



BSI Standards Publication

Wind energy generation systems

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

National foreword

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

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TECHNICAL SPECIFICATION



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

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 27.180

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

WIND ENERGY GENERATION SYSTEMS –

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

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- withdrawn,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 61400-25-41¹ 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.

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>
    ...
  </SubNetwork>
</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" />
      </LDevice>
    </Server>
  </AccessPoint>

```

```

<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,

3) by a tool, which can generate one or both of these file types from or for the IED.

In order to be fully compatible also with IEC 61850-6 in addition to the above, an IED would also have to be able to:

- a) 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);
- b) or be accompanied by a tool which can import a system SCL (SCD) file to set these parameters to the IED.

6 SCL use cases in the wind power domain

6.1 General

An IEC 61400-25 system exchanges data between clients and servers. The clients create associations to the servers in order to monitor and control their behaviour. The SCL can describe the information model of the servers, the data accessible for each client and the relationship of the information model to the wind power plant topology.

The list of potential servers that may be included in an SCL file are:

- WTC – Wind Turbine Controller,
- WPPC – Wind Power Plant Controller
- WPPS – Wind Power Plant Server
- MetMast
- CMS – Condition Monitoring Server
- Alarm Server
- Substation IEDs (protection and control)
- Grid meter

The list of potential clients includes:

- Local HMI
- Park operator
- Gateway
- Remote control centre of DSO and TSO
- Fleet SCADA
- Condition monitoring system

The following use cases for the SCL use are described in this document:

- 1) IED level interface server configuration
- 2) WPPS level interface server configuration
- 3) Client data flow definition
- 4) Topology definition

Annex A describes the changes needed in SCL to be able to work with the IEC 61400-25-2:2016 and IEC 61400-25-6 information models and the IEC 61400-25-4:2016 mappings.

Annex B includes a compatible schema that can be used to configure wind power plants.

Annex C provides a full SCL description of a wind power plant that is in accordance with the examples given elsewhere in this document.

6.2 IED level interface server configuration

6.2.1 General

In this use case, the wind power plant includes several intelligent devices (IEDs) that can behave as servers (information providers).

If the wind turbine manufacturer provides an IEC 61400-25 server interface for the individual turbines, there shall be one IED for each wind turbine in the SCD file in the project (if this file is required). The vendor shall provide an ICD/CID/IID file of each wind turbine for the configuration of the system. Figure 1 describes this configuration.

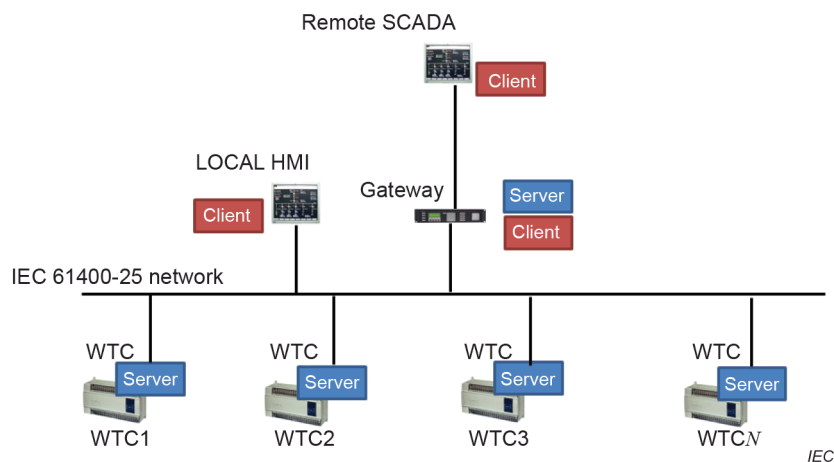


Figure 1 – Example with several IEDs

The SCD file with this approach uses the following structure:

```
<?xml version="1.0" encoding="utf-8"?>
<SCL xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
version="2007" revision="B" release="4" xmlns="http://www.iec.ch/61850/2003/SCL">
  <Header id="Project Omega" version="1"> ...
  <Process " type="windpowerplant" name="WPP1" > ...
  <Communication> ...
  <IED name="LOCAL_HMI" type="HMI_XX" manufacturer="Windtur systems" configVersion="1.2">...
  <IED name="GW" type="GW_GX0" manufacturer="Windtur systems" configVersion="1.4">... <IED
name="WTC1" type="WTC" manufacturer="Windtur systems" configVersion="1.0">...
  <IED name="WTC2" type="WTC" manufacturer="Windtur systems" configVersion="1.0">...
  <IED name="WTC3" type="WTC" manufacturer="Windtur systems" configVersion="1.0">...
  ...
  <IED name="WTCN" type="WTC" manufacturer="Windtur systems" configVersion="1.0">...
  ...
  <DataTypeTemplates>...
</SCL>
```

Figure 2 describes an example of logical node allocation in the different ICD files used to build the SCD file with the project configuration.

