Relion® Protection and Control

IEC 61850
615 series
Engineering Guide

Power and productivity
for a better world™

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Conformity

This product complies with the directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 2004/108/EC) and concerning electrical equipment for use within specified voltage limits (Low-voltage directive 2006/95/EC). This conformity is the result of tests conducted by ABB in accordance with the product standards EN 50263 and EN 60255-26 for the EMC directive, and with the product standards EN 60255-6 and EN 60255-27 for the low voltage directive. The IED is designed in accordance with the international standards of the IEC 60255 series.

Safety information

Dangerous voltages can occur on the connectors, even though the auxiliary voltage has been disconnected.

Non-observance can result in death, personal injury or substantial property damage.

Only a competent electrician is allowed to carry out the electrical installation.

National and local electrical safety regulations must always be followed.

The frame of the IED has to be carefully earthed.

When the plug-in unit has been detached from the case, do not touch the inside of the case. The IED case internals may contain high voltage potential and touching these may cause personal injury.

The IED contains components which are sensitive to electrostatic discharge. Unnecessary touching of electronic components must therefore be avoided.

Whenever changes are made in the IED, measures should be taken to avoid inadvertent tripping.

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Section 1 Introduction

1.1 This manual

Engineering Guide provides information for IEC 61850 engineering of the 615 series protection IEDs with PCM600 and CCT600. This quide concentrates especially on the configuration of GOOSE communication with these tools. The guide can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service. For more details on tool usage, see the PCM600 documentation.

1.2 Intended audience

This manual addresses the system engineers and installation and commissioning personnel.

The system engineer must have a thorough knowledge of protection systems, protection equipment, protection functions and the configured functional logic in the IEDs. The installation and commissioning personnel must have basic knowledge of how to handle the electronic equipment.

1.3 Product documentation

1.3.1 Product documentation set

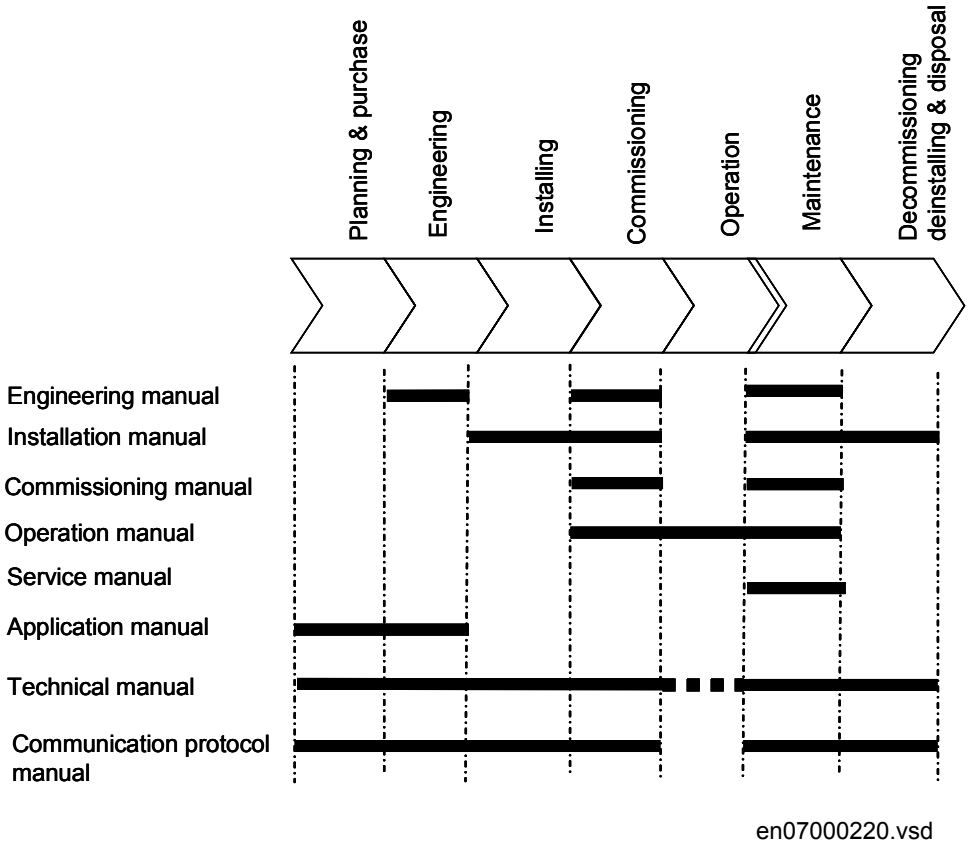

Figure 1: The intended use of manuals in different lifecycles

Engineering Manual contains instructions on how to engineer the IEDs. The manual provides instructions on how to use the different tools for IED engineering. It also includes instructions on how to handle the tool component available to read disturbance files from the IEDs on the basis of the IEC 61850 definitions. It further introduces the diagnostic tool components available for IEDs and the PCM600 tool.

Installation Manual contains instructions on how to install the IED. The manual provides procedures for mechanical and electrical installation. The chapters are organized in chronological order in which the IED should be installed.

Commissioning Manual contains instructions on how to commission the IED. The manual can also be used as a reference during periodic testing. The manual provides procedures for energizing and checking of external circuitry, setting and configuration as well as verifying settings and performing directional tests. The

chapters are organized in chronological order in which the IED should be commissioned.

Operation Manual contains instructions on how to operate the IED once it has been commissioned. The manual provides instructions for monitoring, controlling and setting the IED. The manual also describes how to identify disturbances and how to view calculated and measured network data to determine the cause of a fault.

Service Manual contains instructions on how to service and maintain the IED. The manual also provides procedures for de-energizing, de-commissioning and disposal of the IED.

Application Manual contains application descriptions and setting guidelines sorted per function. The manual can be used to find out when and for what purpose a typical protection function can be used. The manual can also be used when calculating settings.

Technical Manual contains application and functionality descriptions and lists function blocks, logic diagrams, input and output signals, setting parameters and technical data sorted per function. The manual can be used as a technical reference during the engineering phase, installation and commissioning phase, and during normal service.

Communication Protocol Manual describes a communication protocol supported by the IED. The manual concentrates on vendor-specific implementations.

Point List Manual describes the outlook and properties of the data points specific to the IED. The manual should be used in conjunction with the corresponding Communication Protocol Manual.

Some of the manuals are not available yet.

1.3.2 Document revision history

Document revision/date	Product series version	History
A/30.05.2008	1.1	First release
B/02.07.2008	1.1	Content updated
C/04.03.2009	2.0	Content updated to correspond to the product series version
D/03.07.2009	2.0	Content updated

Download the latest documents from the ABB web site http://www.abb.com/substationautomation.

1.3.3 Related documentation

Name of the document	Document ID
IEC 61850 Tissues Conformance Statement (TICS)	1MRS756464
IEC 61850 Protocol Implementation eXtra Information (PIXIT)	1MRS756465
IEC 61850 Protocol Implementation Conformance Statement (PICS)	1MRS756466
IEC 61850 Model Implementation Conformance Statement (MICS)	1MRS756467

Product series- and product-specific manuals can be downloaded from the ABB web site http://www.abb.com/substationautomation.

1.4 Document symbols and conventions

1.4.1 Safety indication symbols

This publication includes icons that point out safety-related conditions or other important information.

The caution icon indicates important information or warning related to the concept discussed in the text. It might indicate the presence of a hazard which could result in corruption of software or damage to equipment or property.

The information icon alerts the reader to important facts and conditions.

The tip icon indicates advice on, for example, how to design your project or how to use a certain function.

Although warning hazards are related to personal injury, it should be understood that operation of damaged equipment could, under certain operational conditions, result in degraded process performance leading to personal injury or death. Therefore, comply fully with all warning and caution notices.

1.4.2 Document conventions

- Abbreviations and acronyms in this manual are spelled out in Glossary. Glossary also contains definitions of important terms.
- HMI menu paths are presented in bold, for example:

Select **Main menu/Information**.

- Parameter names are shown in italics, for example:
  The function can be enabled and disabled with the *Operation* setting.
- Parameter values are indicated with quotation marks, for example:
  The corresponding parameter values are "On" and "Off".
- IED input/output messages and monitored data names are shown in Courier font, for example:
  When the function starts, the `START` output is set to TRUE.

Section 2 IEC 61850 overview

The international IEC 61850 standard defines a framework for substation communications networks and systems. The standard consists of several parts ranging from the requirements on substation automation systems to the details of a communication protocol.

One major difference between the other communication protocols applied in substation automation and IEC 61850 is that the latter is not only a communication protocol, but a whole framework for specifying, engineering and operating substation automation systems. The communication part covers the connection between the IEDs and the substation level, fast peer-to-peer communication between the IEDs and communication to sensors and actuators

Table 1: Structure and parts of the IEC 61850 standard

Part	Subject	Description
1	Introduction and overview	Information and understanding
2	Glossary	
3	General requirements	
4	System and project management	Impact on tenders and project management
5	Communication requirements for functions and device models	Requirements
6	Configuration description language for communication in electrical substations related to IEDs	Impact on engineering
7-1… 7-4	Basic communication structure for substation and feeder equipment (data model and services)	Modelling and services
8	Mapping; stack A, stack B	Station bus mappings
9	Mapping; stack X, stack Y	Process bus mappings
10	Conformance testing	Impact on verification

The IEC 61850 standard specifies an expandable data model and services for substation automation (standard parts 7-x). The standard does not specify any protection or control functions, but specifies how the functions expose their information to a communication network.

The standard supports free allocation of functions to devices. With efficient communication facilities, the functions can be located anywhere in the system, that is, an interlocking function can reside in the IED or on the station level. Additionally, the standard is open for different system philosophies, that is, different integration levels and allocation of functions to different devices is supported.

The standard also defines a description language for substation automation systems. The language facilitates efficient integration of devices into systems in an automated fashion. Additionally the standard supports a comprehensive and consistent system definition and engineering, which makes not only the devices, but also their tools and systems interoperable (standard part 6).

The standard uses Ethernet and TCP/IP for communication. Since Ethernet and TCP/IP are widely accepted and used, the application of these technologies provide a broad range of features from mainstream communication (standard parts 8-1, 9-2). Therefore, IEC 61850 is also open for possible new communication concepts in the future.

