

# 61850 SCL Runner

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The tool capable of simulating a network of IEC 61850 server devices using SCL files.  
Overview.

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# From the recognized supplier of IEC 61850 software libraries and testing tools

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- ☐ **IEC 61850 Software Library (source code)**
  - Client part
  - Server part
  - GOOSE part
  - SV part
- ☐ **61850 CCC and 61850 SCC – client and server communication DLLs for MS Windows**
- ☐ **61850 Avenue - testing toolset**
  - IEC 61850 client tool
  - 61850 Relay Simulator
  - GOOSE toolset
  - Sampled Values toolset
  - 61850 ICD Editor
- ☐ **61850 GOOSE System Viewer - testing & monitoring tool**

# Problem to solve:

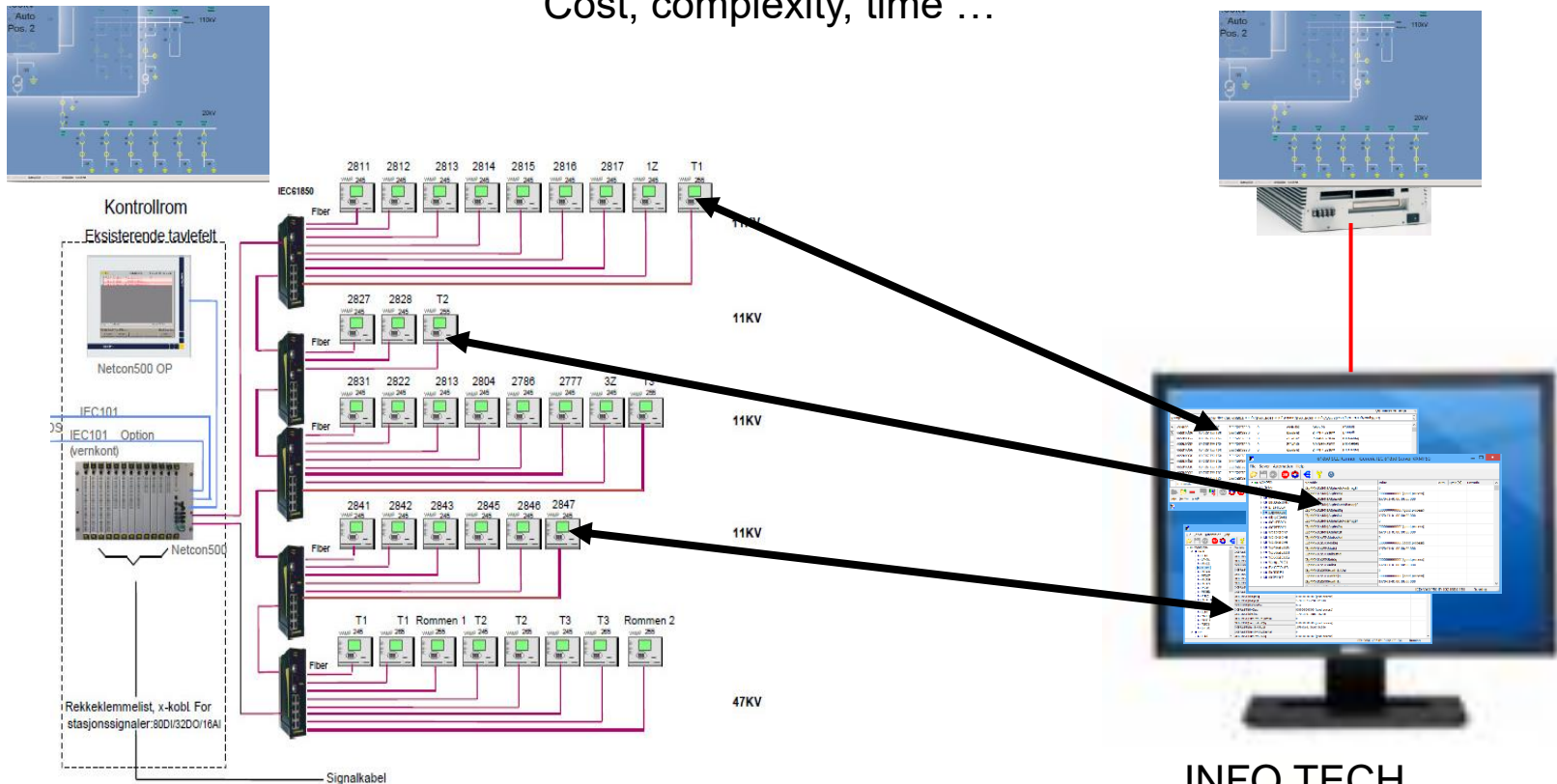
## How to prepare and verify the configuration of the control system?

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- One possible approach for the test lab:
  - Acquire all devices to be installed in the target place.
  - Find and implement the way how process data changes and parameter data changes can be stimulated and how controls can be traced.
  - Build a test network together with the control system to be configured.
  - Configure/reconfigure the devices and the control system and test all configured communication exchanges (can be thousands of signals and data points).
  - Iterate the previous step until all obtained test results are correct.
  
- Is there any more economic and less laborious approach?

# Which way of testing is easier? Real system vs simulated system

Cost, complexity, time ...



INFO TECH  
61850 SCL Runner  
toolset

# 61850 SCL Runner – for whom

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- ❑ Configuration of IEC 61850 based control systems is complex due to thousands of data points in tens of intelligent electronic devices (IEDs).
- ❑ Configuration engineers begin with offline configuration of the control system based on collected SCL files (communication capabilities of IEDs are described in standard based **S**ubstation **C**onfiguration description **L**anguage, called SCL).
- ❑ It would be ideal to verify the control system configuration still before being able to build the target installation with real communication network and tens of devices.
- ❑ Here comes the support ...

# 61850 SCL Runner – how

- ❑ Collected ICD/CID/SCD files can be used to setup an IEC 61850 server device simulator running on MS Windows PC.
- ❑ One or more server devices (IEDs) can be simulated using different IP addresses.
- ❑ Data models exactly as in real IEDs.
- ❑ Data changes can be defined by the user using formulas: either as fixed values or variable and time dependent.
- ❑ The simulator supports data sets and the reporting function with BRCBs and URCBs: data and quality changes, integrity period and GI trigger reports.
- ❑ All subscribed data flows can be tested by one click.
- ❑ The simulator supports control functions with proper behavior dependent on the control model.
- ❑ The simulator supports GOOSE publishing (GoCB) and GOOSE subscription (Inputs).
- ❑ IED start, stop and communication break-down situations can be easily tested by one click.

# 61850 SCL Runner – why

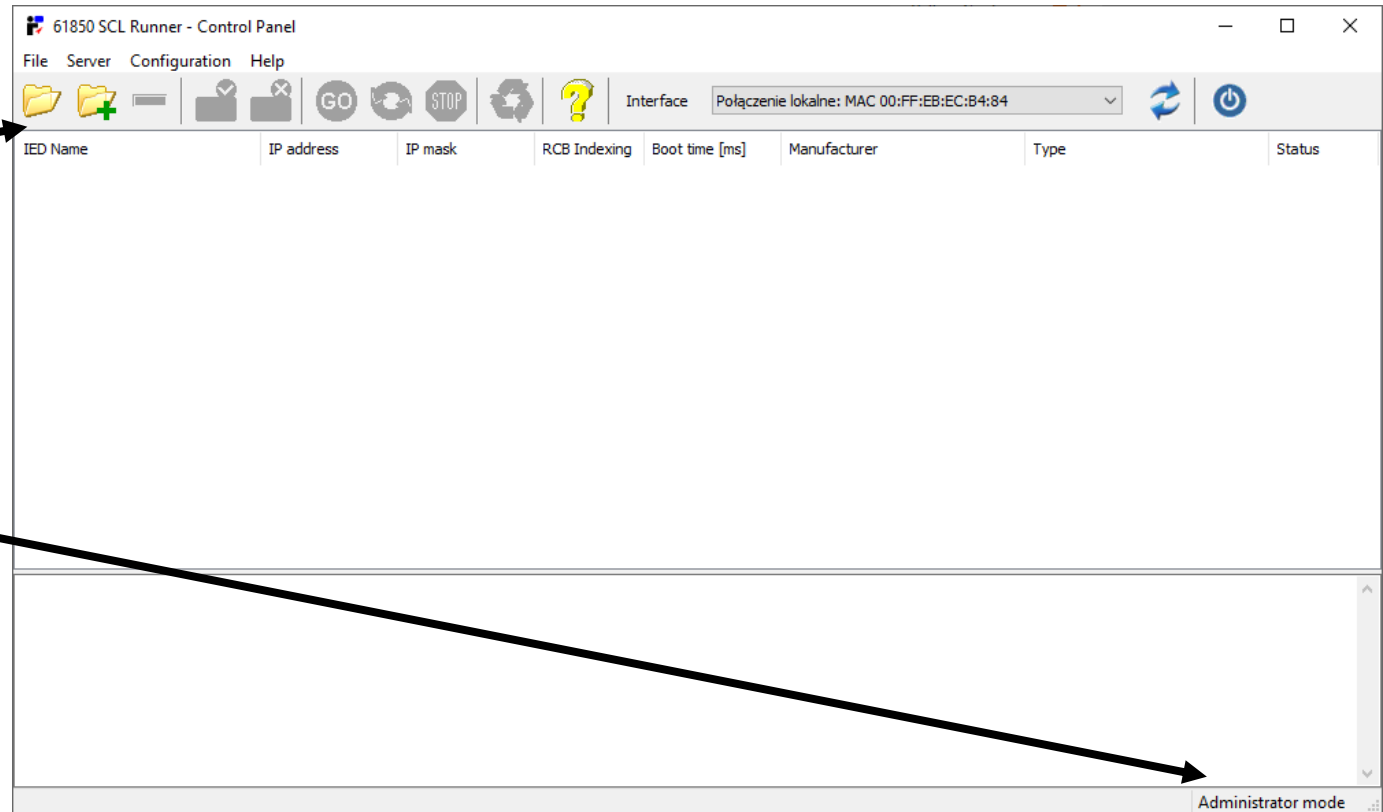
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- ❑ Test the control system under configuration (IEC 61850 client end) for proper data access from simulated target devices – using real SCL files.
- ❑ Save money by reducing purchases of various devices from different vendors to your test lab.
- ❑ Save time by avoiding creation of the target system replica in your lab.
- ❑ Focus on most critical parts of the project before going to the installation site instead of being distracted with lots of device vendor specific details.

# Initial view after the start-up

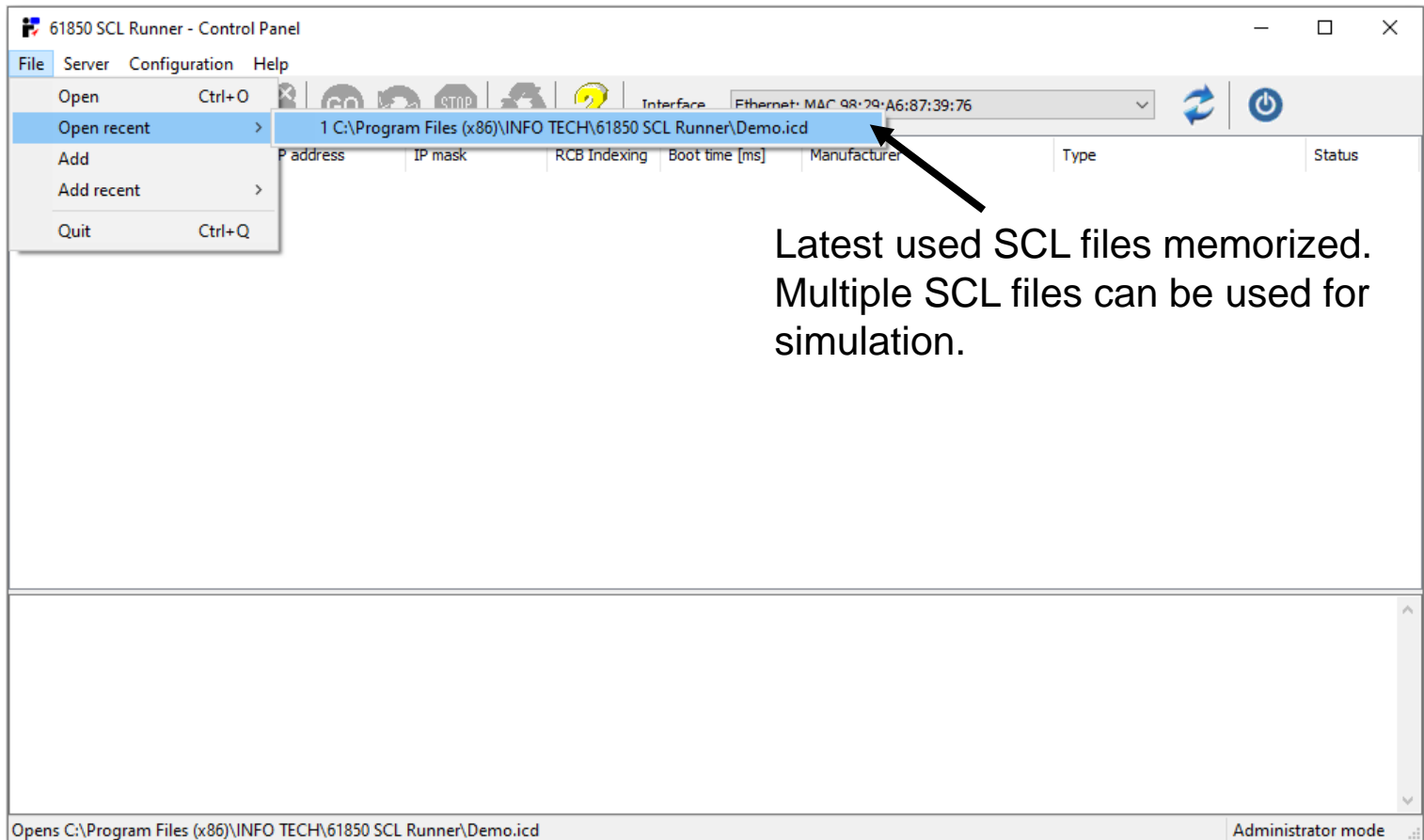
Simple, intuitive GUI to begin with opening an SCL file.

Remember to run the program in administrator mode – if target IP addresses shall be used.