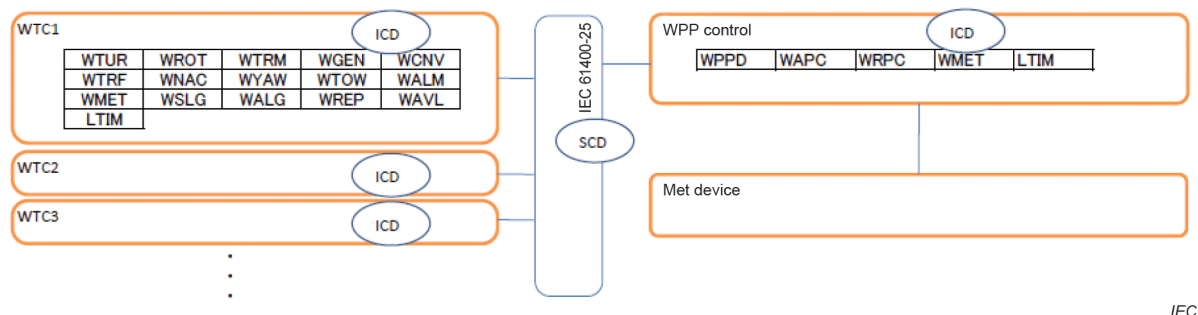


Figure 2 – Configuration diagram

6.2.2 Configuration process

Depending on the IED capabilities, some parameters such as IED name, IP parameters and ReportControlBlocks or Datasets can be configurable by the system integrator.

In this case the process follows some of these steps:

- 1) The IED vendors provide ICD/IID files with the configuration options in the IED Services sections in the SCL.
- 2) The system integrator configures the available parameters (if any) and returns the configuration file to the vendor.
- 3) IED vendor reconfigures and loads the IED with the parameters requested.
- 4) Optionally the IED vendors provide updated ICD/IID files with the configuration in the IED Services sections in the SCL.
- 5) The system integrator compiles all IEDs in the park and provides an SCD file describing the park IEC 61400-25 interface.

NOTE In addition to the above steps the integrator can also configure, for example, aggregated measurements, park optimisation functions or group alarms in IEC 61400-25 park controller or gateway IEDs. In that case these IEDs would also be included in the SCL description.

6.3 WPPS level interface server configuration

6.3.1 General

In this use case, the information of a wind power plant is provided to external clients using a central Wind Power Plant Server (WPPS). This IED will be the only one in the SCL file and it will hold information of several real devices in the system.

Remote clients can use the IEC 61400-25 interface whilst internal communication in the wind power plant remains vendor- or project-specific. Figure 3 describes this configuration.

NOTE IEC TR 61850-90-2 describes communication between substations and control centres. Its content can be used to model the WPPS gateway functionality.