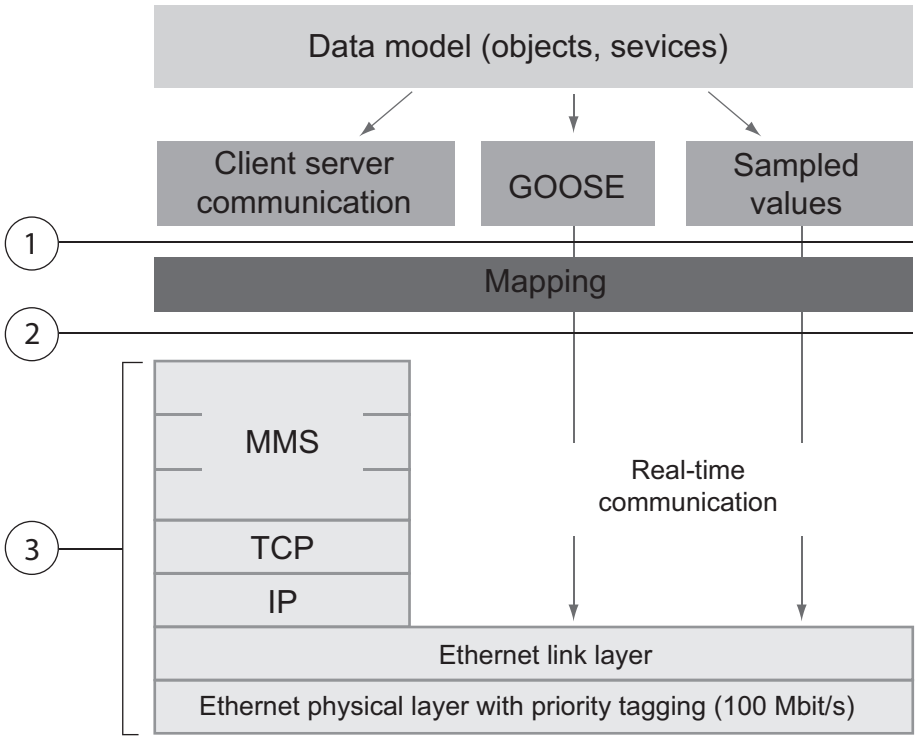

Figure 2: Communication stacks and mapping used in IEC 61850

1 Abstract communication services interface (ACSI)
2 Stack interface
3 ISO/OSI stack

Section 3 PCM600 tool

Protection and Control IED Manager PCM600 offers all the necessary functionality to work throughout all stages of the IED life cycle.

- Planning
- Engineering
- Commissioning
- Operation and disturbance handling
- Functional analysis

With the individual tool components, you can perform different tasks and functions and control the whole substation. PCM600 can operate with many different topologies depending on customer needs.

For more information, see PCM600 documentation.

3.1 Connectivity packages

Connectivity package is a collection of software and information related to a specific protection and control terminal providing system products and tools to connect and interact with the IED.

Connectivity Package Manager is a tool that helps the user to define the right connectivity package versions for different system products and tools. Connectivity Package Manager is included in products supporting the connectivity concept.

Use the connectivity packages to create configuration structure in PCM600. In addition to other products supporting connectivity concept, the connectivity packages for PCM600 contain:

- Description of IED's internal parameters and their properties such as data format, unit, setting range, visibility and access rights. The description texts can be translated into other languages as well.
- Software components that adapt the IED-specific interfaces to the standard interfaces of system products and tools such as IED-specific dispatchers for tools. This means that there is a protocol-specific adaptation for the parameter setting and disturbance handling tool components, for example disturbance uploading according to COMTRADE.

3.2 PCM600 and IED connectivity package version

- Protection and Control IED Manager PCM600 Ver. 2.0 SP2 or later
- RED615 Connectivity Package Ver. 2.5 or later
- REF615 Connectivity Package Ver. 2.5 or later
- REM615 Connectivity Package Ver. 2.5 or later
- RET615 Connectivity Package Ver. 2.5 or later

Download connectivity packages from the ABB web site http://www.abb.com/substationautomation

3.3 CCT600

IEC 61850 also affects the engineering of the devices. PCM600 Engineering Pro, including the communication configuration tool CCT600, is needed to engineer an IEC 61850 system with the 615 series IEDs.

CCT600 acts as a system tool which is used to define and share the system-wide parameters, such as communication addresses, horizontal communication data and its priorities and client/server (system level/IED) connections. The actual configuration of the IED and the downloading of configuration changes are done with PCM600.

Section 4 615 series data model

4.1 615 series implementation

The IEC 61850 communication protocol is always supported by the 615 series IEDs. If the IED is ordered with no Ethernet communication interface, the front port on the device still works according to IEC 61850. All settings and configurations are changed by using IEC 61850 via the front Ethernet port of the LHMI. Without the Ethernet option, event reporting or peer-to-peer services cannot be used.

Only one point-to-point connection is allowed to the front port. This means that no network can be built by using the front port.

The 615 series has been designed to fully support the concepts of IEC 61850. This means that any information and data offered by the 615 series IEDs can be modelled according to IEC 61850 and the services for using the data are widely supported according to the standard.

- Process data: monitoring of status information, measurements
- Application data: protection activations, tripping, fault recordings
- Disturbance recorder files
- Control commands
- Protection settings
- Setting groups
- Configuration data
- Self-supervision messages
- Fast horizontal communication between devices
- Time synchronization

4.2 Information model

According to the IEC 61850 model, a 615 series IED consists of three logical devices.

- Control logical device, CTRL
- Disturbance recorder logical device, DR
- Protection logical device, LD0

Generic functionality, such as physical inputs and outputs as well as the alarming LED functionality, resides under LD0.

Different configurations have different data models.

During the system engineering in system configuration tool, do not delete or change the name of the logical devices or logical nodes in IEC 61850 data model.

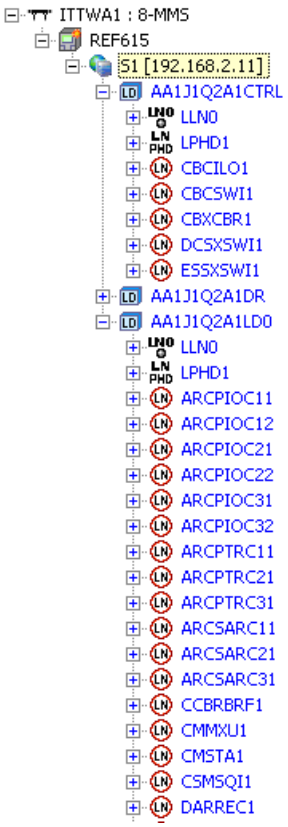

Figure 3: Example of an IEC 61850 data model of a 615 series IED

All definitions for the IEC 61850 communication configuration, such as data sets, report control blocks, GOOSE control blocks and the setting group control block, are always located under LD0.LLN0. The full data model is found in the SCL file, which can be exported from PCM600.

4.3 Vertical and horizontal communication

The 615 series IEDs can communicate by using the monitoring and control services offered by IEC 61850. A client can read and write data, receive either buffered or

unbuffered reports and execute control sequences. Five separate individual clients are supported. An active PCM600 connection is also considered a client as such.

Additionally, the 615 series IEDs can be programmed to publish (send) information to and subscribe (receive) information from other devices according to the IEC 61850-8-1 GOOSE profile. This is often referred to as horizontal communication, that is, peer-to-peer communication. At the moment, only Boolean data (0 or 1) can be received.

4.3.1 Predefined vertical communication data sets

Vertical communication data sets, that is, the information spontaneously communicated to clients (station HMI and gateway) is predefined, but can be changed in PCM600 by changing the data set contents. There are seven predefined vertical communication data sets and corresponding report control blocks for spontaneous event reporting.

- StatIed– generic status information of IEDs
- StatIo – inputs, outputs, LEDs
- StatUrg – measurement limit supervision, control feedback
- StatNrml – protection start and trip signals, auto-reclose status
- StatDR – disturbance recorder status
- MeasReg – registered measurement values at faults
- MeasFlt – measurements

The 615 series supports both buffered and unbuffered reporting. The predefined report control blocks are buffered. A single data set can only be used by one report control block, and the same data set entry cannot be used in different data sets used by different report control blocks.

StatNrml, StatUrg and StatIed are also used by the LHMI of 615 series IEDs. In these data sets, the entries shall not be renamed or removed in any system configuration tool. Generally, the default values of all data sets and control blocks are suitable for most of the systems, so only users with deep knowledge of system configuration should change these if configuration changes are required.

Legacy protocol event handling, for example in Modbus, is also based on the IEC 61850 data sets in the IED data model. When the data sets are edited, the changes also affect the communication properties of the other protocols. If the IEC 61850 event reporting model needs to be changed, no data set entries shall be deleted. If new data is required by the clients, one new data set report control block can be built in PCM600. Data filtering must be done on the IEC 61850 client side.

A 615 series IED can have at maximum 12 configured data sets and 8 report control blocks for event handling. The maximum length for a data set is 320 data attributes.

4.3.2 Vertical communication diagnostic counters

The IEC 61850 data model of the 615 series IEDs includes a logical node LD0.MMSGGIO1 for IEC 61850 vertical communication diagnostic. The counters are available via the HMI or PCM600 path **Monitoring/Communication**.

Table 2: Diagnostic data objects

Data object	Description	Diagnostic information
IntIn1	Successful connections	Number of succeeded client connection attempts
IntIn2	Failed connections	Number of failed client connection attempts
IntIn3	Concludes	Number of session concludes
IntIn4	Sent aborts	Number of association aborts sent by server
IntIn5	Received aborts	Number of received association aborts by server
IntIn6	Sent rejects	Number of sent rejects by server
IntIn7	Received request	Number of received client requests
IntIn8	Failed requests	Number of failed client requests
IntIn9	Reads	Number of variable reads
IntIn10	Failed reads	Number of failed variable reads
IntIn11	Writes	Number of succeeded variable writes
IntIn12	Failed writes	Number of failed variable writes
IntIn13	Reports	Number of sent reports
IntIn14	Active connections	Number of active client connections

To reset the vertical communication diagnostic counters, write `true` to RstCnt.Oper.ctlVal attribute under MMSGGIO1.

4.4 Parameter setting and disturbance recorder

Setting the protection function parameters and changing active setting groups can be accomplished in full scale by using the standard IEC 61850 services. Disturbance recorder files are also retrieved by using the IEC 61850 compatible services.

Section 5 GOOSE

5.1 Horizontal communication

GOOSE is used in substation automation for fast horizontal communication between the IEDs. GOOSE can be used for direct data exchange, for example, of interlocking and blocking information between IEDs. According to the IEC 61850-8-1 standard, GOOSE uses a publisher/subscriber profile in which information is shared from one IED to one or several IEDs by using Ethernet multicast messages. A message is an image of a sent IEC 61850 data set that is defined in the configuration.

CCT600 is used to configure the horizontal communication properties of the 615 series IEDs.

A 615 series IED can send any type of status data in the GOOSE messages from its IEC 61850 data model. The response time, that is, the time it takes for the application to handle a received GOOSE message and to send the concerned data back to the network, is with the 615 series IEDs below 3 ms. The response time fulfils the tightest Type 1A, Class P2/3 requirements of the standard.

The horizontal communication configuration consists of the IEDs' GOOSE control block data set and GOOSE input configuration. The result of the configuration work is a system configuration file which can be downloaded to the IEDs. The used files in the workflow are IEC 61850 standard format SCL files.

5.1.1 Configuring horizontal communication

1. Create devices to a PCM600 project.
2. Export the SCD file.
3. Import the SCD file to CCT600.
4. Engineer the GOOSE connections between the devices.
   4.1. Define the published GOOSE data and control blocks.
   4.2. Define the subscribing IEDs for the GOOSE data.
5. Export the SCD file back to PCM600.
6. In PCM600, engineer the IED applications with GOOSE inputs.

While configuring take back-ups of the PCM600 and CCT600 projects, for example, before importing an SCD file to the project.

