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TECHNICAL SPECIFICATION

colour inside

Wind energy generation systems –
Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language

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CONTENTS

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WIND ENERGY GENERATION SYSTEMS –

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FOREWORD

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- 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.

Technical Specification IEC 61400-25-71 has been prepared by IEC technical committees TC 88: Wind energy generation systems and TC 57: Power systems management and associated information exchange.

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

Draft TS	Report on voting
88/706/DTS	88/715A/RVDTS

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

A list of all parts in the IEC 61400 series, published under the general title *Wind energy generation systems*, can be found on the IEC website.

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

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- withdrawn,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

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

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WIND ENERGY GENERATION SYSTEMS –

Part 25-71: Communications for monitoring and control of wind power plants – Configuration description language

1 Scope

The focus of the IEC 61400-25 series is on the communications between wind power plant components such as wind turbines and actors such as SCADA systems. Non-IEC 61850/IEC 61400-25 internal communication within wind power plant components is outside the normative scope of the IEC 61400-25 series.

This document describes how to extend the IEC 61400-25 series with the IEC 61850-6 Substation Configuration description Language (SCL) file format for describing communication-related Intelligent Electronic Device (IED) configurations of a wind turbine, wind power plant controller, meteorological mast, etc. The extension of SCL to the wind domain is intended to simplify integration of wind power plant equipment for clients, as well as their integration to the electrical system. The adoption of SCL allows formalised tool-based exchange of IED parameters, communication system configurations, switch yard (function) structures, as well as description of the relations between them.

The purpose of this format is to formally and efficiently exchange wind turbine and wind power plant IED capability descriptions, and system descriptions between IED engineering tools and the system engineering tool(s) of different manufacturers in a compatible way. The file format is also intended to provide report configuration and alarms as well as HMI interface information from a wind power plant. This information can be used to engineer overlying SCADA systems for the site, for connected DSO, or TSO, or for fleet operators' maintenance and surveillance systems. Finally, the SCL is intended as a documentation of the configuration and topology of the delivered system.

The System Configuration description Language (SCL) is defined in IEC 61850-6, which in turn is based on Extensible Markup Language (XML) version 1.0. Extensions to the IED and communication system model in SCL to cover IEC 61400-25-2 are included in this document. Also Specific Communication Service Mapping (SCSM) extensions or usage rules to cover all mappings defined in IEC 61400-25-4 and IEC 61400-25-41[1] are included in this document.

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

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.

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1 Under consideration.

IEC 61400-25-1, *Wind energy generation systems – Part 25-1: Communications for monitoring and control of wind power plants – Overall description of principles and models*

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

IEC 61400-25-3, *Wind turbines – Part 25-3: Communications for monitoring and control of wind power plants – Information exchange models*

IEC 61400-25-4:2016, *Wind energy generation systems – Part 25-4: Communications for monitoring and control of wind power plants – Mapping to communication profile*

IEC 61400-25-6, *Wind energy generation systems – Part 25-6: Communications for monitoring and control of wind power plants – Logical node classes and data classes for condition monitoring*

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

IEC 61850-6:2018, *Communication networks and systems for power utility automation – Part 6: Configuration description language for communication in electrical substation related to IEDs*

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

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

IEC 61850-7-4, *Communication networks and systems for power utility automation – Part 7-4: Basic communication structure – Compatible logical node classes and data object 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*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61400-25-1 and the following 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
extensible
ability to include terms from other vocabularies

Note 1 to entry: This is fulfilled in SCL if the other vocabularies come with their own XML name space.

3.2
language
identifiable set of vocabulary terms that has defined constraints

Note 1 to entry: This is the case with SCL, although some constraints are not definable in the XML schema.

3.3
instance
realization by usage of a language

Note 1 to entry: For example, an XML document in SCL describing an IED or a substation is an SCL instance.

3.4
project
system part with engineering responsibility for all contained IEDs

Note 1 to entry: In general, a system is a project. However, sometimes the IED engineering responsibility for different components of a system belongs to different parties or people. Each IED responsibility area is then a separate project. An IED can belong to one project only. It is 'owned' by that project.

3.5
backwards compatible
ability of newer receivers to process all instances of the old language in the context of a language change

Note 1 to entry: For SCL this means that tools built for newer language versions can understand instances from older versions. System tools in particular should understand old ICD and SSD files, while IED tools should understand old SCD files to be backward compatible.

