ATOP Technologies, Inc.

Protocol Gateway
IEC61850 Client/Server

Protocol and
eNode Designer configuration

eNode Configuration

V1.6

August 3rd, 2023

This PDF Document contains internal hyperlinks for ease of navigation.
For example, click on any item listed in the **Table of Contents** to go to that page.

- **IEC 61850 Configuration Guide**
- **IEC 61850 Interoperability**

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Important Announcement

Disclaimer

We have checked the contents of this manual for agreement with the hardware and the software described. Since deviations cannot be precluded entirely, we cannot guarantee full agreement. However, the data in this manual is reviewed regularly and any necessary corrections will be included in subsequent editions.
Suggestions for improvement are welcome.
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1 Introduction

Thank you for Buying ATOP's Protocol Gateway.

The product is bundled with the following three user manuals:

1) Hardware specific installation user manual- **not covered in this document.** It covers ATOP's hardware installation procedure, wiring, power connection etc.
2) Getting started with ATOP's Protocol Gateway user manual – configuration tool introduction, web configuration, software architecture introduction– **not covered in this document**. This manual covers the introduction, installation, network set-up maintenance and using of the configuration tool software, including the procedure to be followed for uploading new configurations to ATOP's device.
3) Protocol specific user manual **(This Manual). One protocol-specific manual will be provided for each protocol installed on the device.** This manual covers:
    a. Basic device network configuration
    b. Step-by-step protocol set-up for in eNode designer
    c. Description of the protocol-specific software features, the device profile and the implementation table of supported functionalities.

This manual is for **IEC 61850 Client/Server** and describes how to use the **IEC 61850 eNode Designer Module** to configure ATOP's *IEC 61850 ADH Application* within the eNode Designer configuration tool.

1.1 Scope

This document is divided into 3 major sections:

- **Overview** with **General Description**; and a
- **IEC 61850 ADH Application Configuration Guide**
- **IEC 61850 ADH Application Interoperability**

IEC 61850 Standard related information and the IEC 61850 Standard itself is not part of the scope of this document, so it is assumed the user to have some basic knowledge about the protocol. For more detailed information on the IEC 61850 Standard visit the official IEC website on http://www.iec.ch

This manual assumes that reader has some basic knowledge of the IEC 61850 standard documents and protocol. The following is the document list:

IEC 61850 Document Part	Description
IEC 61850-1	Introduction and overview
IEC 61850-2	Glossary
IEC 61850-3	General requirements
IEC 61850-4	System and project management
IEC 61850-5	Communication requirements for functions and device models
IEC 61850-6	Configuration description language for communication in electrical substations related to IED's
IEC 61850-7-1	Basic communication structure for substation and feeder equipment – Principles and models

IEC 61850-7-2	Basic communication structure for substation and feeder equipment – Abstract communication service interface (ACSI)
IEC 61850-7-3	Basic communication structure for substation and feeder equipment – Common data classes
IEC 61850-7-4	Basic communication structure for substation and feeder equipment – Compatible logical node classes and data classes
IEC 61850-8-1	Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3
IEC 61850-9-1	Specific communication service mapping (SCSM) – Sampled values over serial unidirectional multi-drop point-to-point link
IEC 61850-9-2	Specific communication service mapping (SCSM) – Sampled values over ISO/IEC 8802-3 2
IEC 61850-10	Conformance testing
IEC 61850-80-1 Ed. 1.0	Communication networks and systems for power utility automation – Part 80-1: Guideline to exchange information from a CDC based data model using IEC 60870-5-101/104

1.2 Overview

1.2.1 Document Reference

[1] Document Title: 197-0100 eNode Designer User Manual
Revision: Version 1.00

1.2.2 List of Abbreviations

ADH = Application Data Hub
DA = Data Attribute
IEC = International Electrotechnical Commission
IED = Intelligent Electronic Device
SCL = Substation Configuration Language

2 General Description

The IEC 61850 eNode Designer Module uses a pre-existing SCL file for configuration; the configuration tool's primary action is to select which data points should be added to or mapped from the ADH database.

When an SCL file is loaded into eNode Designer, a *copy* is automatically saved in the eNode Designer project file. This allows the project file to be sent (e.g. email) and opened anywhere without the need to send the SCL file as well.

The generation or the editing of the SCL file (ICD designer) is not covered inside this manual. For SCL file creation or editing, please contact an ATOP Technologies representative

2.1 General Screen Description

Once an SCL file has been imported, a view similar to the following will be shown. The tab section allows the user to browse the local IED versus the connected remote IEDs.

In the **client**, there are no configuration options for the local IED so that tab will not be displayed. It just has a tab of remote IEDs showing all the servers connected.

In the **server**, the local IED is configurable so that tab is shown. In 61850 servers, the only data points should be accessed access from remote IEDs are those published on GOOSE, so the remote IEDs tabbed is named "GOOSE subscription".

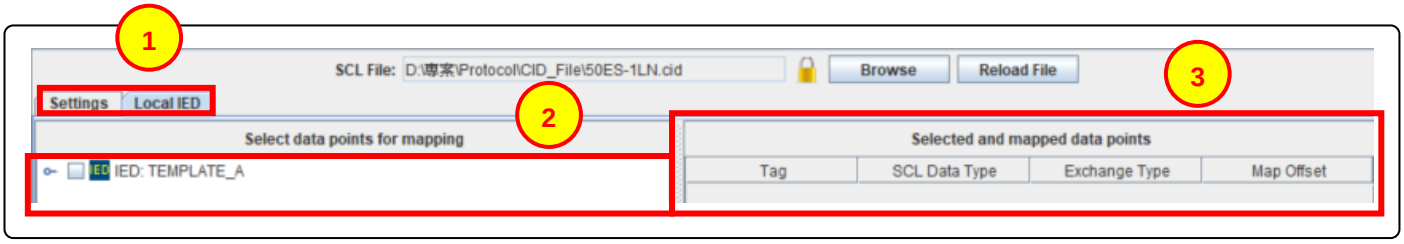

Figure 2-1 – View of a newly loaded server SCL file.

