INFO TECH
IEC 61850 Software Library
with testing and simulation tools

Product presentation

Prepared by Wojciech E. Kozlowski
Version: June 2022

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IEC 61850 communication standard

- **The gossip says:**
  - Terribly complex collection of models and protocols…
  - Huge incomprehensive IEC documentation…
  - Costly implementation…
  - Expensive engineering…

- **The truth is:**
  - Easy to understand and use
  - Complex only in the core implementation (like many modern technologies including Internet, GSM, GPS)
  - There are ready solutions for product vendors and end-users:
    - source code and binary libraries with references from numerous deployments in products
    - devices and systems with verified conformance to the standard,
    - user-friendly testing tools,
    - system configuration tools (though mainly vendor specific),
    - comprehensive training materials describing the essentials of the standard with easy to use training toolsets.
  - **INFO TECH business in just for this truth.**

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INFO TECH solutions for IEC 61850

- **INFO TECH IEC61850 Software Library**:
  - Designed in 2006 by INFO TECH based on Edition 1
  - Updates following **tissue.iec61850.com** and Edition 2
  - Updates following Am.1 Ed.2 (**Edition 2.1**)
  - Licenses offered to source code (for all platforms) and to binary interfacing components (for MS Windows and Linux based platforms)
  - First licensed implementations of server and client interfaces in substation automation products from the beginning of 2007
  - **As of May 2022, licensed to 50 companies** from 15 countries of Europe, Asia, North America
  - Applied by INFO TECH to build testing and simulation tools

Awards granted to INFO TECH IEC 61850 Software Library

- Awarded on the 9th of November 2015 by the quality mark **„LAUR EKSPERTA" ("MERIT OF EXPERT")** and the special prize **„MEDAL NOWOCZESNOŚCI" ("MEDAL OF INNOVATION")** during the official gala in the Residence Belveder belonging to the President of the Republic of Poland


80. Międzynarodowe
Energetyczne Targi Bielskie
„ENERGETAB 2017"

WYRÓŻNIENIE

za produkt:
Biblioteka oprogramowania
INFO TECH IEC61850 Software Library
wraz z programami do testowania i symulacji

zgłoszony przez firmę:
"INFO TECH"
Dr Wojciech E.Kozłowski
Spółka jawna

- Awarded on the 12th of September 2017 by the **Honorable Commendation of the International Power Industry Fair ENERGETAB 2017**

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References

Our customers – licensees are e.g.

- VAMP Ltd. from Finland (now in Schneider Electric)
- Littelfuse, Inc. from USA/Canada
- Ashida Electronics Ptv. Ltd. from India
- Valmet Automation from Finland
- NSE AG from Switzerland (now in Phoenix Contact)
- Camille Bauer Metrawatt from Switzerland
- Elspec Ltd. from Israel
- Netcontrol Oy from Finland
- RTDS Technologies Inc. from Canada

and in Poland e.g.:

- Elester-PKP Sp. z o.o. (controller awarded on EXPOPOWER 2017)
- LUMEL S.A. (controller awarded on ENERGETAB 2018)
- Elektrometal Energetyka S.A. (controller awarded on ENERGETAB 2018)
- ABB Sp. z o.o.
- Computers & Control Sp. z o.o.
- Instytut Energetyki

Position on the global market

- It is hardly possible to assess the market share of protection relays and controllers with the IEC 61850 communication interfaces implemented using INFO TECH IEC61850 Software Library, but a publicly available reference is the list of products with the IEC 61850 conformance confirmed by the UCA International Users Group: https://redmine.ucaiug.org/projects/iec-61850-certificate/issues

- As of May 2022 the products with the IEC 61850 interface implemented using our Library make almost **3.5% of this global list**.

- Over 35 implementations based on INFO TECH library have been successfully tested in the accredited conformance testing labs of DNV (former KEMA), TÜV SÜD, TÜV China, Keptop, Nari Relays, Schneider Electric.

INFO TECH solutions for IEC 61850

- INFO TECH IEC61850 testing and simulation tools:
  - **61850 Avenue toolset** with IEC 61850 client, 61850 Relay Simulator, GOOSE toolset, SV toolset, File Transfer
  - **61850 SCL Runner** – simulator of server devices based on their configuration description files
  - **61850 ICD Editor** – for creating/modifying ICD/CID/IID files
  - **61850 GOOSE System Viewer** – graphical tool for GOOSE transmission supervision in the systems
  - As of June 2022 the licenses to the above software tools have been sold to over 100 companies world-wide.
- INFO TECH offers also IEC 61850 training courses:
  - for end users and integrators (basic and advanced level)
  - for companies licensing our software (implementation-oriented)
  - As of June 2022 over 100 companies attended our trainings.