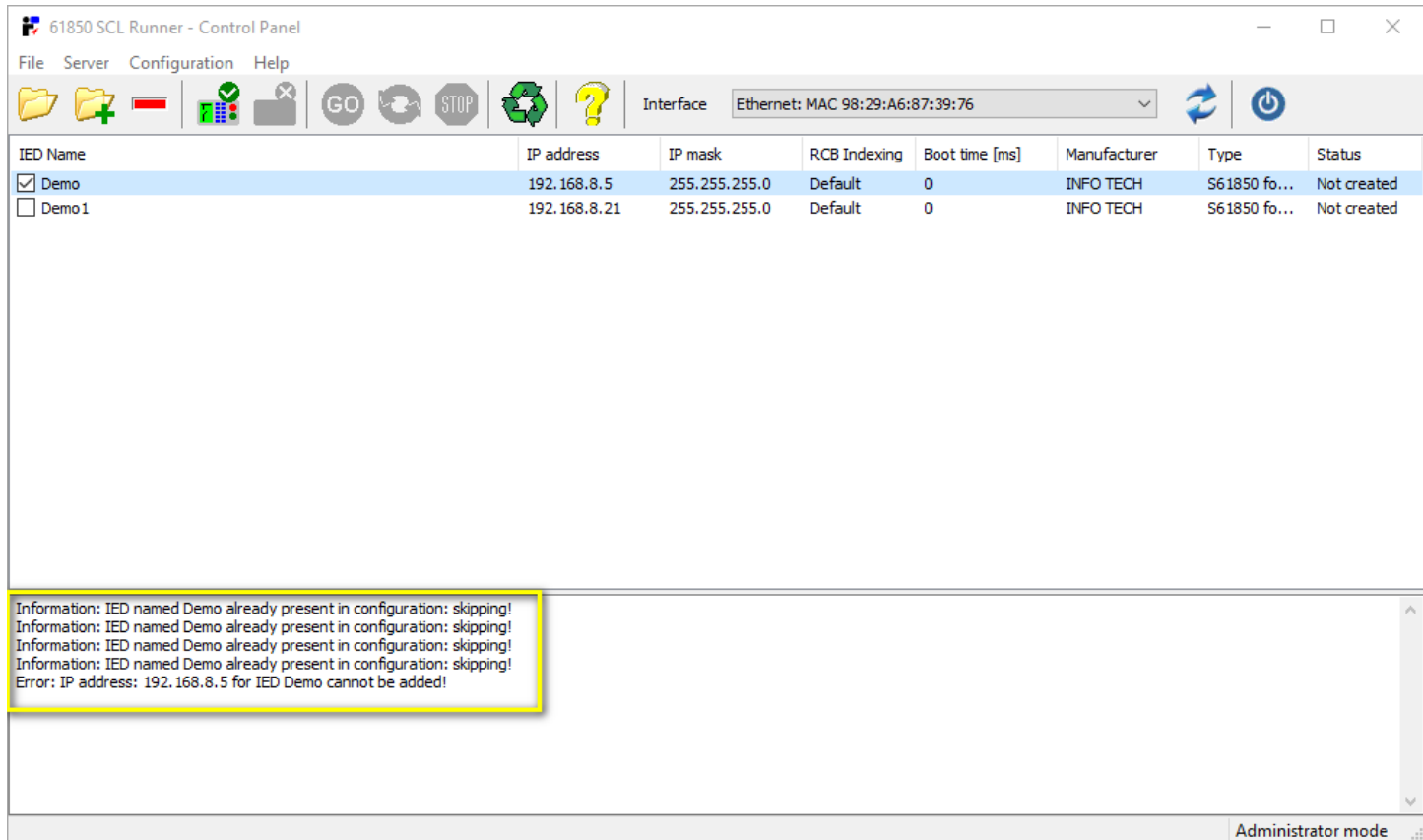




# Selection of ICD, CID or SCD file

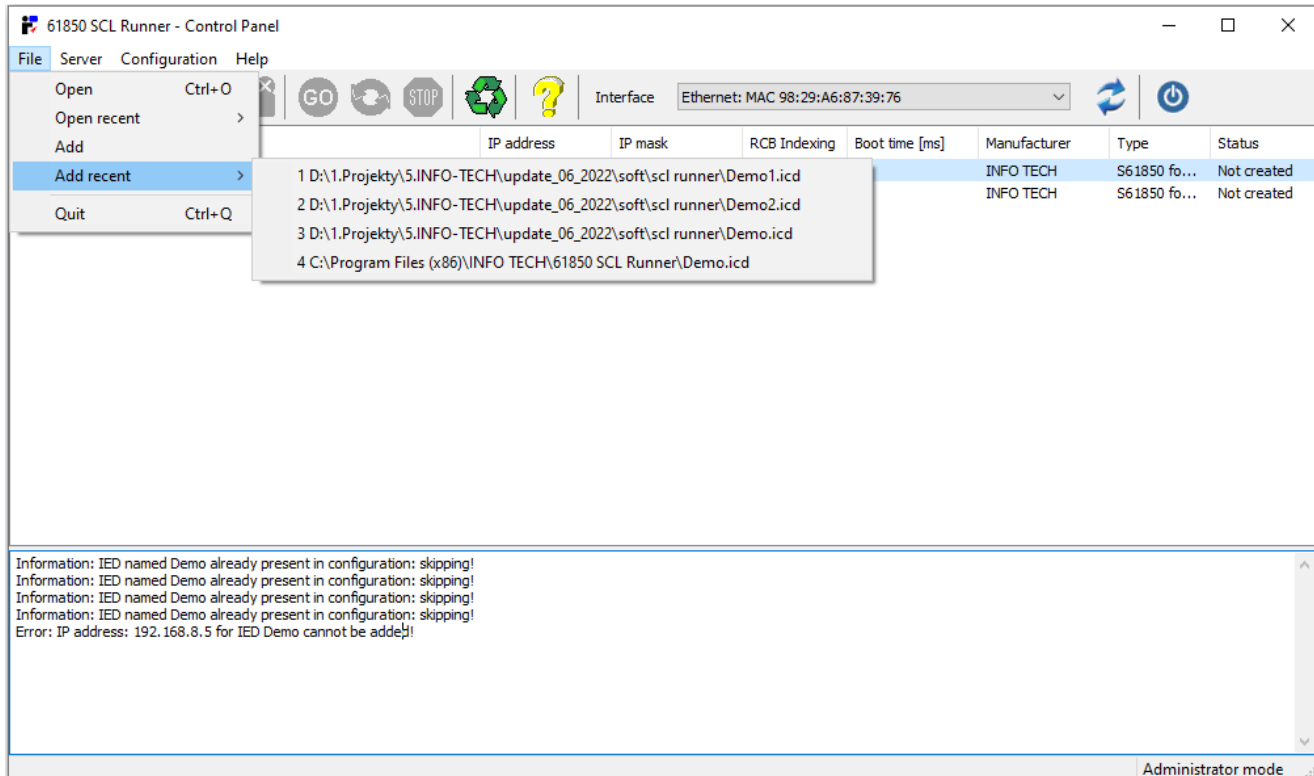


# SCL file parsed



Extracted from SCL file: IED name, IP address, IP mask, IED vendor, IED type description.

# Multiple SCL files can be used



As it is possible that the control system configuration and the simulation will be based on multiple SCL files (ICD/CID) instead of using one SCD file.

# SCL file is validated

The screenshot shows the '61850 SCL Runner - Control Panel' window. It has a menu bar (File, Server, Configuration, Help) and a toolbar with icons for file operations, a 'GO' button, a 'STOP' button, a refresh button, a help button, and an 'Interface' dropdown menu set to 'Ethernet: MAC 98:29:A6:87:39:76'. Below the toolbar is a table of IEDs (Intelligent Electronic Devices).

IED Name	IP address	IP mask	RCB Indexing	Boot time [ms]	Manufacturer	Type	Status
<input checked="" type="checkbox"/> Demo	192.168.8.5	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input type="checkbox"/> Demo1	192.168.8.21	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input type="checkbox"/> P139	192.168.8.105	255.255.255.0	Default	0	Schneider Elect...	P139	Not created
<input type="checkbox"/> P642	192.168.0.220	255.255.255.0	Default	0	ALSTOM	P642	Not created

A 'Warning' dialog box is open in the foreground. It contains a yellow warning icon and the following text: 'Fatal error: Validating D:\1.Projekt\5.INFO-TECH\update\_06\_2022\soft\scl runner\step1\Vamp210.icd against schema failed. Are you sure to continue with this file?'. There are 'Yes' and 'No' buttons at the bottom.

Below the dialog box, the 'Results of validation of file: D:\1.Projekt\5.INFO-TECH\update\_06\_2022\soft\scl runner\step1\Vamp210.icd' are displayed. The results show multiple validation errors related to the 'revision' attribute and the 'rptID' attribute not matching constraints.

At the bottom of the window, there is a status bar with the text 'Add file with servers descriptions' and 'Administrator mode'.

Problems detected during SCL file parsing are listed in the Error log section. The user decides whether to proceed.

# IED properties can be modified

The screenshot shows the '61850 SCL Runner - Control Panel' application. The 'Interface' tab is active, displaying a table of IEDs. The 'Demo' IED is selected, and its properties are shown in the 'Edit IED properties' dialog box.

IED Name	IP address	IP mask	RCB Indexing
<input checked="" type="checkbox"/> Demo	192.168.8.5	255.255.255.0	Default
<input type="checkbox"/> Demo1	192.168.8.21	255.255.255.0	Default
<input type="checkbox"/> P139	192.168.8.105	255.255.255.0	Default
<input type="checkbox"/> P642	192.168.0.220	255.255.255.0	Default

The 'Edit IED properties' dialog box shows the following settings for the 'Demo' IED:

- Set parameters for Demo
- IP: 192 . 168 . 8 . 5 (Change...)
- Mask: 255 . 255 . 255 . 0
- Boot time [ms]: 0
- RCB indexing: Default
- ☐ Use TLS
- ☐ Use ACSE authentication
- Server cybersecurity configuration:
  - Certificate: [Field]
  - Private key: [Field]
- Client cybersecurity configuration:
  - CA file: [Field]
  - CRL file: [Field]
  - Certificate: [Field]
  - Allowed IPs: [List Box]

OK Cancel

Opened by double click. Simulated device IP address, mask, initialization time (boot time), RCB indexing rule, TLS and ACSE authentication settings can be set as required in the test.

# Using secure communication: TLS encryption and ACSE authentication

Enabling / Disabling encryption and authentication.

Server cybersecurity configuration section.

Client cybersecurity configuration section

Set parameters for Demo

IP: 127 . 0 . 0 . 1

Mask: 255 . 255 . 255 . 0

Boot time [ms]: 0

RCB indexing: Default

☒ Use TLS

☒ Use ACSE authentication

Server cybersecurity configuration

Certificate: ECH\61850 SCL Runner\certificates\server.pem

Private key: ECH\61850 SCL Runner\certificates\server.key

Client cybersecurity configuration

CA file: C:\Program Files (x86)\INFO TECH\61850 SCL F

CRL file: C:\Program Files (x86)\INFO TECH\61850 SCL F

Certificate: C:\Program Files (x86)\INFO TECH\61850 SCL F

Allowed IPs:

OK Cancel

Server certificate information

cert. version : 3

serial number : 10:00

issuer name : C=XX, ST=State, O=Organisation, OU=OrgUnit, CN=ValidIntermediateCACommonName1

subject name : C=XX, ST=State, O=Organisation, OU=OrgUnit, CN=ValidServerCommonName1

issued on : 2022-05-20 12:22:35

expires on : 2023-05-20 12:22:35

signed using : RSA with SHA-256

RSA key size : 2048 bits

basic constraints : CA=false

cert. type : SSL Server

key usage : Digital Signature, Key Encipherment

ext key usage : TLS Web Server Authentication

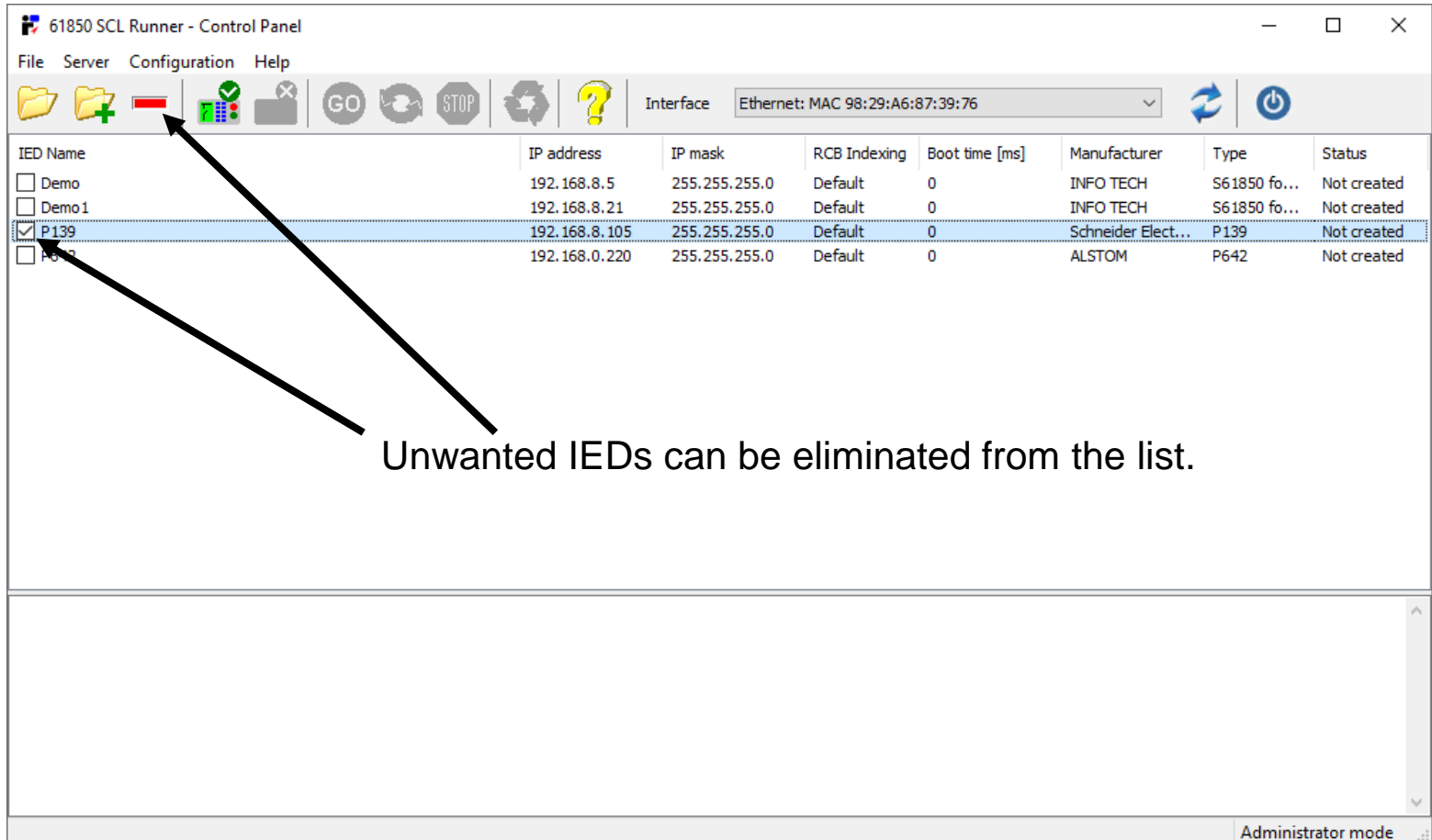
Selected file validation is listed in pop-up window.

Problems detected during validation are listed in window.

Server certificate information

Incorrect server certificate

# Selected IEDs can be deleted from the simulation set



The screenshot displays the '61850 SCL Runner - Control Panel' window. The interface includes a menu bar (File, Server, Configuration, Help), a toolbar with various icons (including a red minus sign for deletion), and a table of IEDs. The table has columns for IED Name, IP address, IP mask, RCB Indexing, Boot time [ms], Manufacturer, Type, and Status. The 'P139' entry is selected, and an arrow points to the delete icon in the toolbar. A text box states: 'Unwanted IEDs can be eliminated from the list.'

IED Name	IP address	IP mask	RCB Indexing	Boot time [ms]	Manufacturer	Type	Status
<input type="checkbox"/> Demo	192.168.8.5	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input type="checkbox"/> Demo1	192.168.8.21	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input checked="" type="checkbox"/> P139	192.168.8.105	255.255.255.0	Default	0	Schneider Elect...	P139	Not created
<input type="checkbox"/> P642	192.168.0.220	255.255.255.0	Default	0	ALSTOM	P642	Not created

# To start the simulation

The screenshot shows the '61850 SCL Runner - Control Panel' window. It features a menu bar (File, Server, Configuration, Help) and a toolbar with icons for file operations, simulation control (GO, STOP, RESTART, HELP), and network configuration (Interface dropdown, refresh, power). Below the toolbar is a table of IEDs. Annotations with arrows point to specific elements: one arrow points to the 'P139' checkbox in the IED list, another points to the 'P139' row, a third points to the 'Interface' dropdown menu, and a fourth points to the 'GO' button in the toolbar.

IED Name	IP address	IP mask	RCB Indexing	Boot time [ms]	Manufacturer	Type	Status
<input type="checkbox"/> Demo	192.168.8.5	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input type="checkbox"/> Demo1	192.168.8.21	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input checked="" type="checkbox"/> P139	192.168.8.105	255.255.255.0	Default	0	Schneider Elect...	P139	Not created
<input checked="" type="checkbox"/> P642	192.168.0.220	255.255.255.0	Default	0	ALSTOM	P642	Not created

Check-in the devices that should be simulated.

