# GOOSE Auditor



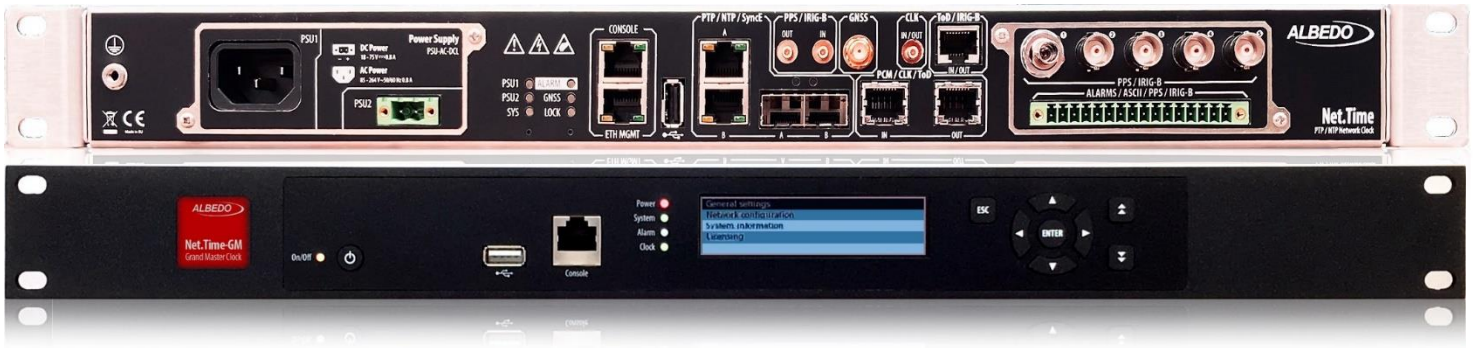

GOOSE Auditor is a solution for engineers commissioning IEC 61850 substations. It consists of two components: a tap for filtering and capturing GOOSE packets and a protocol analysis application. A handheld tap captures the messages to GOOSE Monitor, which displays the topology of the installation, the configuration and status of each node, the messages between IEDs, the changes caused by the protocol, and reports any events that may occur.

ALBEDO

# ALBEDO: a **global** player of **telecom** appliances

ICT electronics (1983)

Trend Comms (2001)



ALBEDO (2009-today)

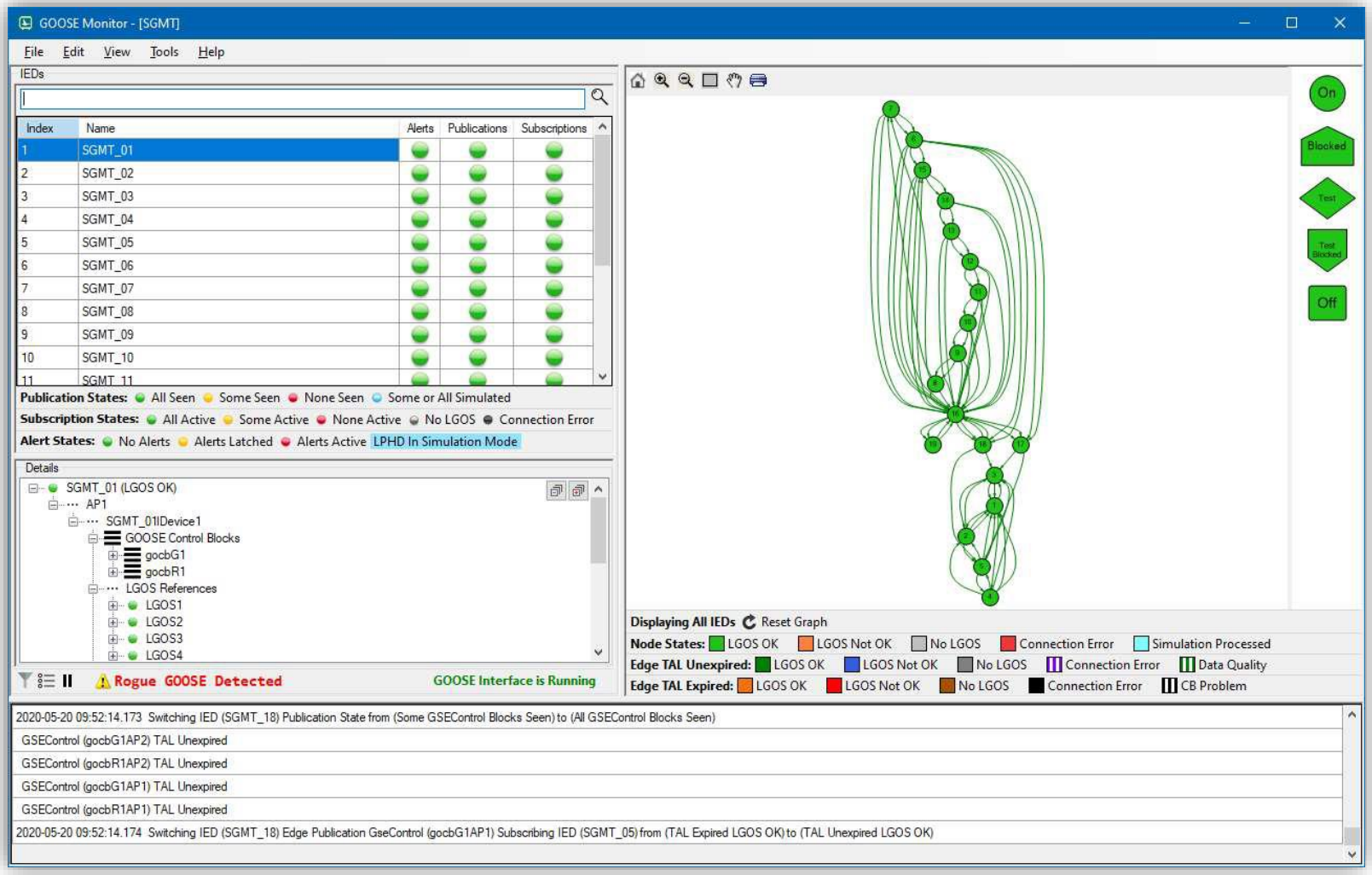
# Commissioning + Monitoring + Troubleshooting