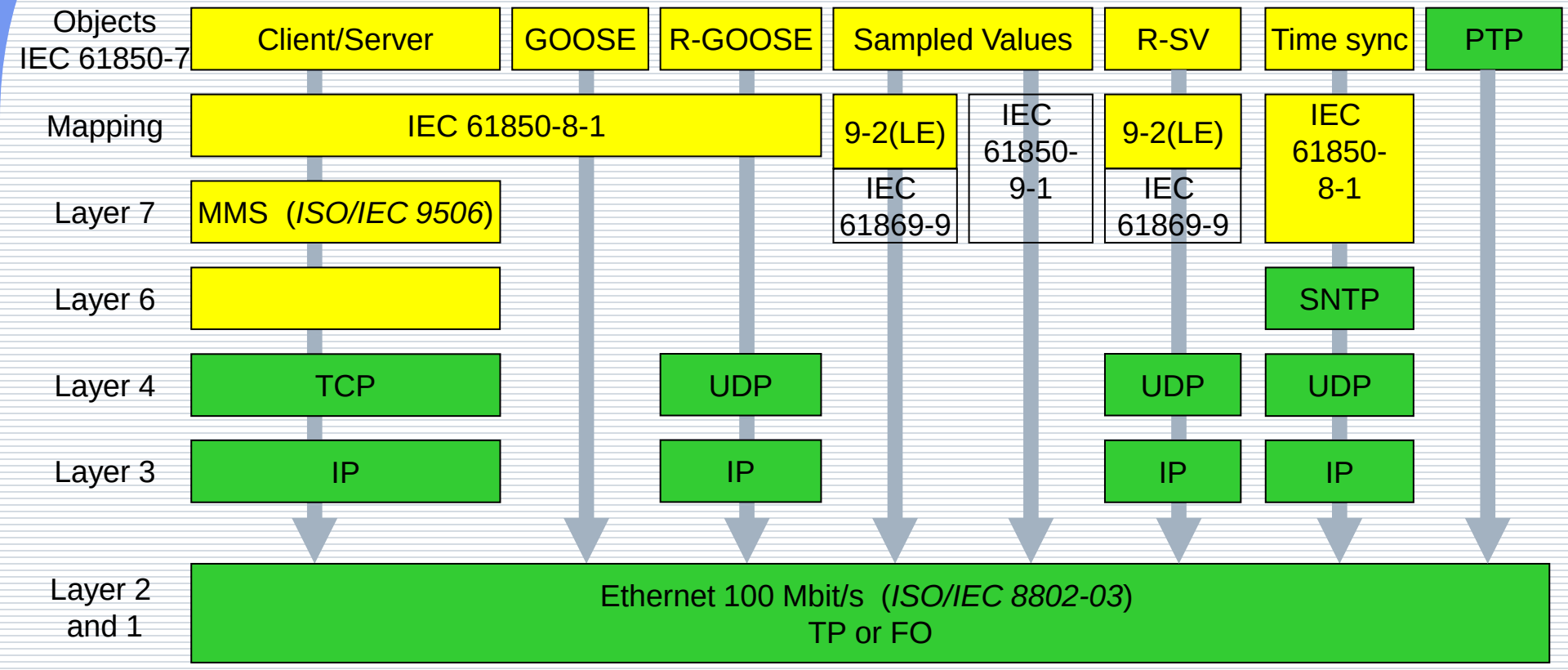
INFO TECH
IEC61850 Software Library

- **Client part**
  - Applicable to data acquisition and control systems and substation gateways.
  - Applicable to testing and simulation tools.
- **Server part**
  - Applicable to bay level devices (protection relays, bay controllers, monitoring units etc.).
  - Applicable to testing and simulation tools.
- **GOOSE part (optional extension to Server part)**
  - Applicable to bay level devices (protection relays, bay controllers, monitoring units etc.)
  - Applicable to testing and simulation tools.
- **Sampled Values (optional extension to Server part)**
  - Applicable to process bus devices (merging units and protection relays), based on so-called **9-2LE**.
  - Applicable to testing and simulation tools.

On-going work on further extensions

- **IEC 62351-3 – data and communications security**
  - Increasing customer interest to protect MMS communication (client/server).
- **IEC 62351-4 – data and communications security**
  - Increasing customer interest to protect MMS communication (client/server).
- **IEC 62351-6 – data and communications security**
  - Increasing customer interest to use secure R-GOOSE and R-SV communication.
- **IEC 61869-9 – Sampled Values communications**
  - Increasing customer interest in Process Bus deployment.

INFO TECH Library – supplied layers and required software platform



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Client part - characteristics

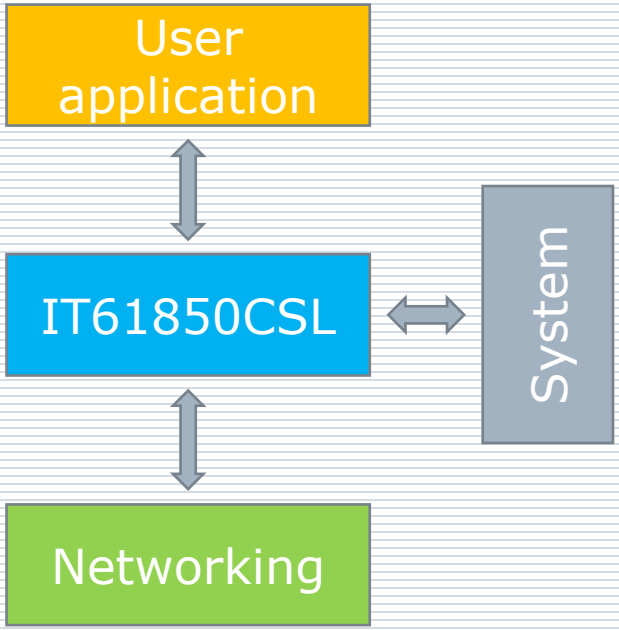
- Implemented in C++
  - API in C++ for the library in source code
  - API in C++ and C# for the library in compiled version (binary)
- Portable to common OS, e.g.
  - MS Windows
  - Linux
- Ready to use build scripts
  - MS Visual Studio family
  - CMake and gcc (native build system or cross-compilation)
- Documentation in source code
  - Help, Intellisense
- Access to data (server model replica)
  - Abstract communication service layer
  - Direct access to MMS objects and lower layers (source code)

Client part - supported features

- Connection establishing and closing
- Learning server IED data model
  - By exploring in on-line mode (after connecting)
  - By using SCL files in off-line mode (before connecting)
- Reading and writing data
- Reading and writing datasets with management
- Control services
- Reporting (buffered and unbuffered)
- Setting groups and parameters
- Access to control blocks for GOOSE and SV
- File transfer

