PROTECTION & AUTOMATION UPDATES

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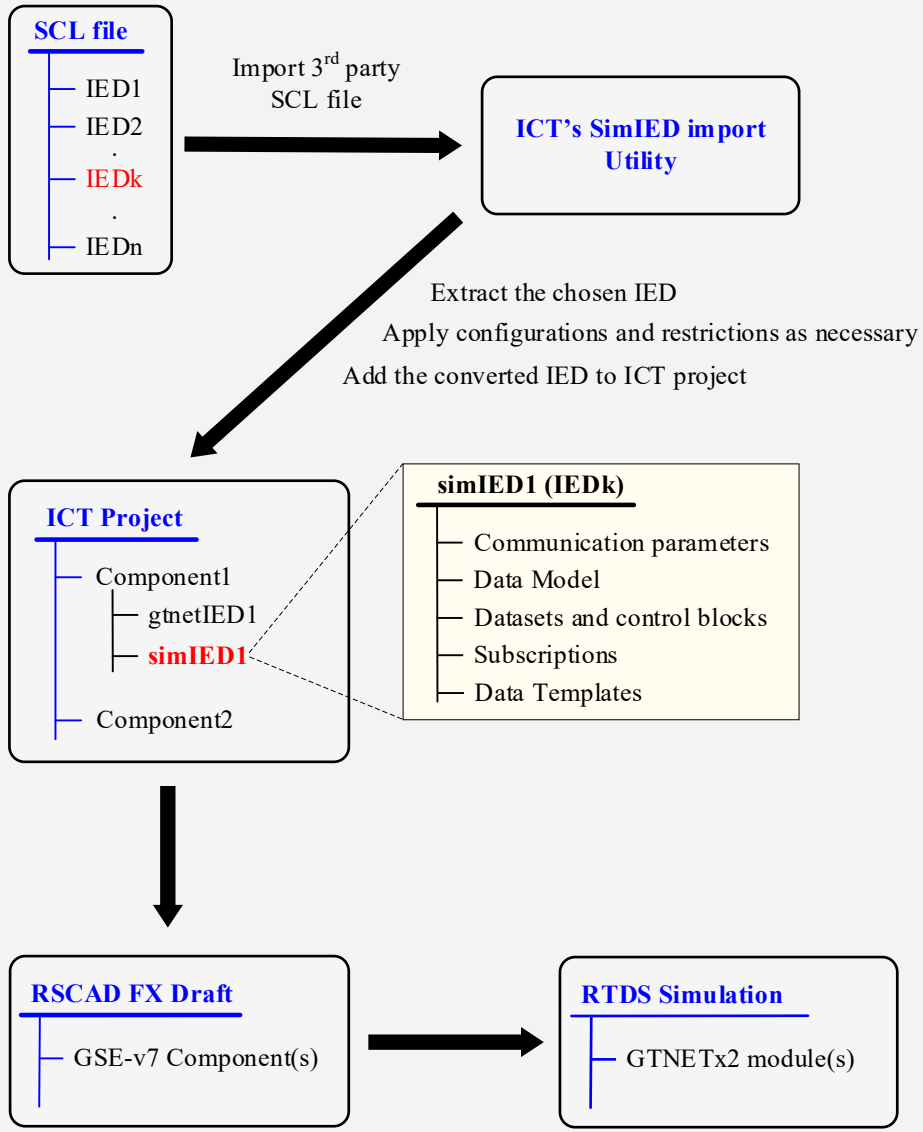
PROTECTION & AUTOMATION UPDATES

- ICT with SimIED
- MODBUS 2.0 and 2.1
- DNP, 104, MODBUS Editors
- GTNET firmware Remove TELNET and FTP, RTDS shell on USB console
- SSO Relay model
- GOOSE Analyzer

ICT ENHANCEMENTS

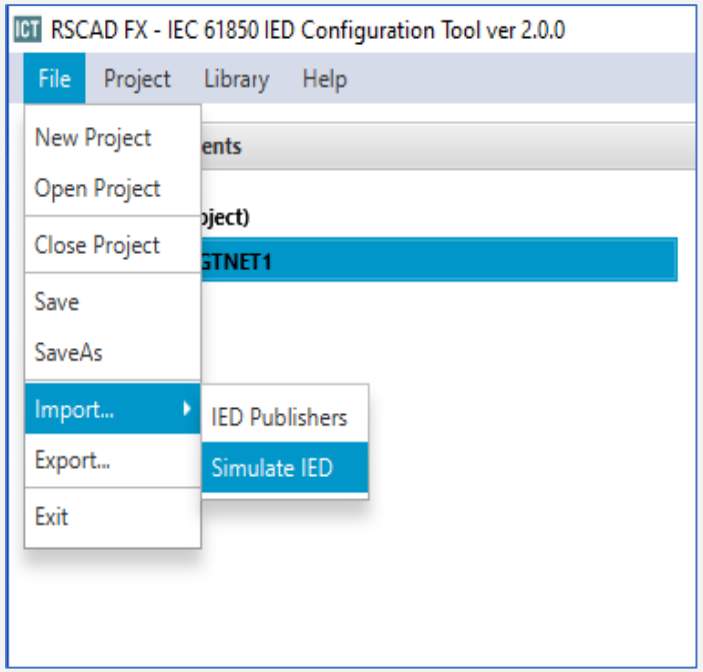
SimIED feature to emulate 3rd party IEDs

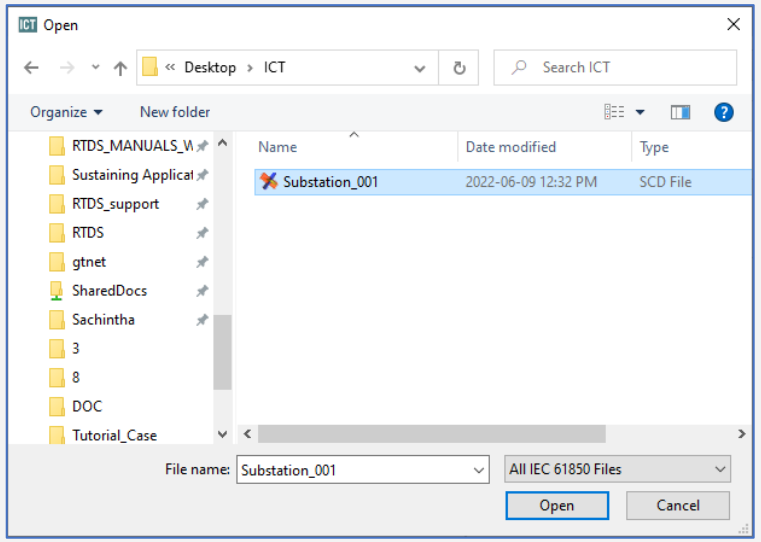
- Any valid IEC 61850 SCL file (such as ICD, CID or SCD) with one or more IEDs
- IEDs will be treated identically to those created from the ICT itself
- Only standard data types and LN classes are supported (as defined in IEC 61850-7-x)
- Tutorial Cases\03 Protection and Automation\06 GTNET Applications\03 Relay Interfacing with IEC 61850\03c Incomplete_IEC61850_SimIEDs