**GOOSE Auditor** is the solution that allows engineers to quickly **deploy**, **commission,** **monitor** and **troubleshoot** the IEC 61850 GOOSE protocol ensuring the correct configuration of Publishers and Subscribers, as well as a reliable operation, detecting bad and inconsistent messages.

# Substation **Automation** & **Protection**

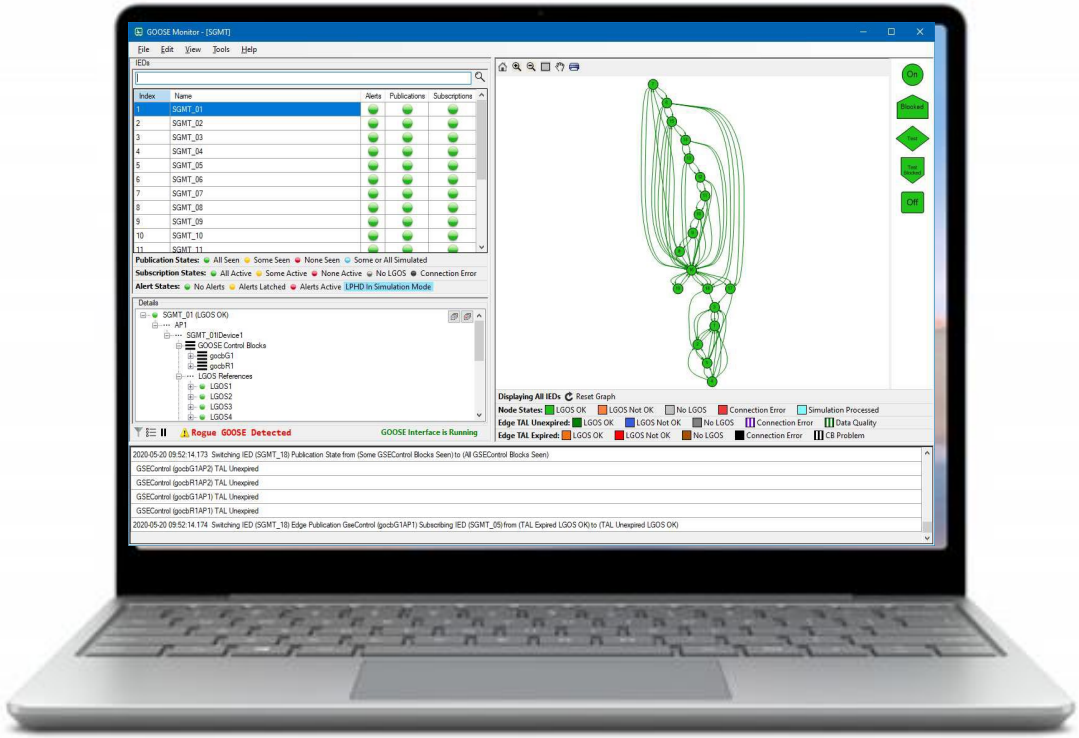





GOOSE Auditor is an essential tool for **substation automation** and **protection systems** using GOOSE. It provides an intuitive visualisation of the IED topology with the flows of GOOSE messages in order to assist engineers in the identification of issues displaying the