Client part - portability

- Library is ready to use for Linux and MS Windows operating systems
- C/C++ memory management
- All non-portable services are indirect
  - Multitasking
  - Networking
  - Time and clock services
  - Non-standard C++/C runtime library
  - Useful utilities
- Only common basic types in use



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Server part - characteristics

- Implemented in ANSI C
- Small footprint (about 300 kB of code memory)
- Short startup time
- Easy to use (only 3 API functions need to be implemented)
- Ready to use for Linux and Windows environment
- Easily portable to other OS
- Optional extensions to Server part:
  - **GOOSE part** - services implementing publisher and subscriber functionality of horizontal communication
  - **Sampled Values part** – for Process Bus communication, services implementing publisher and subscriber functionality for merging unit and signal processing unit

Server part – implemented abstract service layer over MMS

- Connection establishing and closing
- Read/write data access
- Buffered and unbuffered reporting
- Preconfigured and dynamic datasets (persistent and non-persistent)
- Control services (one and two step, with normal and with enhanced security)
- Setting groups and parameters
- Service tracking
- File transfer
- GOOSE (optional part)
- Sampled Values (optional part)

Server part – application data model

Supported two options of creating server data model:

- Option 1: static data model
  - Data model and device application to IEC 61850 mapping defined in spreadsheet files.
  - Automated generation of C-code and ICD file from spreadsheet files.
  - Compilation time definition of the data model.
  - Possibility of removing unused LNs at the server start-up.
- Option 2: dynamic data model
  - Server data structure created in run-time from the supplied ICD/CID file.
  - Application to IEC 61850 mapping is defined in a separate XML file.
  - This option is available for devices with development environment supporting C++ compiler and libxml2 library (e.g. Linux, Windows).

Server part – portability

- The Library is ready to use for Linux and MS Windows operating systems.
- The Library was successfully ported to Windows CE, MQX4.0, NetOS7.0 and several proprietary RTOS'es.
- To port the Library to other OS the following functionality has to be implemented or modified:
  - Access to TCP/IP stack
  - Ethernet chip access (for GOOSE and SV only) – in Linux and Windows the Pcap library is used for that
  - Access to system clock (for time-stamping)
  - Access to local file system (if file transfer services will be used)
  - Access to non-volatile memory for storing control block parameters and persistent dynamic dataset contents

Proof of conformance

- **20 devices** with IEC 61850 server+GOOSE interfaces based on INFO TECH library passed conformance tests to receive UCA **conformance certificates for Edition 1**
- **15 devices** with IEC 61850 server+GOOSE interfaces based on INFO TECH library passed conformance tests to receive UCA **conformance certificate for Edition 2**
- **3 devices** with IEC 61850 client interfaces based on INFO TECH library passed conformance tests to receive UCA **conformance certificate for Edition 2**
- The following UCA accredited laboratories tested implementations based on INFO TECH library:
  - DNV GL from the Netherlands (former KEMA),
  - TŰV SŰD from Germany,
  - TŰV SŰD from China,
  - Central Power Research Institute of India (CPRI),
  - Ketop Lab from China,
  - Schneider Electric corporate test laboratory,
  - Nari Relays laboratory from China.

INFO TECH IEC 61850 testing and simulation tools – built on our Library

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61850 Avenue: Client tool for testing server devices (e.g. protection relays)

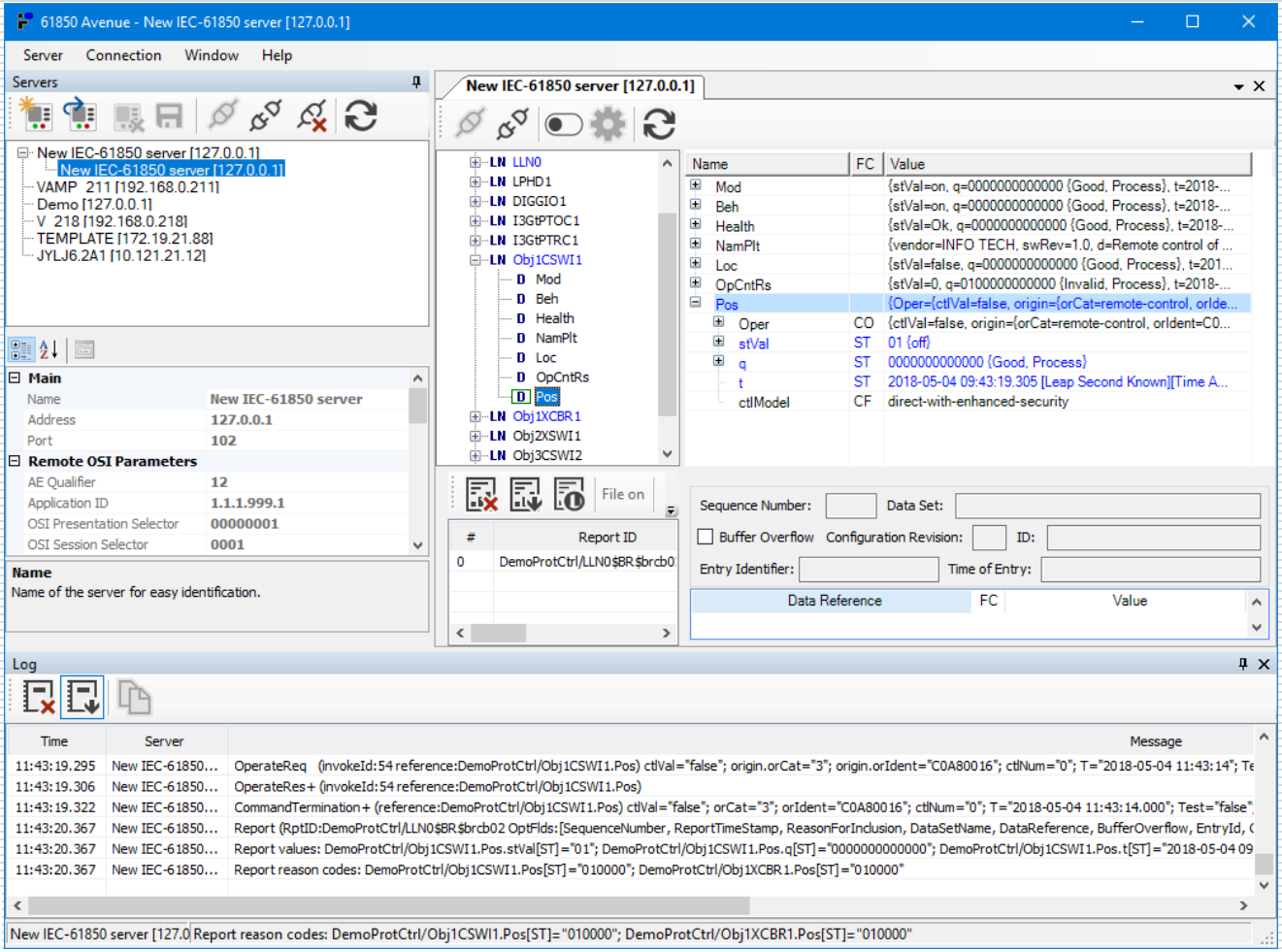
Easy to use.