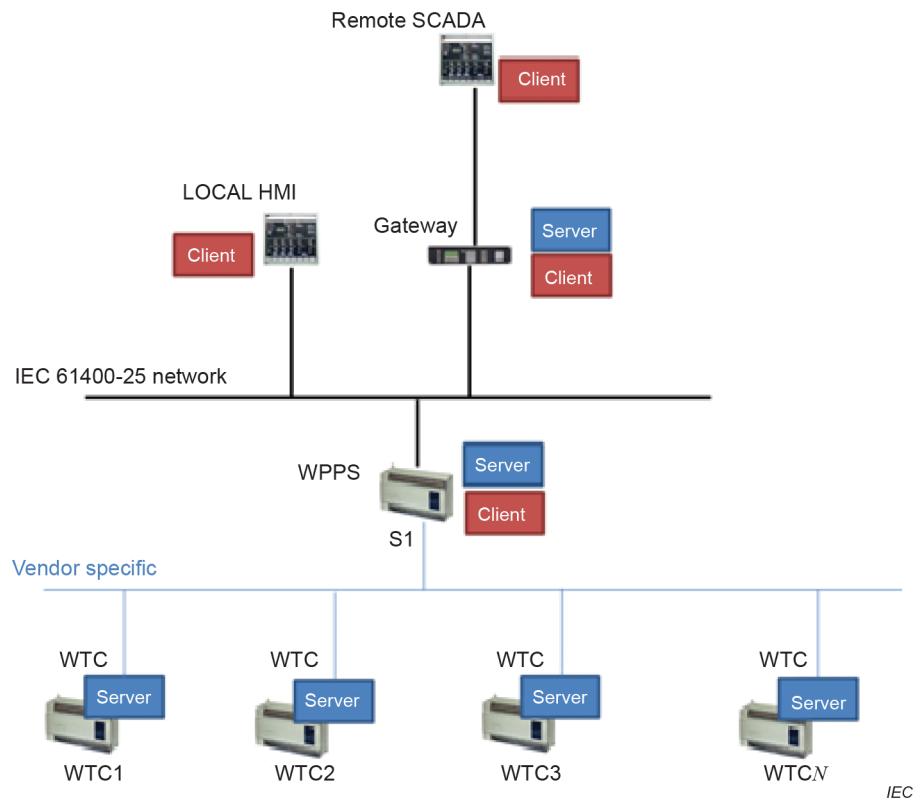


Figure 3 – Example with only one IED as WPPS

The SCL file with this approach uses the following structure:

```
<?xml version="1.0" encoding="utf-8"?>
<SCL xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xmlns:xsd="http://www.w3.org/2001/XMLSchema"
version="2007" revision="B" release="4" xmlns="http://www.iec.ch/61850/2003/SCL">
  <Header id="Project Omega" version="1"> ...
  <Process type="windpowerplant" name="WPP1" > ...
  <Communication> ...
  <IED name="WPPS1" type="WPPS" manufacturer="Windtur systems" configVersion="1.0">...
  ...
  <DataTypeTemplates>...
</SCL>
```

Figure 4 describes an example of logical node allocation in the SCD/IID file with the WPPS configuration

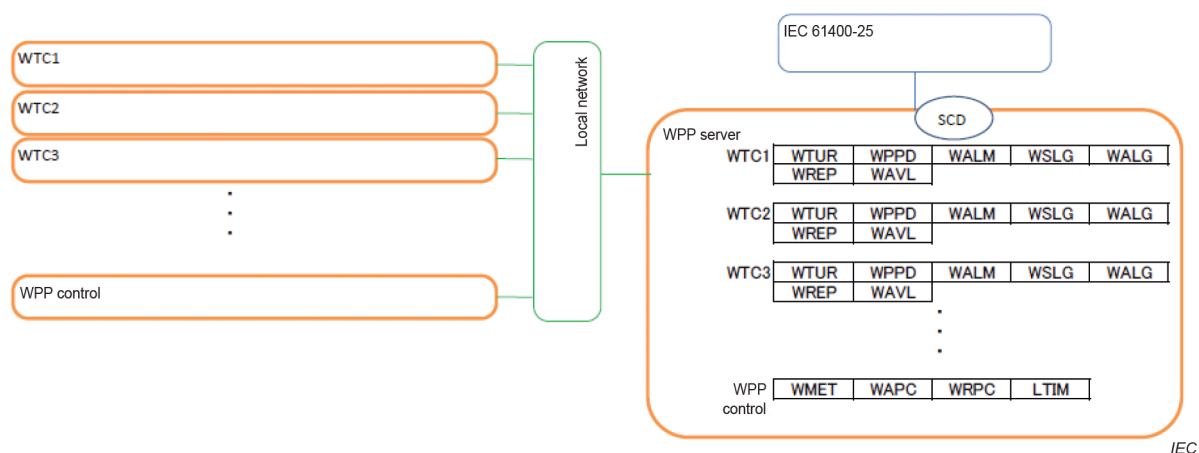


Figure 4 – WPPS logical node allocation

6.3.2 Configuration process

In this use case all park internal configuration options are set by other means than the SCL engineering process. Only the following step applies:

- 1) The system integrator configures the available parameters and provides an SCD/IID file describing the park IEC 61400-25 interface.

6.4 Client data flow definition

6.4.1 General

The main task of this use case is to define the data flow of all the clients that use the IEC 61400-25 interface to control wind power plant components or access wind power plant information.

The IEC 61400-25 interface allows grouping data for reading, spontaneous reporting or internal logging using datasets as defined in IEC 61400-25-3.

The control blocks are data structures that modify the server behaviour and functionality. Each control block includes a dataset to identify the data that is used by that functionality. The control blocks used in IEC 61400-25-3 are the Report Control Block (RCB) and the Log Control Block (LCB).

Each report control block is configured and an instance enabled by one client. Once the client enables the report control block instance, the server monitors the data configured in the related dataset and it notifies the events to the client following the configured parameters, as shown in Figure 5.