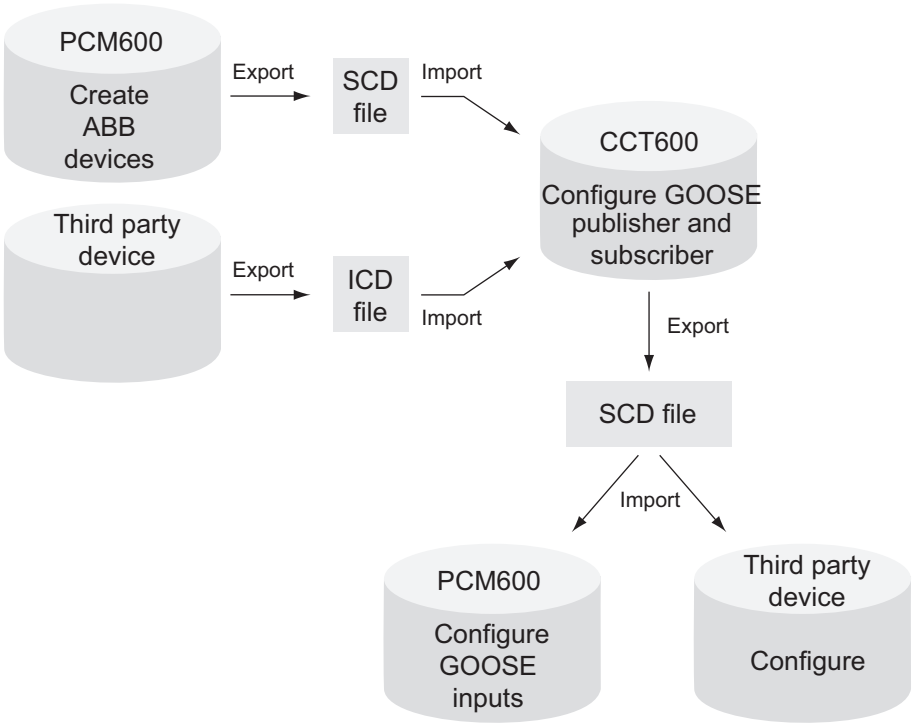

Figure 4: Horizontal communication configuration process

5.2 GOOSE publishing properties

GOOSE data is sent periodically in 802.1Q multicast frames over LAN. By this way, the peer devices know the state of the communication. When the data changes, the GOOSE frame is sent several times in a fast cycle to ensure the receiving of the data change.

In GOOSE, data sending is based on data sets and GOOSE control blocks. The data set defines which data is sent in the GOOSE frame. The GOOSE control block links the data set and its attributes to actual data.

Table 3: GOOSE control block attributes

GoCB attribute	Description
Multicast address	A multicast addressing scheme is used when sending GOOSE messages. A multicast address can be shared by several sending devices, or it can be IED specific. To keep the multicast message filtering of the devices working it is recommended to use unique multicast addresses. The 615 series IEDs are capable of storing 30 addresses for filtering. In some other devices the filtering is statistical and will not work after a certain limit.
Ethernet frame-specific information (802.1 Q tagging info: APPID, priority and VLAN id)	APPID is a GoCB-specific integer value identifying the sender GoCB and its data. The APPID must be unique for the GoCB in the system. The priority can be used according to the local network priority scheme, but the default value can be used normally. The VLAN group can be used when configuring the Ethernet network topology Virtual LANs for routing and filtering multicast messages. Configuration is done in managed Ethernet switches.
GoCB name	The name of the GoCB structure seen from the IEC 61850/MMS client. Some IEDs use this as a unique data reference.
GoID	A GOOSE control block specific string. The default value is the GoCB path in the 61850 namespace if nothing is set. It is recommended to set the value already in CCT600. Check the GOOSE Control block GoID name according to the system requirements of the receiving device. Although the 615 series IEDs use MAC address and APPID for receiving packet detection, some devices require also that the GOOSE control block GoID is named explicitly.
Data set definition	Data sent in GOOSE messages to the network.
ConfRev	ConfRev increases when the referenced data set is modified. Both the GOOSE sender and the receiver must have the same ConfRev value. This ensures that the both IEDs have the same configuration level in the substation configuration. ConfRev usage is done automatically by tools. If the latest system configuration is not downloaded to all required IEDs, the configuration revision may differ between the receiver and sender.

5.3 Configuring GOOSE

5.3.1 Defining IEDs and exporting the SCD file

Use PCM600 to define the substation and the IEDs. Before starting the system engineering, configure the IED settings and logic as much as possible.

For more information, see PCM600 documentation.

1. Create a PCM600 project with all the needed IEDs.
2. To export the SCD file, click the **Plant Structure** tab, right-click the substation node in the submenu and select **Export**.
   The file includes the whole substation configuration in SCL format for other tools.

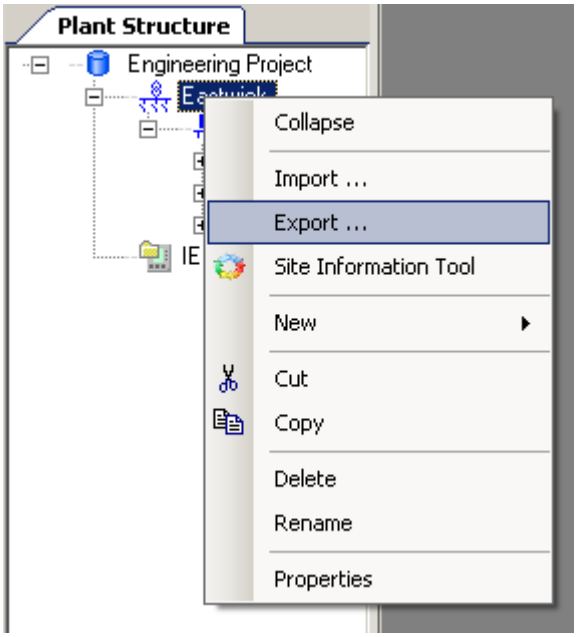

Figure 5: Exporting an SCD file from PCM600

3. To define the export options for the SCL file, select the **Export Private Sections** check box.
   The private sections data of the SCL file is only required by COM600 or MicroSCADA, not by CCT600.

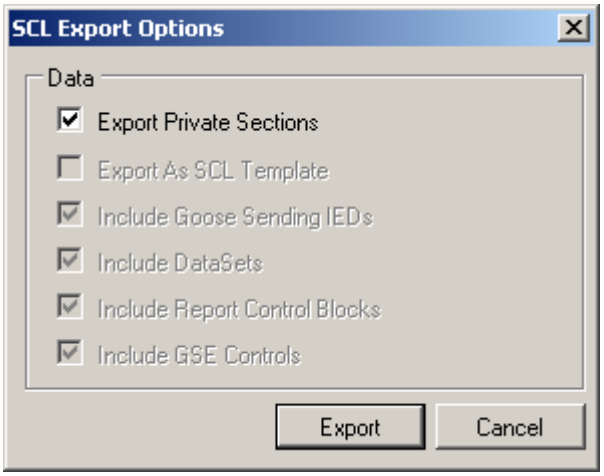

Figure 6: Export options for an SCL file

4. Click **Export**.

5.3.2 Creating an empty project

1. Open CCT600.
2. To create an empty project, select **File/Create New Project**.
3. Name the project.

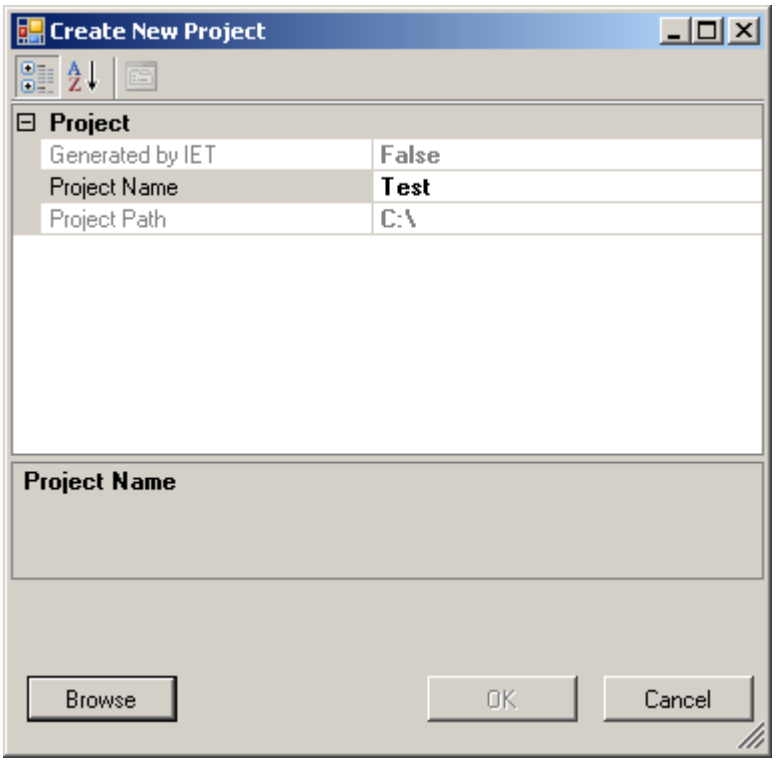

Figure 7: Naming a project

4. To select the destination folder for the project, click **Browse**.
5. Click **OK**.

After creating an empty project, import the SCD file from PCM600 to the project.

5.3.3 Importing the SCD file

Import the SCD file from PCM600 to the empty project.