data contents and status in real time to monitor every change. The result is a solution that facilitates a consistent management of GOOSE.

# 2 x **Components**

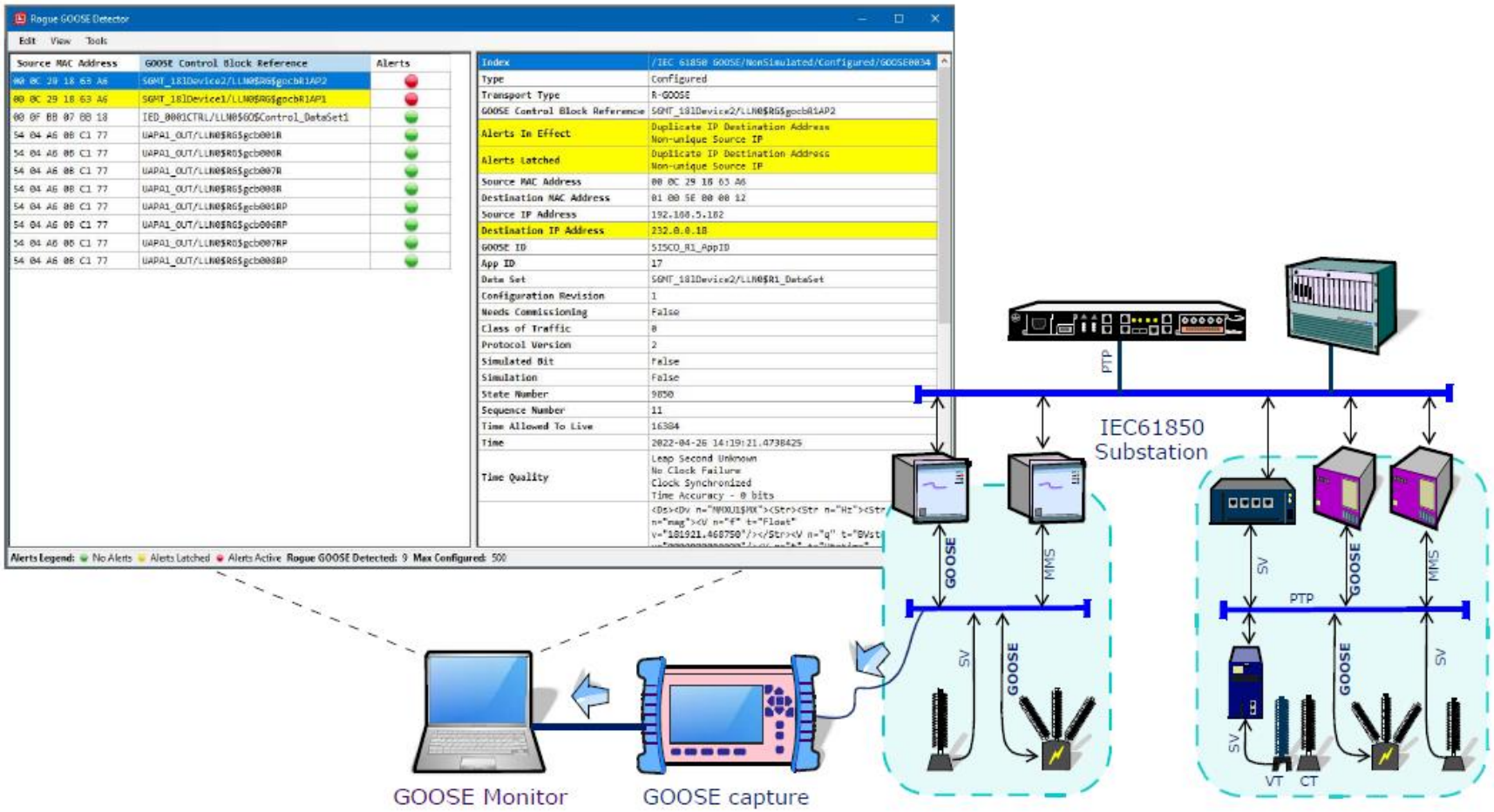





- GOOSE Auditor is a software made of component, a hand-held tap and a laptop with the application:
  - The laptop executes GOOSE Monitor application that represents the GOOSE interactions in several level of details displaying, in real-time, all data structures and the device status.
  - The laptop is the hand-held tap designed to easy capture of GOOSE messages ensuring none will be lost nor cause impairments to the rest of the IEC-61850 traffic.