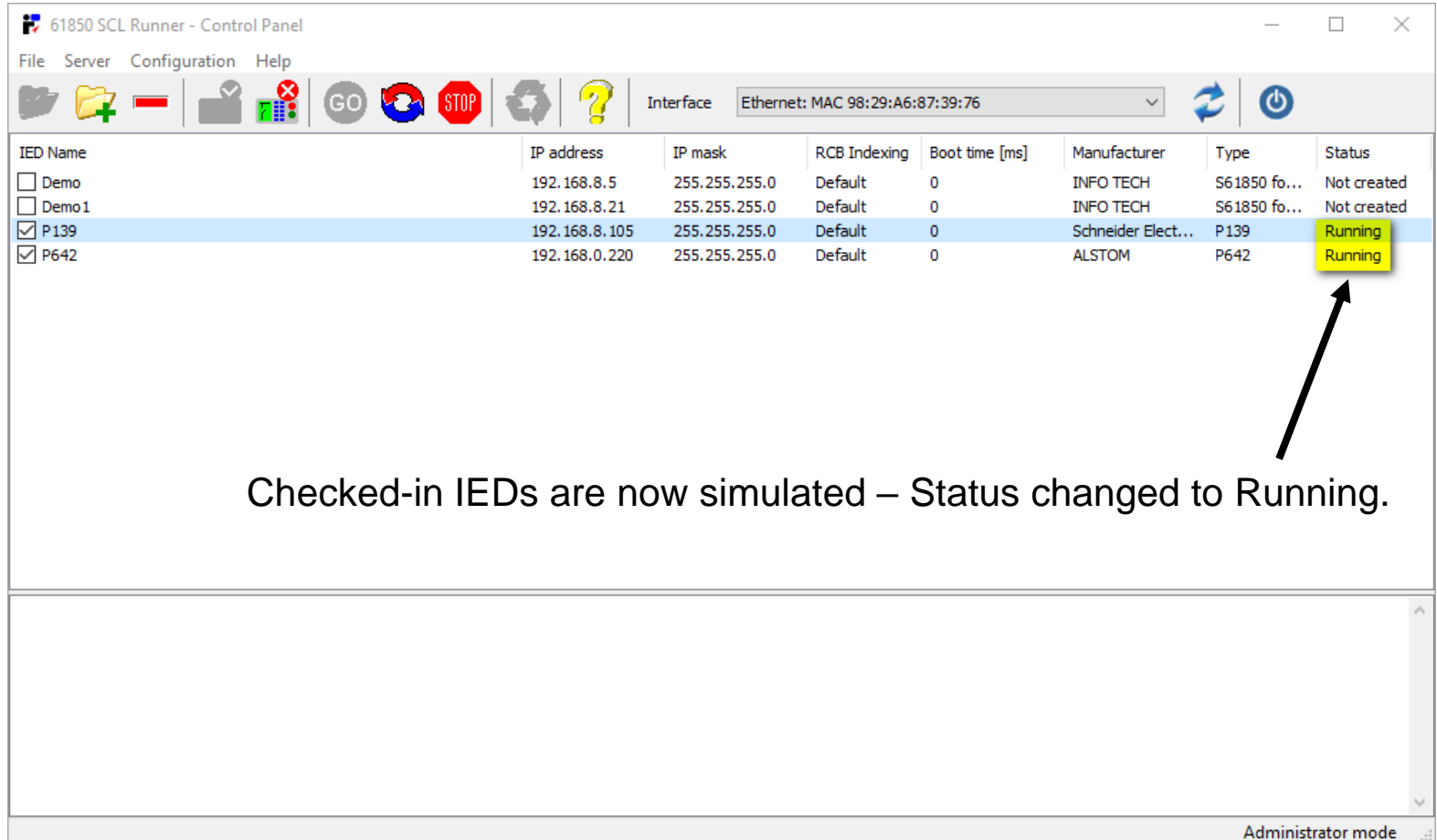
Before starting each simulation it is possible to choose the network adapter (if multiple) to be used by the given instance of the simulation program.

To start the simulation press Create button (or select Server / Create from menu).

Administrator mode



# Simulation started



61850 SCL Runner - Control Panel

File Server Configuration Help

Interface: Ethernet: MAC 98:29:A6:87:39:76

IED Name	IP address	IP mask	RCB Indexing	Boot time [ms]	Manufacturer	Type	Status
<input type="checkbox"/> Demo	192.168.8.5	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input type="checkbox"/> Demo1	192.168.8.21	255.255.255.0	Default	0	INFO TECH	S61850 fo...	Not created
<input checked="" type="checkbox"/> P139	192.168.8.105	255.255.255.0	Default	0	Schneider Elect...	P139	Running
<input checked="" type="checkbox"/> P642	192.168.0.220	255.255.255.0	Default	0	ALSTOM	P642	Running

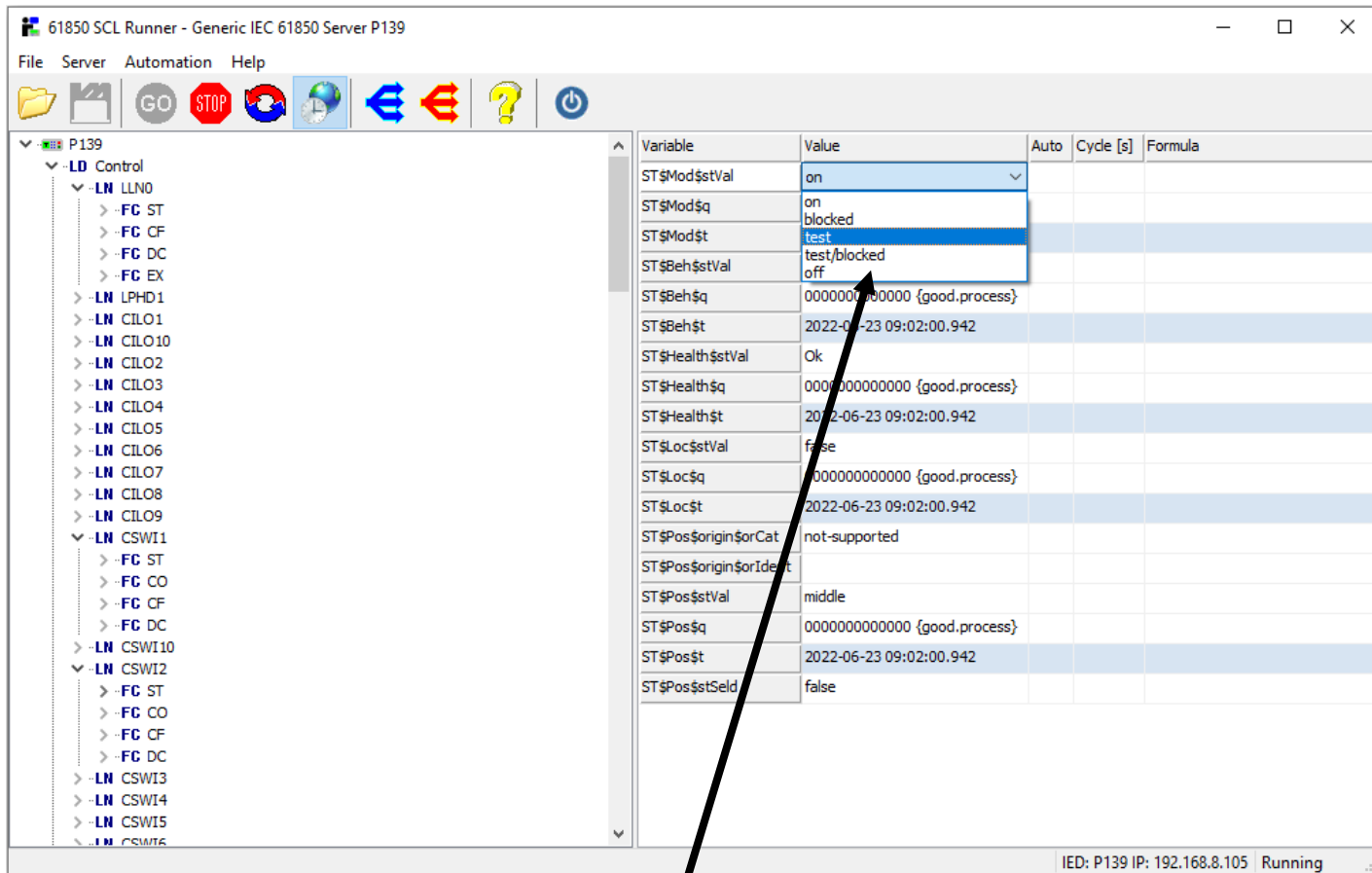
Administrator mode

Checked-in IEDs are now simulated – Status changed to Running.

## IED data model tree allows viewing and driving all data

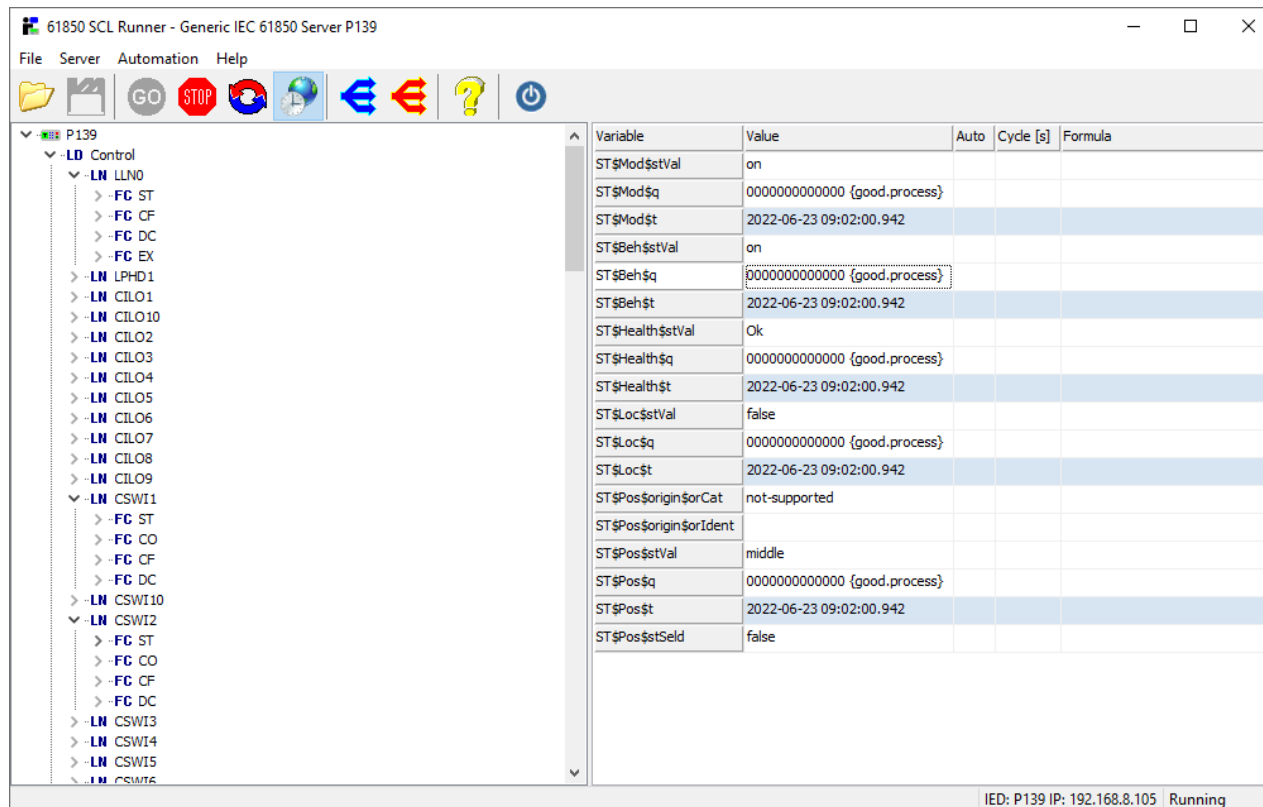


# IED data values can be driven by the user



E.g. CB position can be manually set or chosen from drop down list.

# IED data values can be driven by user defined formulas



The screenshot shows the '61850 SCL Runner - Generic IEC 61850 Server P139' window. On the left is a tree view of the IED structure, including 'LD Control', 'LN LLN0', and various functional components like 'FC ST', 'FC CF', 'FC DC', 'FC EX', 'LN LPHD1', 'LN CILO1', 'LN CILO10', 'LN CILO2', 'LN CILO3', 'LN CILO4', 'LN CILO5', 'LN CILO6', 'LN CILO7', 'LN CILO8', 'LN CILO9', 'LN CSW11', 'LN CSW12', 'LN CSW13', 'LN CSW14', 'LN CSW15', and 'LN CSW16'. On the right is a table with columns: Variable, Value, Auto, Cycle [s], and Formula. The table lists various status variables and their current values, many of which are formulas like '{good.process}' or timestamps.

Variable	Value	Auto	Cycle [s]	Formula
ST\$Mod\$stVal	on			
ST\$Mod\$q	00000000000000 {good.process}			
ST\$Mod\$t	2022-06-23 09:02:00.942			
ST\$Beh\$stVal	on			
ST\$Beh\$q	00000000000000 {good.process}			
ST\$Beh\$t	2022-06-23 09:02:00.942			
ST\$Health\$stVal	Ok			
ST\$Health\$q	00000000000000 {good.process}			
ST\$Health\$t	2022-06-23 09:02:00.942			
ST\$Loc\$stVal	false			
ST\$Loc\$q	00000000000000 {good.process}			
ST\$Loc\$t	2022-06-23 09:02:00.942			
ST\$Pos\$origin\$orCat	not-supported			
ST\$Pos\$origin\$orIdent				
ST\$Pos\$stVal	middle			
ST\$Pos\$q	00000000000000 {good.process}			
ST\$Pos\$t	2022-06-23 09:02:00.942			
ST\$Pos\$stSeld	false			

At the bottom right of the window, it says 'IED: P139 IP: 192.168.8.105 Running'.

E.g. time dependent formulas. The formula can be enabled or disabled for automatic execution, the formula execution cycle in seconds can be defined (0 – as fast as possible).