3.6
language version
version of the IEC 61850-6 XML schema defining the language

Note 1 to entry: 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 Abbreviated terms

DSO	Distribution system operator
IED	Intelligent electronic devices
SAS	Substation automated system
SCADA	Supervision control and data acquisition
SCSM	Specific communication service mapping
TSO	Transmission system operator
WPP	Wind power plant
WPPC	Wind power plant controller
WPPS	Wind power plant server
WS	Web services
WT	Wind turbine
WTC	Wind turbine controller
XSD	XML schema definition
XML	eXtensible markup language

5 SCL introduction

5.1 General

IEC 61850-6 specifies a description language for the configuration of power utility IEDs. This language is called System Configuration description Language (SCL) and shall be referred to as basis for use of SCL within the wind domain. The configuration language is based on Extensible Markup Language (XML) version 1.0.

The scope of SCL is focused on these purposes:

1) system functional specification,
2) IED capability description, and
3) system description.

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

This is reached by defining an object model describing the IEDs, their communication connections, and their allocation to the process or single-line diagram, as well as a standardized way to describe how this model shall be represented in a file to be exchanged between engineering tools.

SCL can be used to describe IED configurations and communication systems in accordance with IEC 61850-5 and with the IEC 61850-7 series, for electrical equipment in the wind power plant components, as well as to describe IED configurations and communication systems in accordance with IEC 61400-25-2. It allows the formal description of the relations between the wind power plant and actors such as SCADA systems, relations to electrical components within a wind power plant, as well as the relation to the utility automation system and process or single-line diagrams.

At the application level, the electrical topology itself and the relation of the electrical topology to the logical nodes configured on the IEDs can be described.

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

IEC 61850-6 specifies a file format for describing communication-related IED configurations and IED parameters, communication system configurations, single-line diagrams, processes and the relations among them.

The IED and communication system model in SCL is in accordance with IEC 61850-5, IEC 61850-7-3 and IEC 61850-7-4. Specific to components of the wind power plant, the communication system model is in accordance with IEC 61400-25-2, IEC 61400-25-3 and IEC 61400-25-6. Services are described in SCL following requirements in IEC 61850-6 and IEC 61850-7-2, following the generic principles outlined also in IEC 61850-7-1.

Specific Communication Service Mapping (SCSM) extensions for mapping to the supported protocols in IEC 61400-25-4 and IEC 61400-25-41 are described in this document.

Engineering may start either with the allocation of pre-configured devices to wind power plants, or with the design of the wind power plant functionality, where functions (logical nodes) are allocated to physical devices later, based on the functional capabilities of devices and their configuration capabilities.

Often a mixed approach to engineering is preferred: a process part such as a single-line diagram is pre-engineered, and then the result is used within the process functionality as the IEDs are configured and added to the system configuration description.

For SCL, this means that the description language shall be capable of describing:

a) a system specification in terms of the single-line diagram, and allocation of logical nodes (LN) to components 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;
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.

In order to support the above capabilities, several different SCL file types are defined in IEC 61850-6, each with a semantic file name indicating its information content or the stage of the engineering process that created the specific SCL file.

5.2 SCL sections

The SCL syntax is specified in IEC 61850-6 using an XML schema (XSD file). This schema describes a hierarchy of information where the top level elements are:

– Header. Defines the version of the configuration files and the track of changes.

  Example from Header section in SCL:

```
<Header id="Project Omega" version="1">
   <History>
     <Hitem version="1" revision="0" when="2017-05-01" what="" why="" />
   </History>
</Header>
```


– Process. Logical container that can model the functionality of any system. A wind power plant can be modelled as a process. A wind turbine can also use a Process to define its functionality. The Process can hold a Substation inside.

  The process part can be nested which means that a process element like a wind turbine may contain a subcomponent that itself is described as one or several processes.

  Example from Process section in SCL:

```
<Process   type="windpowerplant" name="WPP1" >
    <Substation   name="S1">…
    <Line name="L1">…
    <Process type="metmast" name="MET1">..
    <Process type="windturbine" name="WT1">…
    <Process type="windturbine" name="WT2">…
    …
</Process>
```

– Line. Element to model the electrical connection between substations or a substation and other Processes as wind turbines.