1 **Tabs –** Local IEDs will be separate from Remote IEDs. See details above.

2 **SCL Tree Windowpane –** This shows the Project Tree of the currently selected IED. The tick-boxes allow for selection of data points for mapping. Expand the branches to view further down the project tree.

3 **Mapped Points –** This is where the points that have been mapped will appear. Each row in this table corresponds to a single "ticked" leaf DA node in the tree.

2.2 SCL Tree Explanation

The SCL file given is expanded into a tree-view showing different levels of IED, Logical Devices, Logical Nodes, then into Data Objects and Data Attributes. The “final” nodes are mappable data points. A screen shot is shown below.

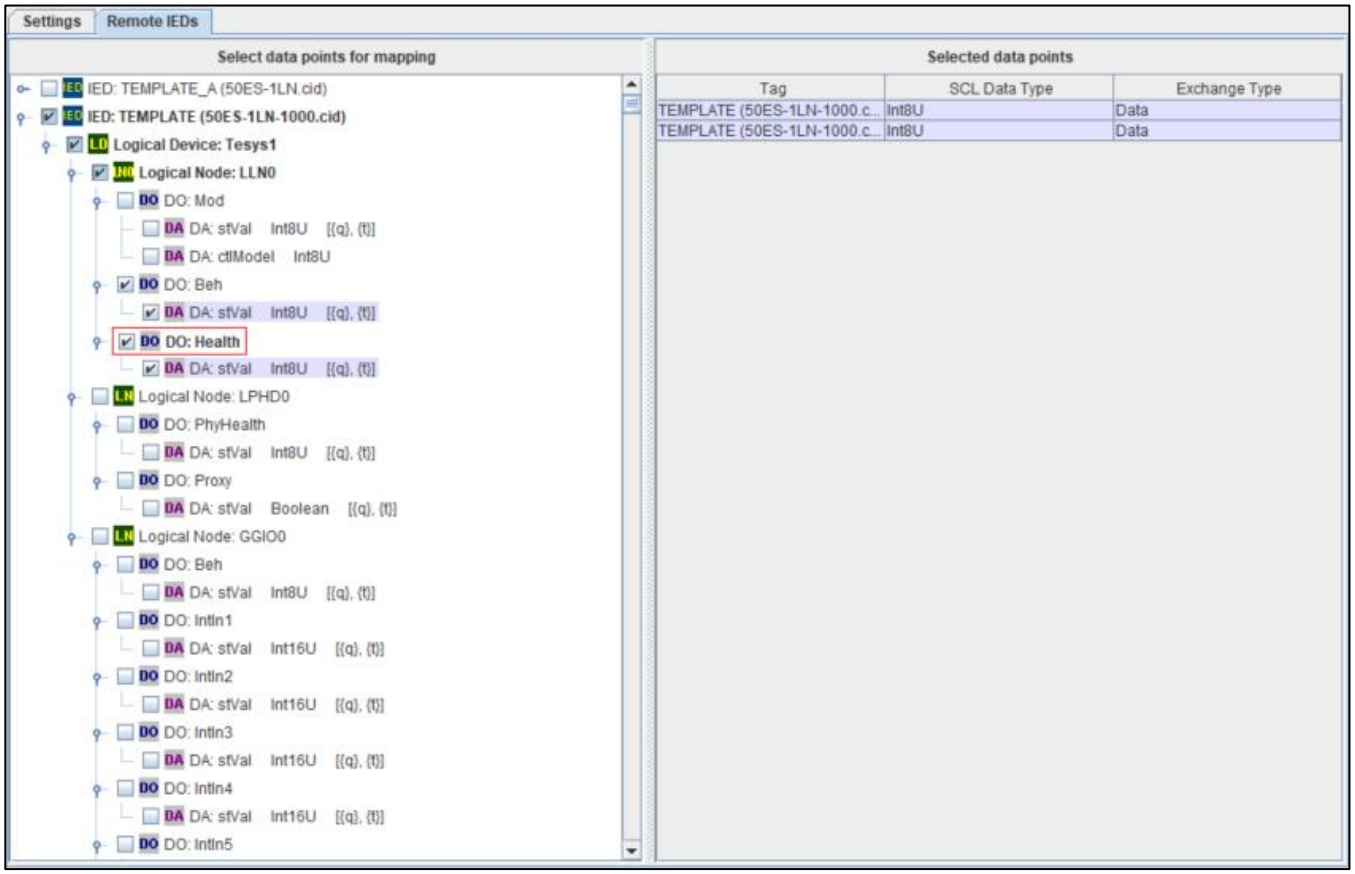

Figure 2-2 - Main screen.

Each mappable point has a description of its data type, which is extracted from the SCL file. A zoomed-in portion of the tree is shown below along with a more detailed description of the components.