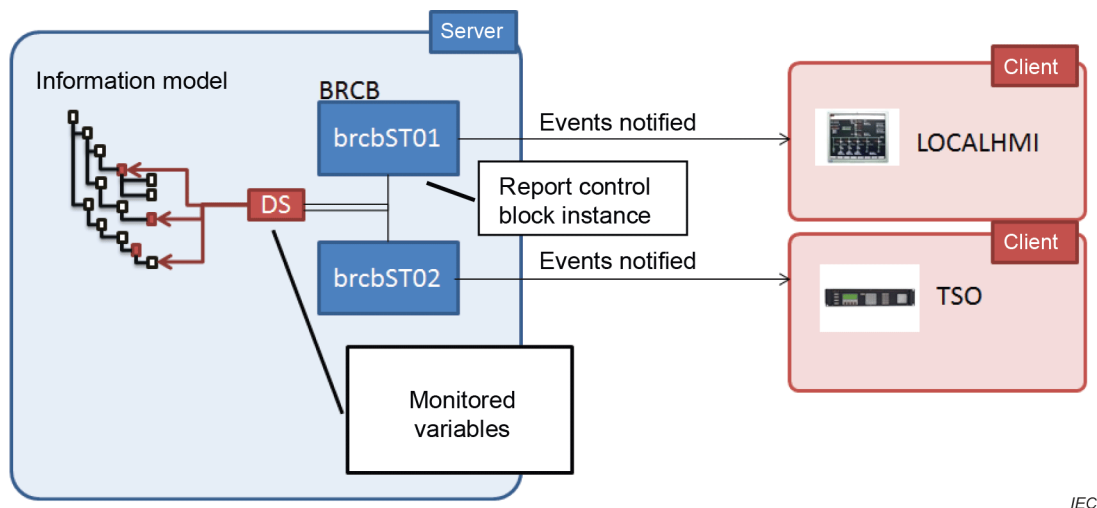


Figure 5 – Report data flow configuration

SCL allows the configuring of which client is responsible for configuring, enabling and using a specific instance of a report control block using the ClientLN element. ClientLN allocation allows the identification of the data that is relevant for different clients as the local HMI, and the RTU to the control centres.

An example of client allocation in SCL is the following:

```
<ReportControl name="brcbST" dataSet="ST" rptID="RPT" confRev="1" buffered="true">
  <TrgOps dchg="true" qchg="true" dupd="true" />
  <OptFields seqNum="true" timeStamp="true" dataSet="true" reasonCode="true" />
  <RptEnabled max="5">
    <ClientLN iedName="TSO" ldInst="LD" lnClass="ITCO" lnInst="1" />
    <ClientLN iedName="LOCALHMI" ldInst="LD" lnClass="IHMI" lnInst="1" />
  </RptEnabled>
</ReportControl>
```

```
</RptEnabled>
</ReportControl>
```

The Log Control Block logs the events internally. Any client can request the log entries specifying the starting point and if it is desired also the ending point.

NOTE The SCL file can contain the information data flow between IED servers and internal clients, such as the local HMI, or external clients outside the wind power plant.

6.4.2 Configuration process

6.4.2.1 Using IED level ICD/IID configuration files as input

In this use case a system integrator adds the client data flow as part of the park configuration:

- 1) IED vendor provides ICD/IID files with the IED template or real configuration of the project IEDs. These files describe the available engineering capabilities of the devices.
- 2) The system integrator compiles all IEDs in the park. Once the files are merged in the complete system configuration file, depending on the IED capabilities, datasets may be modified or created (some IEDs may have predefined dataset only).
- 3) Datasets are linked to report control blocks.
- 4) Report control blocks are associated to the different clients in the system.
- 5) The SCD file is generated describing the park's IEC 61400-25 interface as well as the information flow to and from the park.
- 6) If IED datasets are added or modified, the SCD file is imported back to the IED tool and the IED updated. (To enhance quality / minimise risk of error, step 1 to 2 can be repeated until no dataset modifications are required.)
- 7) Clients interfacing the park import the SCD file and extract data to configure the client communication interface.

The data flow configuration using several ICD/IID files as input is provided in Figure 6.