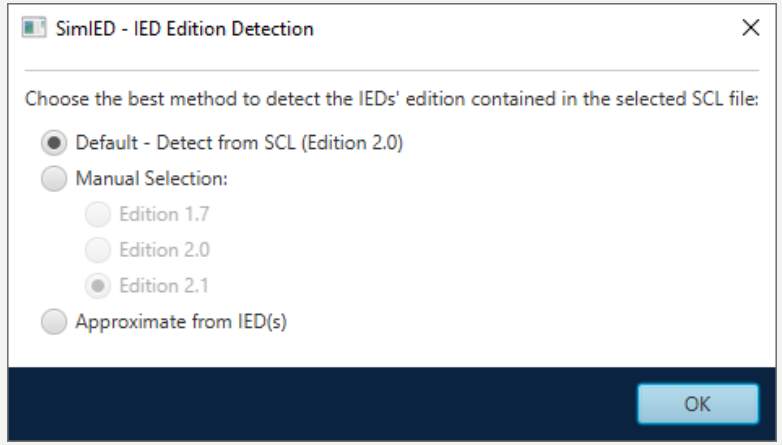


SIM IED

Importing and Simulating a 3rd party IED



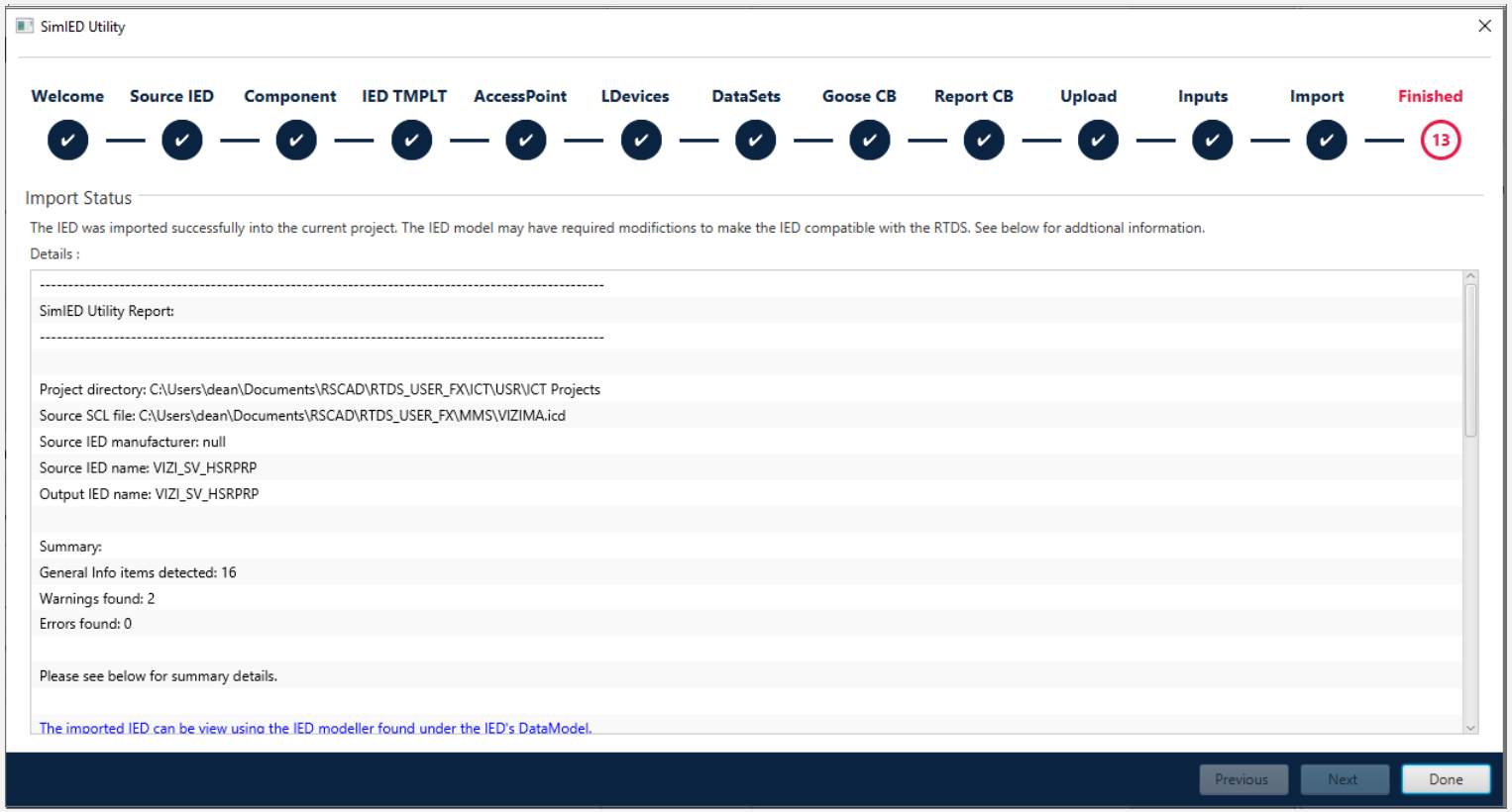




Upon import, the SCL is validated against 61850 schema and a warning/error summary is provided, if any exist

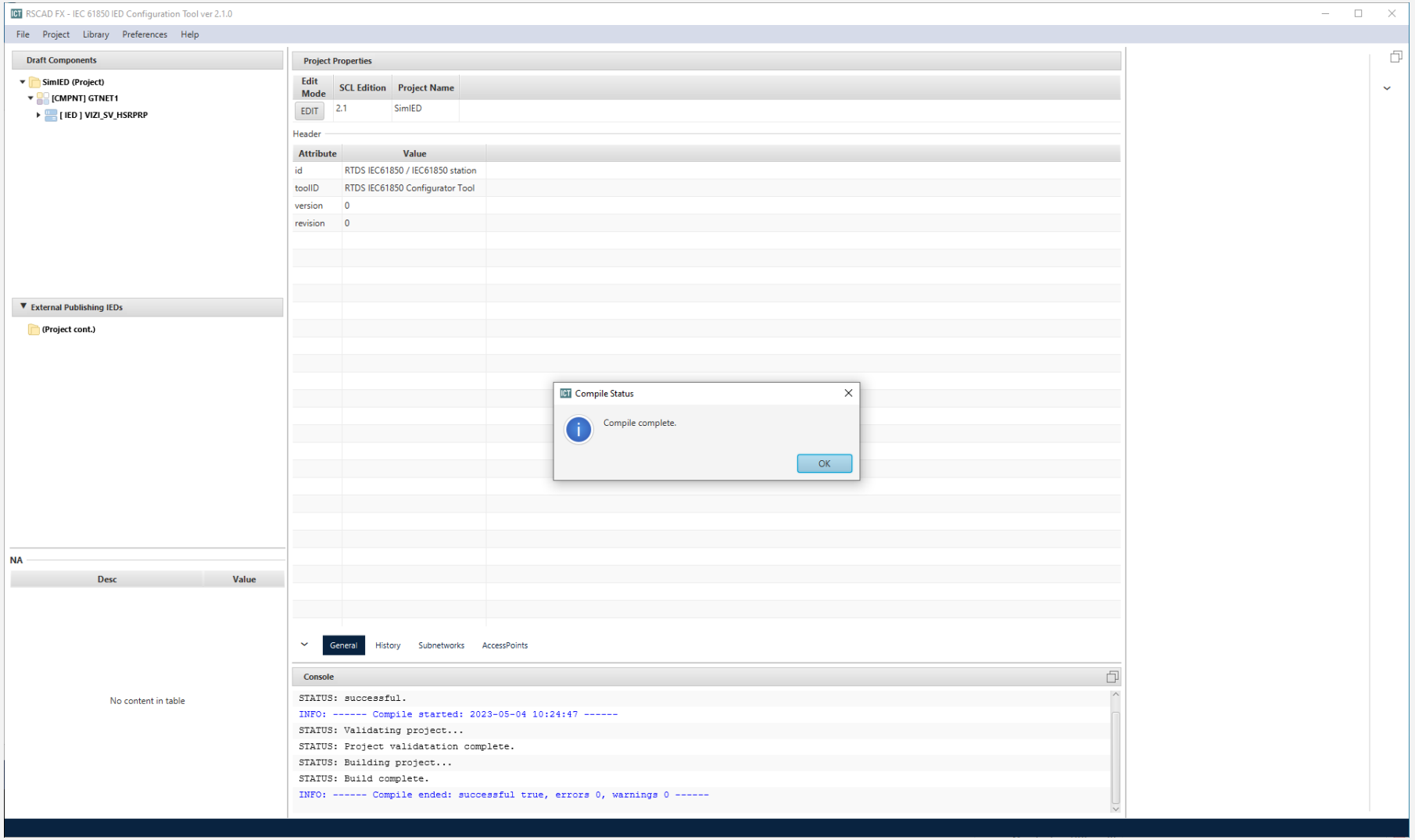
SIM IED

SimIED Utility Makes it Easy step by step



SIM IED

Configure
Compile
Save



MODBUS ENHANCEMENTS

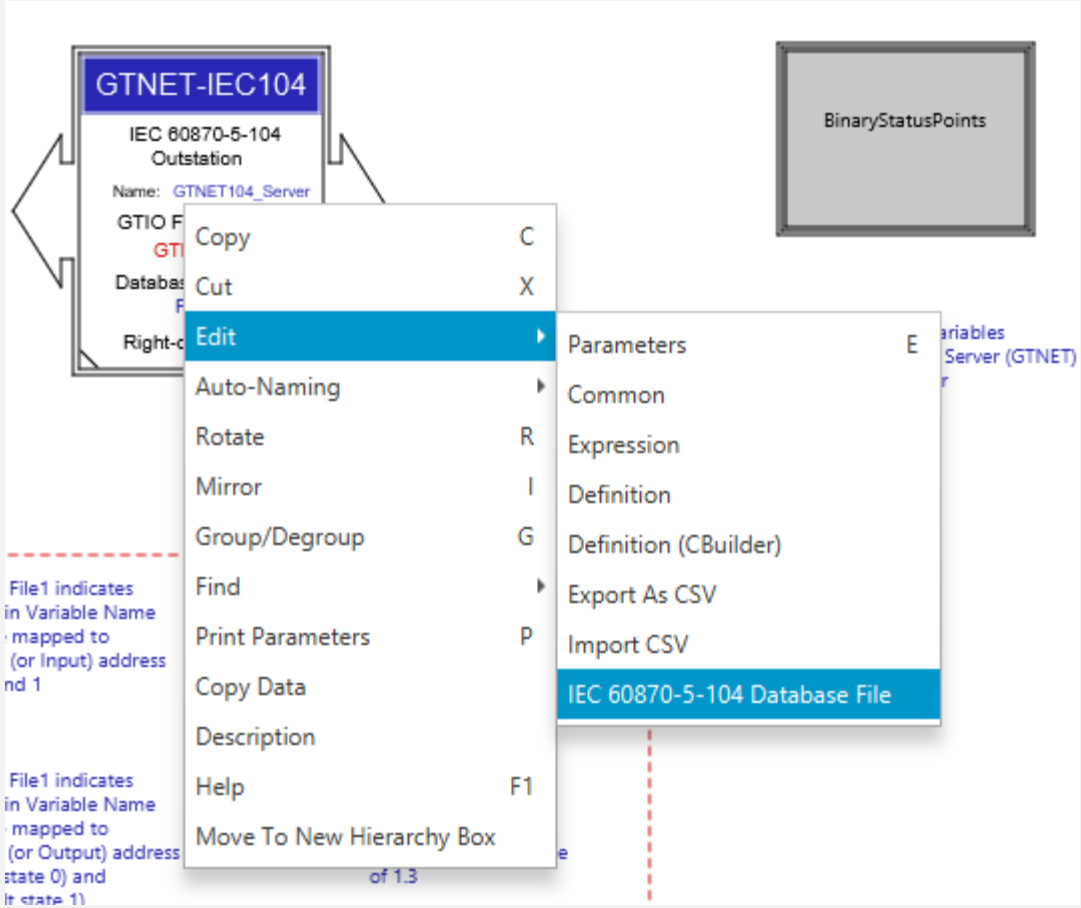
Modbus Component File version 2.0 and 2.1