1. Select **Tools/SCL Import/Export/Import SCL File**.

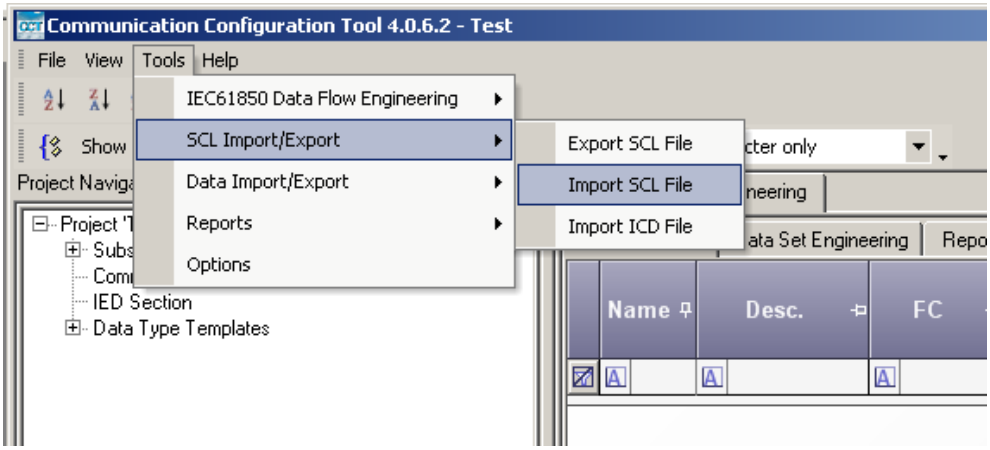

Figure 8: Importing an SCL file

2. In **Import SCL Data** dialog box, clear the check boxes and click **Browse for File**.

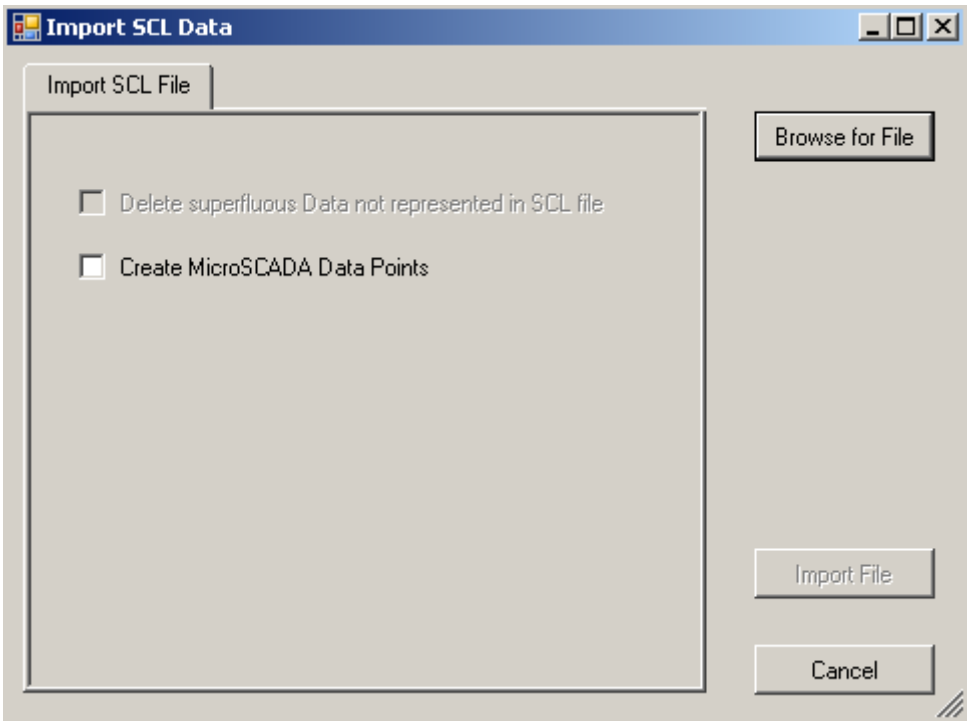

Figure 9: Browsing for an SCL file

3. Locate the SCL file and click **Open**.
4. Click **Import File**.

The project now includes the configuration according to the SCD file, and the GOOSE configuration can start.

If the substation includes third party IEDs which need to be configured for horizontal GOOSE communication, the SCL files holding the information from those IEDs must be imported as well. The third party IEDs have separate tools for creating the ICD/CID/SCD file.

5.3.4 Configuring a GOOSE publisher

To control the GOOSE data publishing, such as addressing, every publisher IED must have at least one data set for GOOSE data and one GOOSE control block.

1. Group the data to a data set sent to IEC 61850 station bus.
2. Define the GOOSE control block.

Currently, the 615 series IED application can receive Boolean and quality-type data. A quality attribute is used at the receiver side to check data validity.

5.3.4.1 Creating a GOOSE data set

Define the sending data set used by the GOOSE control block. With the 615 series IEDs, the sending GOOSE data set can have at maximum 20 data attributes to minimize the message handling load in receiver and sending IEDs.

1. Open the **Project Navigator** and browse to the **IED Section** submenu.
2. Select the IED to be configured.
   For example, select **REF615/LD0/LLN0**.
3. In the **IEC 61850 Data Engineering** window on the right, select the **Data Set Engineering** tab.

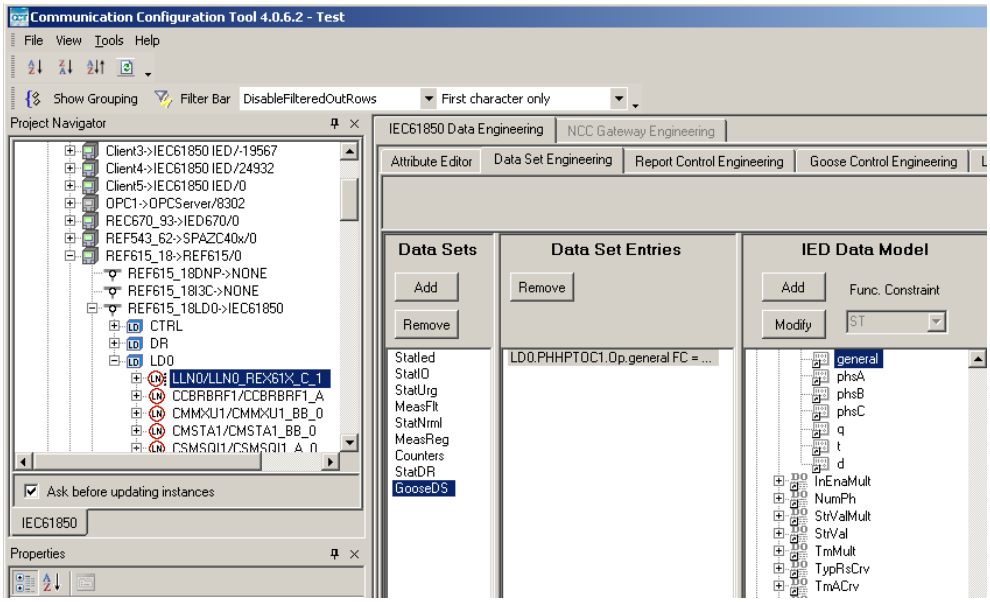

Figure 10: Creating a data set in CCT600

4. To add a new data set, click **Add** in the **Data Sets** window.
5. Give the data set an unique name.
   To define several data sets under the logical node LLN0, give the data sets unique names. However, the maximum number of GOOSE control blocks in a 615 series IED is four. Since one control block uses one data set, the maximum amount of GOOSE data sets is also four. Usually it is enough to define one data set and control block for GOOSE service.

After creating the GOOSE data sets, define the data attributes for the data sets.

Defining data attributes

1. In **IEC 61850 Data Engineering** window, select the **Data Set Engineering** tab.
2. Select a GOOSE data set.
3. In the **IED Data Model** window, select a data attribute to be used and click **Add**.
   A maximum of 20 data attributes can be added to a single GOOSE data set. If the data set is too large to be encoded and fitted in one Ethernet frame, it will not be sent.

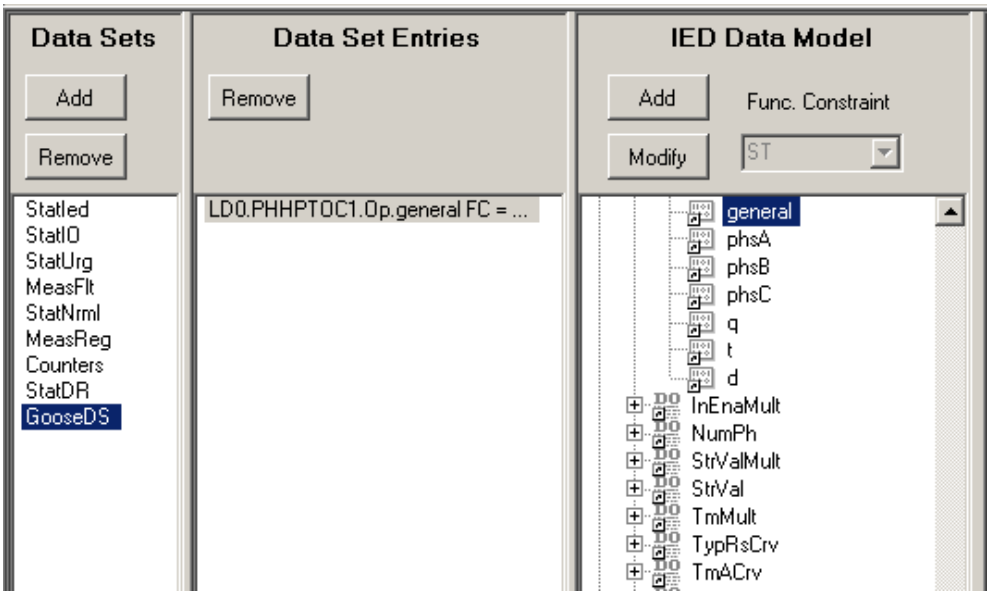

Figure 11: Adding data set entries

If a data set has quality attributes, the attributes must be located after the status value of the same data object.

The data set entries must be single data attributes, such as stVal and q, not structures of functional constrained data objects as the tool proposes by default.

A full list of the available signals with descriptions and IEC 61850 names is available in a file in the connectivity package installation directory, such as `C:\Program Files\ABB\Connectivity Packages\REF615\2.0\Documents\EN\IEC\RE_615 IEC Parameters_1MRS756606C.htm`.

After defining the data attributes for the data sets, configure the GOOSE control block properties.

5.3.4.2 Configuring a GOOSE control block

1. Open the **Project Navigator** and select **LD0/LLN0** in the submenu.
2. In the **IEC 61850 Data Engineering** window on the right, select the **Goose Control Engineering** tab.

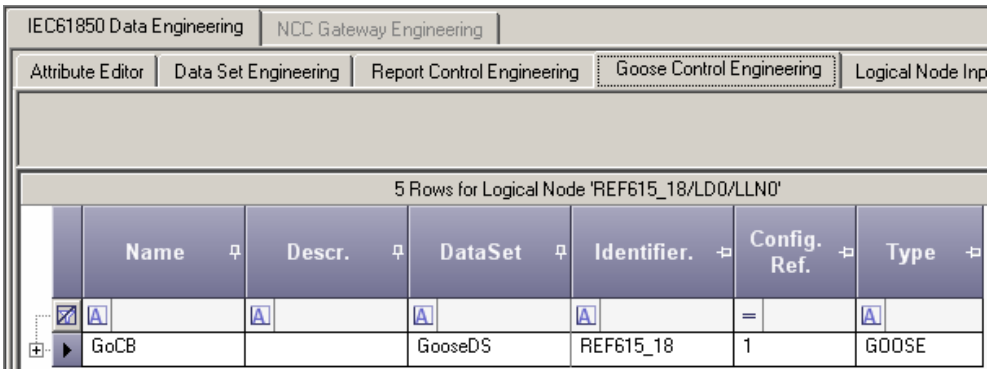

Figure 12: GOOSE control block basic properties

3. Click **Add/GSE Control**.
4. In the **DataSet** dropdown list, select the previously created data set.
   If necessary, edit also the other GOOSE control block properties.

Table 4: Editable GOOSE control block properties

GoCB property	Description
Name	GOOSE control block name
Description	The field is visible and used only in system engineering tool.
Identifier	A unique GoID for each GoCB in the system.
Configuration Revision	Contains an integer value that sent in every GOOSE message. The integer indicates the amount of changes in the data set. The receiver checks the message for configuration mismatches. The **Configuration Revision** is also a writable property. It can be changed, for example, if the receiver configuration requires another confRev value.

After configuring the basic properties, define the GOOSE control block address.

Defining GOOSE control block address

1. Click **Address definition**.
2. To define the GOOSE addresses, click the **MAC Address** or **APPID** field in the address definition table to open the **IEC 61850 GSE Applications** dialog box.