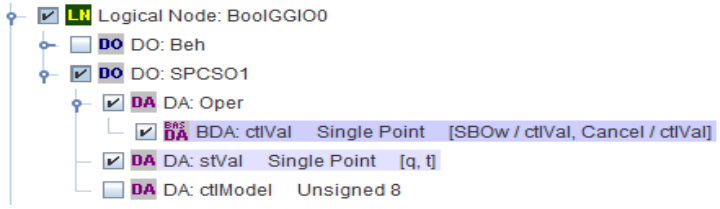

Figure 2-3 - Main screen of a single logical node.

For example with this BoolGGIO0/SPCSO1/stVal, the tree node text contains information about its node type (DA), node name (stVal), ADH Data Type (Single Point), and in this case also some square bracket notation. The square bracket notation shows that the *q* and *t* DAs are bound with the *stVal* data point. This is explained further in section 2.3.

The data type of the point is extracted from the IEC 61850 data type (e.g. “BOOLEAN” becomes “Single Point”). A special case is 61850 enumerated types, which are placed in the eNode Database as “Unsigned 8”. Data types that the ADH does not support, such as string types, are not shown in the SCL tree at all.

2.3 Associated DAs are Combined into a Single Data Point

Every eNode Designer data point has an associated timestamp (when the data value changed) and quality flags. This is similar to how IEC 61850 works with *q* (quality) and *t* (timestamp) DAs being updated together with DAs such as *stVal*. Thus eNode Designer groups the *q* and *t* with the appropriate values according to the 61850 specification to the single eNode (a.k.a. ADH) data point. This means that the with the stVal eNode data point, the associated quality and time are mapped with the 61850 data attributes *q* and *t*.

Multi-stage commands (such as Select Before Operates) are represented as a single data point for mapping in eNode Designer. Thus, the 61850 Operate structures are combined to a single structure: the “Oper”.

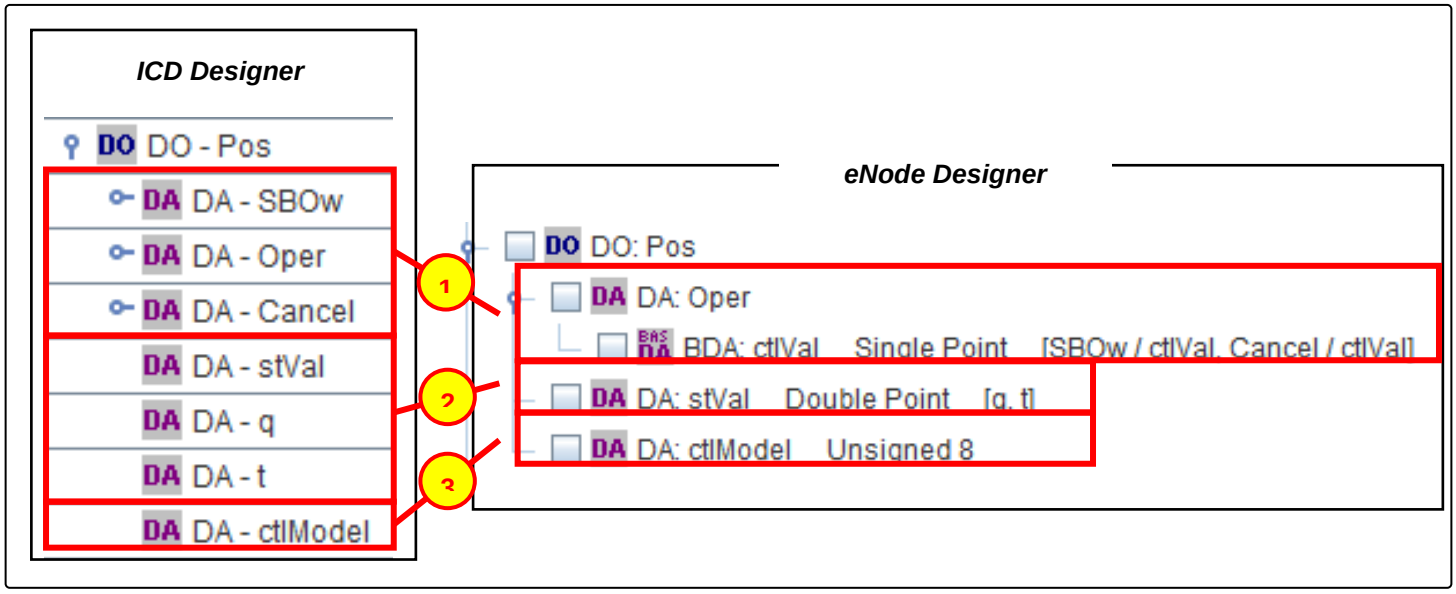

Figure 2-4 – Combined DAs, example one.

This figure contains a screenshot from *ICD Designer* and a screenshot from *eNode Designer* to illustrate how data points are grouped together within *eNode Designer*. **Both images show the same *Pos Data Object*** in a XCBR Logical Node.

1. **DA: Oper –** Shown in the *ICD designer* image as *DA - SBOw, DA - Oper* and *DA – Cancel*, these data attributes are all grouped as *DA: Oper* within *eNode Designer*. This point contains the *ctlVal* data points of *DA - SBOw, DA - Oper* and *DA – Cancel.* This is shown using the square brackets notation.
2. **DA: stVal –** According to IEC 61850 specification, *q* and *t* apply to *stVal*. They are separate DAs but they are grouped together in *eNode Designer*. This is shown using the square bracket notation after the “stVal”: [q, t].
3. **DA: ctlModel** – This is only a single Data Point in both *ICD designer* and *eNode Designer*.