- Version 2.0 supports modification of Holding Registers from Runtime Variables and from Client commands
- Version 2.1 supports only 3 outstations and increased support for up to 415 Input Registers and Holding Registers

NEW GTNET EDITORS

DNP, Modbus, IEC 60870-5-104

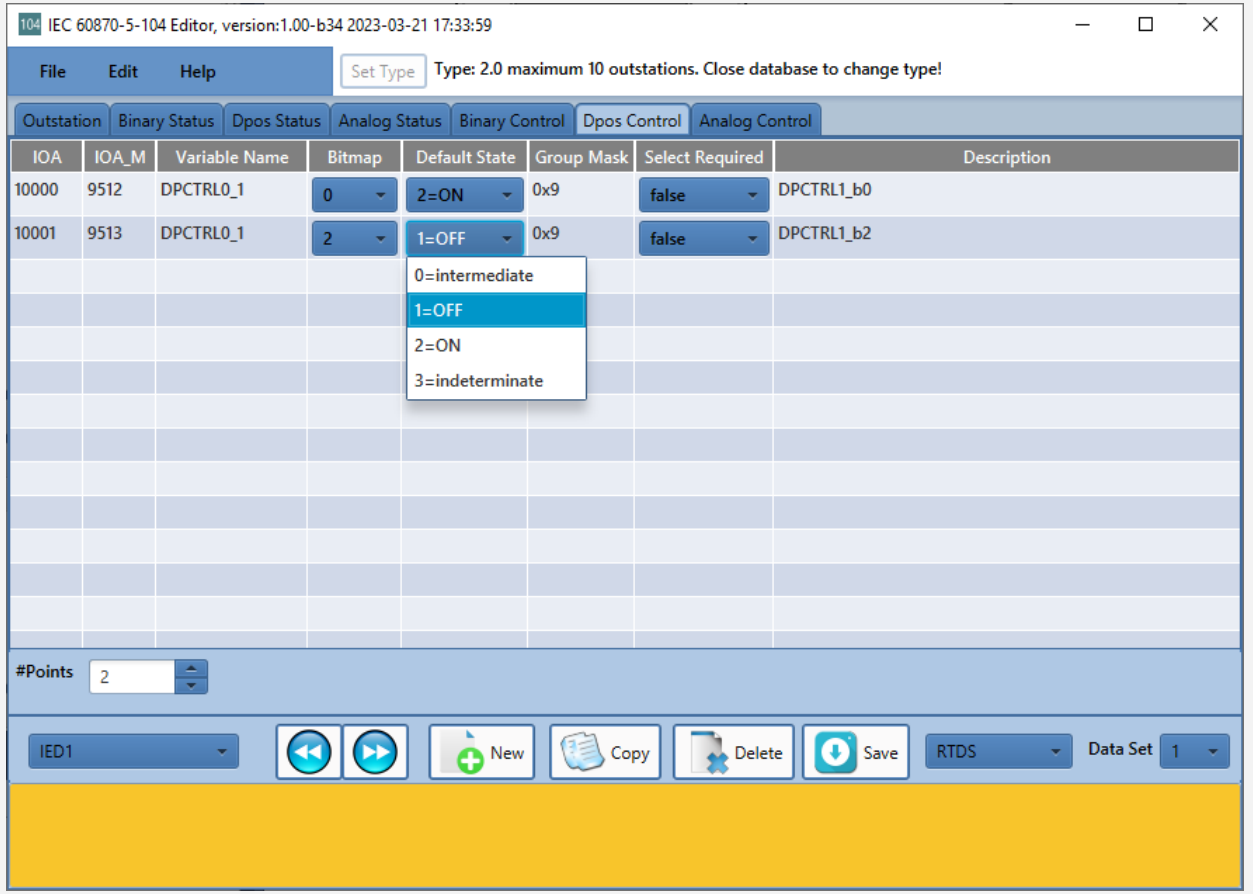
- Right-click menu option to launch new editors for the simulation data mapping of variable to the protocol



NEW GTNET EDITORS

Simple Common Look and Feel

- Automatic conversion of legacy text based mapping file to XML based file
- Description fields for each point to better identify the purpose in the simulation
- Intuitive combo-box options in each point's cell data



GTNET FIRMWARE

Security Updates

- GTNET firmware had a security risk with unsecured access methods such as FTP and TELNET
- GTNET firmware going forward will no longer provide FTP and TELNET
- Access to GTNET terminal messages will be through the USB console

SSO RELAY MODEL

Protection Against Sub-Synchronous Oscillations

- With increased integration of renewable energy resources, FACTs devices and series compensation, sub-synchronous oscillations (SSO) have become more common in electrical power systems in recent years.
- Specially designed relaying devices are often employed to detect and isolate harmful SSO conditions as when unconstrained, they can lead to widespread equipment damage and system instability.
- RTDS has designed and implemented a SSO relay model for the P&A library that can effectively extract sub-synchronous components in system measurements to quickly detect SSO conditions

SSO RELAY MODEL

What are Sub-Synchronous Oscillations?

- Sub-Synchronous Oscillations (SSO) are a form of interactions between an electrical energy source and a transmission system, which cause an energy exchange between the two entities at a frequency below the nominal system frequency (60 or 50 Hz).
- There are several types of SSO phenomena depending on what segments of the power system get involved in the interactions.
- The most prominent types of SSO are Sub-Synchronous Resonance (SSR), Sub-Synchronous Torsional Interactions (SSTI), and Sub-synchronous Control Interactions (SSCI).
- Undesirable power system issues including equipment damage caused by real-world SSO events associated with inverter-based resources are reported in *IEEE Trans. Power Systems*, vol. 38, no. 1, pp. 316-330, Jan. 2023

SSO RELAY MODEL

Technical Challenges to Detect Sub-Synchronous Oscillations

- Conventional numerical protection relays are designed to operate on fundamental frequency components and, therefore, often apply various filtering techniques to remove off-nominal frequencies from measurements.
- In contrast, SSO protection relays are specially designed to detect frequency components in system currents (and voltages) below the system synchronous frequency (i.e., sub-synchronous frequencies).
- Accurate phasor estimation calculations time become larger as the frequency of interest becomes lower. As a result, SSO relays generally have longer operating times that can go up to 1 second with added time delay.