# Examples of simulation formulas

Data attribute	Formula
GGIO1\$ST\$Ind1\$stVal	$T \bmod 2$
<i>Digital input value changing every second between on and off (true and false)</i>	
MMXU1\$MX\$phsA\$cVal\$mag\$f	$2000 + 100 * \sin(T)$
<i>Phase A current amplitude value oscillates around 2000 with <math>\pm 100</math></i>	
CSWI\$ST\$Pos\$stVal	$\text{if}(T > 300, 1, 2)$
<i>CB position closed and changes to open after 300 seconds</i>	

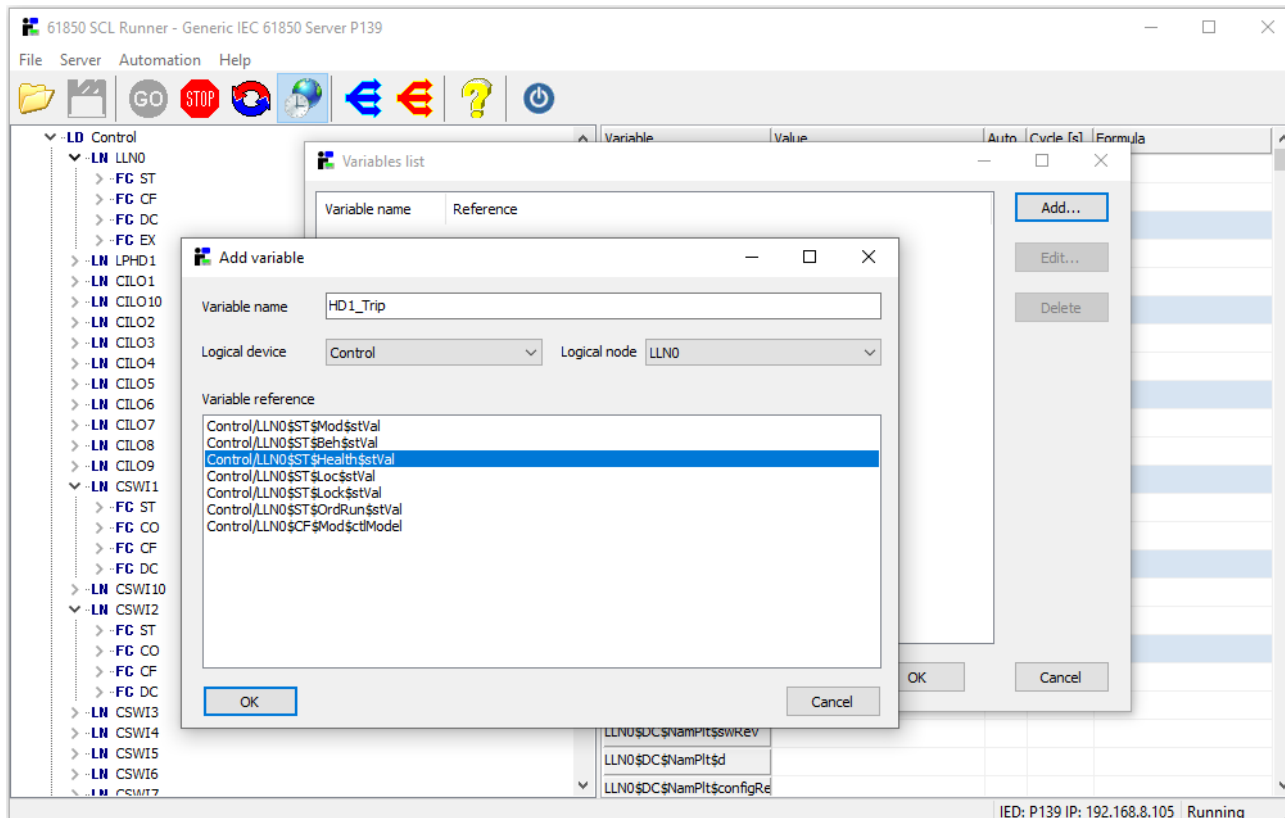
# Operators and functions in formulas

User defined variables and time can be used with variety of operators and functions to create simulation formulas, e.g. analog signal waveforms, trip conditions with start level, CB position dependent on trip status etc.

Symbol	Explanation
!	Factorial i.e. !5 gives $1*2*3*4*5 = 120$
%	Percentage i.e. 10% gives 0.1
-	Negate i.e. -10 gives -10 and --10 gives 10
+	Positive value i.e. +10 gives 10
^	Power i.e. $3^2$ gives 9
*	Multiplication i.e. $2*2$ gives 4
/	Division i.e. $4/2$ gives 2
div	Integer division (result and operands are treated as integers)
mod	Remainder i.e. $3 \bmod 2$ gives 1 (result and operands are treated as integers)
+	Sum i.e. $2+2$ gives 4
-	Subtract i.e. $4-2$ gives 2
-	Subtract i.e. $4-2$ gives 2
-	Subtract i.e. $4-2$ gives 2
<	Less than i.e. $3 < 2$ gives 0 (false)
<=	Less than or equal to i.e. $1 \leq 2$ gives 1 (true)
>=	Greater than or equal to i.e. $4 \geq 2$ gives 1 (true)
>	Greater than i.e. $4 > 2$ gives 1 (true)
=	Equal to i.e. $4 = 2$ gives 0 (false)
<>	Not equal to i.e. $4 \neq 2$ gives 1 (true)
not	Logical negation i.e. not 0 gives 1 and not 1 gives 0
or	Bitwise or i.e. 1 or 4 gives 5
and	Bitwise and i.e. 3 and 6 gives 2
xor	Bitwise xor i.e. 7 xor 5 gives 2

if	Conditional result: if argument 1 evaluates to true (is not 0) result is equal to argument 2 otherwise result is equal to argument 3
intpower	IntPower raises argument 1 to the power specified by argument 2 (both arguments are treated as integers)
ln	Natural logarithm ( $\ln(e) = 1$ ) of the argument
log10	Logarithm of base 10 of the argument
logN	Logarithm base N of X
max	Maximum of 2 arguments
min	Minimum of 2 arguments
pi	The ratio of a circle's circumference to its diameter. Pi is approximated as 3.1415926535897932385
pow	Power raises argument 1 (base) to power given by argument 2 (exponent). For fractional exponents or exponents greater than 2147483647, base must be greater than 0
radtodeg	Converts angles measured in radians to degrees
randG	Produces random numbers with Gaussian distribution parametrized by argument 2 (standard deviation) about the argument 1 (mean).
random	Produces random number within the range $0 \leq X < 1$
round	Rounds a real-type value to an integer-type value
sin	Sine of the argument
sinh	Hyperbolic sine of the argument
sqr	Square of the argument
sqrt	Square root of the argument
tan	Tangent of X
tanh	Hyperbolic tangent of X
trunc	Truncates a real-type value to an integer-type value (value of X rounded toward zero)

# User defined variables in formulas



Formulas can be based on user defined variables, referencing selected IED data attributes. If required, the formulas can be simultaneously enabled and disabled.

# Examples of simulation formulas with user-defined variables

Data attribute		Formula	User variable
MMXU1\$MX\$phsA\$cVal\$mag\$f	=	if(CB_pos = 2, 2+1*sin(2*T), 0)	→ <b>IphsA</b>
<i>Phase A current amplitude value defined by time dependent formula if CB position closed, and value 0 if CB position not closed</i>			
PTOC1\$ST\$Op\$general	=	if(IphsA > 2.85, 1, 0)	→ <b>OC1_trip</b>
<i>Overcurrent protection trip if IphsA (value of phase A current) exceeds the given limit</i>			
PTRC1\$ST\$Tr\$general	=	OC1_trip or OC2_trip or EF1_trip	→ <b>Trip</b>
<i>Common trip signal active if any of the trip signals from 3 protection functions is active</i>			
CSWI\$ST\$Pos\$stVal	=	if(Trip, 1, 2)	→ <b>CB_pos</b>
<i>CB position open if Trip active, and CB position closed if Trip not active</i>			



# Quality attribute values can be driven by the user

Quality attribute values can be enforced by the user directly, by a formula or set in the dialog window.

The screenshot shows the '61850 SCL Runner - Generic IEC 61850 Server P139' application. On the left, a tree view shows the 'LD Control' section with various quality attributes like LLN0, FC ST, FC CF, FC DC, FC EX, LPHD1, CILO1, CILO2, CILO3, CILO4, CILO5, CILO6, CILO7, CILO8, CILO9, CSW11, CSW12, CSW13, CSW14, CSW15, CSW16, and CSW17. A 'Set data quality' dialog box is open, showing 'Validity' (Good, Invalid, Questionable) and 'Source' (Process, Substituted) options. The 'Process' source is selected. A blue arrow points from the 'Process' radio button to the 'Set data quality' dialog box. In the background, a table lists quality attributes with their values, auto status, cycle time, and formula. The 'ST\$Health\$stVal' row is highlighted in yellow.

Variable	Value	Auto	Cycle [s]	Formula
\$ST\$Mod\$stVal	on			
\$ST\$Mod\$q	00000000000000 {good,process}			
\$ST\$Mod\$t	2022-06-23 09:02:00.940			
\$ST\$Beh\$stVal	on			
\$ST\$Beh\$q	00000000000000 {good,process}			
\$ST\$Beh\$t	2022-06-23 09:02:00.940			
\$ST\$Health\$stVal	Ok			
\$ST\$Health\$q	00000000000000 {good,process}			
\$ST\$Health\$t	2022-06-23 09:02:00.940			
\$ST\$Loc\$stVal	false			
\$ST\$Loc\$q	00000000000000 {good,process}			
\$ST\$Loc\$t	2022-06-23 09:02:00.940			
\$ST\$Lock\$stVal	false			
\$ST\$Lock\$q	00000000000000 {good,process}			
\$ST\$Lock\$t	2022-06-23 09:02:00.940			
\$ST\$OrdRun\$stVal	false			
\$ST\$OrdRun\$q	00000000000000 {good,process}			
\$ST\$OrdRun\$t	2022-06-23 09:02:00.940			
\$CF\$Mod\$ctlModel	status-only			
\$DC\$NamPit\$vendor				
\$DC\$NamPit\$swRev				
LLN0\$DC\$NamPit\$d				
LLN0\$DC\$NamPit\$configRe				

# Control system / client can connect to simulated IEDs and act

The screenshot displays the 61850 Avenue 2.1.9 software interface, which is used for configuring and connecting to simulated IEDs (Intelligent Electronic Devices).

**Left Panel: Server Configuration**

- Servers:** A list of servers is shown, including "New IEC-61850 server [192.168.0.224]", "New IEC-61850 server [192.168.8.19]", and "New IEC-61850 server [192.168.8.10]".
- Main:** Configuration details for the selected server (New IEC-61850 server [192.168.8.19]) are displayed, including Name, Address, Port, and Remote OSI Parameters.
- Remote OSI Parameters:** Fields for AE Qualifier, Application ID, OSI Presentation, OSI Session Select, and OSI Transport Select are visible.
- Address:** The Internet Protocol Address of the remote device (IPv4, IPv6 or name) is specified.

**Right Panel: Variable Table**

The right panel shows a table of variables for the selected server (Generic IEC 61850 Server BAY1). The table includes columns for Variable, Value, Auto, Cycle [s], and Formula.

Variable	Value	Auto	Cycle [s]	Formula
DEFLRDIR.1\$MX\$OpAEF\$mag\$f	0			
DEFLRDIR.1\$MX\$OpAEF\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$MX\$OpAEF\$t	2020-01-08 15:02:31.854			
DEFLRDIR.1\$MX\$OpPolAng\$mag\$f	0			
DEFLRDIR.1\$MX\$OpPolAng\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$MX\$OpPolAng\$t	2020-01-08 15:02:31.854			
DEFLRDIR.1\$MX\$OpChrAng\$mag\$f	0			
DEFLRDIR.1\$MX\$OpChrAng\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$MX\$OpChrAng\$t	2020-01-08 15:02:31.854			
DEFLRDIR.1\$ST\$Mod\$setVal	on			
DEFLRDIR.1\$ST\$Mod\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$ST\$Mod\$t	2020-01-08 15:02:31.854			
DEFLRDIR.1\$ST\$Beh\$setVal	on			
DEFLRDIR.1\$ST\$Beh\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$ST\$Beh\$t	2020-01-08 15:02:31.855			
DEFLRDIR.1\$ST\$Health\$setVal	0	No	0	if(OC1_Trip or OC2_Trip, 1, 2)
DEFLRDIR.1\$ST\$Health\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$ST\$Health\$t	2020-01-08 15:02:31.855			
DEFLRDIR.1\$ST\$Dir\$general	false			
DEFLRDIR.1\$ST\$Dir\$dirGeneral	unknown			
DEFLRDIR.1\$ST\$Dir\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$ST\$Dir\$t	2020-01-08 15:02:31.856			
DEFLRDIR.1\$ST\$InRcaCt\$setVal	false			
DEFLRDIR.1\$ST\$InRcaCt\$g	0000000000000000 (good.process)			
DEFLRDIR.1\$ST\$InRcaCt\$t	2020-01-08 15:02:31.856			
DEFLRDIR.1\$CF\$Mod\$setModel	status-only			
DEFLRDIR.1\$CF\$ChrAng\$units\$Unit	0			

Press F2 or double click to edit the values

IED: BAY1 IP: 192.168.1.10 Running

# Control command testing

New IEC-61850 server [192.168.8.19]: DemoProtCtrl/Obj1CSWI1.Pos

Status Information

Value: {intermediate} Control Number:

Quality: 000000000000 {Good, Process}

Time Stamp: 2019-12-30 11:18:07.218 [Leap Second Known][Time Accuracy = 10 bits]

Originator:

Category: Id:

Control

Value:

Time

Time Stamp: 2020-01-02 10:41:12

Originator

Category: remote-control Id: C0A80811

Select With Value Select Operate Cancel

Log

Time	Service	Message
------	---------	---------

Client control window

Control accepted and executed with generated Command Termination.

IED data view

61850 SCL Runner - Generic IEC 61850 Server BAY1

File Server Automation Help

Variable Value Auto Cycle [s] Formula

DEFLDIR1\$MX\$OpAEF\$mag\$f	0		
DEFLDIR1\$MX\$OpAEF\$g	00000000000000 {good,process}		
DEFLDIR1\$MX\$OpAEF\$t	2020-01-08 15:02:31.854		
DEFLDIR1\$MX\$OpAng\$mag\$f	0		
DEFLDIR1\$MX\$OpAng\$g	00000000000000 {good,process}		
DEFLDIR1\$MX\$OpAng\$t	2020-01-08 15:02:31.854		
DEFLDIR1\$MX\$OpChrAng\$mag\$f	0		
DEFLDIR1\$MX\$OpChrAng\$g	00000000000000 {good,process}		
DEFLDIR1\$MX\$OpChrAng\$t	2020-01-08 15:02:31.854		
DEFLDIR1\$ST\$Mod\$stVal	on		
DEFLDIR1\$ST\$Mod\$g	00000000000000 {good,process}		
DEFLDIR1\$ST\$Mod\$t	2020-01-08 15:02:31.854		
DEFLDIR1\$ST\$Beh\$stVal	on		
DEFLDIR1\$ST\$Beh\$g	00000000000000 {good,process}		
DEFLDIR1\$ST\$Beh\$t	2020-01-08 15:02:31.855		
DEFLDIR1\$ST\$Health\$stVal	0		
DEFLDIR1\$ST\$Health\$g	00000000000000 {good,process}		
DEFLDIR1\$ST\$Health\$t	2020-01-08 15:02:31.855		
DEFLDIR1\$ST\$Dir\$general	false		
DEFLDIR1\$ST\$Dir\$dirGeneral	unknown		
DEFLDIR1\$ST\$Dir\$g	00000000000000 {good,process}		
DEFLDIR1\$ST\$Dir\$t	2020-01-08 15:02:31.856		
DEFLDIR1\$ST\$InRcaCt\$stVal	false		
DEFLDIR1\$ST\$InRcaCt\$g	00000000000000 {good,process}		
DEFLDIR1\$ST\$InRcaCt\$t	2020-01-08 15:02:31.856		
DEFLDIR1\$CF\$Mod\$stModel	status-only		
DEFLDIR1\$CF\$ChrAng\$units\$STUnit	0		