Another example is shown below. In this example, the *q* and *t* apply to the *mag* according to the 61850 specification. Any selected point "inside" this mag will have the *q* and *t* values associated with the mag combined into one data point.

For example, in this case, the *mag$i* has its quality and time mapped with the 61850 *q* and *t* DAs adjacent to the *mag*.

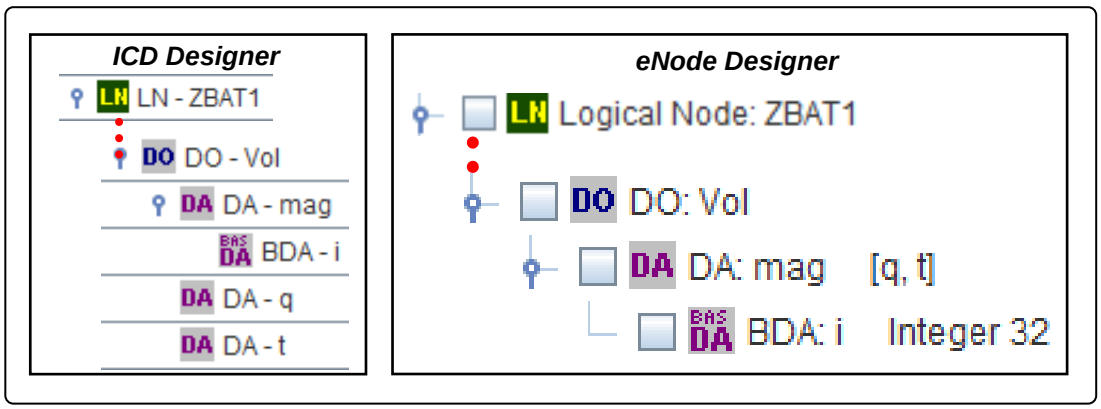

Figure 2-5 – Combined DAs, example two.

2.4 Replaces Ethernet Properties

When generating and sending the configuration to the target platform, the SCL's local IED Ethernet properties are modified to match those specified in eNode Designer.

That is, the following attributes are changed in the Access Point associated with the first IED in the SCL file that is sent to the target device.

Attribute	Modification
<P type="IP">…</P>	*Replaced by Ethernet's property in eNode Designer*
<P type="IP-SUBNET">…</P>	*Replaced by Ethernet's property in eNode Designer*
<P type="IP-GATEWAY">…</P>	*Replaced by Ethernet's property in eNode Designer*
<P type="MAC-Address">…</P>	*Removed. Obtained automatically.*

Table 2-1 – Automatic IP Setting Modifications.

3 IEC 61850 ADH Application Configuration Guide

3.1 Adding the Module in eNode Designer

The IEC 61850 module can only be added to *Ethernet* ports. An IEC 61850 ADH Application can be set up as a Client or a Server. The choice will be presented when adding it to the project. ATOP device supports one server application per protocol per device.

To add the module to the project, follow the steps explained below.

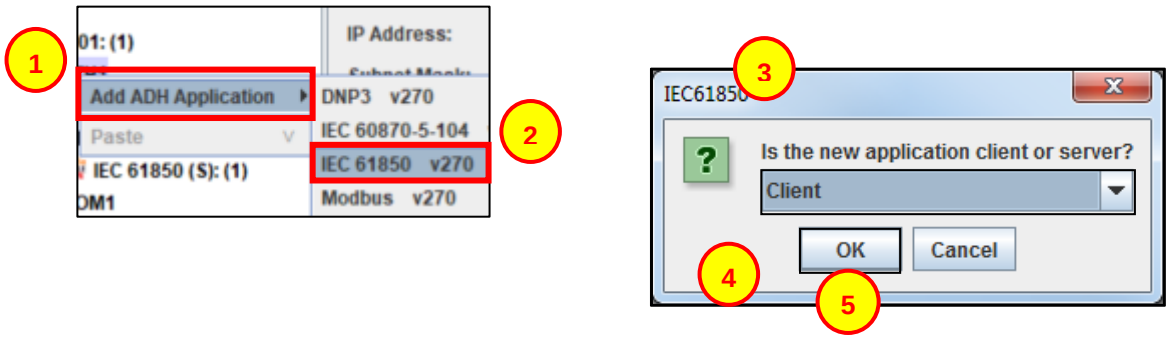

Figure 3-1 - Adding an IEC 61850 module to the project.

1. Click **Add ADH Application**.
2. Click **IEC61850**.
3. This dialogue box will appear asking whether the new application is to be configured as a *Client* or a *Server*.
4. Select either *Client* or *Server* from the drop down menu.
5. Click **OK** to add the application.

3.2 Common Configuration Details

After a new *IEC61850 Server* or *Client* is added, an *SCL file* needs to selected. The following pane will appear at the top centre of the screen for both *IEC61850 Servers* and *Clients*.

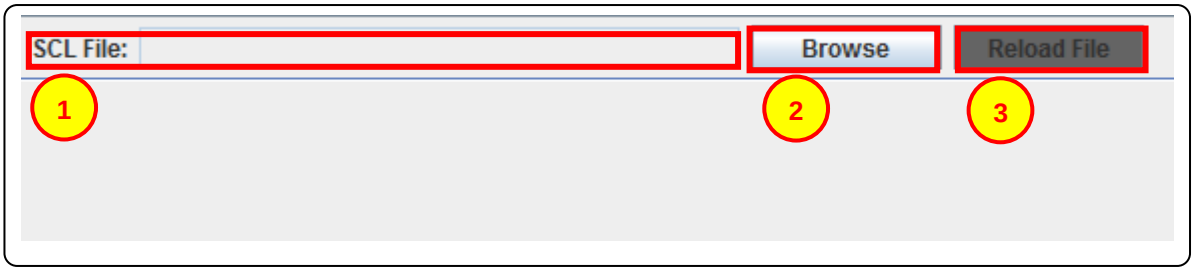

Figure 3-2 – SCL file selection.