SSO RELAY MODEL

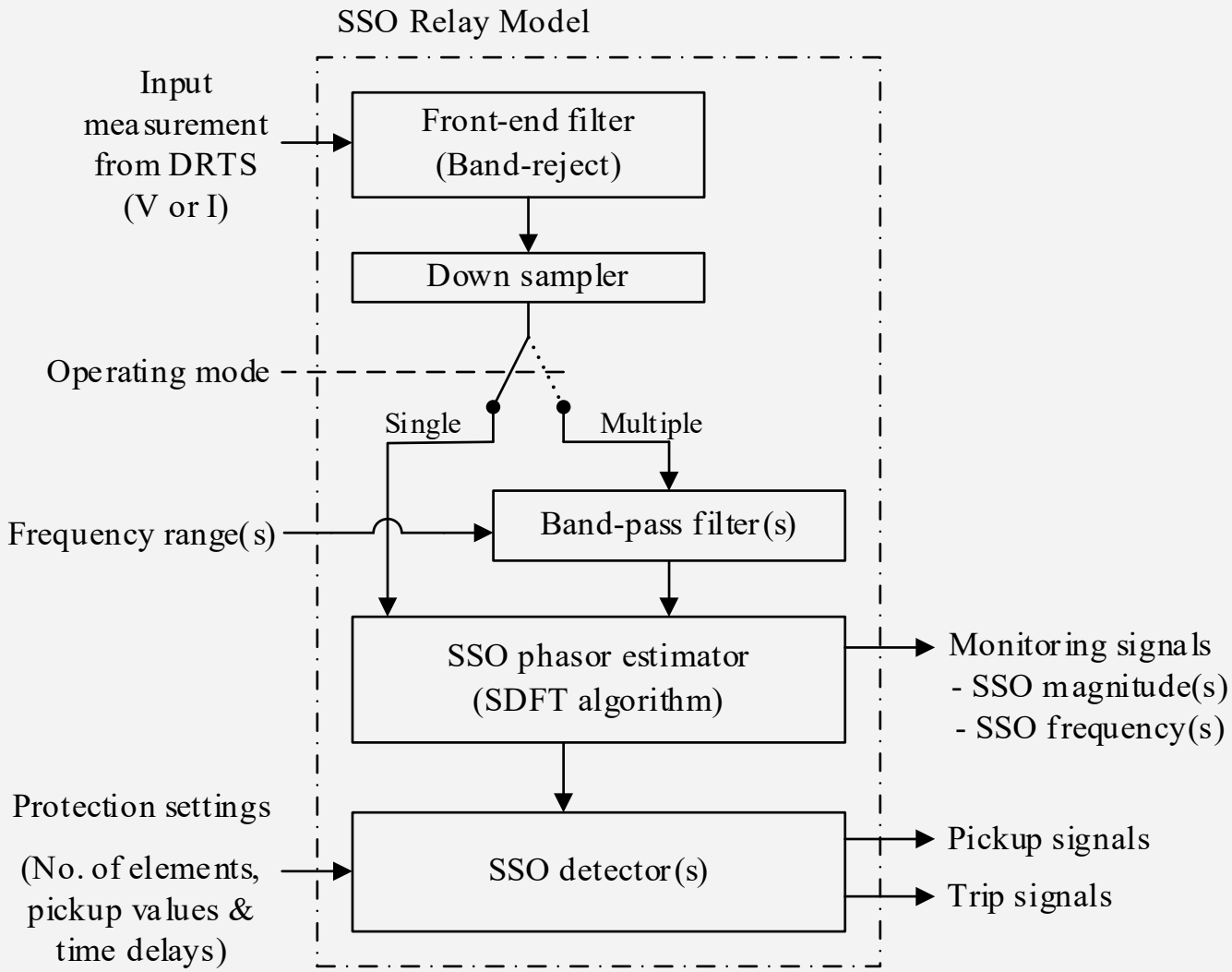
Technical Challenges to Detect Sub-Synchronous Oscillations

- However, quicker operation is required from relays to be effective against fast-developing SSO phenomena such as SSCI.
- Transient events that are not SSO can generate sub-harmonics. These events, however, are transient in nature and tend to be well-damped, hence SSO protection relays should not respond to them.
- Modern power systems containing various entities that interact with each other can potentially generate SSO conditions with more than one genuine sub-synchronous frequency component, further complicating their detection.

SSO RELAY MODEL

Detection Algorithm

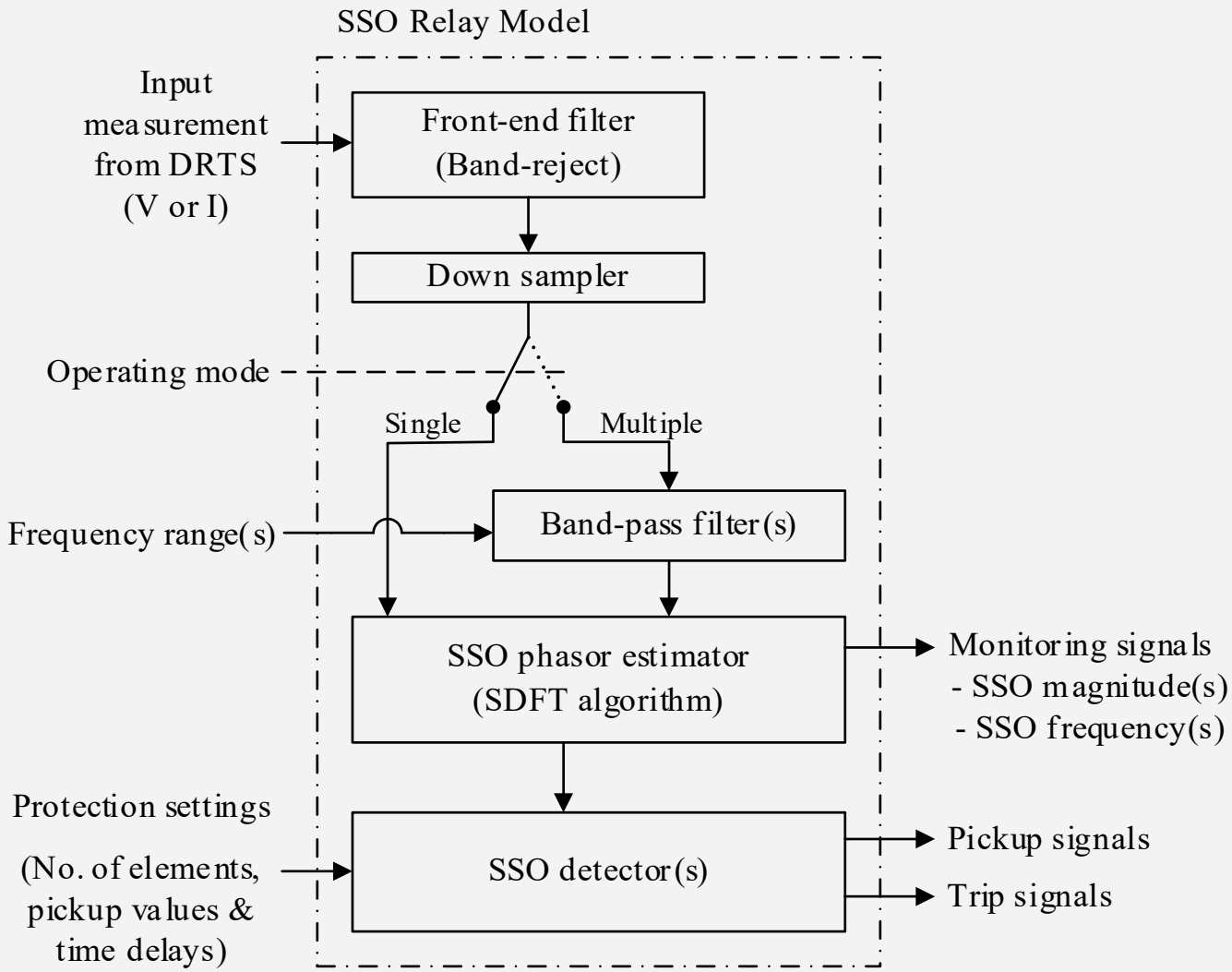
- 2nd order band-reject filter eliminates nominal frequency component.
- Magnitude errors introduced by the band-reject filter are appropriately compensated and down-sampled.
- Single or Multiple SSO Frequency detection operating mode.
- Additional filtering results in an added time delay of about 80-120 ms in the multiple mode operation



SSO RELAY MODEL

Detection Algorithm

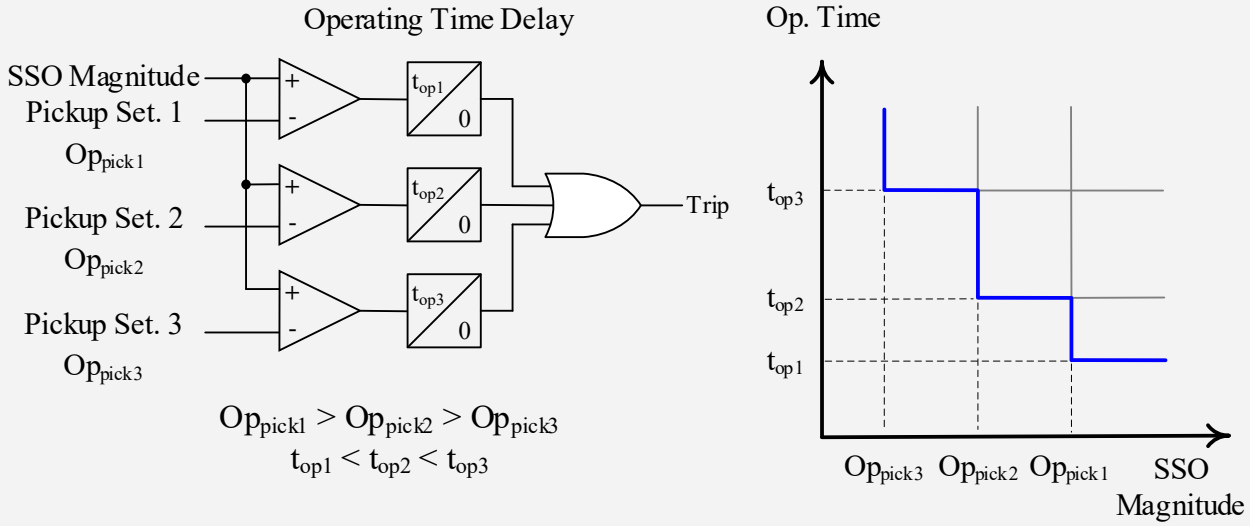
- The SSO phasor estimator uses a Smart Discrete Fourier Transform (SDFT) algorithm, an extension to the standard DFT, to estimate the SSO frequency(s).
- The SDFT algorithm is effective for a wider off-nominal frequency range and immune to noise and harmonics, therefore dedicated ani-aliasing is not necessary.