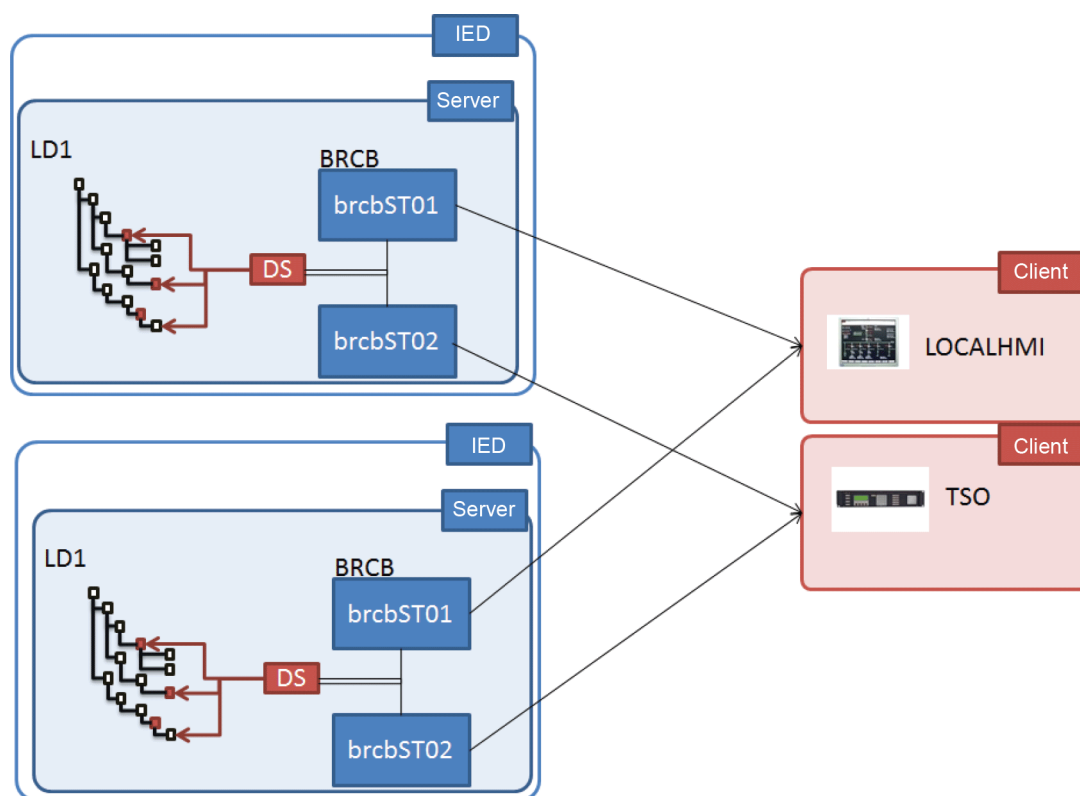


Figure 6 – Data flow configuration using several ICD/CID/IID files as input

6.4.2.2 Using system level SCD configuration file as input

In this use case the generated SCD file is used to configure the client communication interface.

- 1) The system integrator provides an SCD file with the information model of the system, the different IEDs or the WPPS IED interface, the communication parameters, the datasets and the report control blocks configured.

```
<ReportControl name="brcbST" dataSet="ST" rptID="RPT" confRev="1" buffered="true">
  <TrgOps dchg="true" qchg="true" dupd="true" />
  <OptFields seqNum="true" timeStamp="true" dataSet="true" reasonCode="true" />
  <RptEnabled max="5">
    </RptEnabled>
  </ReportControl>
```

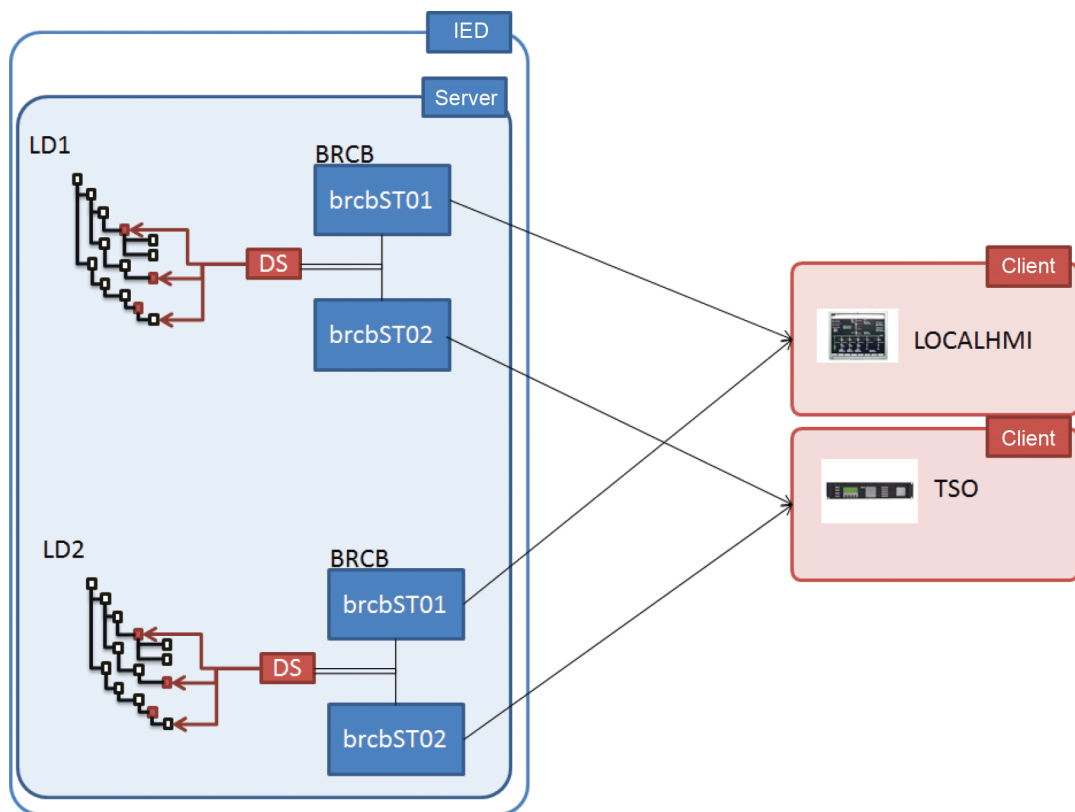
- 2) Using the provided SCD file, the report control blocks are associated to the different clients in the system.