  Incomplete example of Line section in SCL:

```
<Line  name="L1">
  <ConductingEquipment  name="S1" type="LIN">…
       <Terminal name="T1" connectivityNode="P1/S1/V35/AAF10+04/C7"
            processName="P1"    substationName="S1"    voltageLevelName="V35"
                 bayName="AAF10+04" cNodeName="C7" />
       <Terminal  name="T2"  connectivityNode="P1/L1/C19"  processName="P1/L1"
                 cNodeName="C19" />
       </ConductingEquipment>
  <ConductingEquipment   name="S3" type="LIN">…
       <ConnectivityNode name="C1" pathName="P1/L1/C1" />
       <ConnectivityNode name="C2" pathName="P1/L1/C2" />
```

```
            <ConnectivityNode name="C3" pathName="P1/L1/C3" />
          <ConnectivityNode name="C4" pathName="P1/L1/C4" />
          …
        </Line>
```

– Substation. It defines the topology of a substation with the different VoltageLevel, PowerTransformers, Bays and ConductingEquipments. The different protection and control functions can be allocated in the topology using LNode tags.

  Incomplete example of Substation section in SCL:

```
<Substation   name="S1">
    <VoltageLevel   name="V110">…
          <PowerTransformer   name="PTR2" type="PTR">…
          <PowerTransformer   name="PTR" type="PTR">…
                <Bay   name="D05">…
                <Bay   name="D02">…
                <Bay   name="D04">…
                <Bay   name="BUS-1-2">…
                <Bay   name="BUS-1-1">…
                <Bay   name="D01">…
                <Bay   name="D03">…
    </VoltageLevel>
    <VoltageLevel   name="V35">…
</Substation>
```

– Communication. This section describes a set of SubNetworks and access points (ConnectedAP) with the Address and all the needed parameters to create a connection (Association) to the system IED.

  Example from Communication section in SCL:


```
  <Communication>
    <SubNetwork name="S1">
      <ConnectedAP iedName="E1Q1SB8" apName="M1">…
      <ConnectedAP iedName="E1Q1SB10" apName="M1">…
      <ConnectedAP iedName="E1Q1SB14" apName="M1">
        <Address>
          <P type="IP">10.10.10.3</P>
          <P type="IP-GATEWAY">255.255.255.0</P>
          <P type="OSI-PSEL">00000001</P>
          <P type="OSI-SSEL">0001</P>
          <P type="OSI-TSEL">0001</P>
        </Address>
      </ConnectedAP>
      …
  </Communication>
```


– IED. This section describes the different intelligent devices that build the system. In this element the LogicalDevice and the LN (logical nodes) exposed in the device are defined. The IED element holds the initial configuration values and the DataSets and Control Blocks.

  An incomplete example of IED section in SCL is included.

```
<IED name="WTC1" type="WTC" manufacturer="WindTurbMan" configVersion="1.0">
    <Services>
      …
    </Services>
    <AccessPoint name="AP1">
      <Server>
        <Authentication />
        <LDevice inst="WTC">
          <LN0 lnType="LLN0" lnClass="LLN0" inst="">
            <DataSet name="Dataset1">…
        <ReportControl  name="rcb01"  datSet="Dataset1"  rptID="WTC/LLN0.RP.rcb01"
              confRev="1">
             <TrgOps dchg="true" period="true" />
             <OptFields    seqNum="true"    timeStamp="true"    dataSet="true"
reasonCode="true" />
           </ReportControl>
          </LN0>
          <LN lnType="LPHD" lnClass="LPHD" inst="1"/>
          <LN lnType="WTUR1" lnClass="WTUR" inst="1" />
```

```
            <LN lnType="WROT1" lnClass="WROT" inst="1" />
            <LN lnType="WTRM1" lnClass="WTRM" inst="1" />
            <LN lnType="WGEN1" lnClass="WGEN" inst="1" />
            <LN lnType="WCNV1" lnClass="WCNV" inst="1" />
            <LN lnType="WTRF1" lnClass="WTRF" inst="1" />
            <LN lnType="WNAC1" lnClass="WNAC" inst="1" />
            <LN lnType="WYAW1" lnClass="WYAW" inst="1" />
            <LN lnType="WALM1" lnClass="WALM" inst="1" />
            <LN lnType="MMXU1" lnClass="MMXU" inst="1" />
        </LDevice>
    </Server>
</IED>
```

– DataTypeTemplates. A set of information structures organized as LNodeType (logical node types), DOType (data object types), DAType (data attribute types) and EnumType (enumeration types) where the information model structure is described. Its main purpose is the data structure definition and the reusability of types between IEDs of the same model.