SSO RELAY MODEL

SSO Relay Settings

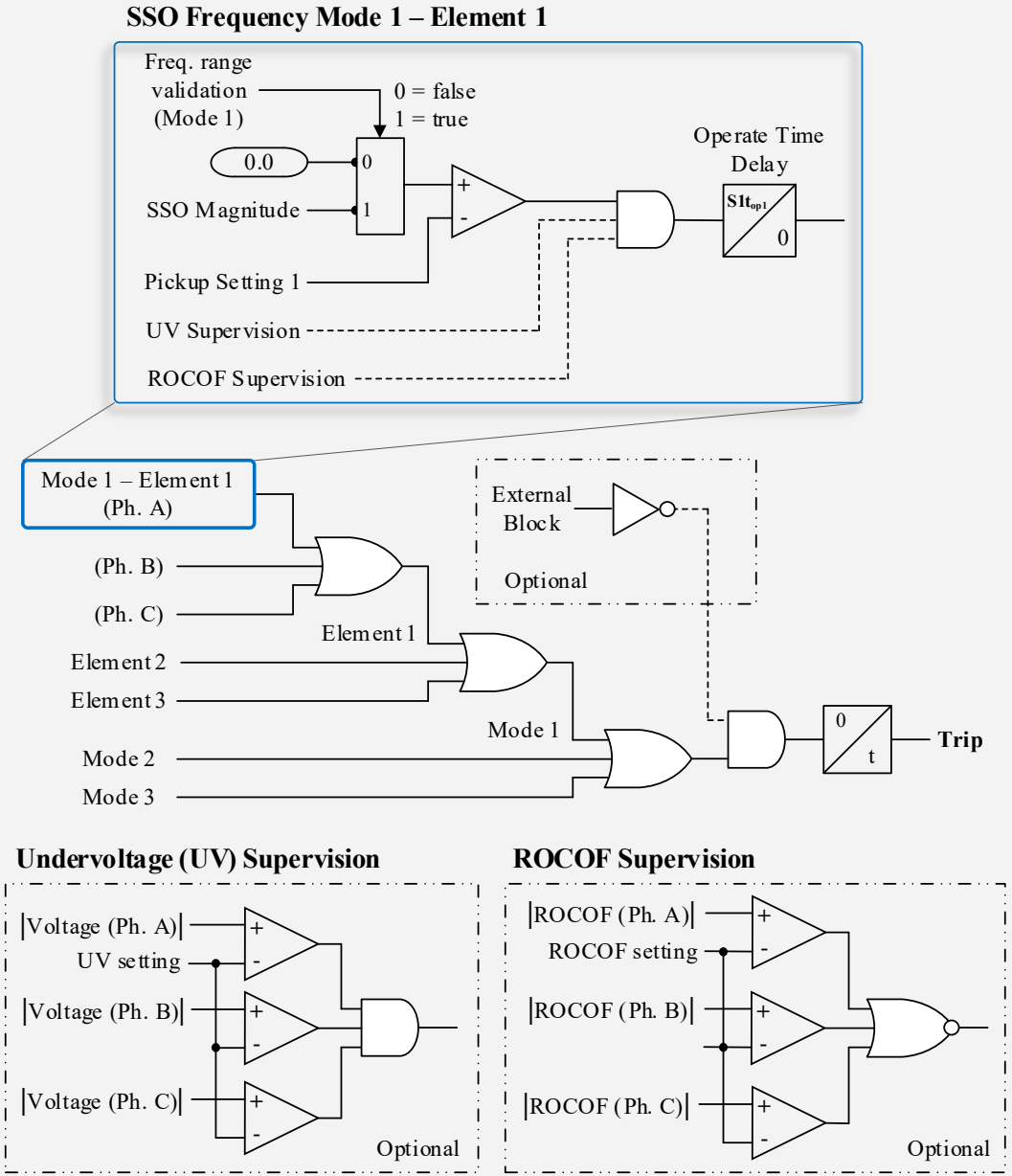
- Up to 3 SSO elements that can be setup in parallel with different pickup settings and time delays.
- This forms a definite-time characteristic that provides faster operation for rapidly growing SSO conditions and slower operation for low levels of SSO conditions.



SSO RELAY MODEL

Optional Security Features

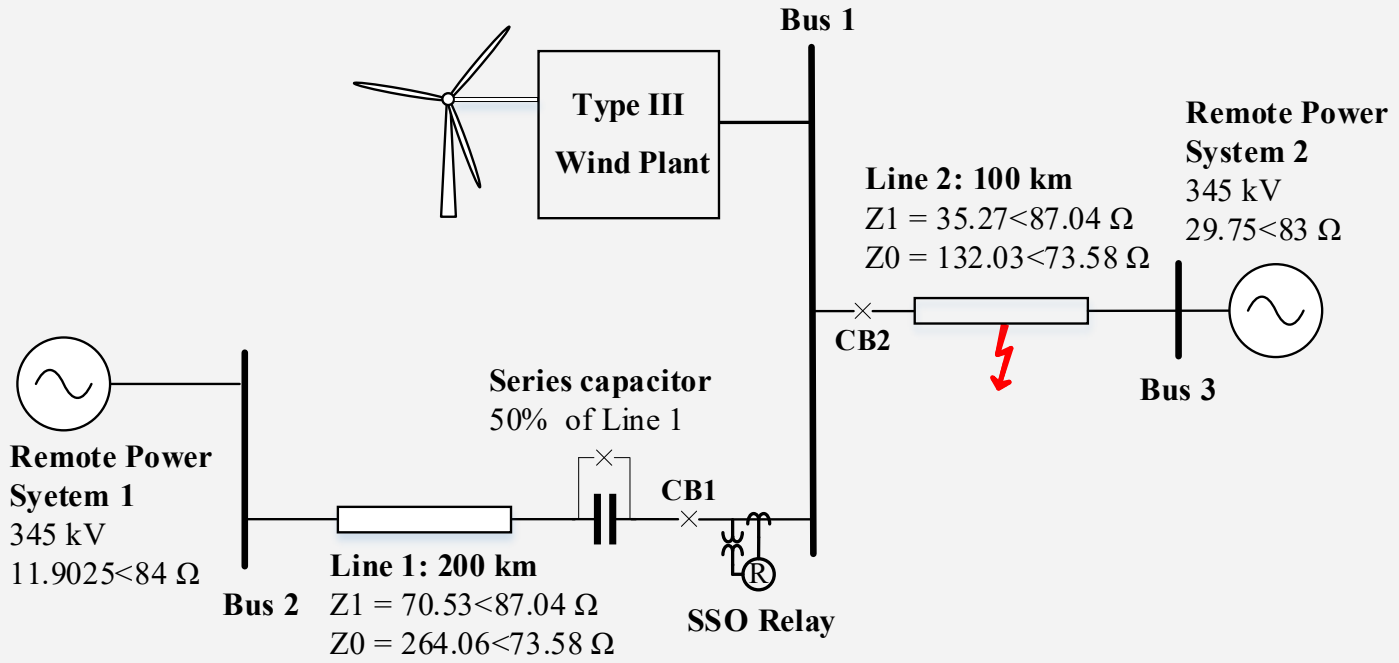
- The SSO relay model comprises of an optional security feature to have the SSO detection logic supervised by system line-to-neutral voltage and/or the rate of change of frequency (ROCOF) of estimated SSO frequencies.
- The supervisory elements guard against misoperation of the relay for fault-induced behaviours of the system.