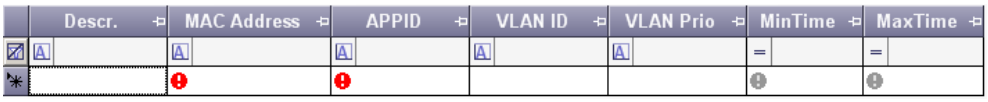

Figure 13: Defining GOOSE control block address

The **IEC 61850 GSE Applications** dialog box shows all the GOOSE control blocks of the active project. In this dialog box, all the GOOSE control block addresses in a project can be edited, and it can be ensured that several GOOSE control blocks are not using the same addresses.

The multicast MAC address is usually unique, and APPID must be unique.

3. To configure a new addressing scheme for a new GOOSE control block, click **GSE Application** in the **IEC 61850 GSE Applications** dialog box.
4. Check the address values.

Table 5: Address value description

Address value	Description
APPID	The application identifier must be a unique HEX value for sending the GoCB within the system. It identifies the purpose of this particular data set. The value range is 0000...3FFF.
MAC Address	A multicast MAC address to which the specific GOOSE data is sent. The receiving IED filters the frames and starts to process them if a specific multicast address is defined in the configuration. It is recommended to have one unique multicast address per GoCB. In a larger system with more than 30 IEDs in one subnet, the efficiency of the multicast filtering decreases. In this case, the multicast addresses can be used as group addresses. Thereby the IED-specific multicast message filtering works and useless frames are not processed. The address can be unique or shared by several IEDs. The address range for GOOSE Multicast addresses is 01-0C-CD-01-00-00...01-0C-CD-01-01-FF.
VLAN ID	The VLAN identifier can be used if the Ethernet switches in a station bus support VLAN. If static VLAN IDs are defined, it affects also to switch port configuration. The value 000 means a non-configured VLAN and switches do not filter these messages in port basis. This value is recommended value if there is no need to split logical network. The VLAN identifier is a 3-character HEX value with range 000...FFF.
VLAN Prio	The VLAN priority properties can be used in the networks supporting VLANs. The priority is used with network switches. The default value for GOOSE is 4 and the value range is 0...7.
MinTime **MaxTime**	With the 615 series IEDs, only the MaxTime is configurable. The MinTime indicates the maximum response time in milliseconds to data change. This time can be used by the receiver to discard messages that are too old. In principle, the MinTime can vary depending on the data type, but for the 615 series IEDs, the value is always 10 ms for sent data. The MaxTime indicates the background "heartbeat" cycle time in milliseconds; the default value is 10 000 ms. If there are no data changes, the IED still resends the message with the heartbeat cycle to enable the receiver to detect communication losses, that is, the communication is supervised.

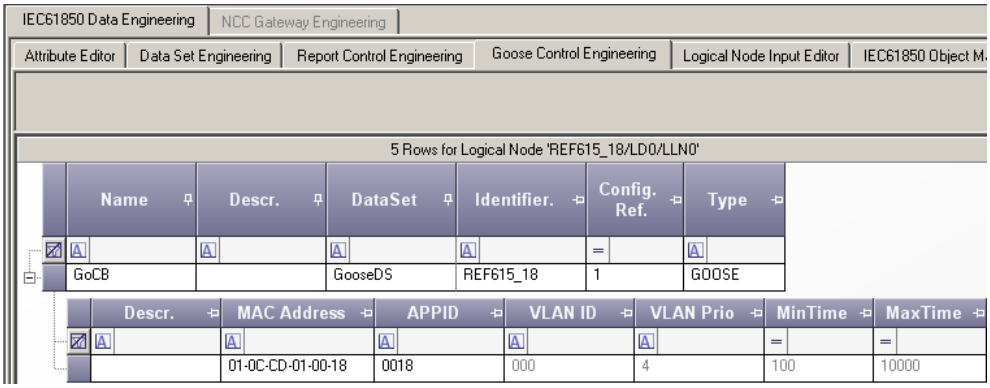

Figure 14: Updated address properties for the new GOOSE control block

5.3.5 Configuring a GOOSE subscriber

A 615 series IED application can receive and use only Boolean type data attribute values. A Quality attribute is received and processed automatically.

5.3.5.1 Configuring GOOSE inputs

1. Open the **Project Navigator** window.
2. In the **IEC 61850 Data Engineering** window on the right, select the **Goose Control Engineering** tab.
3. To configure the GOOSE data connections between the IEDs, drag the data-receiving IED from **Project Navigator** submenu to GSE Control.

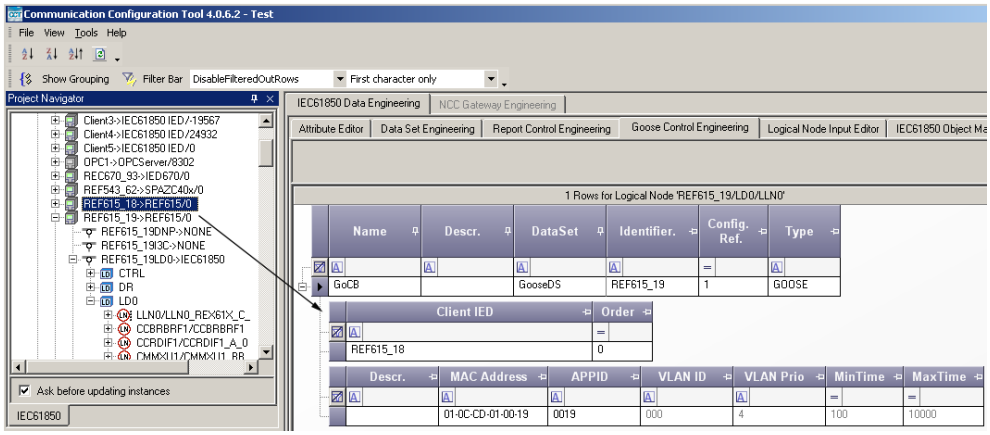

Figure 15: Dragging the data-receiving IED to GSE Control

The dragged IED is a GOOSE receiver, and all the receiver IEDs are listed in the **Client IED** box.

4. To update the data flow, select **Tools/IEC 61850 Data Flow Engineering/ Update DataFlow**.

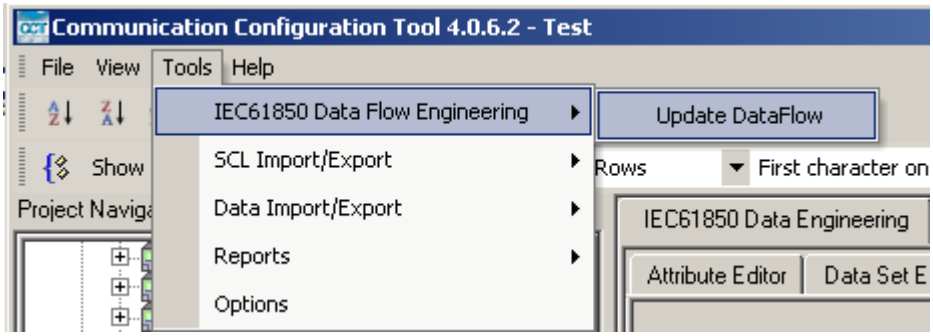

Figure 16: Updating data flow

After the update, the GOOSE inputs are shown in **Project Navigator** submenu under **LD0/LLN0/Inputs** in the receiving IED.

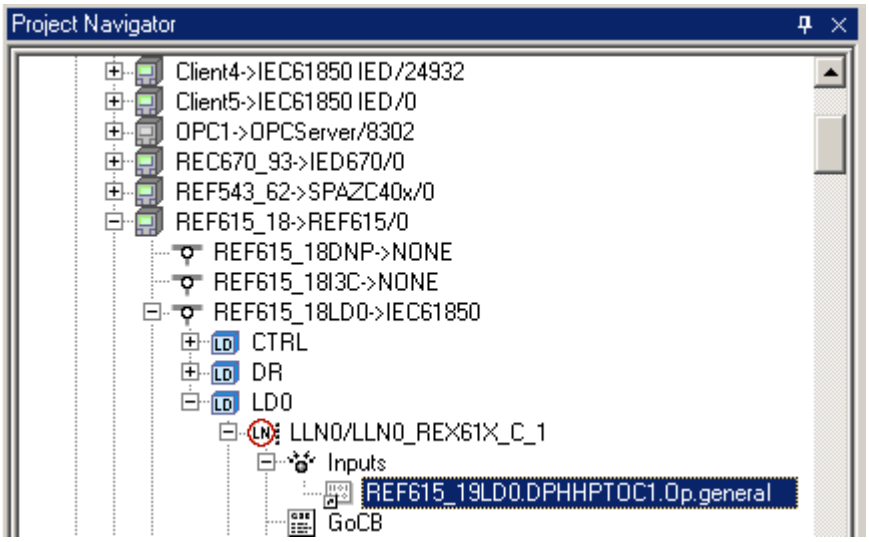

*Figure 17: GOOSE inputs show under the **Inputs** submenu.*

5. Repeat the drag-and-drop operation for every IED receiving data from the selected GOOSE control block.

Deleting a GOOSE input

1. Select the IED in the **Client IED** box.
2. Press **Delete** and confirm the deletion by clicking **Yes**.

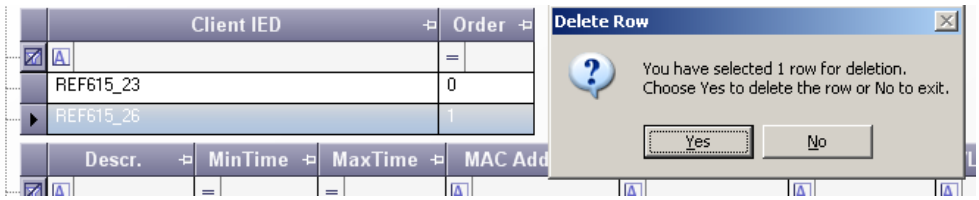

Figure 18: Confirming a GOOSE input deletion

3. To update the data flow, select **Tools/IEC61850 Data Flow Engineering/ Update DataFlow**.

5.3.6 Finalizing GOOSE configuration

5.3.6.1 Exporting the SCL file

1. Click **Tools/SCL Import/Export/Export SCL File**.

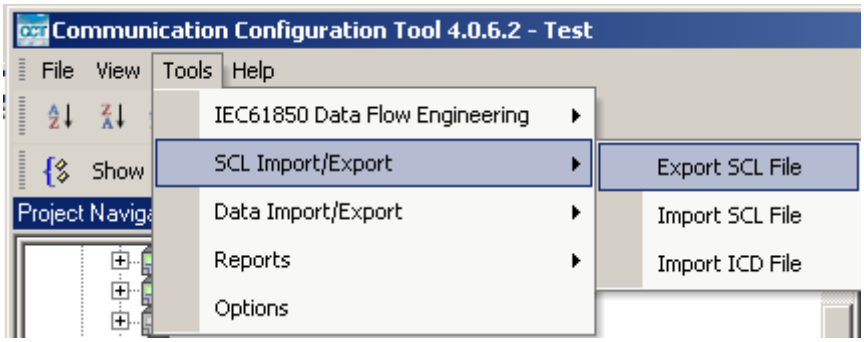

Figure 19: Exporting an SCD file

2. Click **Browse** to select the file destination and click **OK**.
   The tool proposes its project location for the SCD file, and it is recommended to leave the SCD file exported from PCM600 as a backup.
3. In **FormSclExportDialog**, select the **Suppress Private CCT Type Information** check box.
   PCM600 does not require private CCT type information.