An example of client allocation in SCL is the following:

```
<ReportControl name="brcbST" dataSet="ST" rptID="RPT" confRev="1" buffered="true">
  <TrgOps dchg="true" qchg="true" dupd="true" />
  <OptFields seqNum="true" timeStamp="true" dataSet="true" reasonCode="true" />
  <RptEnabled max="5">
    <ClientLN iedName="TSO" ldInst="LD" lnClass="ITCO" lnInst="1" />
    <ClientLN iedName="LOCALHMI" ldInst="LD" lnClass="IHMI" lnInst="1" />
  </RptEnabled>
</ReportControl>
```

- 3) The SCD file generated is used to reconfigure the client communication interface.

Figure 7 describes this data flow configuration.



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Figure 7 – Data flow configuration using an SCD file as input

6.5 Topology definition

6.5.1 General

SCL can be used to describe the electrical topology of a wind power plant and the relationship of the electrical topology with the different logical nodes of the wind power plant components needed to measure, control or protect the system.

6.5.2 SCL components used to define the topology

6.5.2.1 Process

6.5.2.1.1 General

SCL Ed. 2.1 adds the Process element to model energy-related processes or functions as required by hydropower, DER, or wind power. The Process element in the SCL can hold:

- Process
- Substation
- Line
- GeneralEquipment
- ConductingEquipment
- LNode (an abstract object in SCL to reference IED Logical Nodes).

6.5.2.1.2 Wind power plant as a process

In the event that the project requirements include the definition of the wind power plant components and their functional relationship to the electrical topology, the wind power plant shall be modelled as a top level Process element using the type: "windpowerplant".

NOTE The process structure is not limited to describing the hierarchy of the electrical topology as in this example. The process structure allows application-related naming in parallel to the communication-related naming. It can therefore also be used to relate the WPP data objects and IED logical nodes to other structures in a hierarchy such as RDS-PP. A complete SCD file might therefore serve as a database to translate from one application to the other.

6.5.2.1.3 Wind turbine as a process

Inside the "windpowerplant" process, each wind turbine may be modelled as a Process with the type "windturbine".

NOTE The content and detail of the electrical topology of the windturbine inside the Process is vendor- or project-specific. Neither the IEC 61400-25 series nor this document requires any level of detail in the internal electrical description of the wind turbine components. This is an option in order to associate a semantically defined logical node in an IED to a function or component in a hierarchical structure reflecting, for example, the electrical topology.

6.5.2.1.4 WPPC – Wind power plant controller

This process holds the logics of control of a set of turbines or the complete group of turbines of the wind power plant to provide some power control mechanism. It shall be modelled as a Process with the type "wppcontroller".

6.5.2.1.5 WPPS – Wind power plant server process

The wind power plant server is a specific device that exposes an IEC 61400-25-2 interface with the information of several components of the wind power plant. As a data concentrator or gateway, it can also hold its own functions and logical nodes that are not related to any wind power plant component. It shall be modelled as a Process with the type "wppserver".

6.5.2.1.6 Met mast process

Each met mast station shall be modelled as a Process with the type "metmast".

6.5.2.1.7 CMS – Condition monitoring system process

The condition monitoring system shall be modelled as a Process with the type "cms".

6.5.2.1.8 Additional process

No specific type is defined for any other process, such as aviation lights, bird detection, flight detections, etc.

NOTE Proprietary process types can be added.

6.5.2.2 Line

The connectivity between the wind power plant substation and the wind turbines shall be accomplished using Line and ConductingEquipment of type Segment.

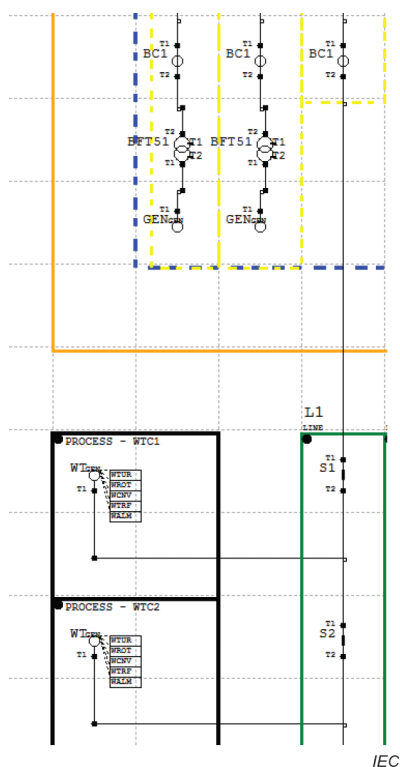


Figure 8 – Electrical connection using Line and Segments

As described in Figure 8, the processes named WTC1 and WTC2 represent two wind turbines connected to line L1, which includes two different segments, S1 and S2. Line L1 is connected to a bay in the substation of the windpowerplant.

