substation, switch yard). At the application level, the switch yard topology itself and the relation of the switch yard structure to the SAS functions (logical nodes) configured on the IEDs can be described.

NOTE The process description, which is in this standard restricted to switch yards and general process functions, will be enhanced by appropriate add-ons for wind mills, hydro plants and distributed energy resources (DER).

SCL allows the description of an IED configuration to be passed to a communication and application system engineering tool, and to pass back the whole system configuration description to the IED configuration tool in a compatible way. Its main purpose is to allow the interoperable exchange of communication system configuration data between an IED configuration tool and a system configuration tool from different manufacturers.

IEC 61850-8-1 and IEC 61850-9-2, which concern the mapping of IEC 61850-7-x to specific communication stacks, may extend these definitions according to their need with additional parts, or simply by restrictions on the way the values of objects have to be used.

COMMUNICATION NETWORKS AND SYSTEMS FOR POWER UTILITY AUTOMATION –

Part 6: Configuration description language for communication in electrical substations related to IEDs

1 Scope

This part of IEC 61850 specifies a file format for describing communication-related IED (Intelligent Electronic Device) configurations and IED parameters, communication system configurations, switch yard (function) structures, and the relations between them. The main purpose of this format is to exchange IED capability descriptions, and SA system descriptions between IED engineering tools and the system engineering tool(s) of different manufacturers in a compatible way.

The defined language is called System Configuration description Language (SCL). The IED and communication system model in SCL is according to IEC 61850-5 and IEC 61850-7-x. SCSM specific extensions or usage rules may be required in the appropriate parts.

The configuration language is based on the Extensible Markup Language (XML) version 1.0 (see XML references in Clause 2).

This standard does not specify individual implementations or products using the language, nor does it constrain the implementation of entities and interfaces within a computer system. This part of the standard does not specify the download format of configuration data to an IED, although it could be used for part of the configuration data.

2 Normative references

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

IEC 61850-2, *Communication networks and systems in substations – Part 2: Glossary*

IEC 61850-5, *Communication networks and systems in substations – Part 5: Communication requirements for functions and device models*

IEC 61850-7-1, *Communication networks and systems in substations – Part 7-1: Basic communication structure for substation and feeder equipment – Principles and models*

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

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

IEC 61850-7-4, *Communication networks and systems in substations – Part 7-4: Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes*

IEC 61850-8-1, *Communication networks and systems in substations – 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 61850-9-2, *Communication networks and systems in substations – Part 9-2: Specific Communication Service Mapping (SCSM) – Sampled values over ISO/IEC 8802-3*

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

ISO/IEC 8859-1, *Information technology – 8-bit single-byte coded graphic character sets – Part 1: Latin alphabet No. 1*

RFC 1952, *GZIP file format specification version 4.3*, RFC, available at <http://www.ietf.org/rfc/rfc1952.txt>

RFC 2045, *Multipurpose Internet Mail Extensions (MIME) Part One: Format of Internet Message Bodies*, RFC, available at <http://www.ietf.org/rfc/rfc2045.txt>

Extensible Markup Language (XML) 1.0, W3C, available at <http://www.w3.org/TR/2000/REC-xml-20001006>

XML Schema Part 1: Structures, W3C, available at <http://www.w3.org/TR/2001/REC-xmlschema-1-20010502>

XML Schema Part 2: Datatypes, W3C, available at <http://www.w3.org/TR/2001/REC-xmlschema-2-20010502/>

3 Terms and definitions

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

Additionally the following terms are used in the context of language name spaces. Only general meanings are given here. More details about the handling in the context of SCL can be found later in this standard.

3.1
extensible
a language is extensible if instances of the language can include terms from other vocabularies

NOTE This is fulfilled in SCL if the other vocabularies come with their own XML name space.

3.2
language
an identifiable set of vocabulary terms that has defined constraints

NOTE This is the case with SCL, although some constraints are not definable in the XML schema.

3.3
instance
a realization by usage of a language

NOTE For example, an XML document in SCL describing an IED or a substation is an SCL instance.

3.4
sender
a tool that creates or produces an instance for processing by another application (receiver)

NOTE SCL senders are typically IED and system configuration tools; e.g. the IED tool sends (produces) ICD files, the system tool sends SCD files.

3.5
Receiver
a tool that consumes an instance which it obtained from a sender

NOTE SCL receivers are IED tools and system configuration tools; e.g. the IED tool receives SCD files, the system tool ICD, IID, SSD and SED files.

3.6
processor
a component which receives SCL instances and produces new instances, i.e. is sender and receiver

NOTE This is typically the system configuration tool.

3.7
project
a system part with engineering responsibility for all contained IEDs

NOTE Mostly a system is a project. However, sometimes the IED engineering responsibility of different parts of a system belong to different parties or people. Each IED responsibility area is then a separate project. An IED can belong only to one project. It is 'owned' by this project.

3.8
backwards compatible
a language change is backwards compatible, if newer receivers can process all instances of the old language

NOTE For SCL this means that tools built for newer language versions can understand instances from older versions. Especially system tools should understand old ICD and SSD files, while IED tools should understand old SCD files to be backward compatible.

3.9
forward compatible
a language change is forward compatible if older receivers can process all instances of the newer language

NOTE For SCL this means that tools built according to older SCL versions can also process instances of newer SCL versions. Especially old system tools should handle new ICD and SSD files, while old IED tools should handle new SCD files to be forward compatible.

3.10
language version
the version of the XML schema defining the language

NOTE A language instance is produced according to a language (schema) version, which is called its assigned version, although it may also be valid against other language versions.