1 **SCL file –** Shows location and name of the SCL file once it has been added to eNode Designer.

2 **Browse –** This button will bring up an *Open File* dialogue box to select the SCL file to be loaded for the ADH Application, see: **Open SCL File Dialogue Box**.

3 **Reload File –** This option is only available once a file has been loaded. Reload file is explained further in **Changing and Reloading SCL Files**.

3.2.1 Changing and Reloading SCL Files

When an *SCL* file is loaded into *eNode Designer*, it is saved into the *eNode Designer* project file. If the SCL file has been changed, a warning will appear next to Reload File, Left clicking the reload file button will load the changes into *eNode Designer*.

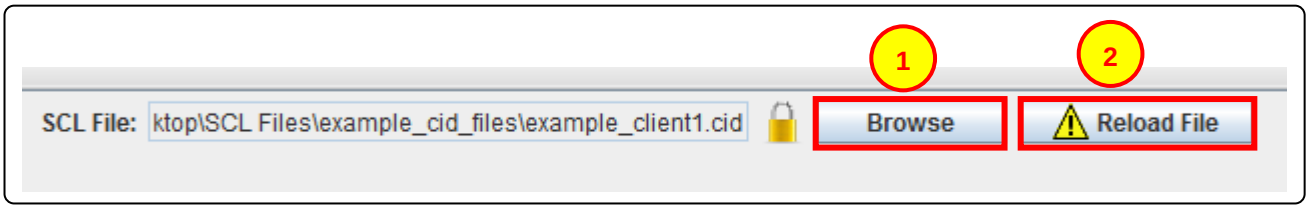

Figure 3-3 – Altered file warning.

1 **Browse –** This button can be used to change the current SCL file, however this will require confirming login details. This will bring up the *Open File* dialogue box to select the SCL file to be loaded for the ADH Application, see: **Open SCL File Dialogue Box**.

2 **Altered File Warning –** The exclamation mark within the yellow triangle will be shown when the currently loaded SCL file has been changed externally. This indicates that it will need to be reloaded to reflect those changes within eNode Designer.

3.3 Client Configuration

3.3.1 IEC 61850 Client – Select which data points to use in eNode Designer.

Once a Client SCL file has been imported, the following view will be shown. In this example, some of the *SCL Tree* has been expanded and some data points selected.

Selecting data attributes in the tree assigns eNode Data points to them. Each eNode data point is shown in the table on the right. All the data points in the table are those available in eNode Designer for mapping. All data point values have default values automatically assigned based on the SCL file. The *Tag* and *Description* are, however, changeable by the user.

Checking (or unchecking) a tree node will check (or uncheck) all tree nodes "inside" it.

Figure 3-4 - Mapped client example.

1 **Remote IEDs –** This shows the Remote IED's connected to the client, all Remote IED's will show in this area under their respective IED tree nodes within the *Project Tree Windowpane*.

2 **Project Tree Windowpane –** This shows a tree view of all remote IEDs. The tick-boxes allow for selection of data points to be made available for mapping in the database. Expand the branches to view further down the project tree.

3 **Selected Data Points –** This is where the points selected for inclusion in the database will appear. Points that show in this area have been made available to the database and can be utilised by other applications.

3.4 Server Configuration

If the server SCL file has more than one IED in the file, the first one is the Local IED, and the rest are remote IEDs. The GOOSE subscription tab shows all remote IEDs. The way 61850 works, the only data points accessible in a server from remote IEDs are those that are published on GOOSE.

The IEC 61850 server application in some way acts like a server *and* a client. It is able to reference "client" points to and from the local IED, but also "produces" client points it puts in to the eNode Database from the remote IEDs.

3.4.1 IEC 61850 Server – Mapping Data Points to the Local IED

To select a DA to map, expand the tree down to the final level (the final DA) and tick the checkbox.

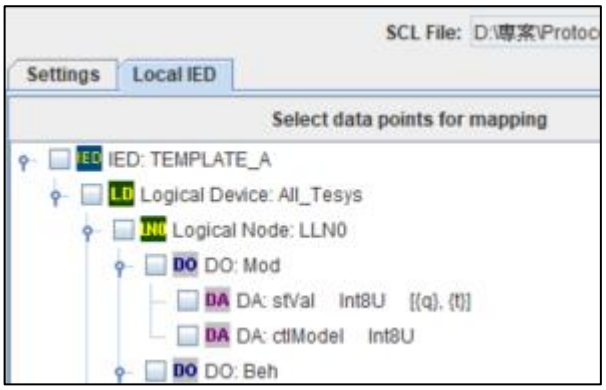

Figure 3-5 - To map, first browse to the desired point.

Selecting a point for mapping from eNode will bring up the following window. This window allows you to select which data point value to map to. Points are ***live mapped*** within the dialogue: as soon as a mapping is changed in this window, it is changed within *eNode Designer*.