Able to connect and browse server devices.

Able to import SCL file and connect to the described server device.

Allows to read and write data values, configure control blocks, receive reports with data model update, perform control commands.

Optional support of secure client-server communication (TLS & ACSE).



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Outgoing feeder bay simulator (**61850 Relay**)

Feeder bay model with circuit breaker and disconnector.

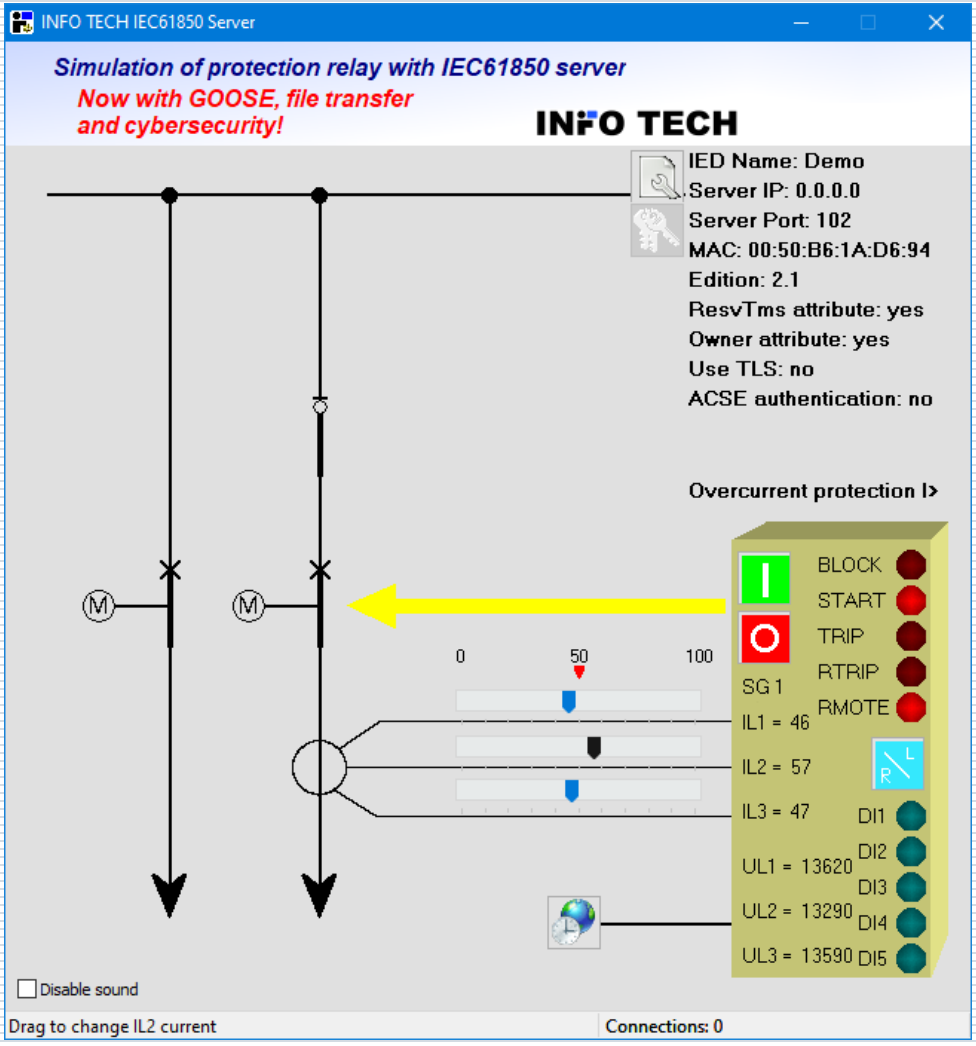
Simple overcurrent protection relay with IEC61850 server interface (fixed but representative data model).

Remote and local monitoring.

Remote and local control (DO control model).

Additional line with circuit breaker for demonstration of an alternative control model (SBO).