4 Abbreviations

In general, the glossary and abbreviations defined in IEC 61850-2 apply. The following abbreviations are either exclusive to this standard, or particularly useful for understanding this standard and are repeated here for convenience.

BDA	Basic DATA Attribute (i.e. not structured)
CIM	Common Information Model for energy management applications
DAI	Instantiated Data Attribute
DO	DATA in IEC 61850-7-2, data object type or instance, depending on the context
DOI	Instantiated Data Object (DATA)
ID	Identifier
IED	Intelligent Electronic Device
IdInst	Instance identification of a Logical Device as part of its name
InInst	Instance number of a Logical Node as part of its name
MSV	Multicast Sampled Value

MsvID	ID for MSV (Multicast Sampled Value)
RCB	Report Control Block
SCL	System Configuration description Language
SDI	Instantiated Sub-DATA; middle name part of a structured DATA name
SDO	Sub-DATA within a DOType, referencing another DOType
SED	System Exchange Description
UML	Unified Modelling Language according to http://www.omg.org/uml
URI	Universal Resource Identifier
UsvID	ID for USV (Unicast Sampled Value)
XML	Extensible Markup Language

5 Intended engineering process with SCL

5.1 General

Engineering of a substation automation system may start either with the allocation of functionally pre-configured devices to switch yard parts, products or functions, or with the design of the process functionality, where functions are allocated to physical devices later, based on functional capabilities of devices and their configuration capabilities. Often a mixed approach is preferred: a typical process part such as a line bay is pre-engineered, and then the result is used within the process functionality as often as needed. For SCL, this means that it must be capable of describing:

a) a system specification in terms of the single line diagram, and allocation of logical nodes (LN) to parts and equipment of the single line to indicate the needed functionality;

b) pre-configured IEDs with a fixed number of logical nodes (LNs), but with no binding to a specific process – may only be related to a very general process function part;

c) pre-configured IEDs with a pre-configured semantic for a process part of a certain structure, for example a double busbar GIS line feeder, or for a part of an already configured process or automation system;

d) complete process configuration with all IEDs bound to individual process functions and primary equipment, enhanced by the access point connections and possible access paths in subnetworks for all possible clients;

e) as item d) above, but additionally with all predefined associations and client server connections between logical nodes on data level. This is needed if an IED is not capable of dynamically building associations or reporting connections (either on the client or on the server side).

Case e) is the complete case. Both cases d) and e) are the result after SAS engineering, while case a) is a functional specification input to SAS engineering, and b) and c) are possible results after IED pre-engineering either for a typical usage of the IED, or for a specific usage within a project.

5.2 Scope of SCL

The scope of SCL as defined in this standard is clearly focussed on these purposes:

1) SAS functional specification (point 5.1 a) above),

2) IED capability description (points 5.1 b) and 5.1 c) above), and

3) SA system description (points 5.1 d) and 5.1 e) above).

These purposes shall provide standardized support to system design, communication engineering and to the description of readily engineered system communication for device engineering tools.

For practical purposes, the following is also supported:

4) exchange of system interfacing information between two projects handling two systems, which need to exchange data;

5) exchange of IED modifications on an IED instance engineered specifically for a project back from the IED tool to the system tool.

This is reached by defining an object model describing the IEDs, their communication connections, and their allocation to the switch yard, as well as a standardized way to describe how this model shall be represented in a file to be exchanged between engineering tools. The resulting object model could also be the base for other engineering tasks, possibly with some additions. Therefore, and because of the additional needs of SCSMs, this standard considers the language as defined here as the core model, and defines how extensions of this core model for SCSMs as well as other (engineering) purposes can be carried out in a standardized and compatible way.

5.3 Use of SCL in the Engineering process

Figure 1 explains the usage of SCL data exchange in the above-mentioned engineering process. The text boxes above the dashed line indicate where SCL files are used. The text box *IED capabilities* corresponds to a result of steps 5.1 b) and 5.1 c) above, the text box *System specification* corresponds to step 5.1 a) above, the text box *Associations*... refers to steps 5.1 d) or 5.1 e) above.

To make the engineering tasks and responsibilities clear, tool roles are introduced for an IED configurator and a system configurator. A 'real' tool can play both roles. In this case the transfer of partly engineered data within the tool is private, but to any other (mostly to an IED tool) it has to be seen from the role the tool has played when modifying the project data, i.e if the modification was done in the scope of an IED tool, or in the scope of a system tool.

The **IED Configurator** is a manufacturer-specific, may be even IED specific, tool that shall be able to import or export the files defined by this part of IEC 61850. The tool then provides IED-specific settings and generates IED-specific configuration files, or it loads the IED configuration into the IED.

An IED shall only be considered compatible in the sense of the IEC 61850 series, if:

- it is accompanied either by an (ICD) SCL file describing its capabilities, or by an (IID) SCL file describing its project specific configuration and capabilities, or by a tool, which can generate one or both, of these file types from or for the IED (not shown in Figure 1);
- it can directly use a system SCL (SCD) file to set its communication configuration, as far as setting is possible in this IED (i.e. as a minimum, its needed communication addresses), or it is accompanied by a tool which can import a system SCL file to set these parameters to the IED.

The **System Configurator** is an IED independent system level tool that shall be able to import or export configuration files defined by this part of IEC 61850. It shall be able to import configuration files from several IEDs, as needed for system level engineering, and used by the configuration engineer to add system information shared by different IEDs. Then the system configurator shall generate a substation-related configuration file as defined by this part of IEC 61850, which is fed back to the IED Configurator for system-related IED configuration. The System Configurator should also be able to read a System specification file for example as a base for starting system engineering, or to compare it with an engineered system for the same substation.