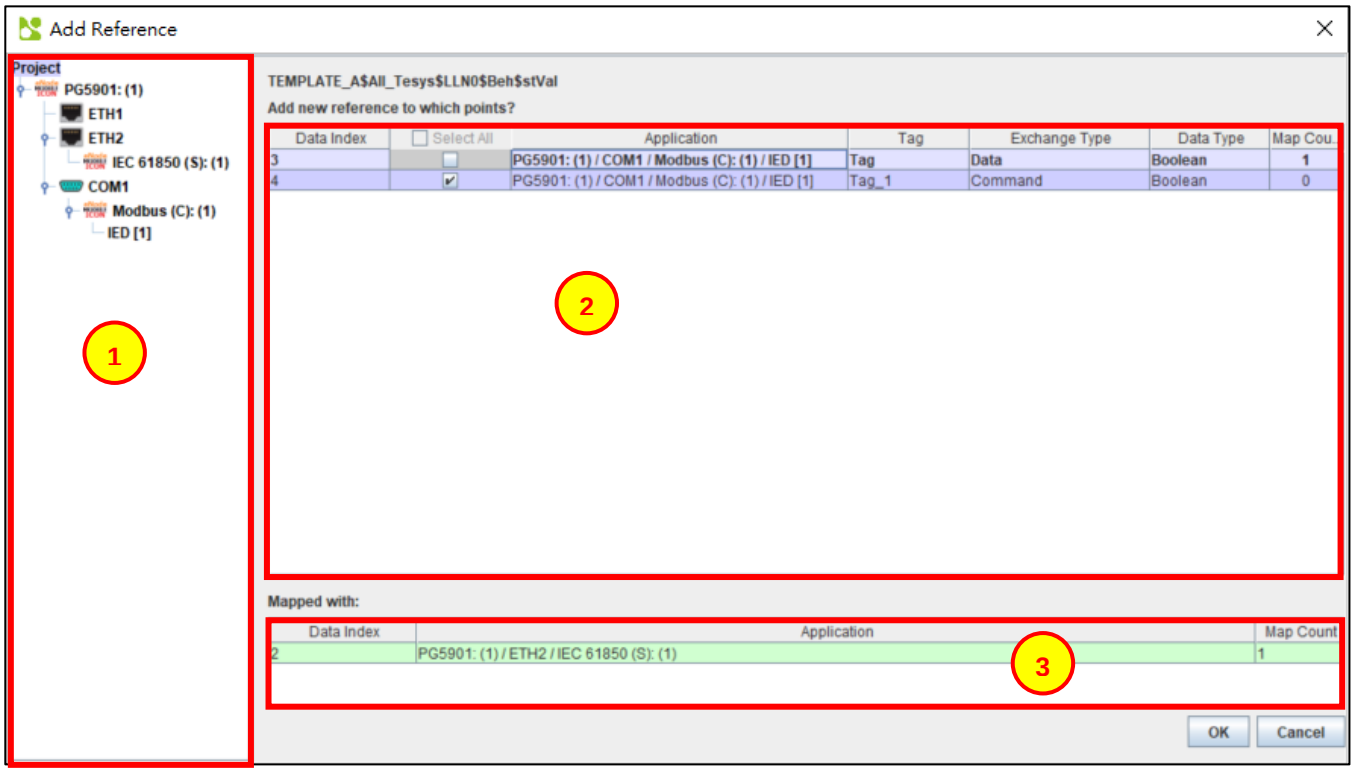

Figure 3-6 - Mapping a server point.

1. **Project Tree Windowpane –** This shows the eNode Designer project view. Use this to filter the list of available data points.
2. **Available Points –** This shows the list of possible points which can map to the given point.
3. **Mapped Points –** Shows the applications the selected point in (2) is currently mapped to.

Once points have been mapped they are added to the table.

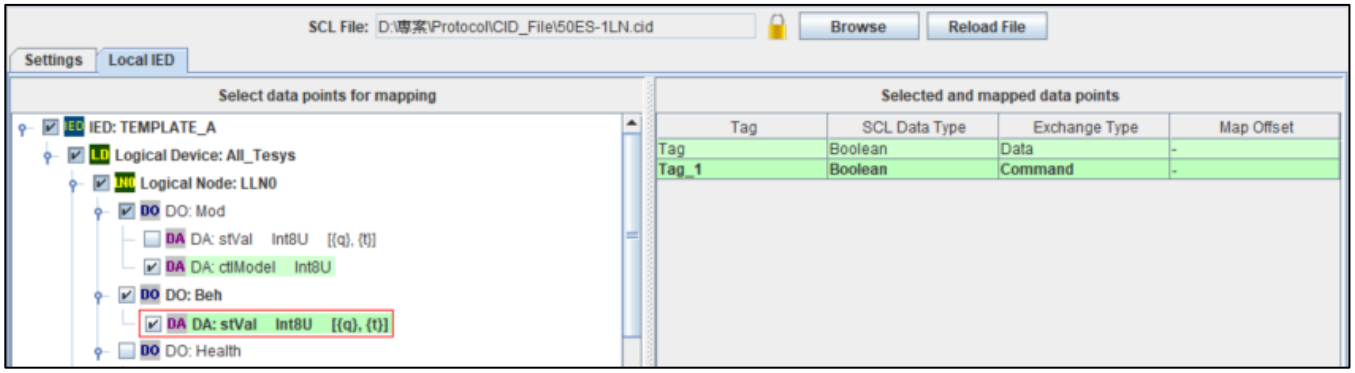

Figure 3-7 - Point has been mapped.

4 Reference Guide

4.1 Mass Tree Expanding and Collapsing

There are several options for expanding and collapsing many tree nodes at once.