Optional support of secure client-server communication (TLS & ACSE).



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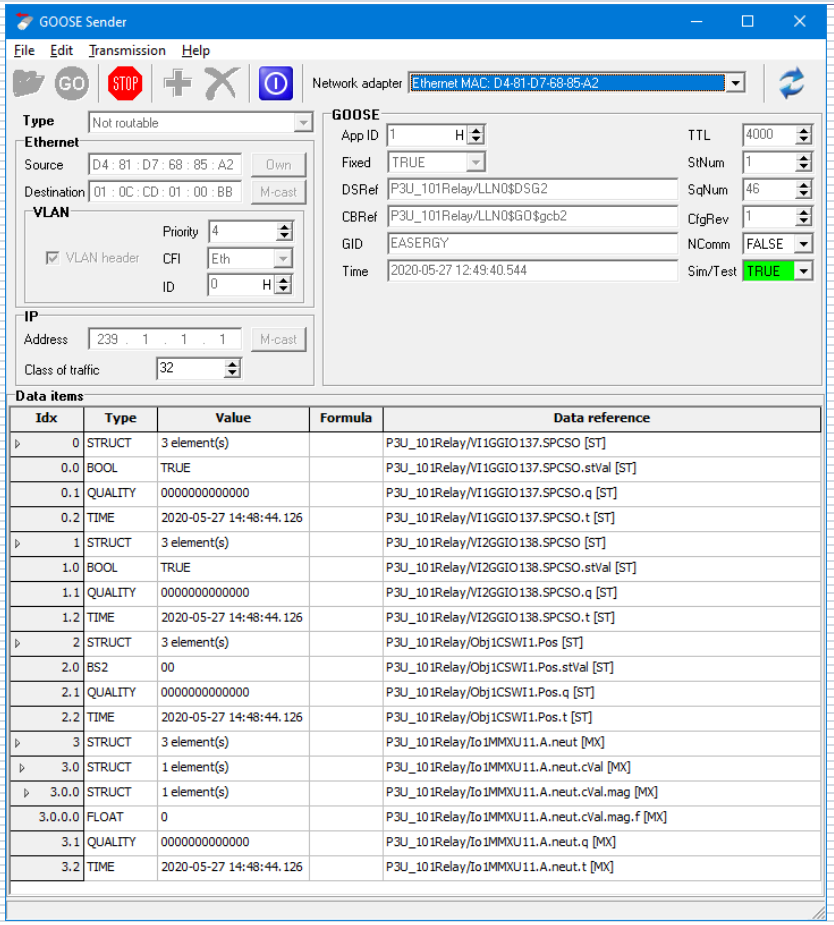
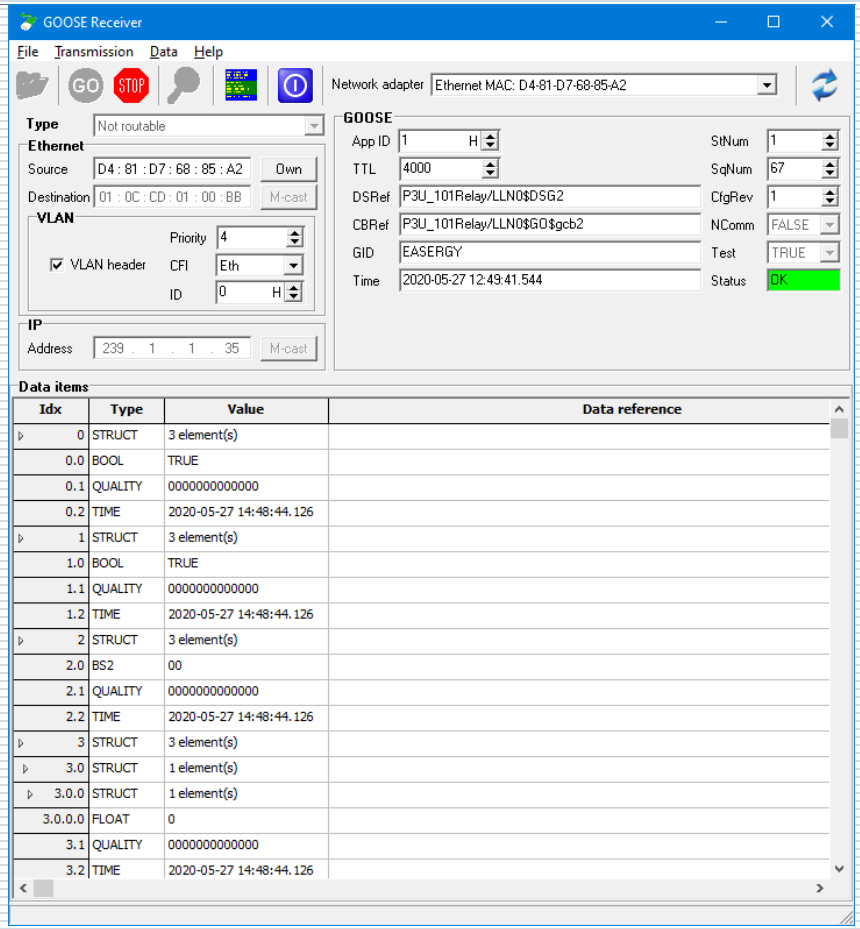
GOOSE toolset:
GOOSE Sender and GOOSE Receiver





Sender: Publisher simulation (configuration: manual or from SCL file).

Receiver: For tracking transmission from selected publisher (configuration: manual, from captured message stream or from SCL file).