# GOOSE Auditor in **Operation**





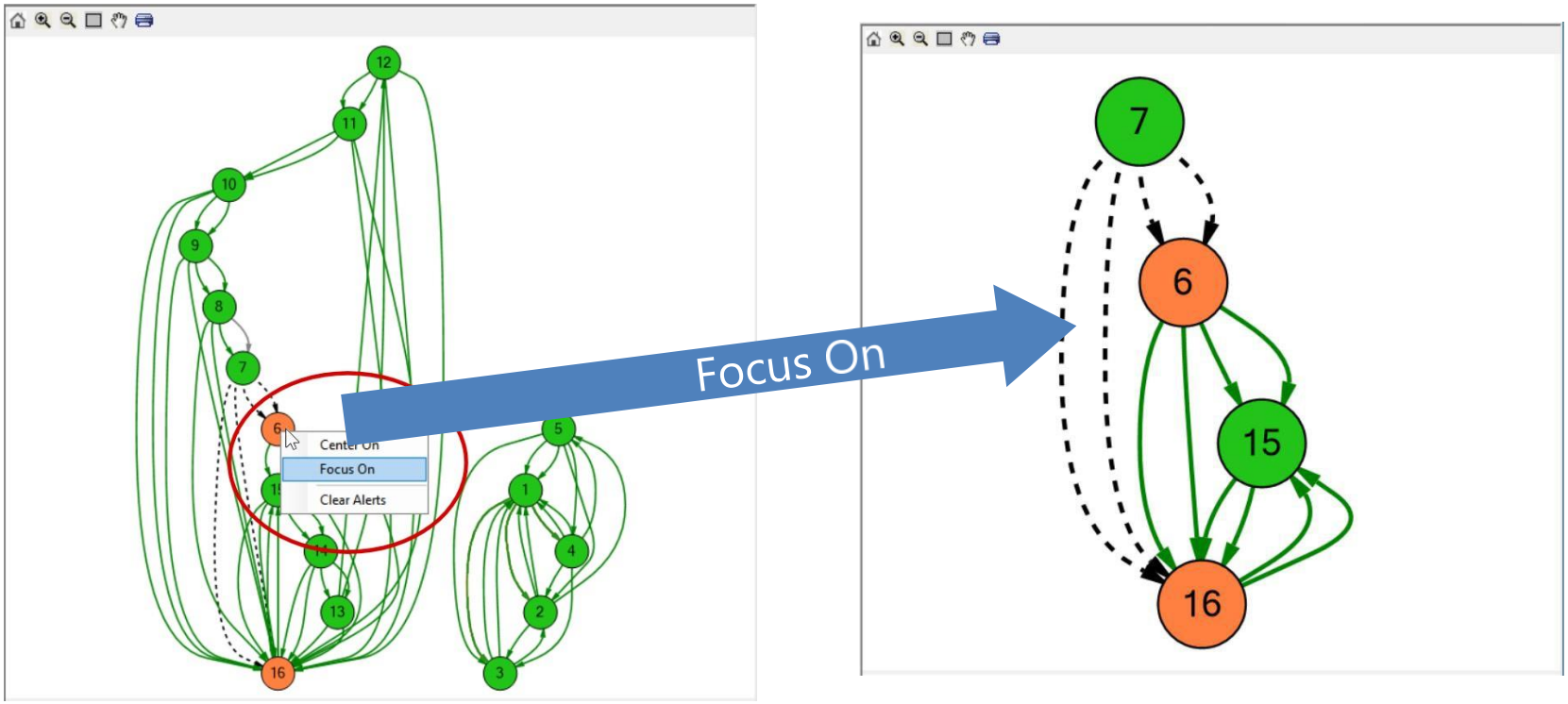

Substations using GOOSE have to deal with thousands of messages constantly being exchanged between IEDs. Trying to determine whether a particular protocol sequence is correct is a tedious task because <u>GOOSE messages are cryptic, difficult to decode and difficult to correlate</u>.