  An incomplete example of the DataTypeTemplates section in SCL is presented.

```
<DataTypeTemplates>
     <LNodeType id="LLN0_0" lnClass="LLN0">
          <DO name="Mod" type="ENC_Mod_Ctrl" />
          <DO name="Beh" type="ENS_Beh" />
          <DO name="Health" type="ENS_Health" />
          <DO name="NamPlt" type="LPL_0" />
          <DO name="Loc" type="SPS_0" />
          <DO name="Diag" type="SPC_0" />
          <DO name="LEDRs" type="SPC_1" />
          <DO name="Ind1" type="SPS_0" />
          <DO name="Ind2" type="SPS_0" />
         </LNodeType>
         <LNodeType id="LPHD_0" lnClass="LPHD">..
    …
    <DOType id="SPS_0" cdc="SPS">
          <DA name="stVal" bType="BOOLEAN" dchg="true" fc="ST" />
          <DA name="q" bType="Quality" qchg="true" fc="ST" />
          <DA name="t" bType="Timestamp" fc="ST" />
          <DA name="d" bType="VisString255" fc="DC" />
         </DOType>
    …
    <DAType id="Originator_0">
              <BDA name="orCat" bType="Enum" type="OriginatorCategoryKind" />
              <BDA name="orIdent" bType="Octet64" />
         </DAType>
    <EnumType id="RangeKind">
          <EnumVal ord="0">normal</EnumVal>
          <EnumVal ord="1">high</EnumVal>
          <EnumVal ord="2">low</EnumVal>
          <EnumVal ord="3">high-high</EnumVal>
          <EnumVal ord="4">low-low</EnumVal>
         </EnumType>
</DataTypeTemplates>
```


5.3 SCL file types

Rules for the different SCL files are described in IEC 61850-6. They are distinguished by their extension:

– ICD: IED Capability Description.

  Data exchange from the IED configurator to the system configurator. This file describes the functional and engineering capabilities of an IED type.

– CID: Configured IED Description.

  Data exchange from the IED configurator to the IED. It describes the communication related part of an instantiated IED within a project. The communication section contains the address of the IED. The process section related to this IED may be present and then shall have name values assigned according to the project-specific names. It is an SCD file, possibly stripped down to what the concerned IED shall know (restricted view of source IEDs). Observe that in the general case more information than this has to be

loaded onto an IED to have it completely configured, for example, the relation of internal signals to HW terminals, programs in the form of IEC 61131-3 or other code, or local control panel configuration information.

– IID: Instantiated IED Description.

  Data exchange from the IED configurator to the system configurator for a single IED preconfigured specifically for a project, for example, to include a preconfigured instance file or IED instance value changes or data model modifications. In this case the IED has its project-specific name; it may also have project-specific addresses, and a data model possibly included with some data set definitions preconfigured for the project.

– SSD: System Specification Description.

  Data exchange from a system specification tool to the system configurator. This file describes the single-line diagram and functions of the wind power plant and the required logical nodes. It shall contain a process description section and may contain the needed data type templates and logical node type definitions.

– SCD: System Configuration Description.

  Data exchange from the system configurator to IED configurators. This file contains all IEDs, including the configured data flow and needed DataTypeTemplates, a communication configuration section and a substation description section.

– SED: System Exchange Description.

  Data exchange between system configurators of different projects. This file describes the interfaces of one project to be used by the other project, and at reimport the additionally engineered interface connections between the projects. It is a subset of an SCD file, containing the interfacing components of the IEDs to which connections between the projects shall be engineered and "fix" IEDs referenced by them so as not to lose the source object of already defined references. Therefore additionally to an SCD file it states at each IED the engineering rights and the owning project from the view of the using (importing) project.

NOTE To facilitate the engineering data exchange between projects, IEC 61850-6:2018, 5.5 defines a set of rules regarding engineering responsibilities. These include definitions to connect an IED with a project and how to transfer the right to add data flow definitions for a specific IED.

5.4 SCL tools

According to IEC 61850 (all parts), an IED which is claimed to implement a server or client according to the System Configuration description Language (SCL) defined in IEC 61850-6 shall be accompanied by an ICD file or an IID file if the configuration is specific to an IED instance of the project. The different SCL tools are the IED configurator and the system configurator.

The IED configurator is manufacturer-specific (may be even IED-specific). When applying SCL to the wind domain, the tool shall be able to import or export the files defined by this document. The tool then provides IED-specific settings and generates IED-specific configuration files, or it loads the IED configuration into 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 document. 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 wind power plant related configuration file. 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 wind power plant.

An IED shall only be considered compatible with this document, if it is accompanied:

1) by an (ICD) SCL file describing its capabilities, or
2) by an (IID) SCL file describing its project specific configuration and capabilities, or