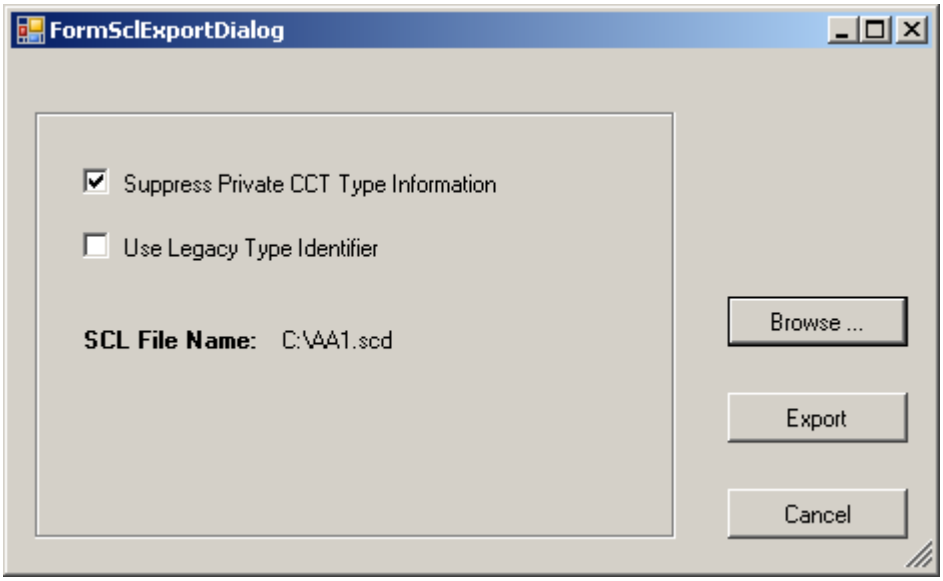

Figure 20: SCL export options

4. Click **Export**.

5.3.6.2 Importing the SCL file

1. Open PCM600.
2. Go to the **Project Explorer** view and select the **Plant Structure** tab.
3. Right-click the project and select **Import**.

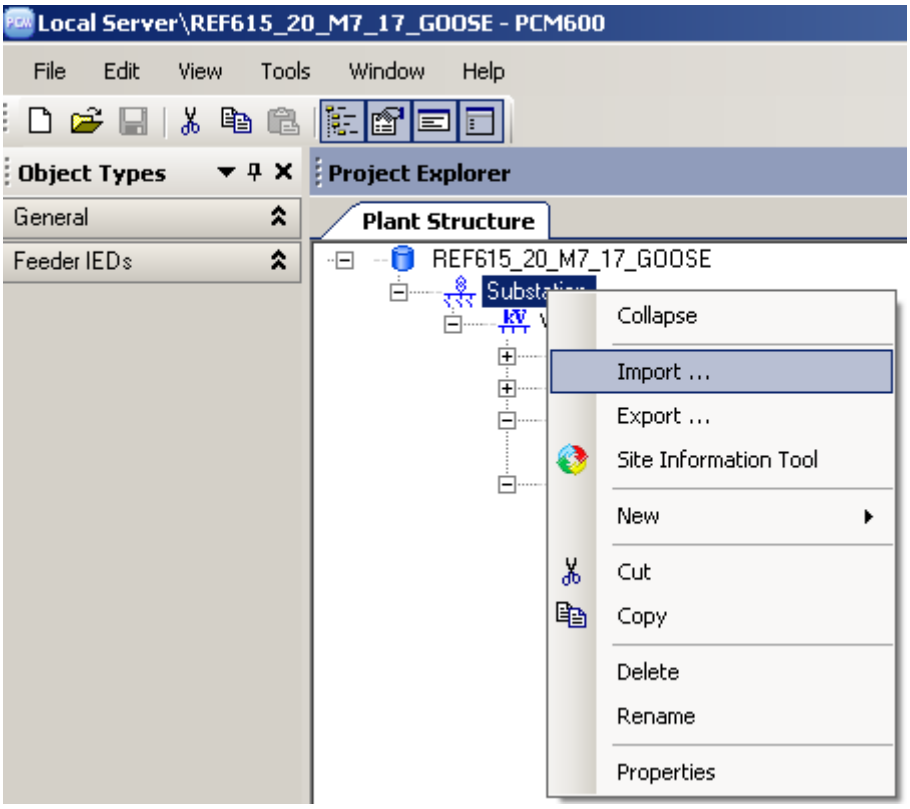

Figure 21: Importing an SCD file to PCM600

4. Open the SCL file exported from CCT600.
5. In the **SCL Import Options** dialog box under IED Types, select **Don't import IEDs of unknown type** if the GOOSE configuration does not include third party devices.

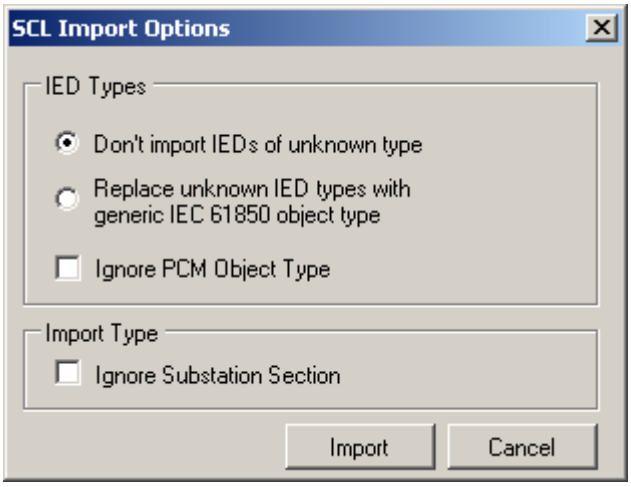

Figure 22: SCL import options in PCM600

6. Click **Import**.

For more information, see PCM600 documentation.

5.3.6.3 Connecting GOOSE inputs to an IED application

1. In PCM600, open the **Project Explorer** and select the **Plant Structure** tab.
2. To open the Signal Matrix Tool, right-click the IED, and select **Signal Matrix**.
3. In Signal Matrix Tool, the received GOOSE data can be directly connected to the IED application.
   The GOOSE inputs are shown on the Binary Inputs sheet and they can be connected in the application in the same way as the IED inputs. The columns represent publisher data and the rows represent the possible subscriber input points.
4. To map the input points to the receiving input data, click the cell.

   To expand the source field, click the edge of field and expand it until the whole GOOSE source address is visible.

   If the data type, for example timestamp, is not supported by the IED application, the attribute column is shown in red color. The quality attribute is automatically incorporated in the application with the status value, and it is not seen in Signal Matrix Tool.

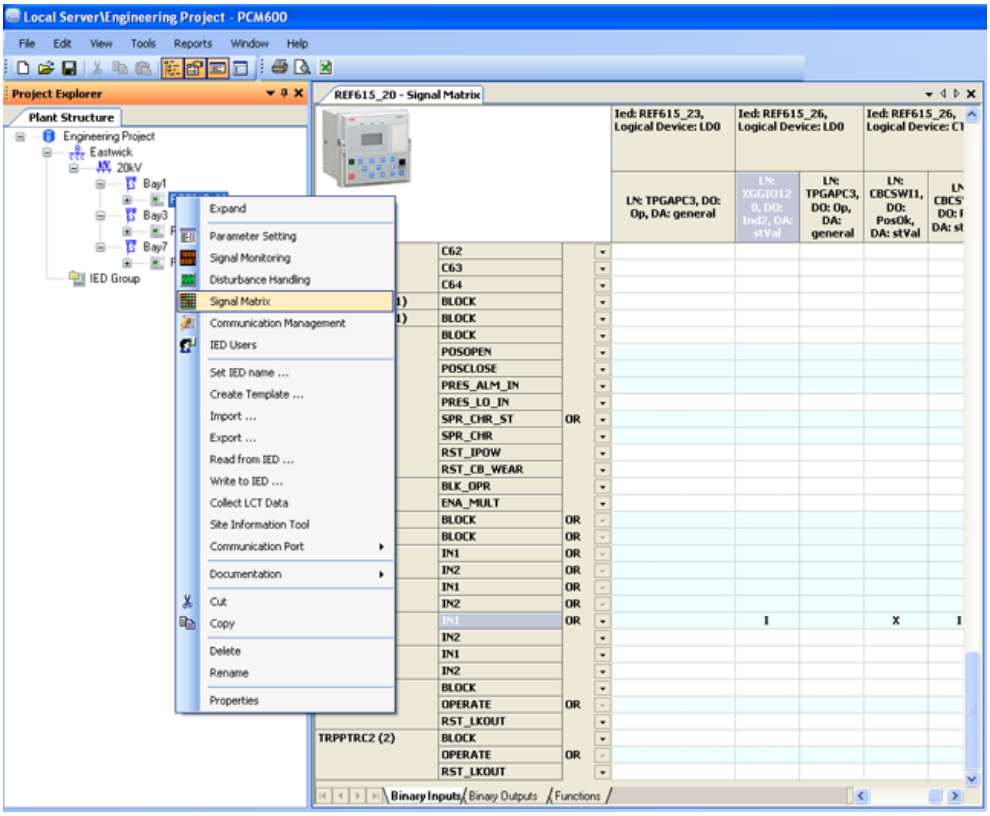

Figure 23: Connecting GOOSE inputs in Signal Matrix Tool

5.4 Received GOOSE message handling

A GOOSE frame is not accepted if the Needs Commission bit is set. A frame with the Test bit set is only accepted if the receiving IED is also in the test mode. The Test bit is active in the sender if the IED is set to test mode.

See the technical manual for more information on the test mode.

The GOOSE frame is also not accepted if the ConfRev deviates from the one in the configuration. These error situations can be noticed in the GSEGGIO1 diagnostic counters.

The default GOOSE input value is false (0) for the Boolean input data. This value is used when the subscribed GOOSE data is corrupted, or it is not received from the network and the peer IED is considered to be in a time-out state.

If a peer device sends the data including the quality attribute, the receiver IED input object is not updated according to the received status value if the data quality is bad, questionable or blocked. The default value is also used in this case.

5.5 GOOSE supervision

5.5.1 Background sending

To ensure reliability and availability of the application, the GOOSE communication must be supervised. Design the application so that it can handle communication losses, for example, when a peer IED is not available or there are communication time-outs.

If there are no GOOSE-related data changes, the 615 series IED resends the message with a heartbeat cycle to enable the receiver to detect communication losses. The heartbeat cycle is defined by modifying the *MaxTime* property on GOOSE control block.

Every GOOSE frame has a TAL field which shows how long the frame is valid until the next heartbeat frame. Other devices may have their own TAL values. Nevertheless, all the TAL values under 1000 ms are rounded up to 1000 ms on the receiving side.

If no frames are received during 2xTAL, that is, if at least two consecutive frames are lost, the receiver defines the quality of the whole received data set as "bad" and sets the input value to the default, that is, to fail-safe. Consider this when designing the application. For example, the IEDs should use an enabling signal for interlocking purposes, and a blocking-type signal for protection purposes. By this way, a fail-safe functionality is ensured.