A simplified example of this simple line is the following:

```
<Line name="L1">
  <ConductingEquipment name="s1" type="LIN">
    ...
  </ConductingEquipment>
  <ConductingEquipment name="s2" type="LIN">
    ...
  </ConductingEquipment>
  <ConnectivityNode name="C1" pathName="P1/L1/C1" />
  <ConnectivityNode name="C2" pathName="P1/L1/C2" />
</Line>
```

6.5.2.3 Substation

SCL allows for defining of a Substation as top level element and also inside the Process elements.

If the wind power plant substation is inside the scope of the project part described by SCL, it is recommended to model it inside the Process "windpowerplant".

At least one PowerTransformer and two different VoltageLevels are included in the Substation. Each VoltageLevel includes several Bays for the control and protection of the electrical assets in the system.

The circuit breakers, switches, current and voltage transformers are modelled as ConductingEquipment. The different ConductingEquipment and PowerTransformers are interconnected using Terminals and ConnectivityNodes.

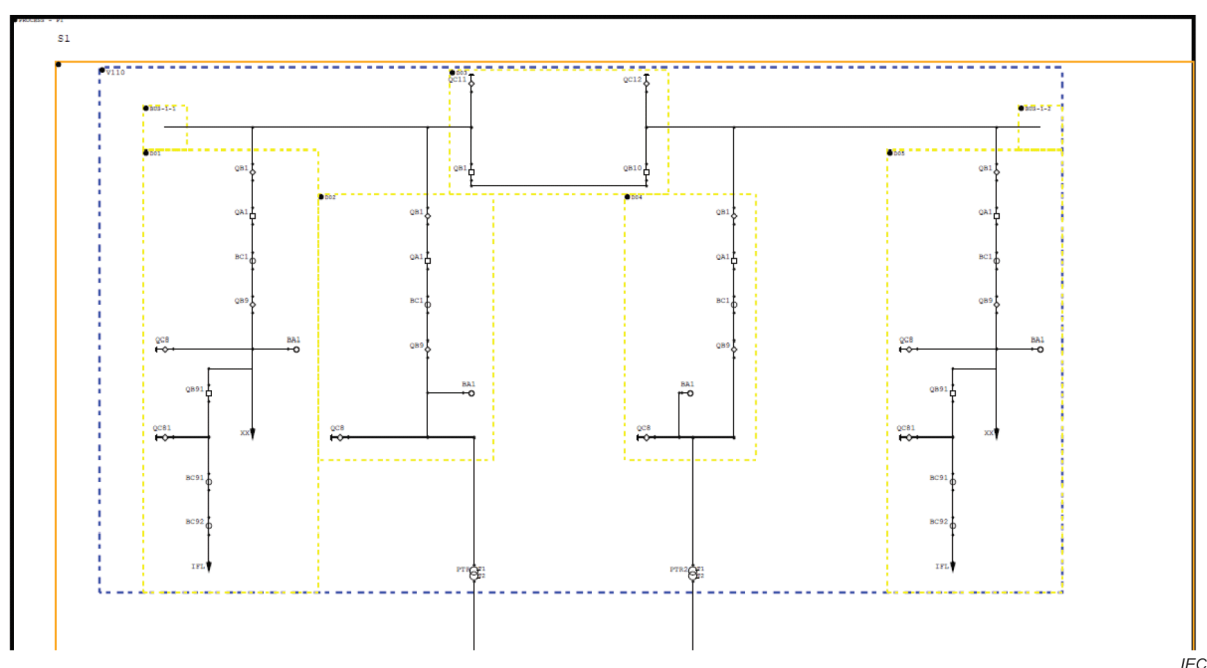


Figure 9 – Example of substation connectivity

The SCL section related to VoltageLevel "V1" described in Figure 9 includes the different Bays and two PowerTransformers that connect to different VoltageLevels in the Substation.

```
<Substation sxy:x="1" sxy:y="1" name="S1">
  <VoltageLevel sxy:x="1" sxy:y="0" name="V110">
    <PowerTransformer sxy:x="14" sxy:y="11" name="PTR2" type="PTR">...
    <PowerTransformer sxy:x="8" sxy:y="11" name="PTR" type="PTR">...
    <Bay sxy:x="1" sxy:y="2" name="D01">...
    <Bay sxy:x="18" sxy:y="2" name="D02">...
    <Bay sxy:x="18" sxy:y="2" name="D03">...
    <Bay sxy:x="18" sxy:y="2" name="D04">...
    <Bay sxy:x="18" sxy:y="2" name="D05">...
    <Bay sxy:x="1" sxy:y="1" name="BUS-1-1">...
    <Bay sxy:x="21" sxy:y="1" name="BUS-1-2">...
  </VoltageLevel>
</Substation>
```