GOOSE Auditor helps to discover the topology, assist with configuration, display protocol flows, IED relationships, detect alarms... everything needed to commission and troubleshoot the IEC-61850 installation.

# Enhanced **Graphical Interface**

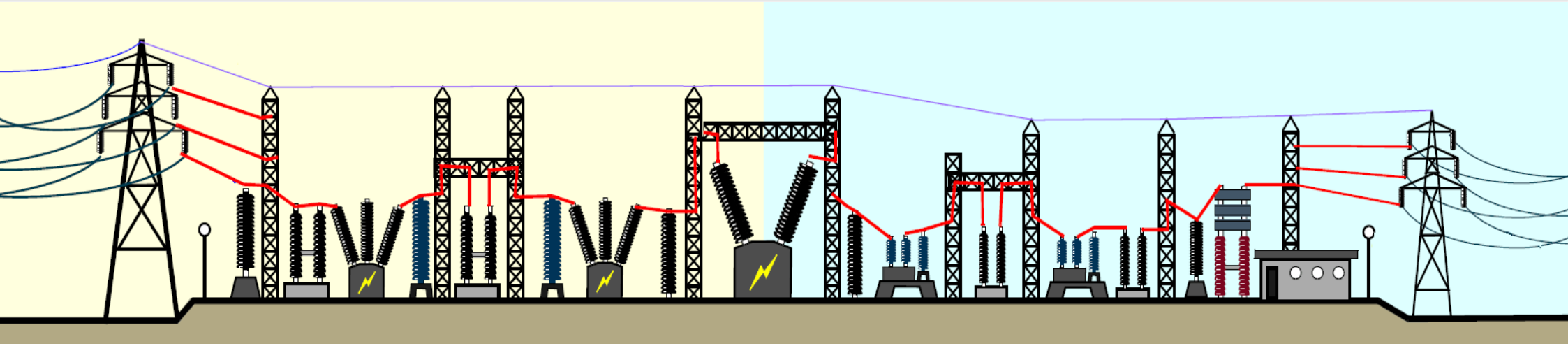


- GOOSE Auditor captures GOOSE/R-GOOSE packets using Net.Hunter or a PC/Laptop
- Captures and displays publication and subscription status for all the GOOSE messages in a real-time
- Provides the substation engineer with the ability to see at a glance if there are problems and the source of the problem
- Uses graphical visualisation to help engineers quickly identify where problems are occurring