Press F2 or double click to edit the values

IED: BAY1 IP: 192.168.1.10 Running

# Reporting function testing

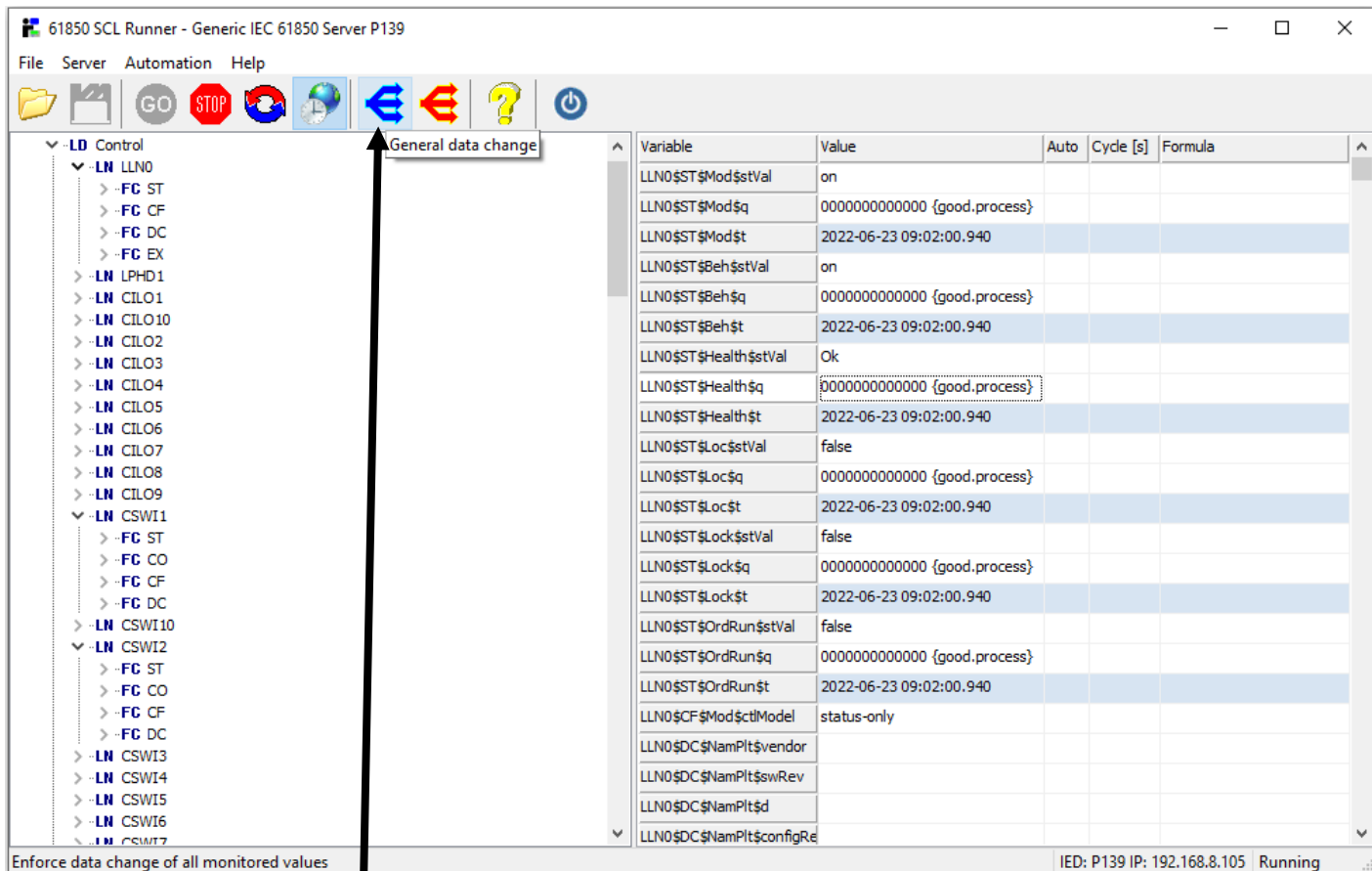
Data changes driven by user  
are reported by enabled  
RCB.

The screenshot displays the IEC 61850 software interface with several windows open:

- Configuration Window:** Shows the configuration for a new IEC-61850 server (192.168.8.19). The 'Data Set Reference' is set to 'DemoProtCtrl/LLN0\_DS1\_Disconnector'. The 'Buffer Time [ms]' is 1000, and the 'Sequence Number' is 1. The 'Time Of Entry' is 2020-01-02 09:55:46.898.
- Reporting Window:** Shows a table of reported data changes. The table has columns for Report ID, Reason, Received, SN, Bof, and Data Set. The first row shows a report for 'DemoProtCtrl/LLN0\_DS1\_Disconnector' with a reason of 'gi' and a received time of 2020-01-02 9:55:47.030.
- Automation Window:** Shows a list of variables and their values. The table has columns for Variable, Value, Auto, Cycle [s], and Formula. The first row shows 'CO#Mod\$Oper\$CtrlVal' with a value of 0.

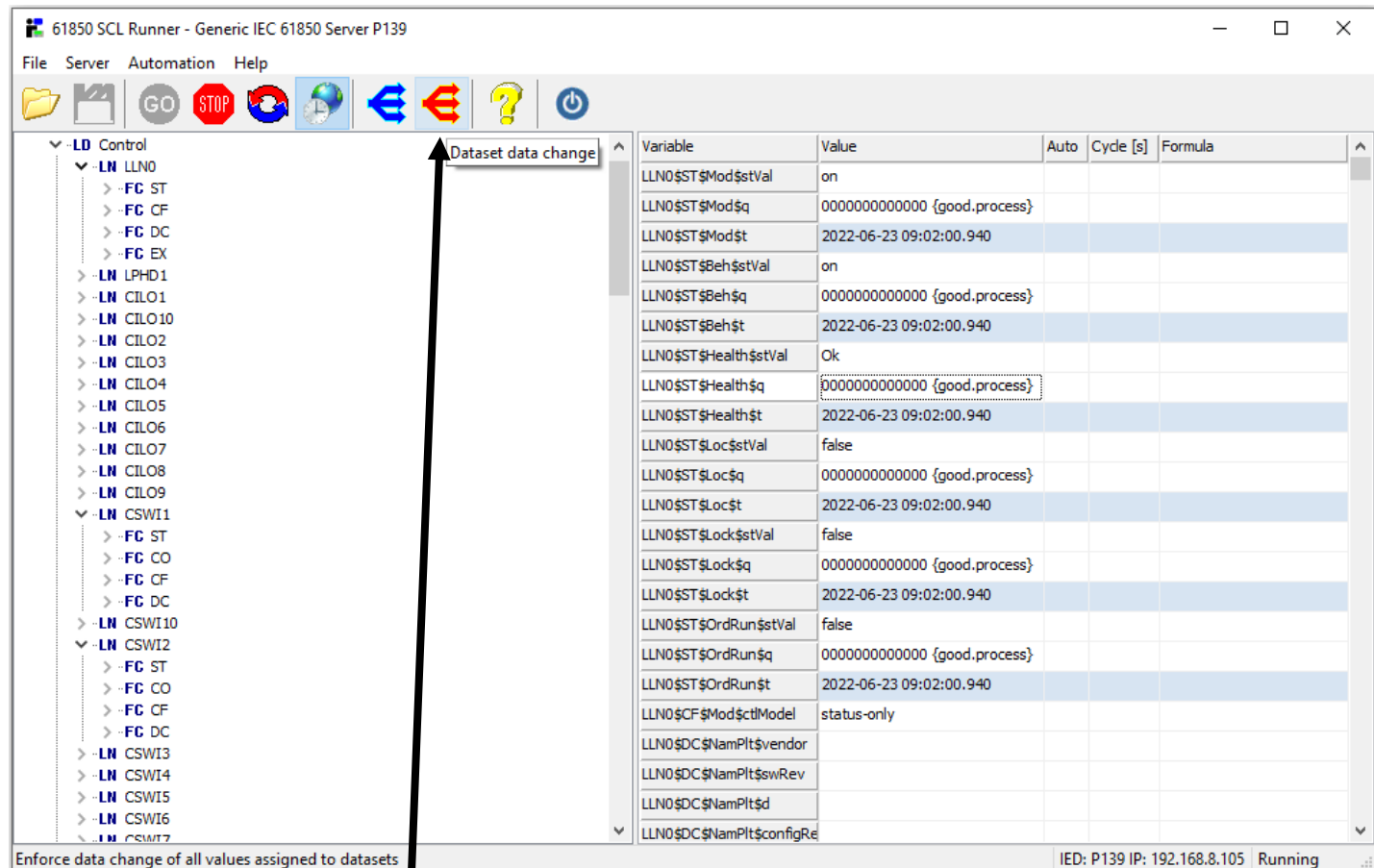
Arrows from the text 'Data changes driven by user are reported by enabled RCB.' point to the 'Reason' column in the Reporting Window and the 'CO#Mod\$Oper\$CtrlVal' variable in the Automation Window.

# General data change button

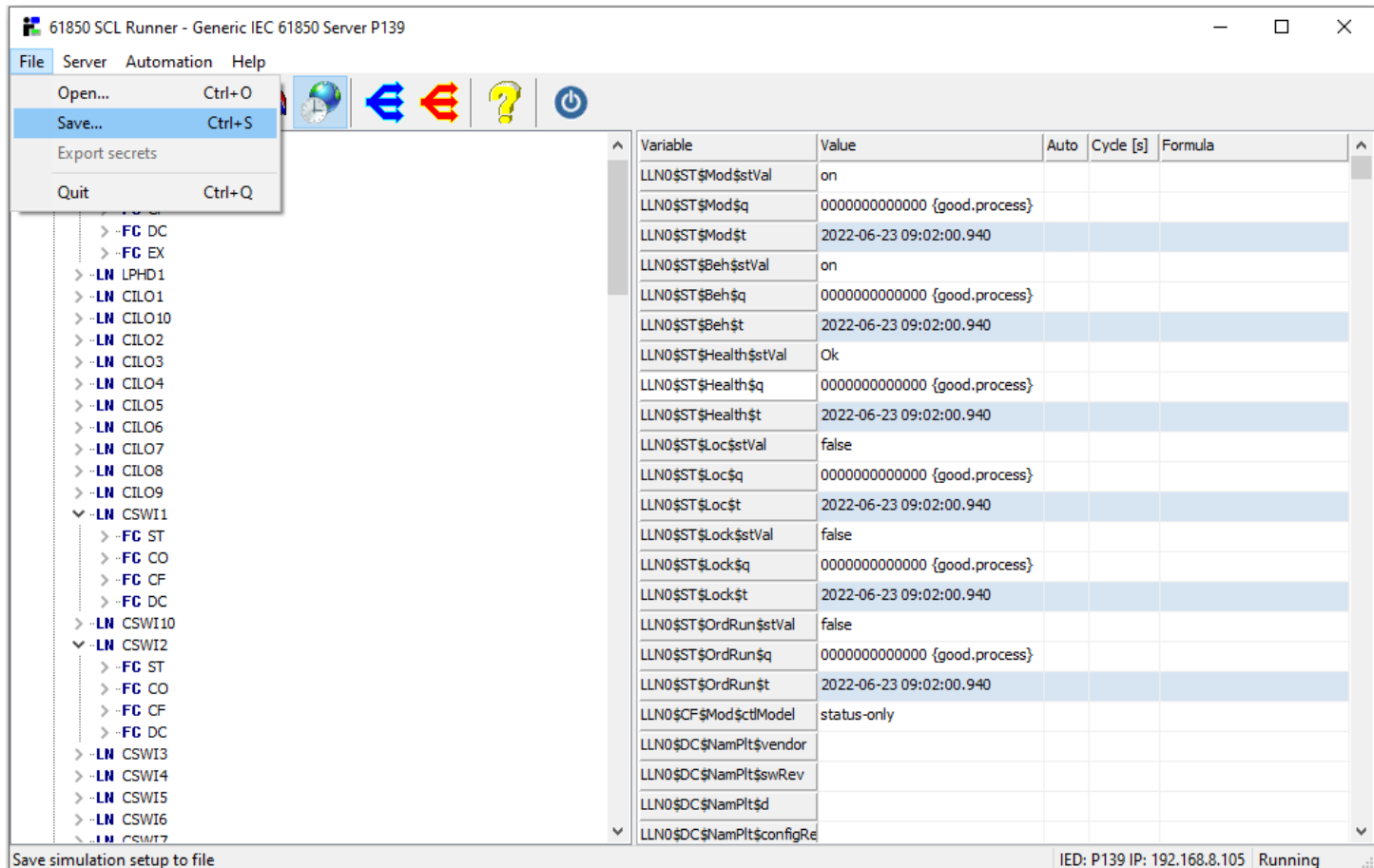


Allows to enforce automatic value change for **ALL** data subscribed by clients (from all enabled RCBs) – test of all subscribed data flows to the clients!

# Dataset data change button



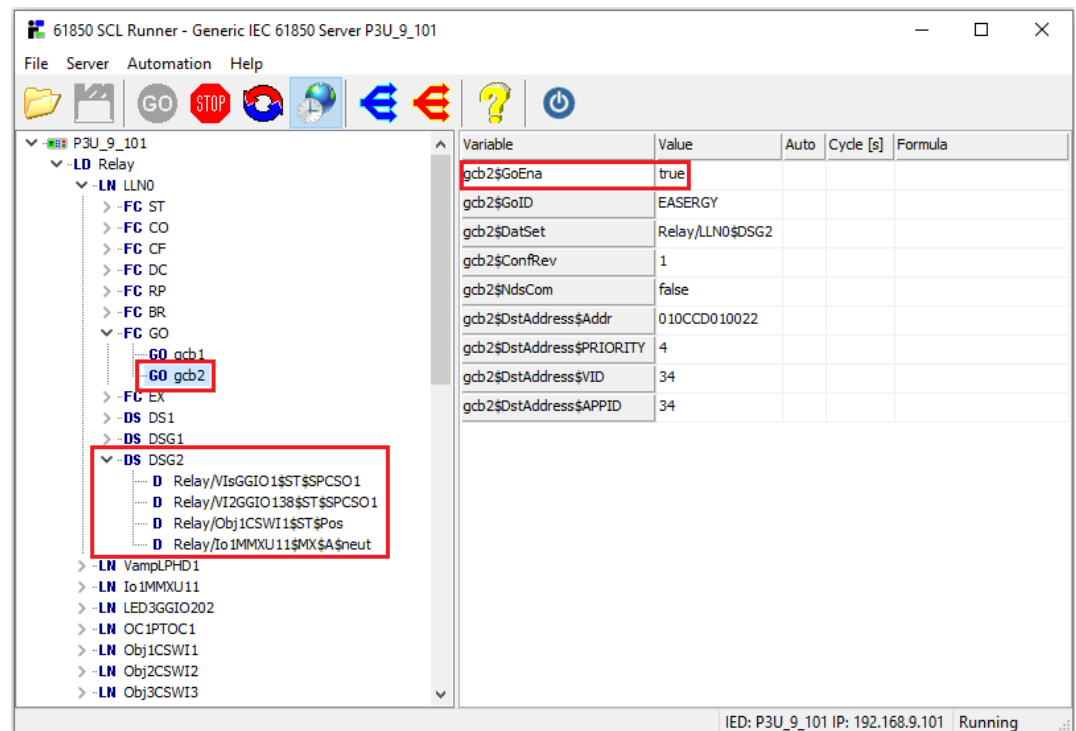
# Remember to save created data change formulas for the next test



# SCL Runner as GOOSE Publisher

Using SCL Runner it is possible to simulate GOOSE Publisher function by the definition of GoCB object included in the imported SCL file. Transmission parameters and the dataset will be configured as specified in the chosen control block of the selected device.

In this way SCL Runner can simulate GOOSE transmission performed by another device. It allows to test how GOOSE messages will be received and processed by devices with GOOSE Subscriber function.





# SCL Runner as GOOSE Publisher

The screenshot displays the SCL Runner interface for a Generic IEC 61850 Server P3U\_9\_101. The left pane shows a project tree with a selected GOOSE object: `D Relay/VisGGIO1$ST$SPCSO1`. The right pane shows the variable values for this object:

Variable	Value
SPCSO1\$stVal	true
SPCSO1\$q	00000000000000 (good.process)
SPCSO1\$t	2020-01-20 09:53:31.007

The Parser window shows the GOOSE data structure and transmission parameters. The GOOSE Data values are:

```
0: P3U_9_101Relay/VisGGIO1.SPCS01 [ST] STRUCT: 3 elements
0.0: BOOL:TRUE
0.1: BS:00000000000000
0.2: TIME:20_01_20 09:53:31.007500
```

The GOOSE Receiver configuration shows the following parameters:

Parameter	Value
App ID	22
StNum	2
TTL	4000
SqNum	165
DSRef	P3U_9_101Relay/LLN0\$DSG2
CfgRev	1
CBRef	P3U_9_101Relay/LLN0\$GO\$gcb2
NComm	FALSE
GID	EASERGY
Test	FALSE
Time	2020-01-20 09:53:31.040
Status	OK

The Data items table shows the transmitted data structure:

Idx	Type	Value	Data reference
0	STRUCT	3 element(s)	P3U_9_101Relay/VisGGIO1.SPCS01 [ST]
0.0	BOOL	TRUE	
0.1	QUALITY	00000000000000	
0.2	TIME	2020-01-20 09:53:31.007	
1	STRUCT	3 element(s)	P3U_9_101Relay/VisGGIO138.SPCS01 [ST]
1.0	BOOL	FALSE	
1.1	QUALITY	00000000000000	
1.2	TIME	2020-01-20 09:25:00.171	
2	STRUCT	3 element(s)	P3U_9_101Relay/Obj1CSW11.Pos [ST]
2.0	BS2	00	

The selected GoCB can be monitored to test the performance of transmitting device (e.g. detect data changes, interruptions of transmissions, etc.).