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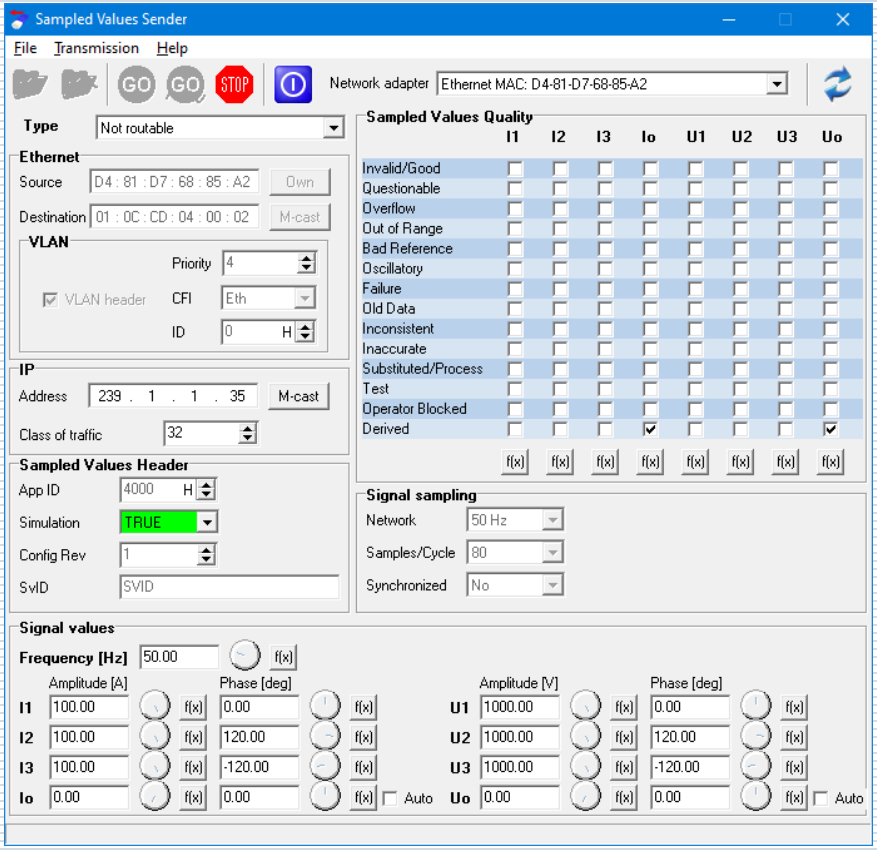
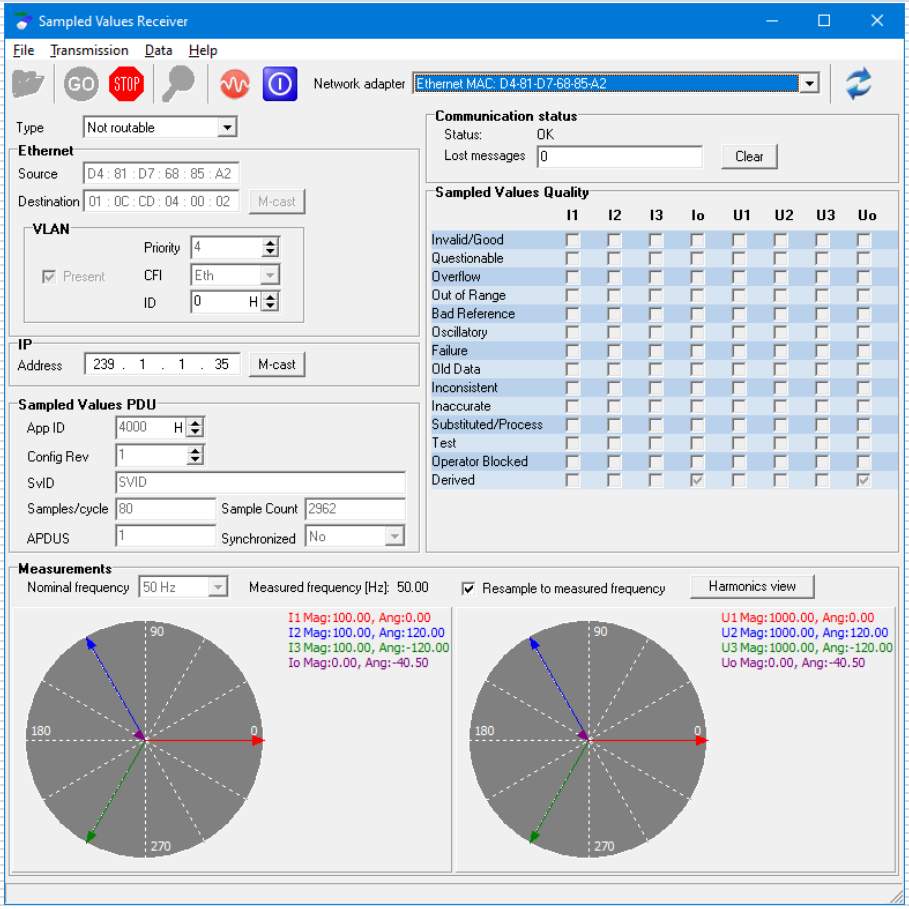
SV toolset: SV Sender (simulator of Merging Unit) and SV Receiver (signal processing unit))



Transmission of SV message stream for given signal characteristics.



Calculation of signal characteristics based on received SV message stream.