6.5.3 Configuration process

The topology section is not required for communication, its main task is in relation to the documentation and it makes it easier to relate components and data points in the different IEDs in a project. The way the topology components are included and the level of detail is project specific.

The topology section (Process or Substation) uses the LNode element to create the relationship between the topology and the real data points in the IED section of the SCL file.

An example of the relationship in a Process related to a wind turbine is included:

```
<Process sxy:x="1" sxy:y="29" name="WTC2">
  <ConductingEquipment name="WT" type="GEN">
    <LNode lnClass="WTUR" />
    <LNode lnClass="WROT" />
    <LNode lnClass="WCNV" />
    <LNode lnClass="WTRF" />
    <LNode lnClass="WALM" />
    <Terminal name="T1" connectivityNode="P1/L1/C6" processName="L1" cNodeName="C6" />
  </ConductingEquipment>
</Process>
```

An example of the relationship in a Bay of the Substation section is included:

```
<Bay name="D03">
  <ConductingEquipment name="QB1" type="CBR">
    <LNode lnClass="CSWI" ....="" />
  ...
</Bay>
```

7 Mapping specific configuration

7.1 General

IEC 61400-25-2 and IEC 61400-25-3 define an information model and a set of services and functionality that is independent from the communication protocol mappings used to exchange data.

Each mapping requires different parameters to establish the communication link. The SCL Communication section shall include these parameters in the "P" parameter types used. Clause 7 defines the P type names used in IEC 61400-25-4 and IEC 61400-25-41.

Each mapping may require extensions to the information model common data classes or conversion information between the textual references used in IEC 61400-25-2 and numerical addresses used by the communication protocol in use. Clause 7 defines how these extensions shall be done using the SCL.

7.2 Web Services mapping configuration parameters – WS communication parameters

Web Service specific parameters shall be as defined in IEC 61400-25-4:2016, Annex A. SCL shall include the URL needed to connect with the web server (see Table 1).

Table 1 – WS specific communication configuration parameters

P parameter type	Description
URL	URL of the web server

An example of the definition of the WS address is the following:

```
<Address>
  <P type="URL"> ws://10.10.10.10:8080/iec6140025/ServerName</P>
</Address>
```

The client and server using the WS are linked using the same "SubNetwork" element of the SCL communication section. The "type" attribute shall be "WS".

7.3 MMS mapping configuration parameters

7.3.1 MMS communication configuration parameters

MMS specific communication parameters include the IP related parameters, the OSI selectors and, optionally, the AP-title and AE-qualifier as described in Table 2.

Table 2 – MMS specific communication configuration parameters

P parameter type	Description
IP	IP address to access the device
IP-SUBNET	Subnet mask
IP-GATEWAY	IP address of the gateway if needed
OSI-PSEL	OSI presentation layer selector (0000001)
OSI-SSEL	OSI session layer selector (0001)
OSI-TSEL	OSI transport layer selector(0001)
AP-TITLE	Application specific identification parameter
AE-QUALIFIER	Application specific identification parameter
NOTE 1 The IP address is decided in the project planning, the rest of the P parameters are usually provided by the device manufacturer with default values and are not changed during the system engineering.	
NOTE 2 The list of P parameters to be included in the Address of the Communication section of the SCL is defined in IEC 61850-8-1.	

An example of an MMS address configuration is the following:

```
<Address>
  <P type="IP">10.10.10.2</P>
  <P type="IP-SUBNET">255.255.255.0</P>
  <P type="IP-GATEWAY">10.10.10.1</P>
  <P type="OSI-PSEL">0000001</P>
  <P type="OSI-SSEL">0001</P>
  <P type="OSI-TSEL">0001</P>
</Address>
```

The client and server using MMS are linked using the same "SubNetwork" element of the SCL communication section. The "type" attribute shall be "8-MMS".

7.3.2 MMS extension data types configuration

MMS mapping in IEC 61400-25-4:2016, Annex C extends the IEC 61850-7-3 controllable common data classes with the inclusion of specific data attributes: SBO, SBOw, Oper and Cancel.

SCL includes the attribute ProtNs to indicate that the DataTypeTemplates have been updated for a specific mapping. This ProtNs feature shall be added to the DA or DAType that has been extended.