# Features

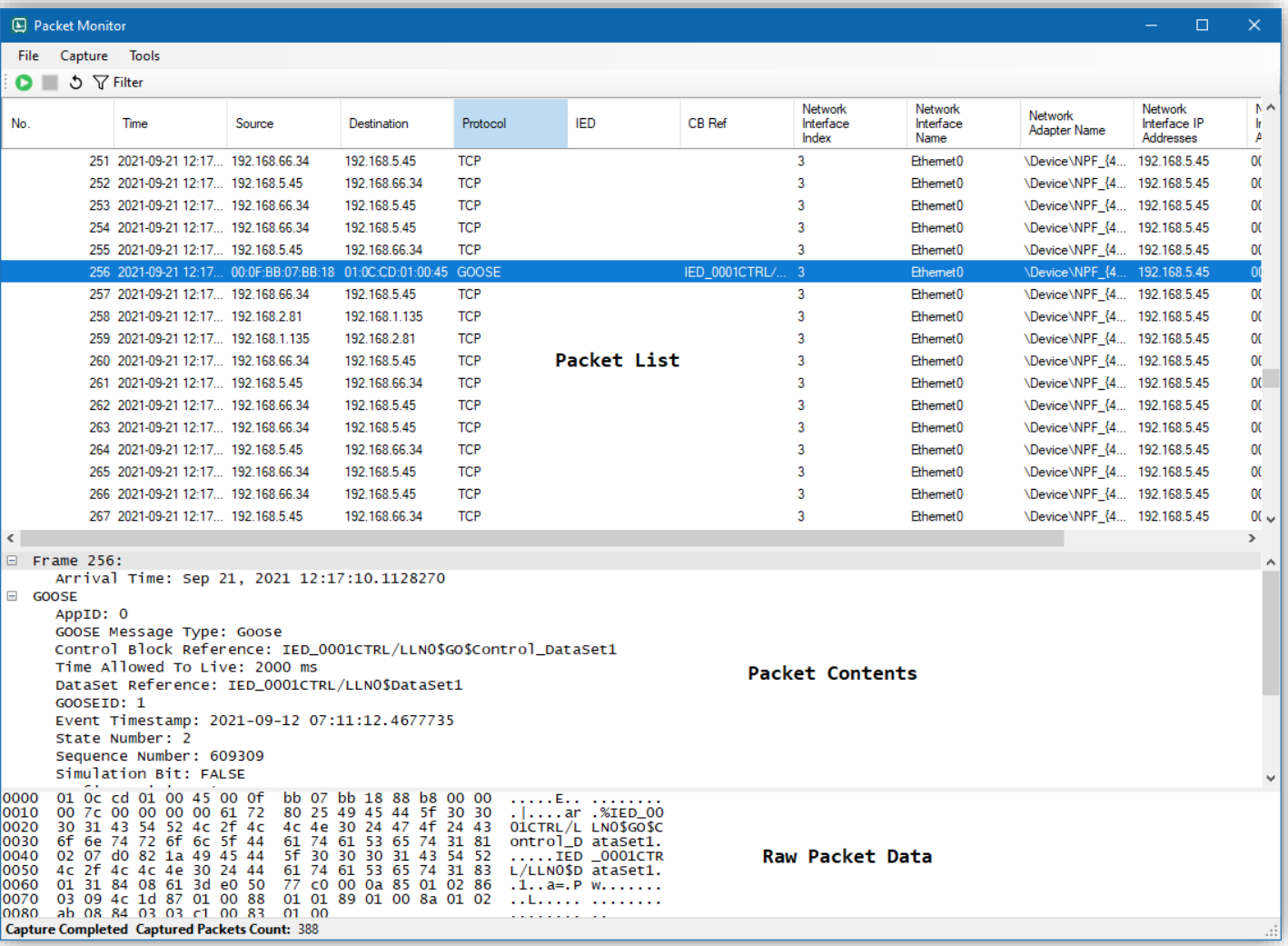




- **Automatic configuration**, visualisation and communications in a single step using SCL files
- **Subscriber** information from Logical Nodes (LGOS) to indicate which IEDs are not receiving the expected data
- GOOSE data extracted from the **Publishers**
- Details are displayed, including data set values, device mode, LGOS subscriptions, quality, timestamps...
- Detection of **Rogue messages**, unconfigured, error conditions, including duplicate publishers, out of sequence messages, mismatched ConfRevNum
- **Syslog client** so that all error conditions can be monitored locally or remotely for security purposes