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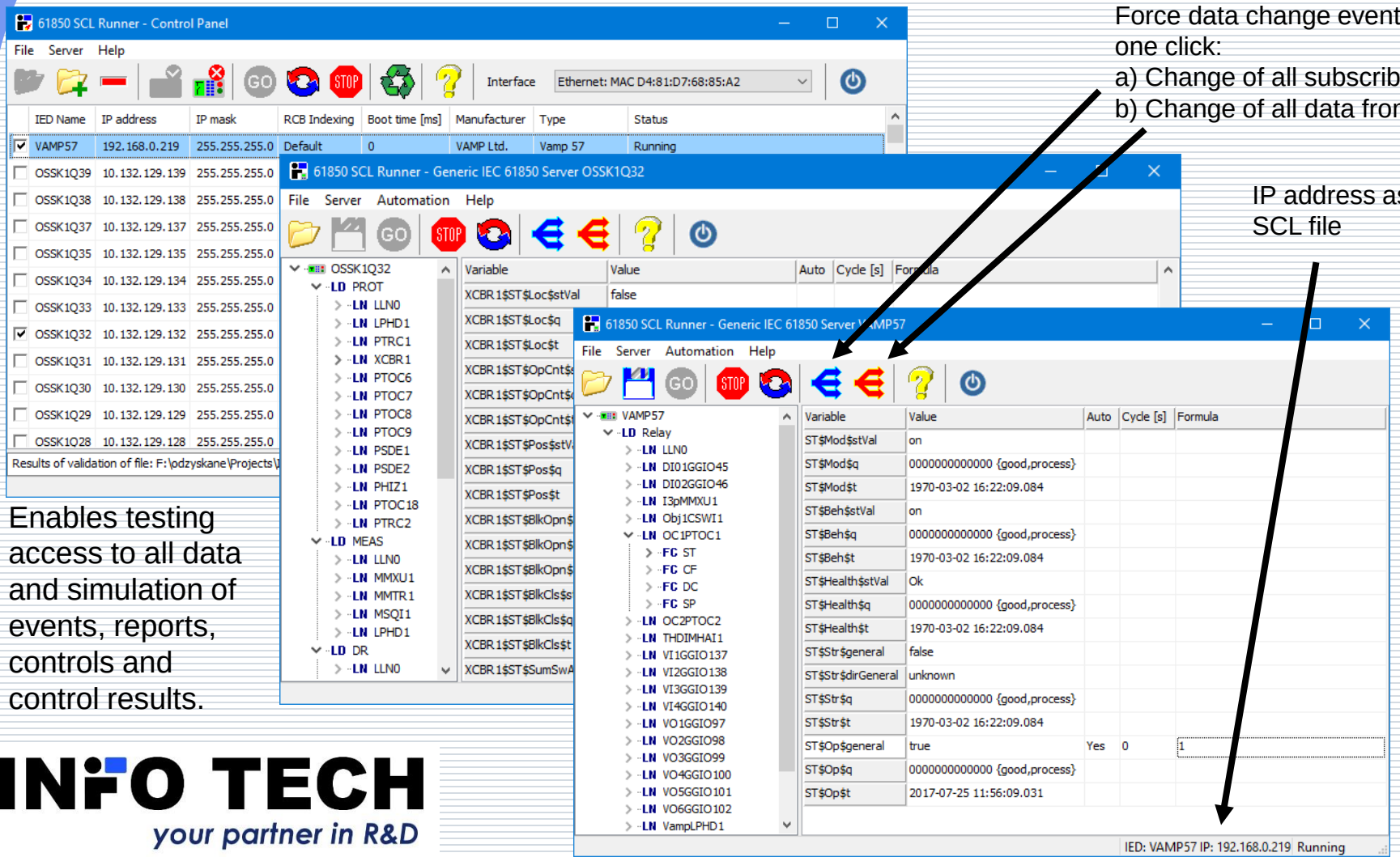
61850 SCL Runner – simulator of server devices based on SCL files



Force data change event flow by one click:
a) Change of all subscribed data
b) Change of all data from data sets

IP address as in the SCL file

Enables testing access to all data and simulation of events, reports, controls and control results.

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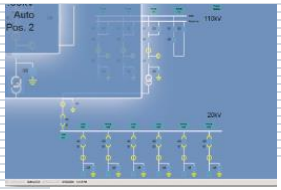
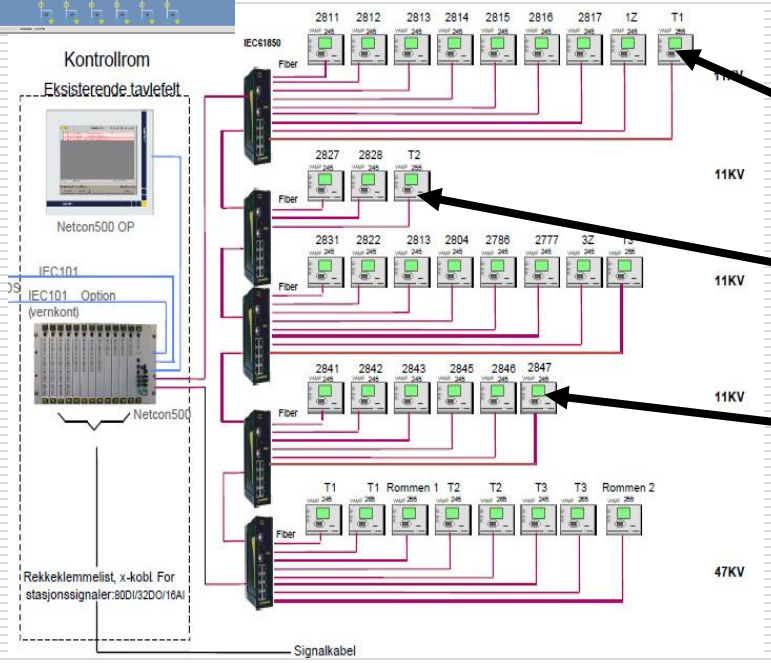
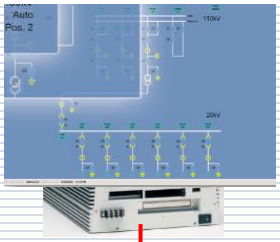
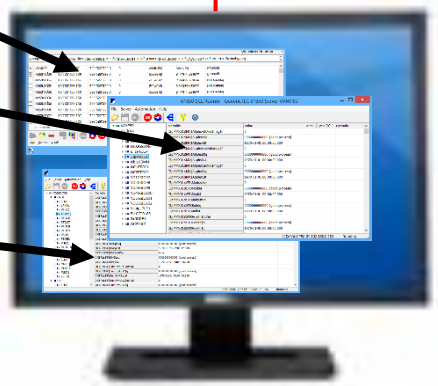
Which way of testing is easier? Real system vs simulated system