5.5.2 Default value handling

The information is of point-to-point type which means that there is only one signal connected to the input. The default value of the input, FALSE (0), is taken into use when there is a communication error on the receiver side. If one input receives several signals from several IEDs, the input value is calculated in OR or AND operation from several inputs. In this case, one default signal is treated as logical FALSE (0), but the other signals can keep the function block input value active. It works similarly as copper cables connected between IEDs having no detection of single data loss. In all cases, however, a separate alarm event is always generated by the GSEGGIO1.Alm data object for IEC 61850 event clients.

GSEGGIO1.Alm can also be used on the application side as an input in the Signal Matrix Tool's Binary Outputs sheet (signal GSEGGIO ALARM). Thereby it is possible to change the setting group in case one or several IEDs are disconnected from the network.

5.5.3 Alarm supervision in application

In a communication time-out situation, all the peer IEDs receive information about the problem. The drawback of this is that the system does not tolerate single failures or non-existing devices, for example, in service situations.

Disable GOOSE sending by writing “false” from IEC 61850 clients to the GoEna attribute under the GOOSE control block. Use this feature carefully, and for test purposes only.

5.5.4 Diagnostic counters

The IEC 61850 data model of the 615 series IEDs includes a logical node LD0.GSEGGIO1 for GOOSE communication diagnostic. The counters are also available via the HMI or PCM600 path **Monitoring/Inputs**.

Table 6: Diagnostics data objects

Data object	Description	Diagnostics information
IntIn1	Received messages	When increasing, the IED is receiving GOOSE messages.
IntIn2	Transmitted messages	When increasing, the IED is sending GOOSE messages.
IntIn3	Received state changes	Received GOOSE messages with new stNum value.
IntIn4	Received sequence number	Received GOOSE re-transmissions or heartbeat cycle messages with new sequence number.
IntIn5	Received frames with test bit	Received GOOSE frames with test flag on.
IntIn6	State or sequence number errors	Number of notified sequence number jumps.
IntIn7	Receiver time-outs	Number of notified peer IED time-outs.
IntIn8	Received ConfRev mismatches	When increasing, there is a mismatch between the received GOOSE frame information and the used GOOSE configuration.
IntIn9	Received frames with Needs Commissioning	One peer IED Indicates that its configuration is not valid or up-to-date.
IntIn10	Errors in received data set	Received data is syntactically wrong, or there is less data in received data set than expected.
Alm	Receiver alarm	Alarm signal value connected to event and application logic. It is active when one peer IED is in time-out.

A *GOOSE Alarm* is activated in the receiver IED in certain situations.

- Time-out
- Configuration revision mismatch
- Error in the received data set
- Needs Commissioning bit is active in the received message

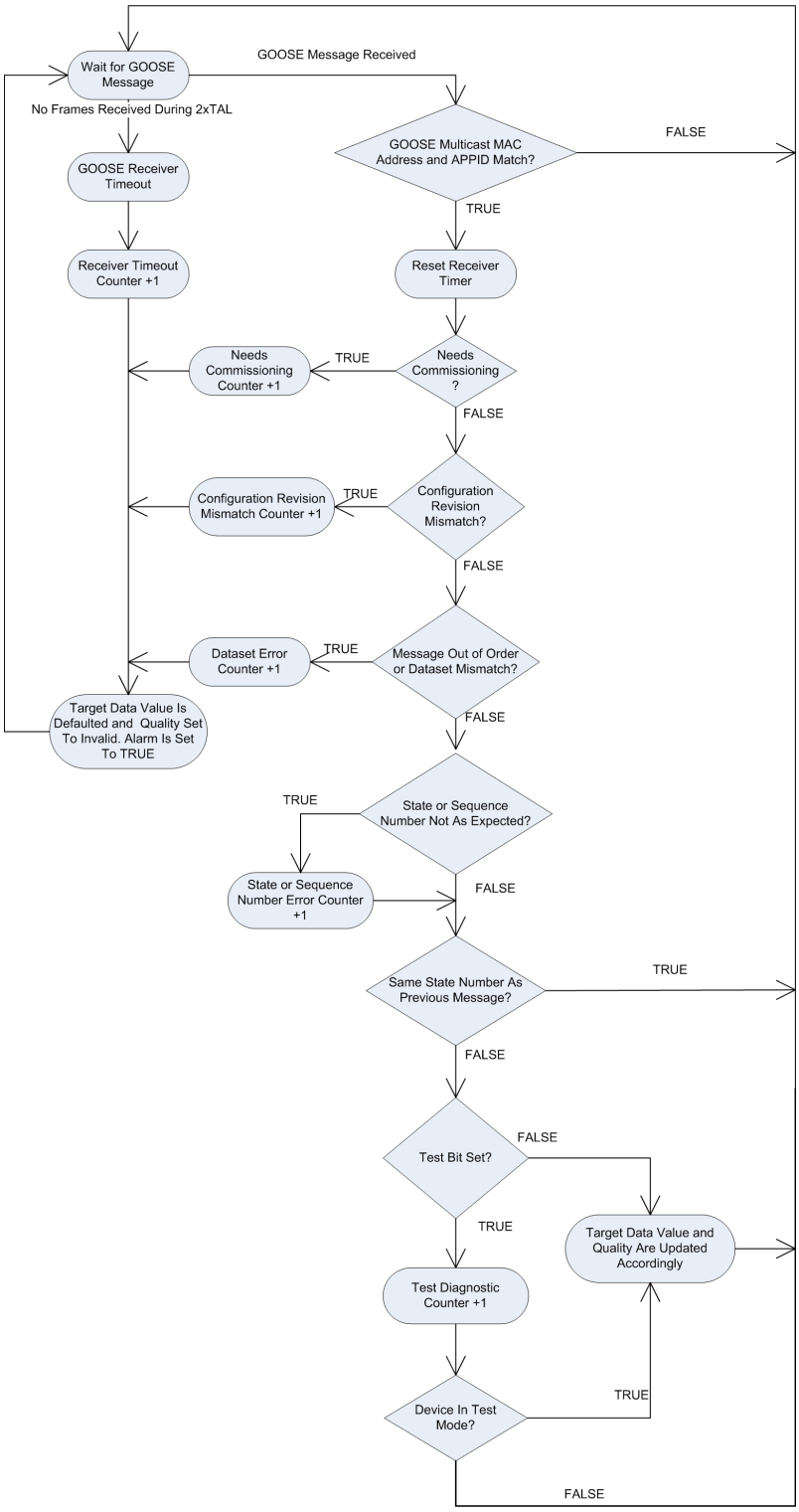

Figure 24: Receiving GOOSE data in 615 series IEDs

Section 6 Required CCT600 project modifications

When the IED configurations are changed using CCT600, some preparations are required when starting a project and importing the 615 series IED data model to the tool for the first time. The imported or exported file can be an SCD or CID file.

- The default 615 series IED SCL export from PCM600 contains five default client definitions, Client1...Client5, which are used by all the report control blocks. The MicroSCADA and COM600 clients are able to use the client definitions directly.
  In other cases, import the ICD file describing the client data model to the project, and attach the file to the same IEC 61850 subnetwork in communication section view.
- Attach the new client to report control blocks.
- Keep the IEC 61850 event reporting configuration consistent with the CCT600 project.

  1. Create the bus connections for the IEC 61850 clients.
  2. Define that the server IEDs are not IEC 61850 clients.
  3. Check that in IED Properties, all the DataFlowGeneration options have the value TRUE before the first SCL file export from CCT600.

For more information, see CCT600 documentation.

6.1 Attaching the IEC 61850 clients to the bus

1. In CCT600, open the **Project Navigator** and select an IEC 61850 client from the submenu.
2. In the **Properties** window below the **Project Navigator**, select the bus from the **Bus Connection** list to attach the IEC 61850 client to the bus.

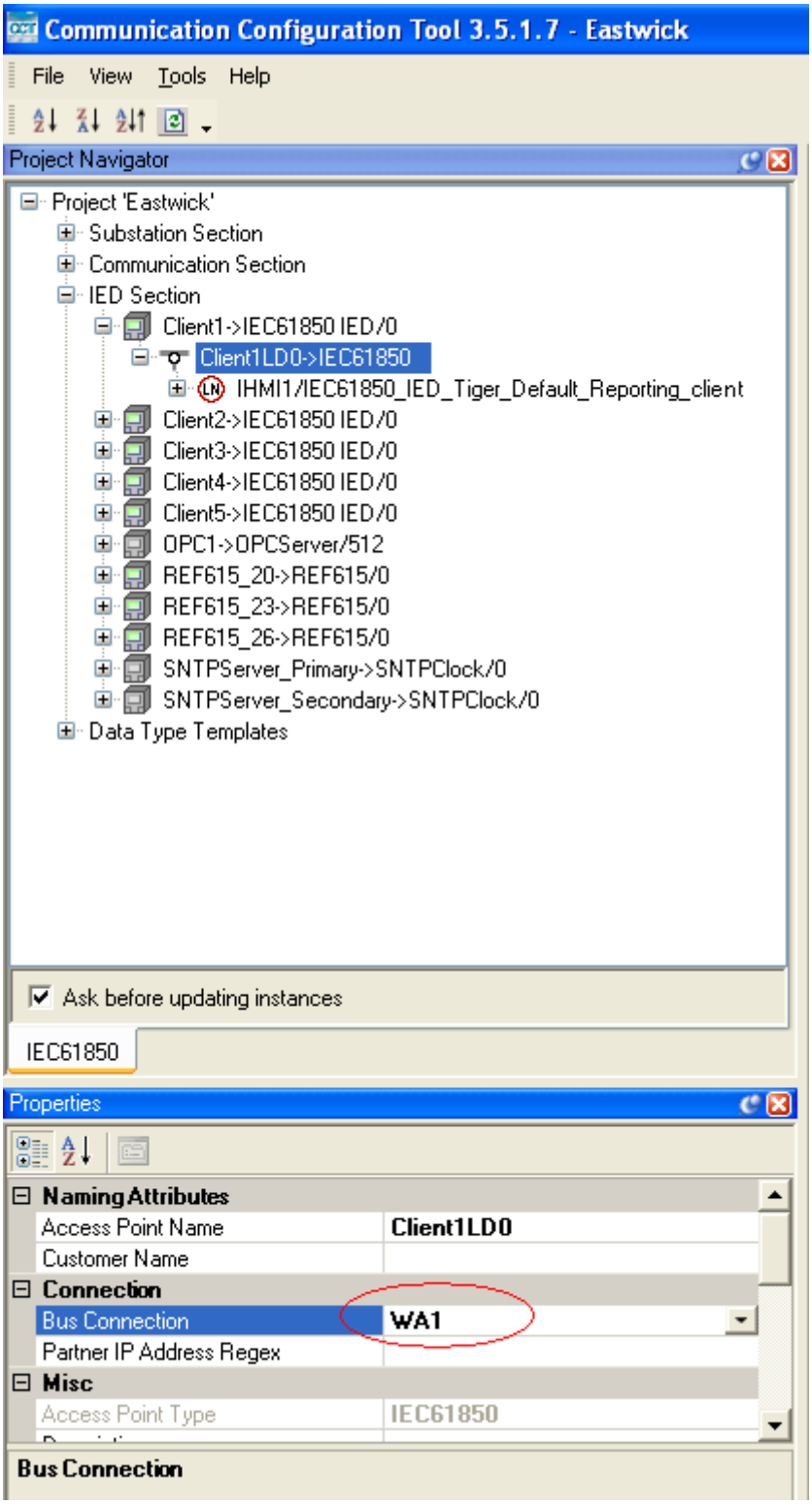

Figure 25: Defining bus connection properties for IEC 61850 clients

3. Repeat the procedure for all five clients of the project.

The IEDs' bus connections are ready-made when the configuration work is started and need not to be set separately.