Right click a tree node:

Expand All	Expands all tree nodes inside the tree node.
Collapse All	Collapses the tree nodes inside it and the tree node itself.
Collapse Below	Collapses the tree nodes inside it

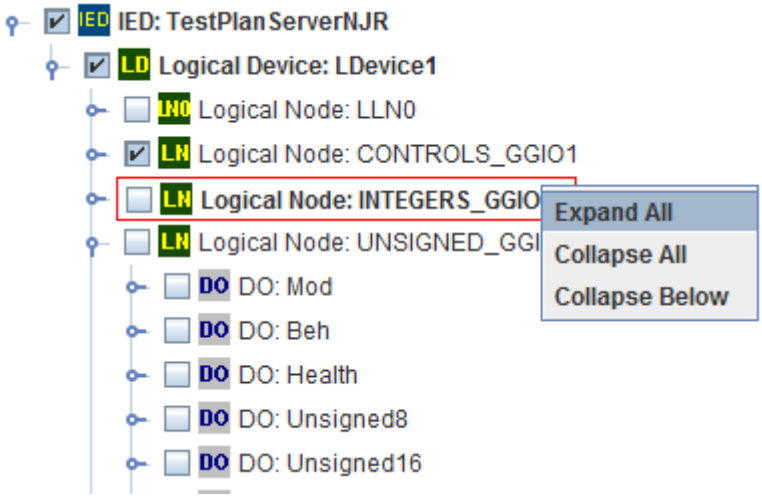

Figure 4-1 - SCL tree node context menu

Right click empty space in the SCL tree pane:

Expand Entire Tree	Expands the entire SCL tree. For very large files, it enforces a limit as a maximum number of nodes it will expand.
Collapse Entire Tree	Collapse the entire SCL tree.

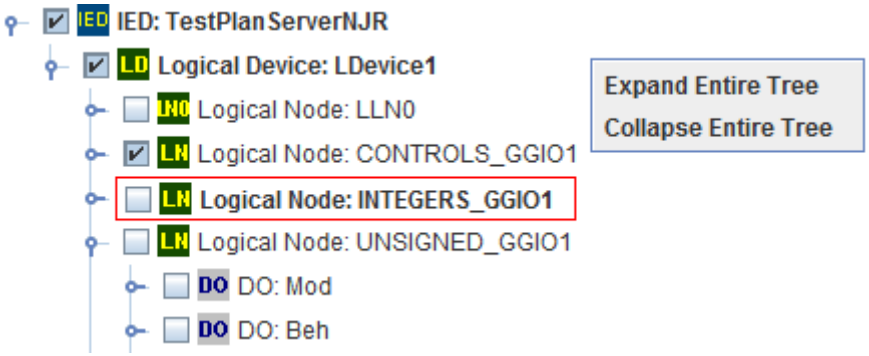

Figure 4-2 - SCL tree pane context menu

5 Protocol Implementation Conf. Statement (PICS)

5.1 IEC 61850 Protocol Implementation Conformance Statement

Protocol Implementation Conformance Statements (PICS) contain information regarding the Abstract Communication Service Interface (ACSI) {IEC61850-7-2 edition 2.0 2010-08} components that may be tested. This tick list is a summary of the ACSI that has not been implemented and has been implemented by ATOP Technologies Inc.

The following ACSI conformance statements are used to provide an overview and details about the ATOP implementation for IEC 61850 software:

- ACSI basic conformance statement
- ACSI models conformance statement
- ACSI service conformance statement

5.2 ACSI Basic Conformance

The basic conformance statement shall be as defined in Table 1.

Table 1 - Basic conformance statement

		Client/ subscriber	Server/ publisher	Value/ comments
Client-server roles				
B11	**Server** side (of TWO-PARTY-APPLICATION-ASSOCIATION)	☐	☒	
B12	**Client** side of (TWO-PARTY-APPLICATION-ASSOCIATION)	☒	☐	
SCSMs supported				
B21	**SCSM**: IEC 61850-8-1 used	☒	☒	
B22	**SCSM**: IEC 61850-9-1 used	☒	☒	
B23	**SCSM**: IEC 61850-9-2 used	☒	☒	
B24	**SCSM**: other			
Generic substation event model (GSE)				
B31	**Publisher** side	☐	☒	
B32	**Subscriber** side	☒	☐	
Transmission of sampled value model (SVC)				
B41	**Publisher** side	☐	☐	
B42	**Subscriber** side	☐	☐	

5.3 ACSI Models Conformance Statement

The ACSI models conformance statement shall be as defined in Table 2.