SSO RELAY MODEL

Simulation Test Case

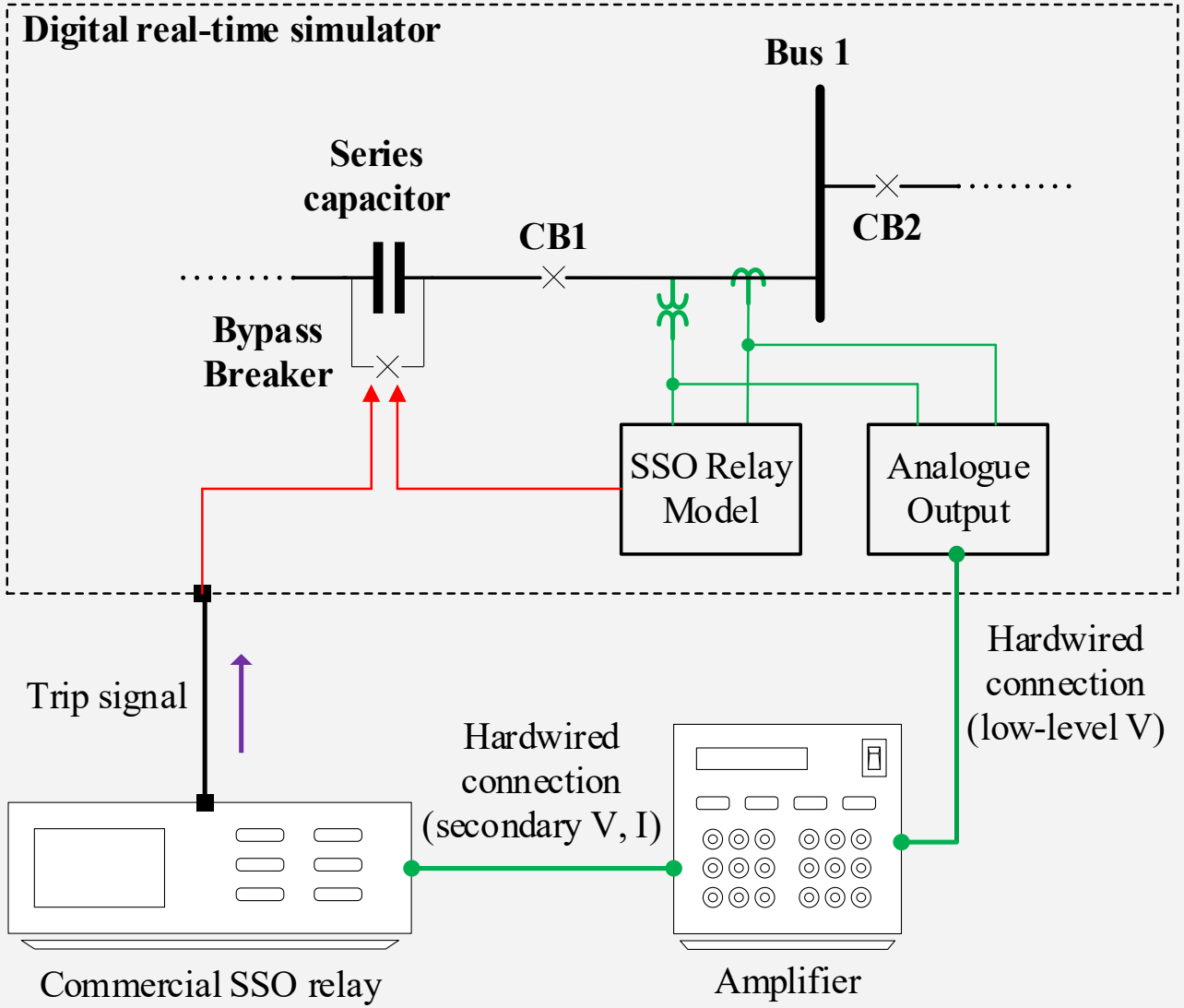
- Power system simulated in this work consists of a Type III wind plant and a series compensated transmission line, which as a result, is prone to produce SSCI



SSO RELAY MODEL

Simulation Test Case

- In order to benchmark performances of the developed SSO relay model, a commercial SSO relay (physical) is connected and tested in parallel
- Configured in such a way that only one is active at a given instant. This arrangement helps to observe performances of the two SSO relays independently.

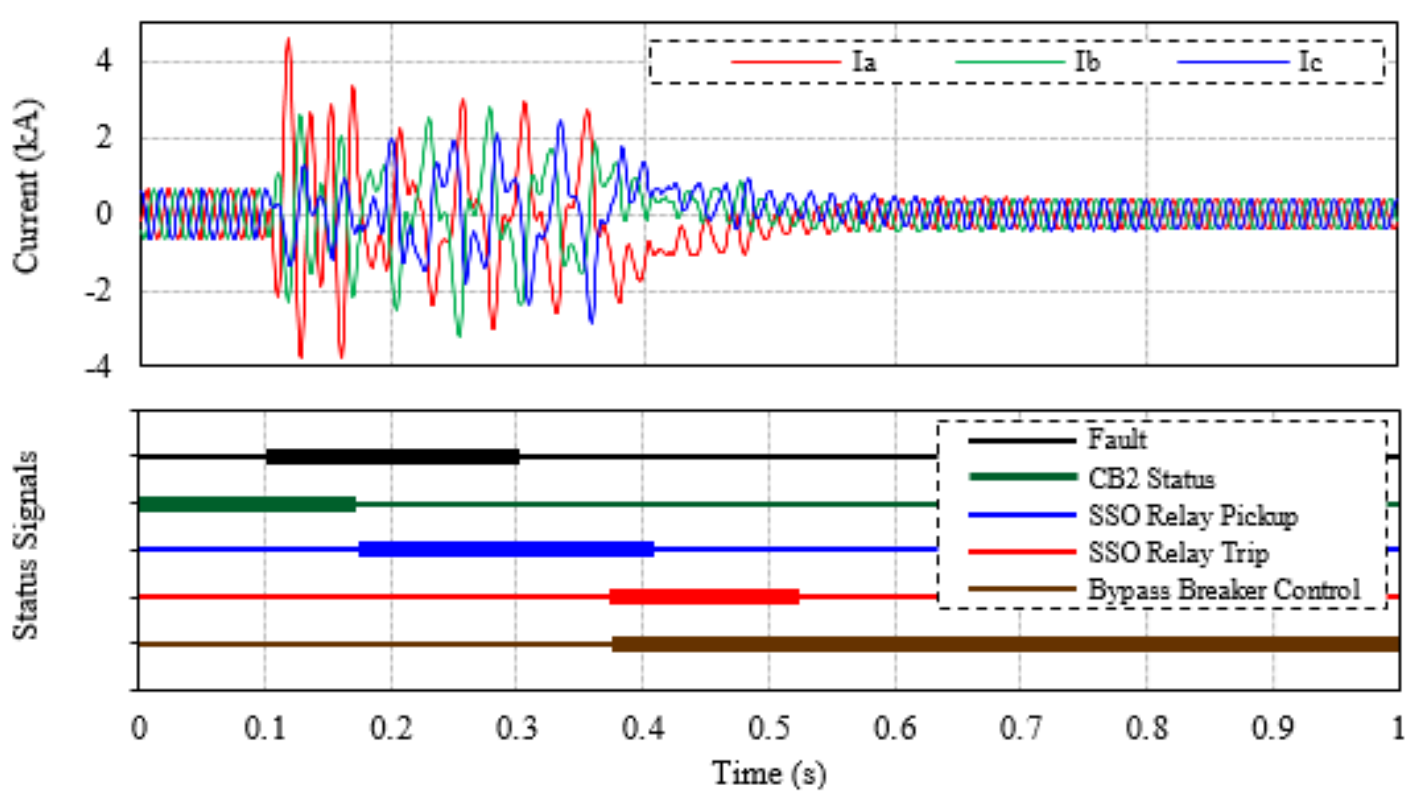


SSO RELAY MODEL

Simulation Test Case

- Operation of the SSO Relay Model during a SSCI condition.

- Operation of the SSO Relay Model during a faster growing SSCI condition.