Building a lab version of the target system
or simulation?
Cost, complexity, time …









INFO TECH
61850 SCL Runner
toolset

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Problem to solve: How to prepare and verify the configuration of the control system?

- 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? **INFO TECH 61850 SCL Runner** - with excellent references from integrators from over 15 countries

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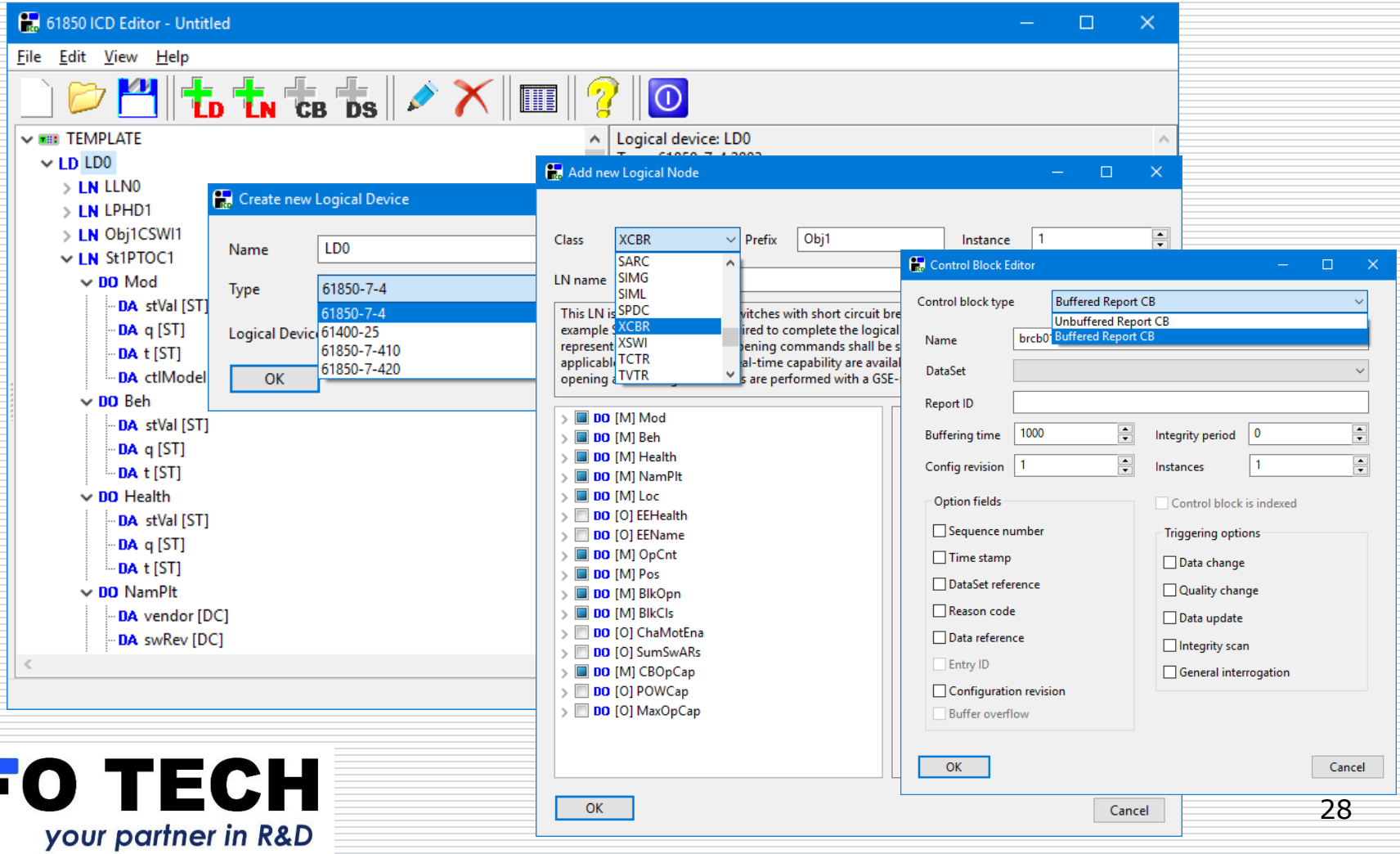
61850 SCL Runner – what can it do

- 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 and different network adapters.
- 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 available and all actually subscribed data flows can be tested by one click.
- The simulator supports control functions with proper behavior and responses dependent on the control model.
- The simulator supports GOOSE publish function, GOOSE subscribe function (Inputs) and SV publish function.
- IED start, stop and communication break-down situations can be easily tested by one click.
- The simulator can be also driven from an external program using telnet protocol for sending commands.

61850 ICD Editor
– tool to create/modify SCL files



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For more information including licensing conditions and license prices

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