# Packet Monitor





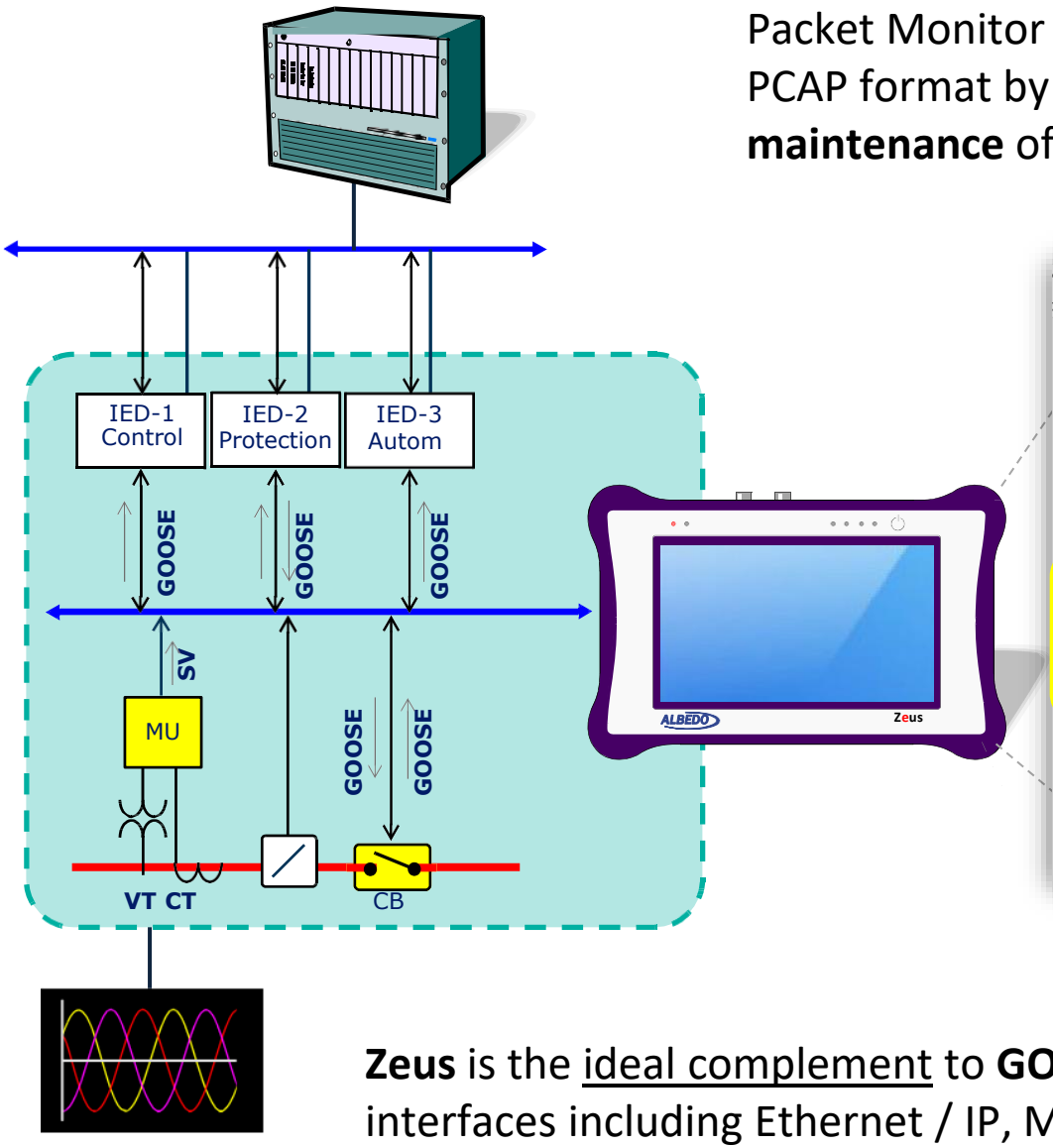

Packet Monitor is the application that provides an intuitive way to capture, view, store and replay GOOSE network traffic from one or more interfaces.

Captures can be filtered by:

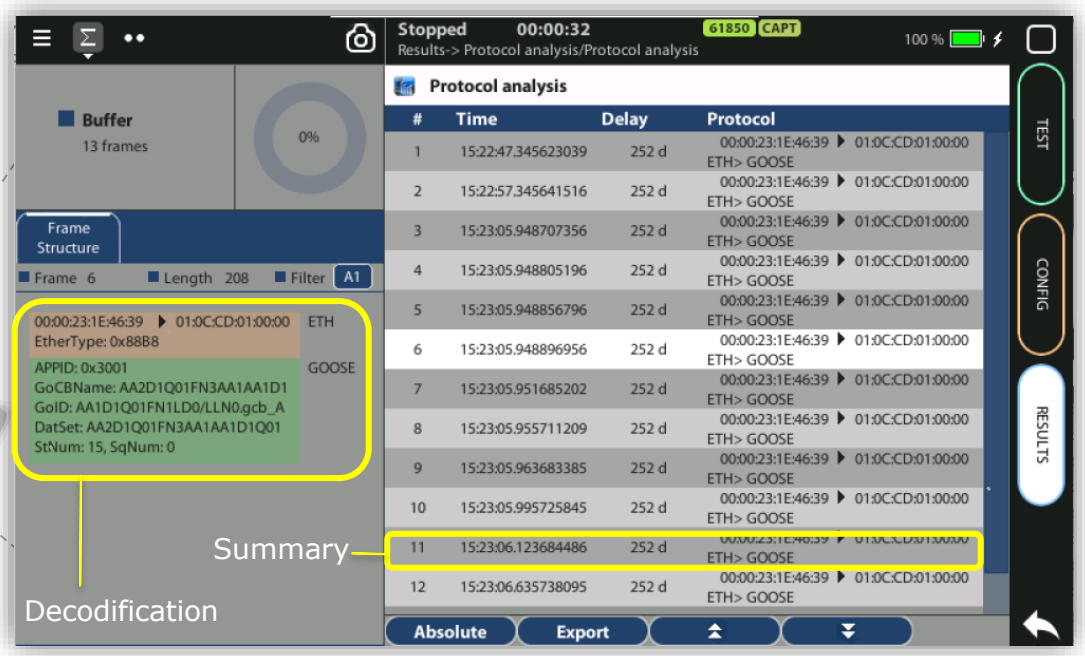
- IED
- Control Block Reference
- Protocol types
- Date/Time
- Ignored retransmissions

Messages can be saved to disc for later analysis. It can also read GOOSE messages captured by other devices and stored in PCAP.