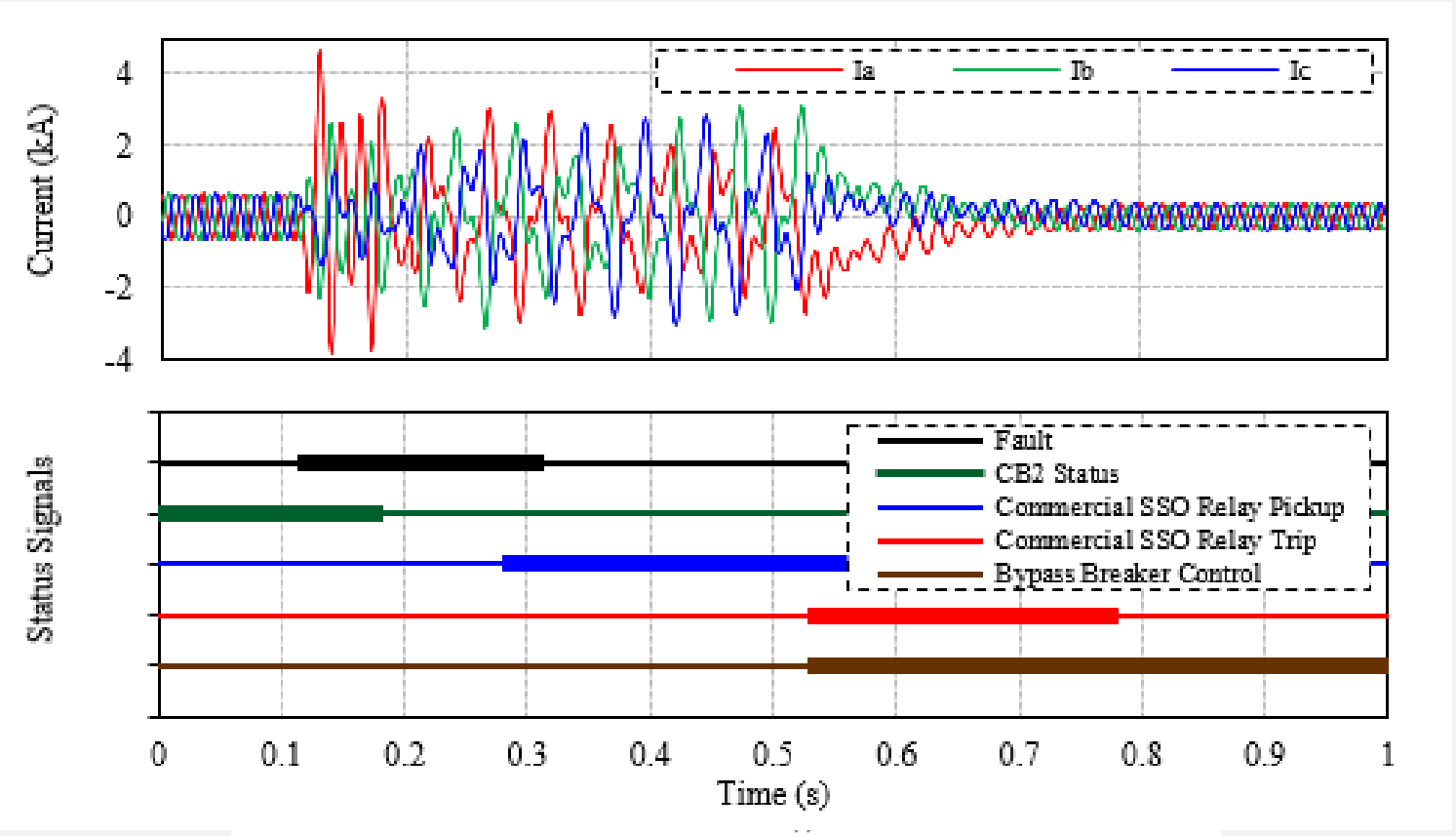


SSO RELAY MODEL

Simulation Test Case

- Operation of the Commercial SSO Relay during a SSCI condition.

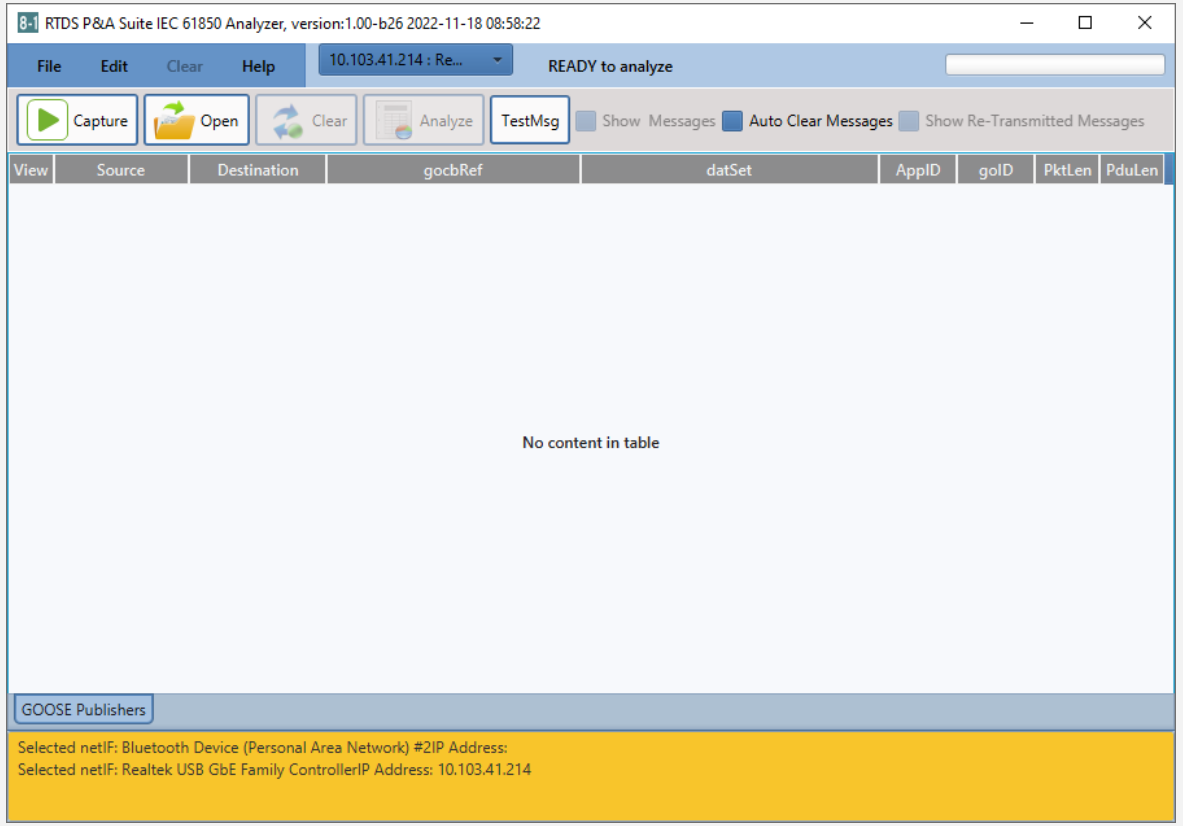
- Operation of the Commercial SSO Relay during a faster growing SSCI condition.



GOOSE ANALYZER

Intuitive Tool to Capture and Analyze GOOSE Packets

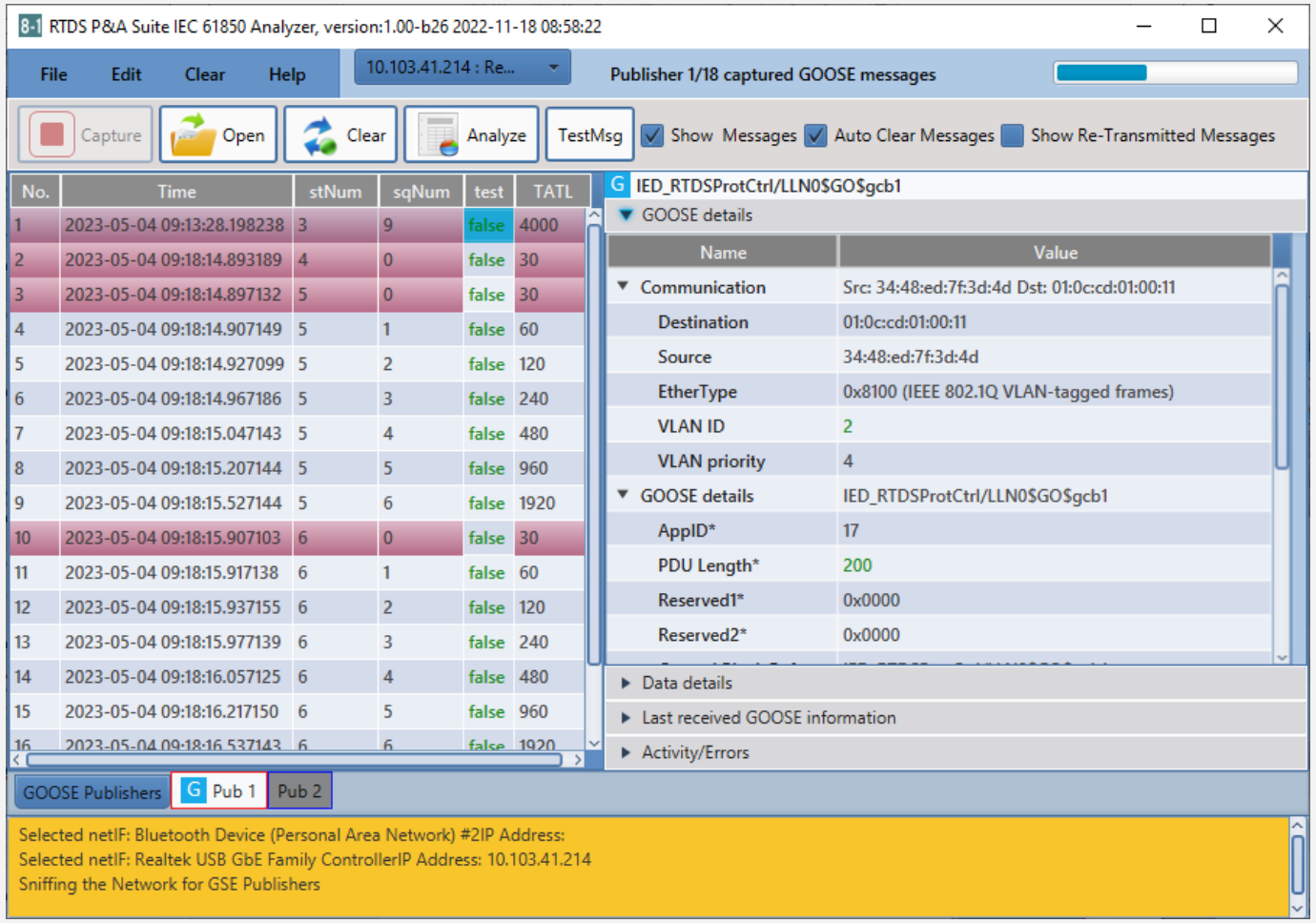
- GOOSE (layer2)
- Routable-GOOSE (layer3)
- Wireshark capture files
- Deep level packet inspection
- Visual representation of information