# SCL Runner as GOOSE Subscriber

The screenshot displays the SCL Runner interface on the left and two GOOSE Sender windows on the right. The SCL Runner shows a project tree with 'P3U\_211' and 'LD Relay'. Under 'LD Relay', there are 'LN' objects and 'INP Inputs'. The 'INP Inputs' are 'NI Relay/LLN0.NI1' and 'NI Relay/LLN0.NI3'. The 'Value' column shows 'open' for 'Relay/LLN0.NI1' and 'closed' for 'Relay/LLN0.NI3'. The 'GOOSE Sender' windows show configuration for two GOOSE messages. The top window is for App ID 218, and the bottom window is for App ID 220. Both windows show the 'Data items' table with 'Idx', 'Type', 'Value', 'Formula', and 'Data reference' columns. The 'Value' column shows '01' for the top window and '10' for the bottom window. The 'Data reference' column shows 'P3U\_211Relay/LLN0\$DSG1' for the top window and 'P3U\_220Relay/Obj1CSWI1.Pos.stVal [ST]' for the bottom window. Arrows indicate the data flow from the GOOSE Sender windows to the SCL Runner inputs.

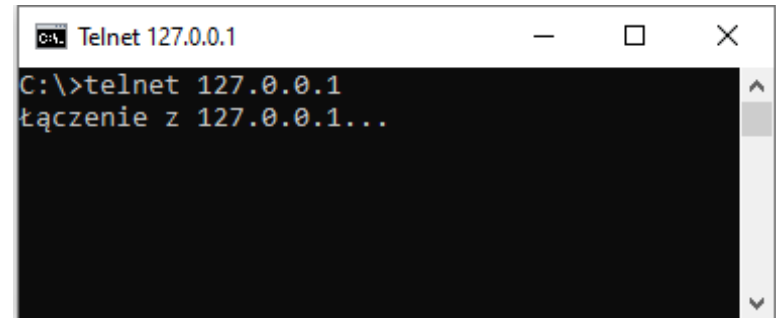
Data incoming via GOOSE Subscriber interface are exposed as Inputs and can be used in formulas that determine other data values.

# Access to data of simulated devices (IEDs) via telnet

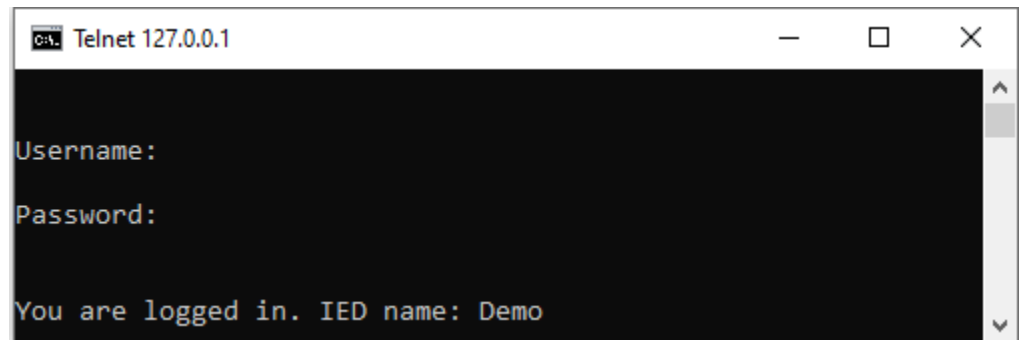
61850 SCL Runner allows for simulation control and read/write access to data attribute values of the simulated server devices (IEDs) via telnet protocol. This enables external programs to define scenarios of data changes in the simulated devices. The toolset package includes an example of such a program in Python.

To connect to simulated server device the user needs to open connection via telnet with IP address of the simulated server device.

Username and password needed for telnet connection are not checked.



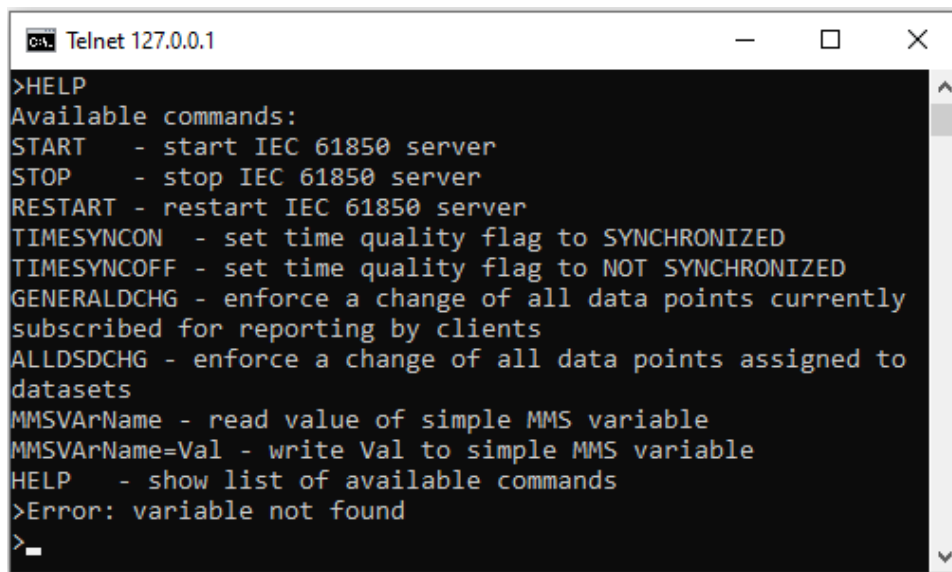
```
C:\>telnet 127.0.0.1
łączenie z 127.0.0.1...
```



```
Username:
Password:
You are logged in. IED name: Demo
```

# Access to data of simulated devices (IEDs) via telnet – list of commands

Telnet connection allows to perform the following commands on the simulated server device.



```
>HELP
Available commands:
START - start IEC 61850 server
STOP - stop IEC 61850 server
RESTART - restart IEC 61850 server
TIMESYNCON - set time quality flag to SYNCHRONIZED
TIMESYNCOFF - set time quality flag to NOT SYNCHRONIZED
GENERALDCHG - enforce a change of all data points currently
subscribed for reporting by clients
ALLDSDCHG - enforce a change of all data points assigned to
datasets
MMSVArName - read value of simple MMS variable
MMSVArName=Val - write Val to simple MMS variable
HELP - show list of available commands
>Error: variable not found
>
```

Seven of these commands correspond to the buttons on the application GUI:



**START**



**STOP**



**RESTART**



**GENERALDCHG**



**ALLDSDCHG**

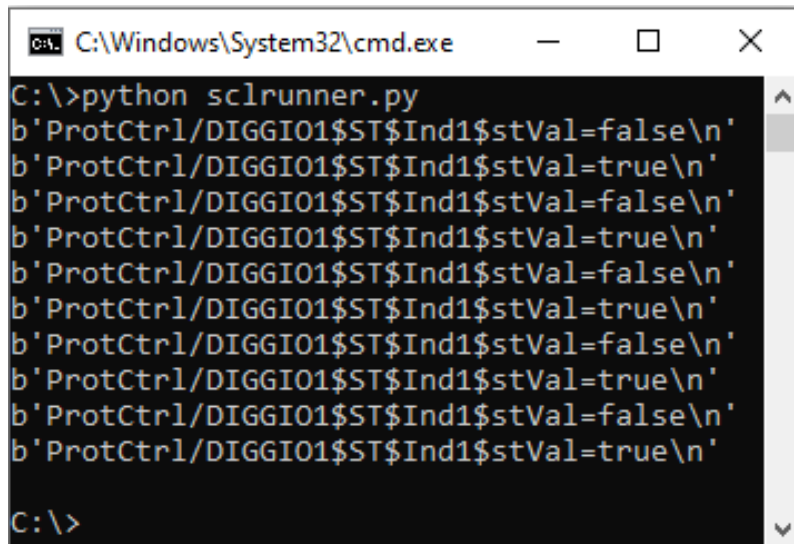


**TIMESYNCON**

**TIMESYNCOFF**

# Example of automation via telnet

An example of Python program code (*sclrunner.py* - part of the installation package): connects to the simulated server device (*Demo.icd* - part of the installation package) and then performs 10 control commands on the selected object (ProtCtrl/DIGGIO1\$ST\$Ind1\$stVal):



```
C:\Windows\System32\cmd.exe
C:\>python sclrunner.py
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=false\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=true\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=false\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=true\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=false\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=true\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=false\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=true\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=false\n'
b'ProtCtrl/DIGGIO1$ST$Ind1$stVal=true\n'
C:\>
```

```
#IP address of the simulated server device
HOST = "127.0.0.1"

#Establish telnet connection using default port (23)
tn = telnetlib.Telnet(HOST,23)

#Username and password is not checked
tn.read_until(b"Username: ",2)
tn.write(b"\n")
tn.read_until(b"Password: ",2)
tn.write(b"\n")

#Cycle of ten control commands on selected object
tn.read_until(b">")
for i in range(0,10):
    if( i%2 != 0 ):
        line=b"ProtCtrl/DIGGIO1$ST$Ind1$stVal=true\n"
        print(line)
        tn.write(line)
        tn.read_until(b">")
    else:
        line=b"ProtCtrl/DIGGIO1$ST$Ind1$stVal=false\n"
        print(line)
        tn.write(line)
        tn.read_until(b">")
        time.sleep( 1 )
```

# 61850 ICD Editor

Supplementary tool to create and modify ICD/IID/CID files used for simulation.



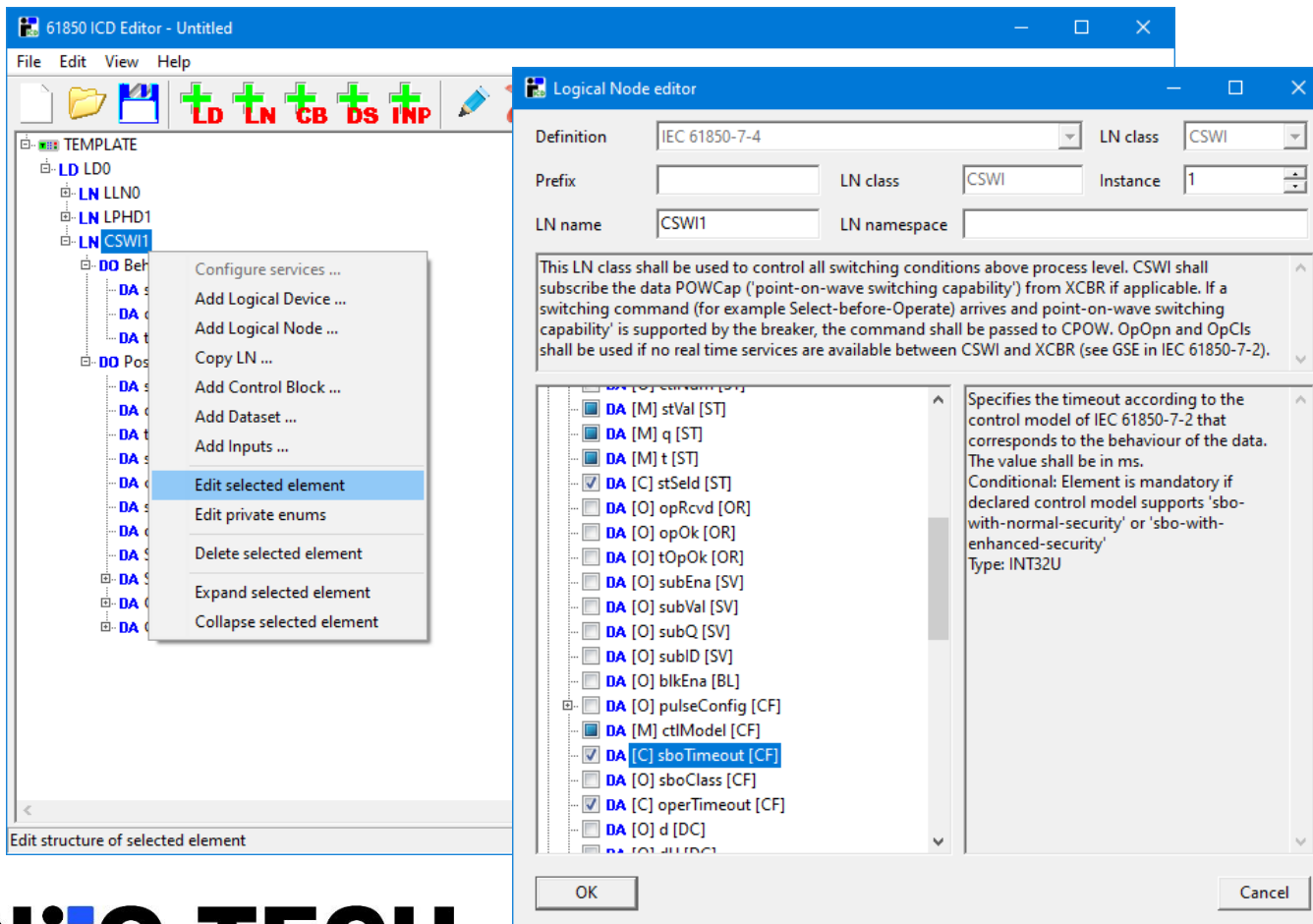
# 61850 ICD Editor allows to build an ICD file of the server device

The screenshot displays the 61850 ICD Editor application. The main window is titled '61850 ICD Editor - Untitled'. Overlaid on this are two dialog boxes. The 'Create new IED' dialog box has fields for 'IEC 61850 version' (set to 'Edition 1'), 'IED name' (with a list showing 'Edition 1', 'Edition 2', and 'Edition 2 Amd.1'), 'Manufacturer', 'Type', and 'Description'. An 'OK' button is at the bottom. The 'Logical Node editor' dialog box is open for 'IEC 61850-7-4'. It shows 'Prefix' as an empty field, 'LN class' as 'CSWI', 'Instance' as '1', and 'LN name' as 'CSWI1'. A text area contains a description of the CSWI LN class. Below this is a tree view of logical nodes, including 'DO [O] ClnXntImms', 'DO [M] Pos', and several 'DA' nodes like 'DA [O] origin [ST]', 'DA [O] ctiNum [ST]', 'DA [M] stVal [ST]', 'DA [M] q [ST]', 'DA [M] t [ST]', 'DA [C] stSeld [ST]', 'DA [O] opRcvd [OR]', 'DA [O] opOk [OR]', 'DA [O] tOpOk [OR]', 'DA [O] subEna [SV]', 'DA [O] subVal [SV]', 'DA [O] subQ [SV]', 'DA [O] subID [SV]', 'DA [O] blkEna [BL]', 'DA [O] pulseConfig [CF]', 'DA [M] ctiModel [CF]', and 'DA [C] sboTimeout [CF]'. A right-hand text area describes the controllable data as 'selected' with a conditional statement and 'Type: BOOLEAN'. 'OK' and 'Cancel' buttons are at the bottom.

From scratch (new IED, new LD, new LN)  
or by modification of an existing file.