Table 2 - ACSI models conformance statement

		Client/ subscriber	Server/ publisher	Value/ comments
If Server side (B11) supported				
M1	Logical device	☒	☒	
M2	Logical node	☒	☒	
M3	Data	☒	☒	
M4	Data set	☒	☒	
M5	Substitution	☒	☒	
M6	Setting group control	☐	☐	
	Reporting			
M7	Buffered report control	☒	☒	
M7-1	sequence-number	☐	☐	
M7-2	report-time-stamp	☐	☐	
M7-3	reason-for-inclusion	☐	☐	
M7-4	data-set-name	☐	☐	
M7-5	data-reference	☐	☐	
M7-6	buffer-overflow	☐	☐	
M7-7	entryID	☐	☐	
M7-8	BufTm	☐	☐	
M7-9	IntgPd	☐	☐	
M7-10	GI	☐	☐	
M8	Unbuffered report control	☒	☒	
M8-1	sequence-number	☐	☐	
M8-2	report-time-stamp	☐	☐	
M8-3	reason-for-inclusion	☐	☐	
M8-4	data-set-name	☐	☐	
M8-5	data-reference	☐	☐	
M8-6	BufTm	☐	☐	
M8-7	IntgPd	☐	☐	
M8-8	GI	☐	☐	
	Logging			
M9	Log control	☐	☐	
M9-1	IntgPd	☐	☐	
M10	Log	☐	☐	
M11	Control	☒	☒	
If **GSE** (B31/B32) is supported				
M12	GOOSE	☒	☒	
M13	GSSE	☐	☐	
If **SVC** (B41/B42) is supported				
M14	Multicast SVC	☐	☐	
M15	Unicast SVC	☐	☐	
For all IEDs				
M16	Time	☒	☒	
M17	File Transfer	☐	☐	

5.4 ACSI Service Conformance Statement

The ACSI service conformance statement shall be as defined in Table 3 (depending on the statements in Table 1).

Table 3 - ACSI service conformance statement

	Services	AA:TP/MC	Client/ subscriber	Server/ publisher	Comments
Server (Clause 7)					
S1	ServerDirectory	TP	☐	☒	
Application association (Clause 8)					
S2	Associate		☒	☒	
S3	Abort		☒	☒	
S4	Release		☒	☒	
Logical device (Clause 9)					
S5	LogicalDeviceDirectory	TP	☒	☒	
Logical node (Clause 10)					
S6	LogicalNodeDirectory	TP	☒	☒	
S7	GetAllDataValues	TP	☐	☒	
Data (Clause 11)					
S8	GetDataValues	TP	☒	☒	
S9	SetDataValues	TP	☐	☐	
S10	GetDataDirectory	TP	☐	☒	
S11	GetDataDefinition	TP	☐	☒	
Data set (Clause 12)					
S12	GetDataSetValues	TP	☐	☒	
S13	SetDataSetValues	TP	☐	☐	
S14	CreateDataSet	TP	☐	☐	
S15	DeleteDataSet	TP	☐	☐	
S16	GetDataSetDirectory	TP	☐	☐	
Setting group control (Clause 16)					
S18	SelectActiveSG	TP	☐	☐	
S19	SelectEditSG	TP	☐	☐	
S20	SetSGValues	TP	☐	☐	
S21	ConfirmEditSGValues	TP	☐	☐	
S22	GetSGValues	TP	☐	☐	
S23	GetSGCBValues	TP	☐	☐	

Reporting (Clause 17)					
Buffered report control block (BRCB)					
S24	Report	TP	☒	☒	
S24-1	data-change (dchg)		☒	☒	
S24-2	qchg-change (qchg)		☐	☐	
S24-3	data-update (dupd)		☐	☐	
S25	GetBRCBValues	TP	☒	☒	
S26	SetBRCBValues	TP	☒	☒	
Unbuffered report control block (URCB)					
S27	Report	TP	☒	☒	
S27-1	data-change (dchg)		☐	☐	
S27-2	qchg-change (qchg)		☐	☐	
S27-3	data-update (dupd)		☐	☐	
S28	GetURCBValues	TP	☒	☒	
S29	SetURCBValues	TP	☒	☒	
Logging (Clause 17)					
Log control block					
S30	GetLCBValues	TP	☒	☒	
S31	SetLCBValues	TP	☐	☒	
Log					
S32	QueryLogByTime	TP	☒	☒	
S33	QueryLogAfter	TP	☒	☒	
S34	GetLogStatusValues	TP	☒	☒	
Generic substation event model (GSE)					
GOOSE (Clause 18)					
S35	SendGOOSEMessage	MC	☒	☒	
S36	GetGoReference	TP	☐	☐	
S37	GetGOOSEElementNumber	TP	☐	☐	
S38	GetGoCBValues	TP	☐	☐	
S39	SetGoCBValues	TP	☐	☐	
GSSE					
S40	SendGSSEMessage	MC	☐	☐	
S41	GetGsReference	TP	☐	☐	
S42	GetGSSEElementNumber	TP	☐	☐	
S43	GetGsCBValues	TP	☐	☐	
S44	SetGsCBValues	TP	☐	☐	
Transmission of sampled value model (SVC) (Clause 19)					
Multicast SVC					
S45	SendMSVMessage	MC	☒	☒	
S46	GetMSVCBValues	TP	☐	☐	
S47	SetMSVCBValues	TP	☐	☐	

S48	SendUSVMessage	TP	☐	☐	
S49	GetUSVCBValues	TP	☐	☐	
S50	SetUSVCBValues	TP	☐	☐	
Control (Clause 20)					
S51	Select		☒	☐	
S52	SelectWithValue	TP	☒	☐	
S53	Cancel	TP	☐	☐	
S54	Operate	TP	☒	☒	
S55	Command-Termination	TP	☒	☒	
S56	TimeActivated-Operate	TP	☐	☐	
File transfer (Clause 23)					
S57	GetFile	TP	☐	☒	
S58	SetFile	TP	☐	☐	
S59	DeleteFile	TP	☐	☐	
S60	GetFileAttributeValues	TP	☐	☒	
Time (5.5)					
T1	Time resolution of internal clock	Nearest negative power of 2 in seconds			
T2	Time accuracy of internal clock	T0			
		T1			
		T2			
		T3			
		T4			
		T5			
T3	Supported TimeStamp resolution	Nearest value of 2**-n in seconds			

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