GOOSE ANALYZER

GOOSE details

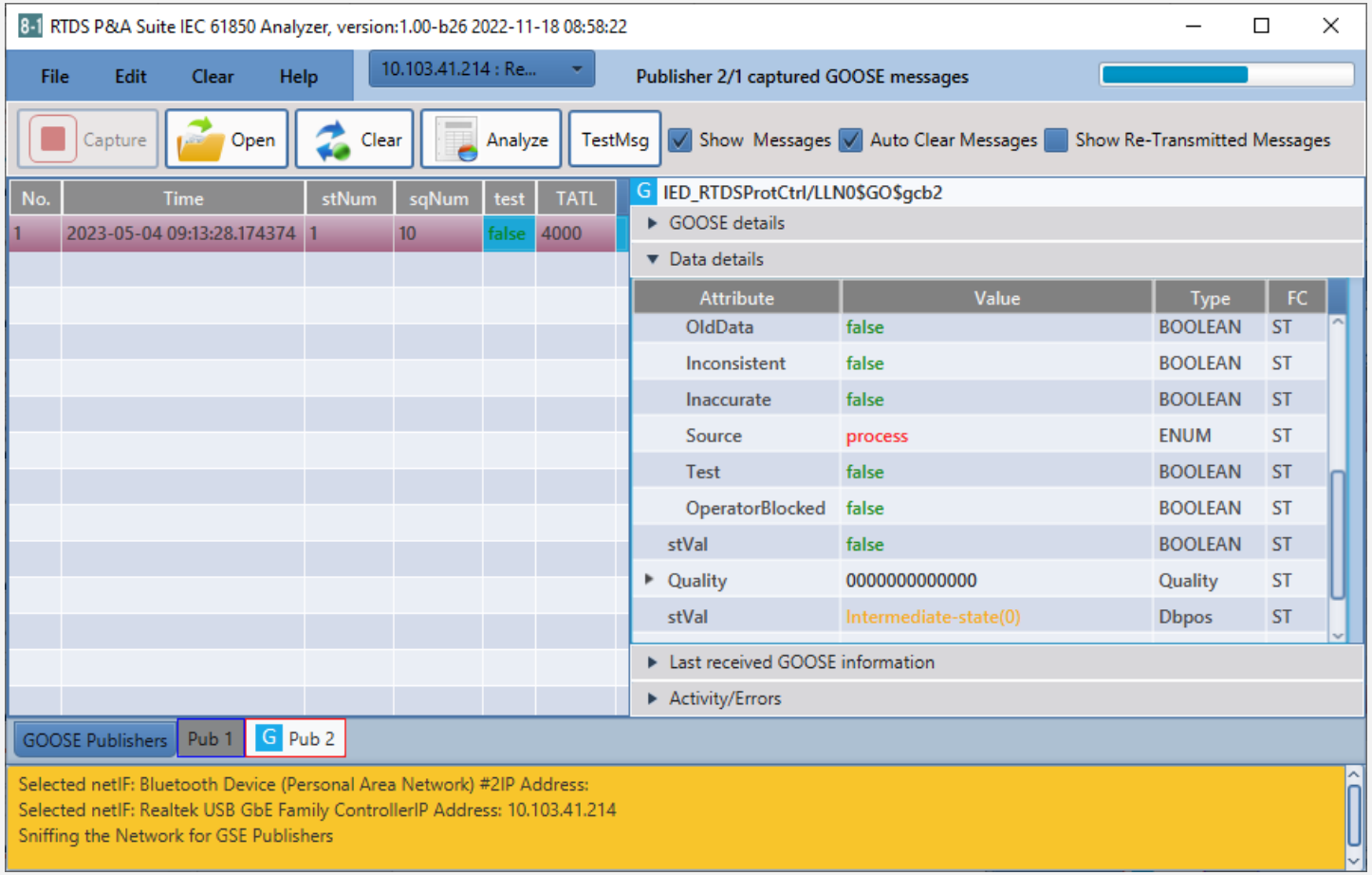
- Review content of the stream
- Communication Section
- GOOSE details section



GOOSE ANALYZER

DATA details

- Data details is used to view contents of GOOSE stream
- Data items are decoded into BOOLEAN, INT32, FLOAT, D-POS, Structures
- Quality items are decoded
- Value of item visually changes color i.e. false true



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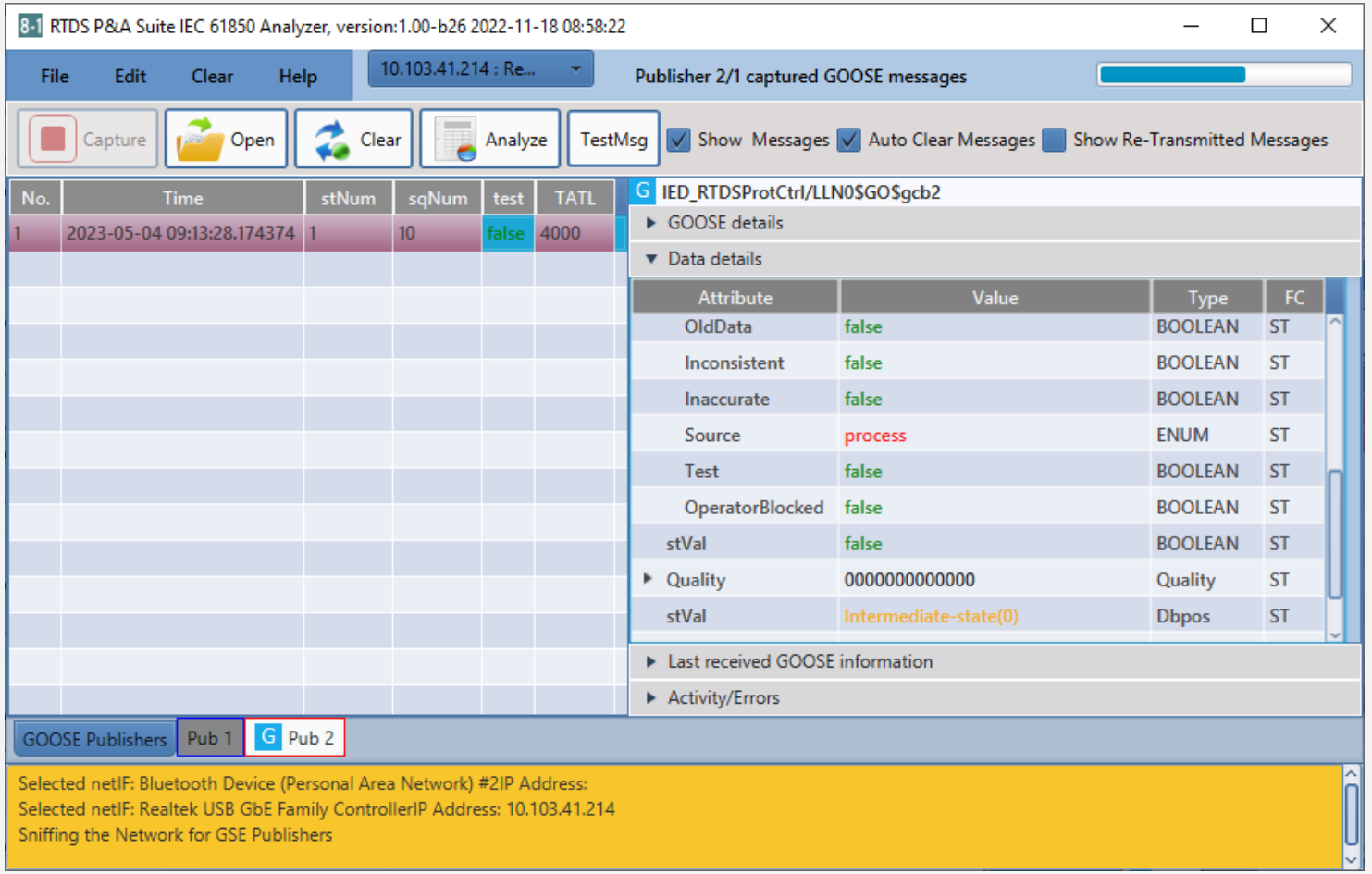

THANK YOU!