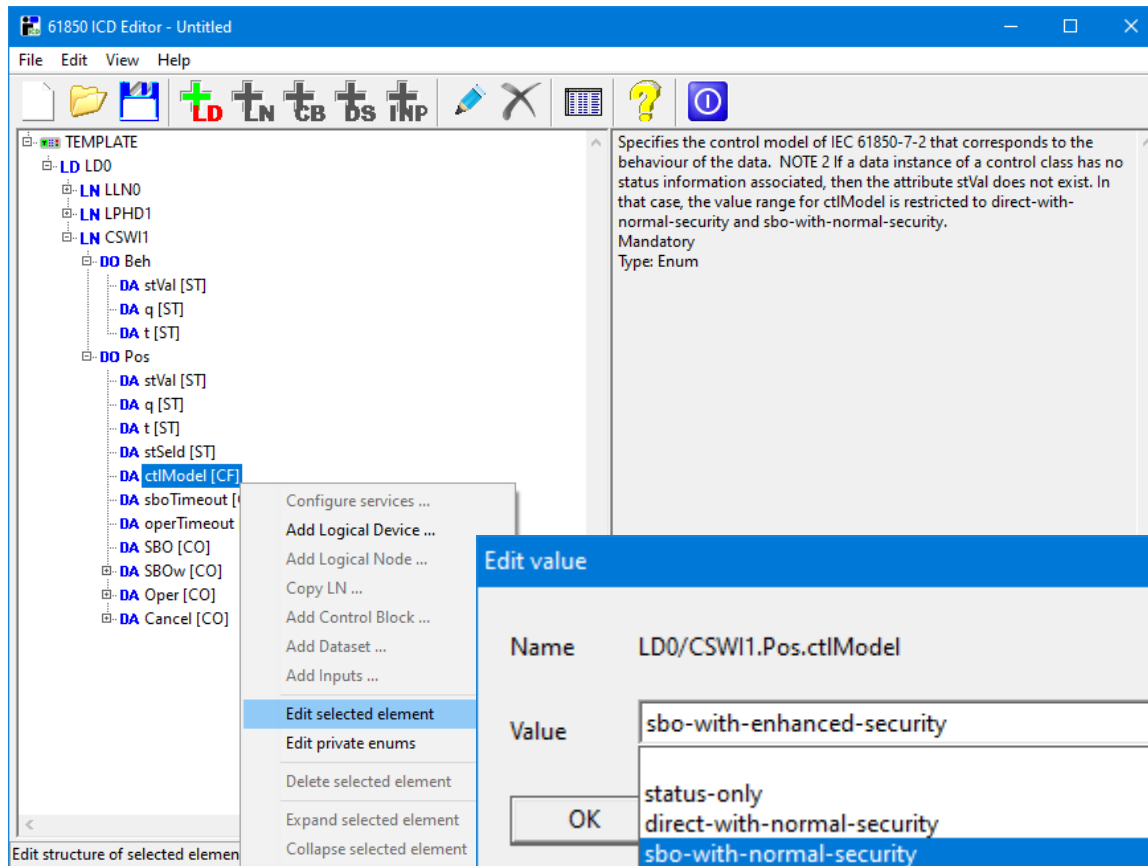
# Editing data model



Any added LN can be later modified by adding/deleting optional DOs and DAs.

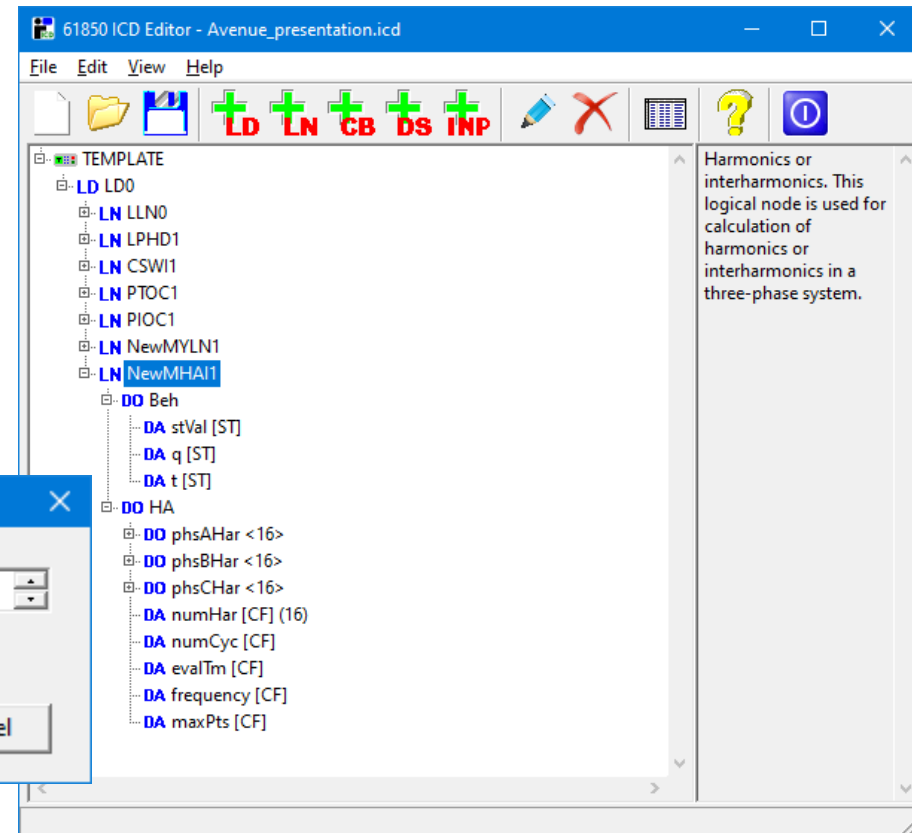
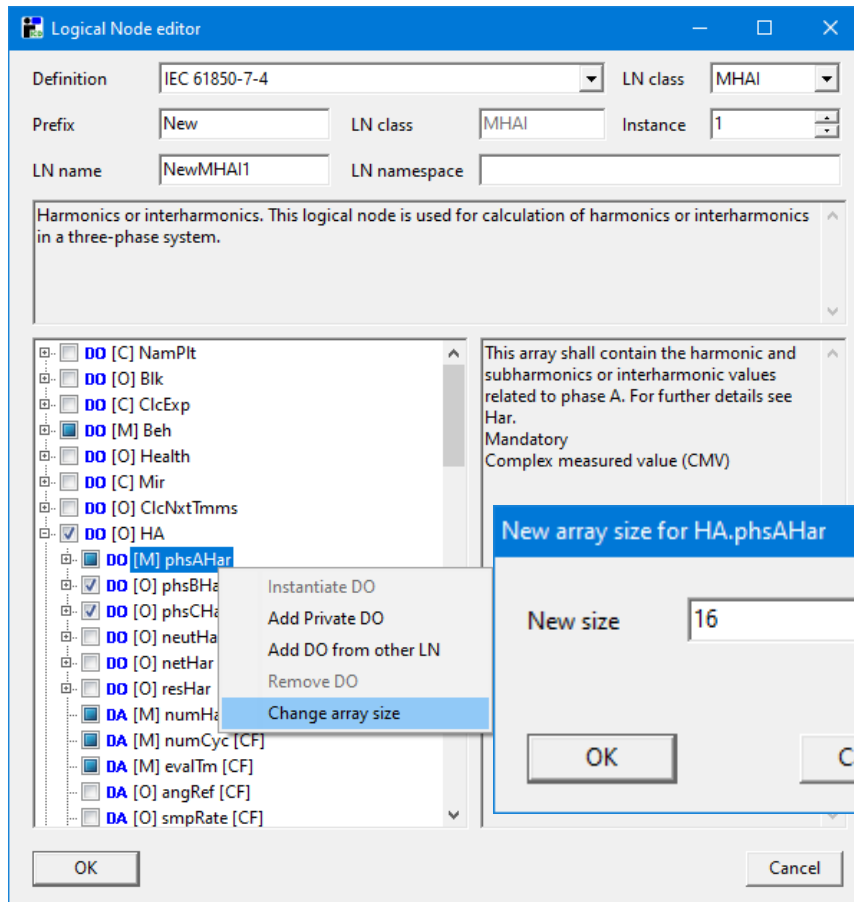


# Presetting DA values



Data attribute values can be preset if needed. Standard defined enums are supported.

# LNs with DOs containing array types



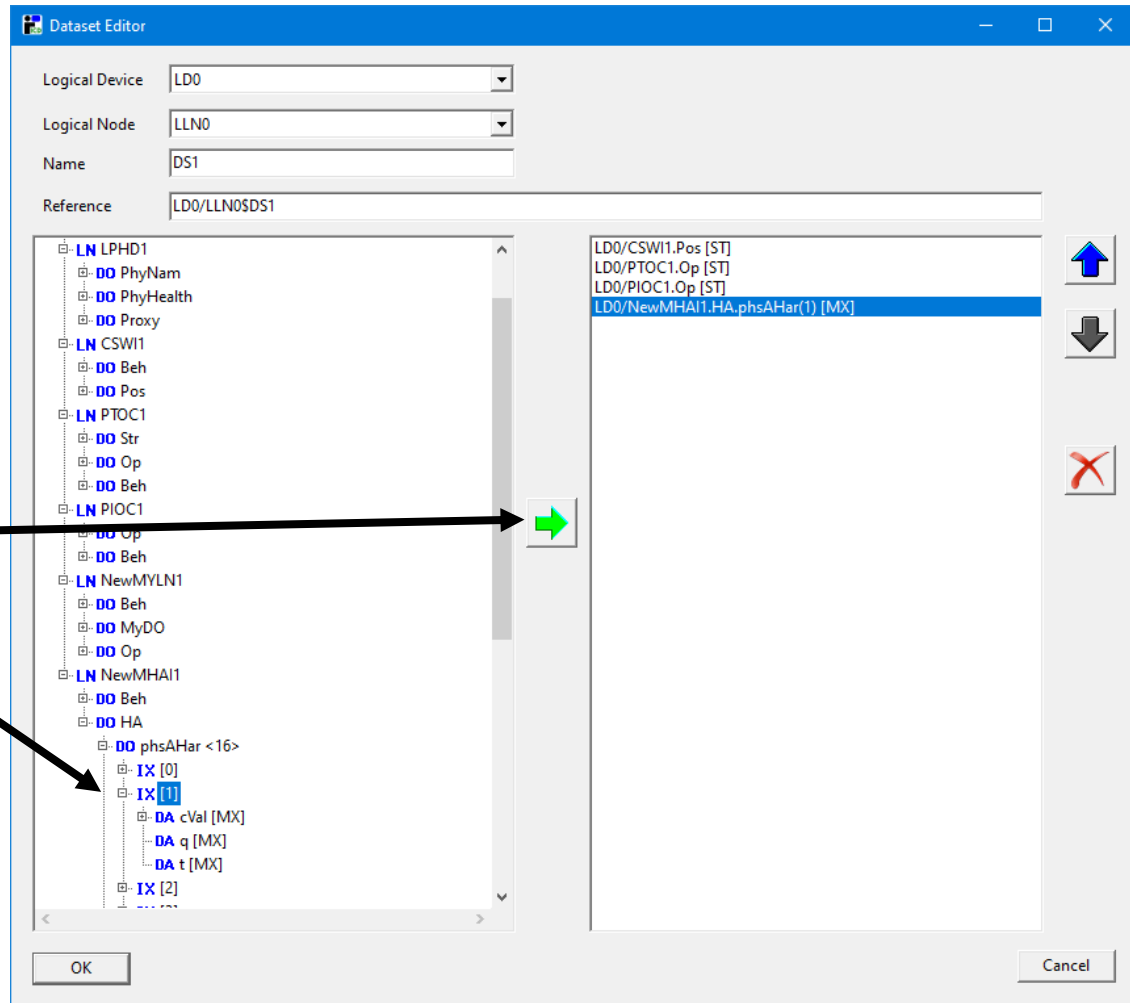
Array size can be set (default is 32).

# Dataset creation by selection of elements from the data model

Any defined dataset can be later re-edited if needed.

Button for adding a selected element of data model to dataset.

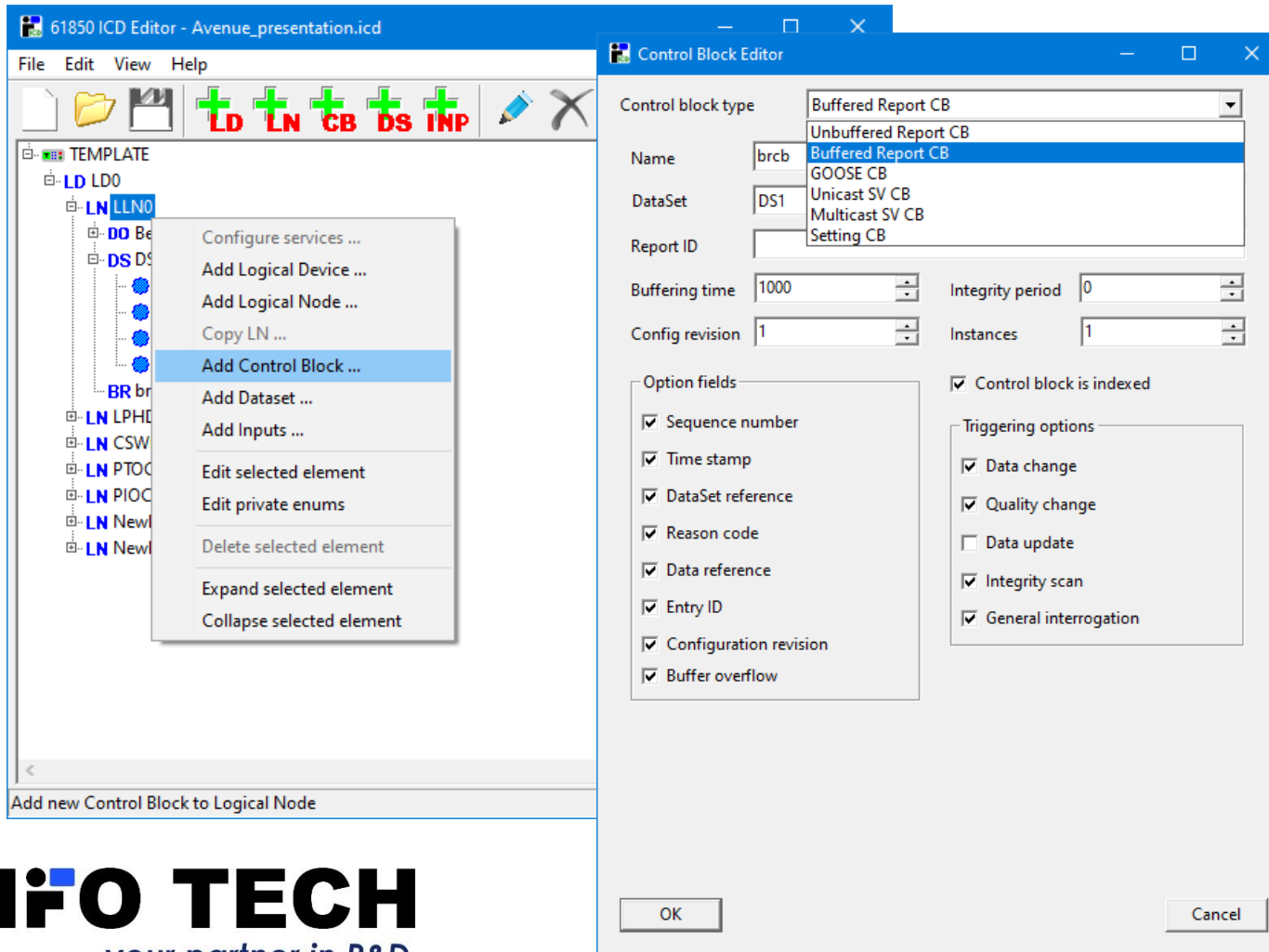
Note that in Ed.2.1 also indexed data can be elements of datasets.



Buttons for changing order of elements in dataset.

Button for removing element of dataset.