4. In the **Tools** menu, change the user level to "Expert".
5. Open the IED's **Properties** window and check that all the DataFlowGeneration options have the value TRUE before the first SCL export from the CCT600 project.
   If the value is FALSE, the dataflow is not updated when the SCL file is imported back to the project.
6. To allow the event clients appear under LD0.LLN0 for every report control block, update the data flow from the tool.

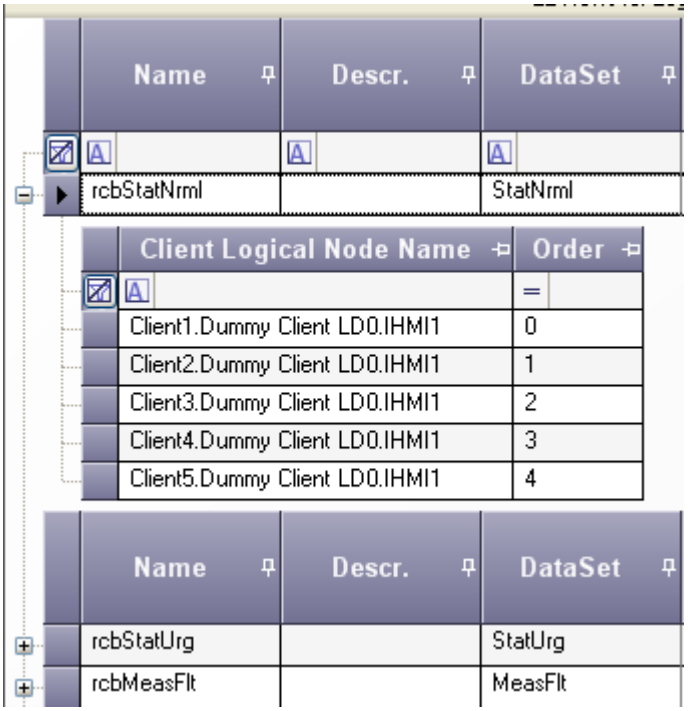

Figure 26: IEC 61850 event reporting clients

6.2 Defining server IEDs

Do this task only for server IEDs, not for client IEDs.

1. In CCT600, open the **Project Navigator** and select an IED from the submenu.
2. In the **Properties** window below the **Project Navigator**, type any text string to **Partner IP Address Regex** field to define that the IED is not an IEC 61850 client.

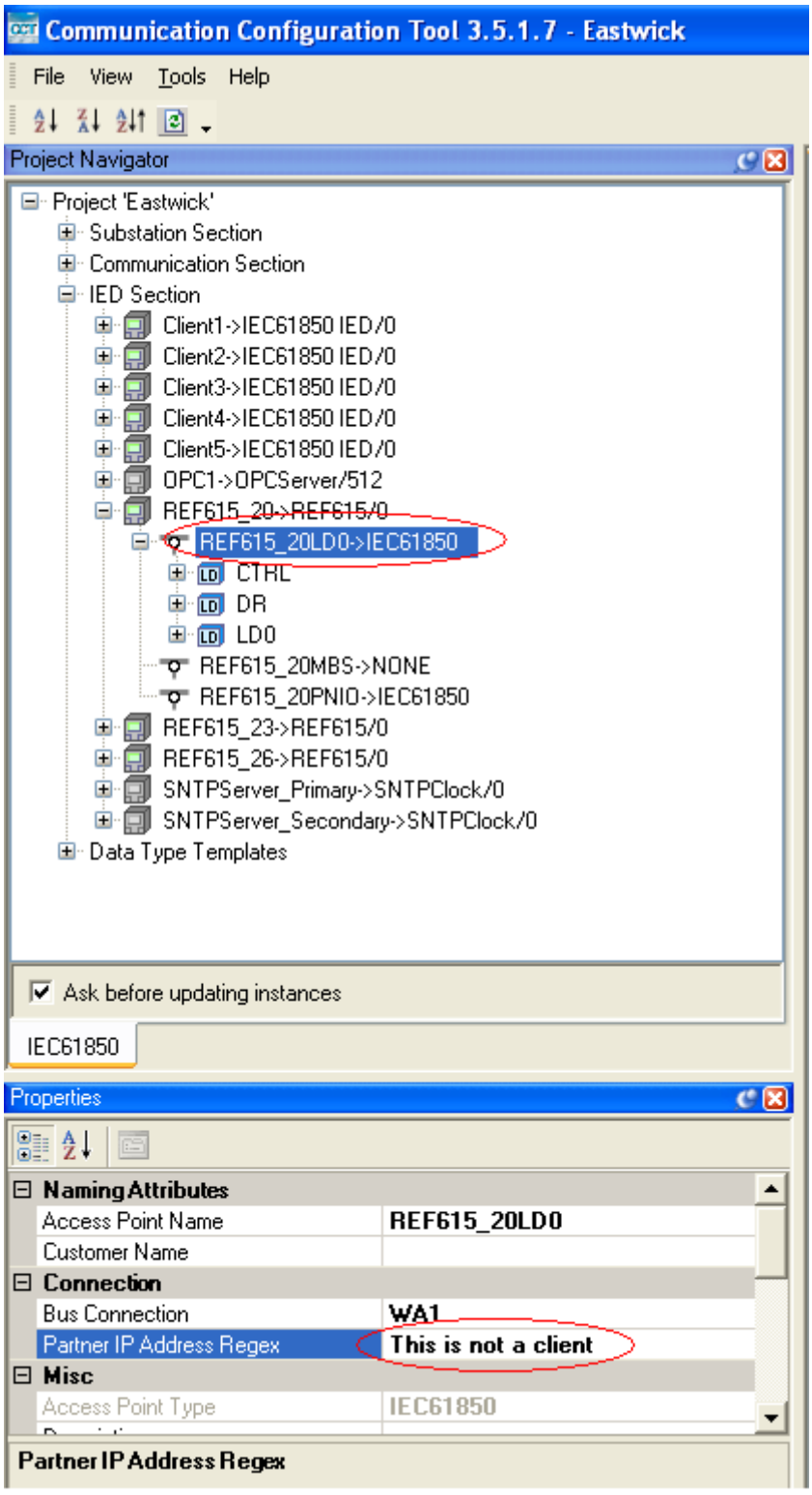

Figure 27: Defining server IEDs in CCT600

6.3 Defining the substation structure name

The actual substation structure name is the technical key of the PCM600 project. The substation object names shown on the PCM600 **Plant Structure** tab are the substation object descriptions. By default, CCT600 replaces the descriptions with its own default names. Make sure to keep the user-given substation structure name the same as the one defined in PCM600 project even after importing an SCD file from CCT600 back to PCM600.

1. In Communication Configuration Tool, open the **CCT600 Options** dialog box.
2. From the menu, browse to **SCL Export Options/Substation**.
3. Set the **Replace Description with Customer Name** value to "False" for all the substation objects.
   The value should be set to "False" even if it should be the opposite after reading the attribute name.

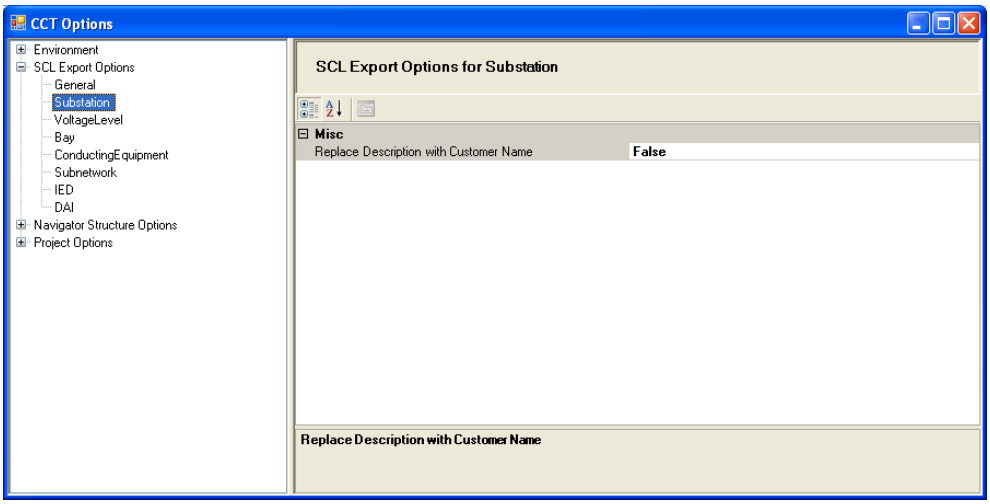

Figure 28: SCL export options for substation

Section 7 Glossary

615 series	Series of numerical IEDs for low-end protection and supervision applications of utility substations, and industrial switchgear and equipment
802.1Q	The IEEE standardized protocol for VLAN trunking
ACSI	Abstract communication service interface
APPID	Application identifier
CCT	Communication Configuration Tool in PCM600
CCT600	Communication Configuration Tool
CID	Configured IED description
COM600	An all-in-one communication gateway, automation platform and user interface solution for utility and industrial distribution substations
COMTRADE	Common format for transient data exchange for power systems. Defined by the IEEE Standard.
Connectivity Package Manager	Software that helps the user to define right connectivity package versions for different applications and tools
CTRL	Control logical device
DR	Disturbance recorder
EMC	Electromagnetic compatibility
Ethernet	A standard for connecting a family of frame-based computer networking technologies into a LAN
GoCB	GOOSE control block
GoID	GOOSE control block specific string
GOOSE	Generic Object Oriented Substation Event
GSE	Generic substation event
HMI	Human-machine interface
ICD	IED capability description
IEC	International Electrotechnical Commission
IEC 61850	International standard for substation communication and modelling
IEC 61850-8-1	A communication protocol based on the IEC 61850 standard series and a standard for substation modelling

IED	Intelligent electronic device
LAN	Local area network
LD0	Logical device zero (0)
LED	Light-emitting diode
LHMI	Local human-machine interface
LLN0	Logical node zero (0)
MicroSCADA	Substation automation system
MMS	Manufacturing message specification; Metering management system
Modbus	A serial communication protocol developed by the Modicon company in 1979. Originally used for communication in PLCs and RTU devices.
Multicast address	An identifier for a group of hosts that have joined a multicast group
PCM600	Protection and Control IED Manager
SCD	Substation configuration description
SCL	Substation configuration language
stVal	Status value
TAL	Time allowed to live
TCP/IP	Transmission Control Protocol/Internet Protocol
VLAN	Virtual LAN
VLAN ID	VLAN identification defined by the standard IEEE 802.1Q

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