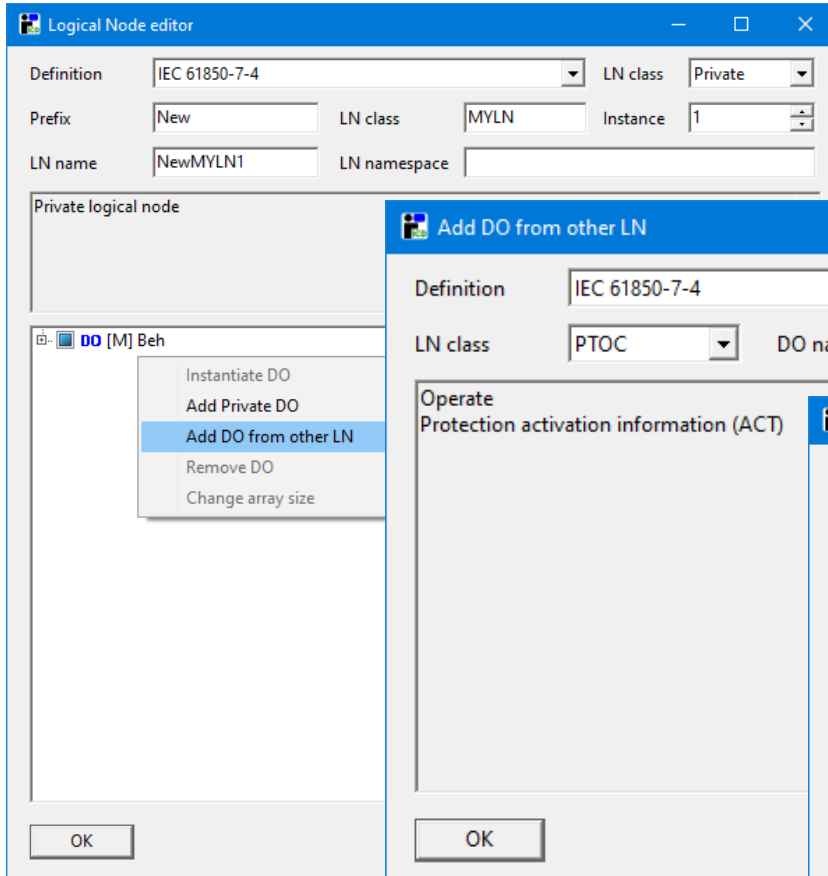
# Control blocks



URCB, BRCB, GoCB, USVCB, MSVCB and SGCB can be added to the data model and initially preset.

Any defined control block can be later re-edited if needed.

# Private Logical Nodes



Logical Node editor

Definition: IEC 61850-7-4 LN class: Private

Prefix: New LN class: MYLN Instance: 1

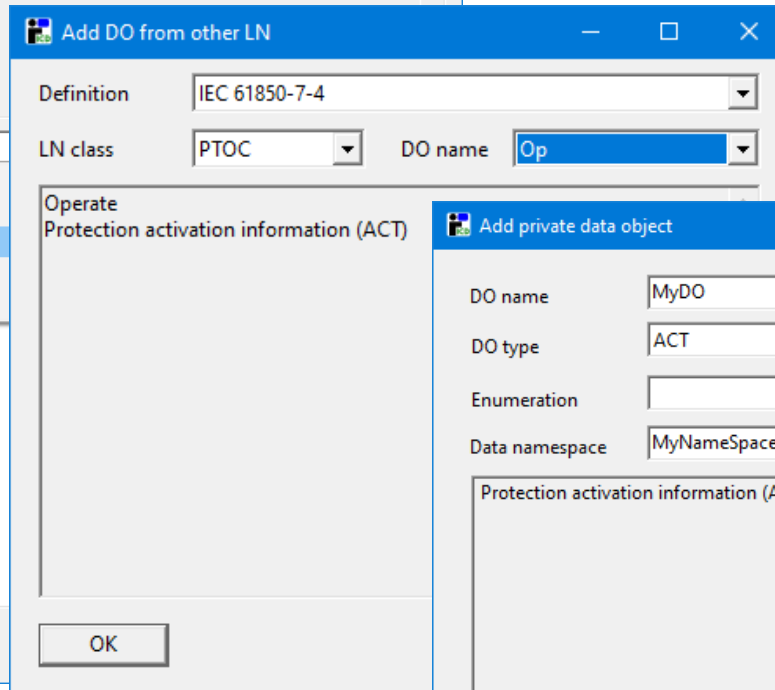
LN name: NewMYLN1 LN namespace:

Private logical node

DO [M] Beh

- Instantiate DO
- Add Private DO
- Add DO from other LN
- Remove DO
- Change array size

OK



Add DO from other LN

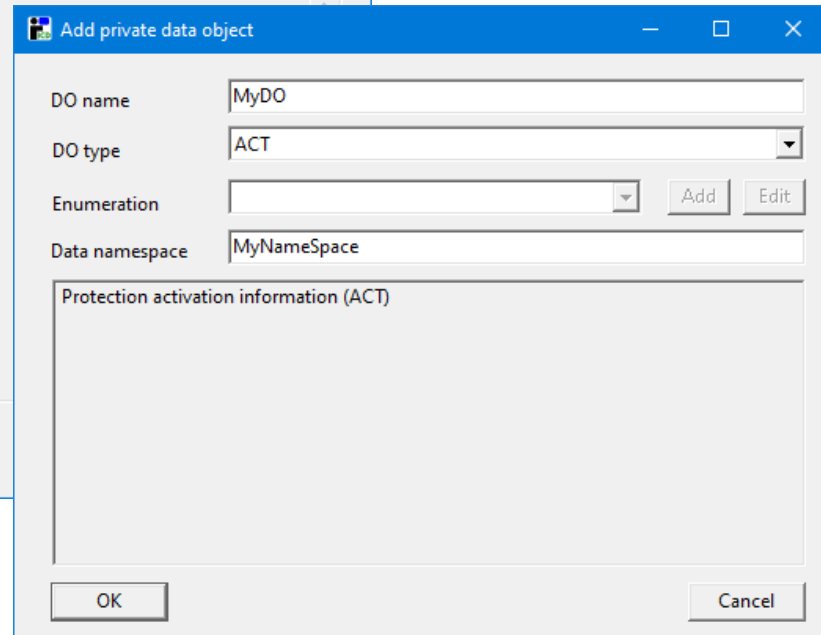
Definition: IEC 61850-7-4

LN class: PTOC DO name: Op

Operate

Protection activation information (ACT)

OK



Add private data object

DO name: MyDO

DO type: ACT

Enumeration: Add Edit

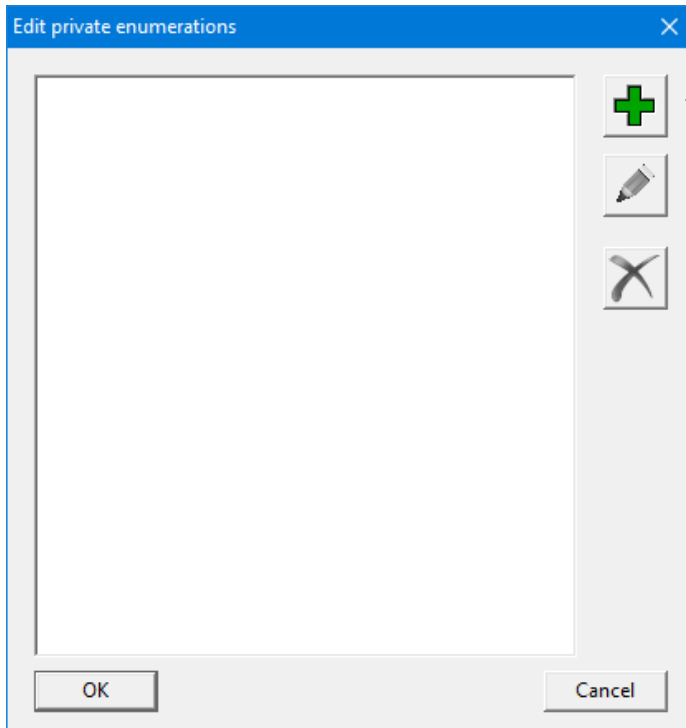
Data namespace: MyNameSpace

Protection activation information (ACT)

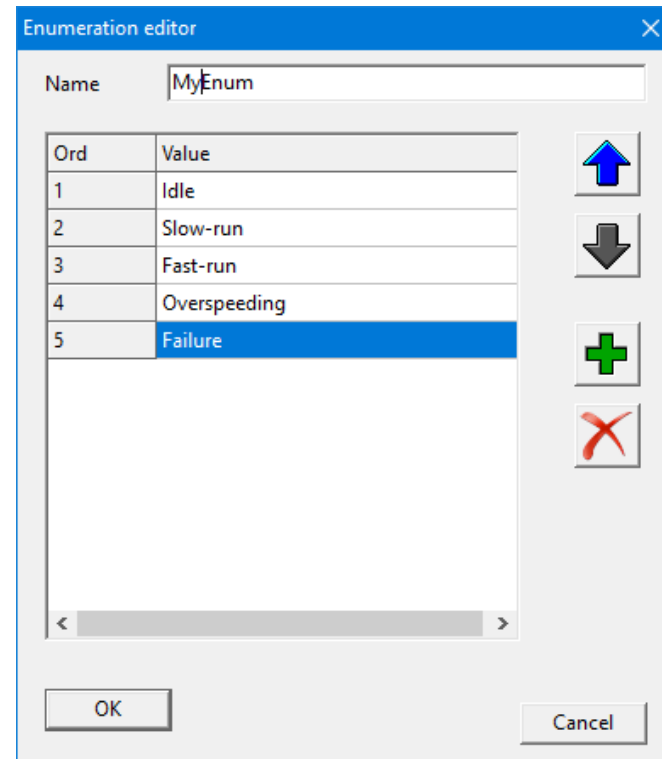
OK Cancel

Private LN class and instance can be defined with the use of DOs from other LN classes or using defined private DOs.

# Private enums



Continuous range of integer values with assigned user-defined names.



# Data model parameters setup

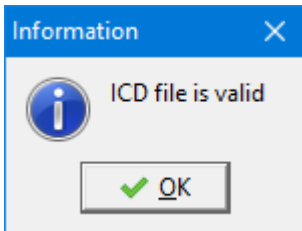
The screenshot shows the '61850 ICD Editor - Untitled' window. On the left, a tree view shows the project structure. A context menu is open over the 'LD LDO' node, with 'Configure services ...' selected. The 'Edit server services' dialog box is open, displaying a list of services and their parameters. The 'MaxAttribute' parameter for the 'DynDataSet' service is highlighted and set to 30.

Service	Parameter	Value
ClientServices (TClientServicesEd2_1)	Available	<input checked="" type="checkbox"/> (True)
	Max	4
DynDataSet (TServiceWithMaxAndMaxAttributes)	Available	<input checked="" type="checkbox"/> (True)
	max	10
DynDataSet (TServiceWithMaxAndMaxAttributes)	MaxAttribute	30
	FileHandling	(TServiceYesNo)
GetCBValues	(TServiceYesNo)	
	GetDataObject	(TServiceYesNo)
GetDataSetVal	(TServiceYesNo)	
	GetDirectory	(TServiceYesNo)
GOOSE	(TServiceWithMax)	

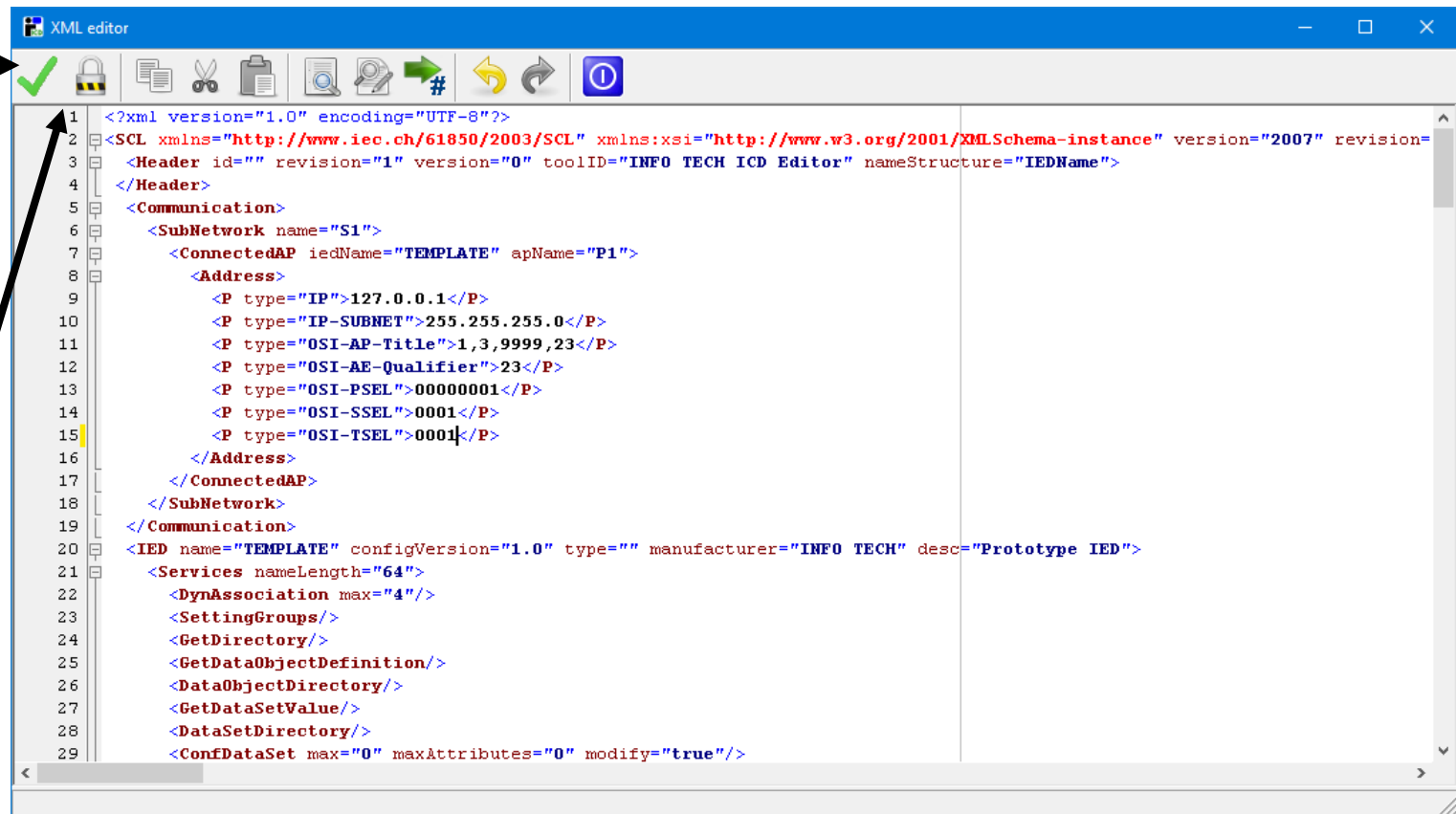
Necessary !!

# XML Editor and ICD file validation

Validation  
check button



Unlock/lock  
button for  
manual  
editing.





# Possible applications of 61850 ICD Editor program

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- ❑ Creation and modification of ICD/IID/CID file for the device under configuration.
- ❑ Processing of an ICD file into a IID/CID file (addresses, datasets, parameters of control blocks).
- ❑ Creation and modification of ICD/IID/CID file to be used for server device simulation (e.g. with the use of INFO TECH 61850 SCL Runner tool).
- ❑ Modification of ICD/IID/CID file for the IEC 61850 client program (e.g. 61850 Avenue client), for example to enable execution of negative test cases on the server device.

# 61850 SCL Runner – and what?

---

Comments of our customers (system integrators):

**„Wow ... This simulation seems so easy! We have to try it!”**

**„Overall, I would just like to say that the SCL Runner is fantastic!”**

# Order 61850 SCL Runner with 61850 Avenue

- Good luck on your safe and easy road to learn and use the IEC 61850 standard



Contact: [www.infotech.pl](http://www.infotech.pl)

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