# Packet Monitor & **Zeus**




Packet Monitor can read GOOSE messages captured and saved in PCAP format by **Zeus** which a tester designed for the **installation** & **maintenance** of communications in the energy industry.

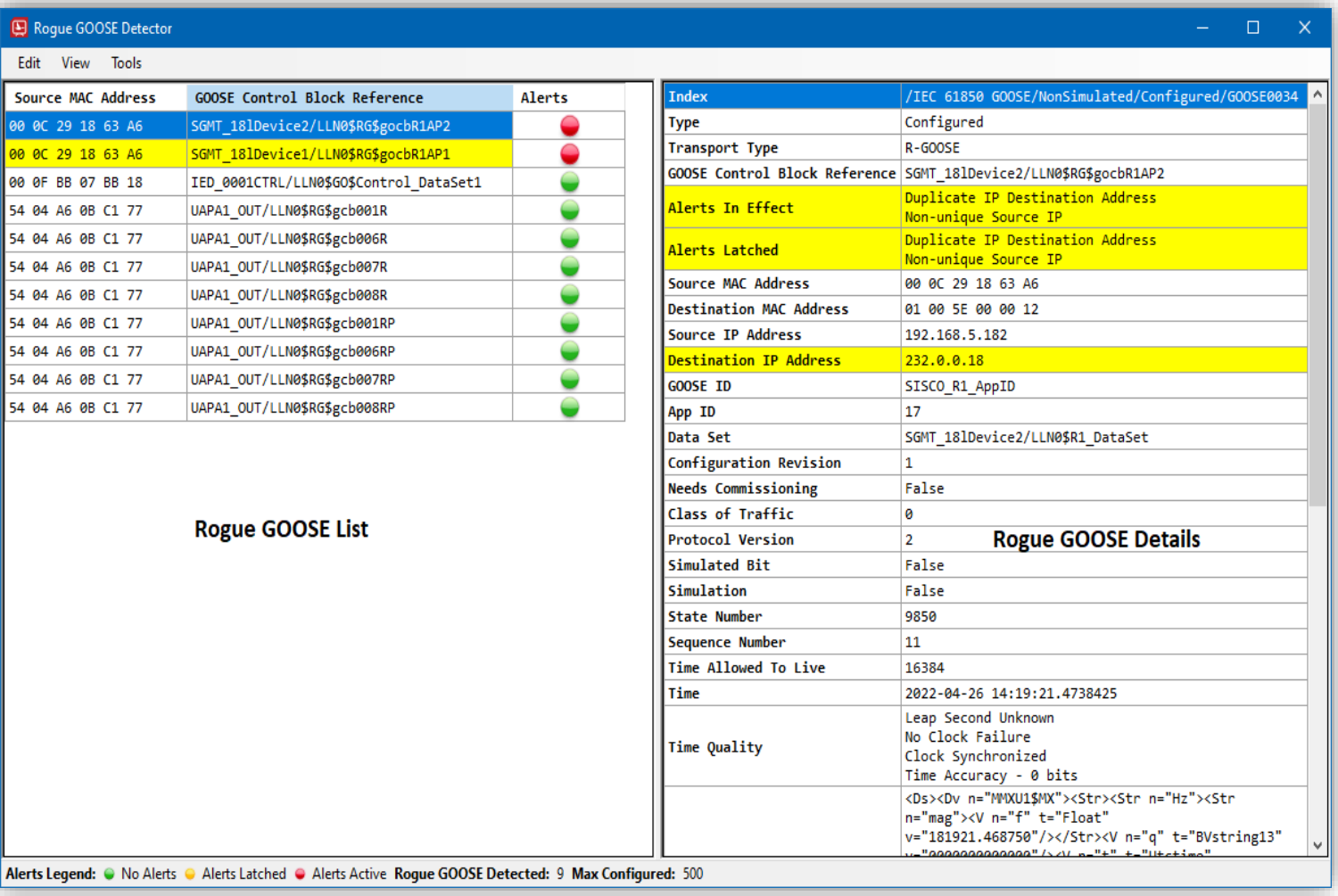



**Zeus** is the <u>ideal complement</u> to **GOOSE Auditor** as it supports legacy and IEC-61850 interfaces including Ethernet / IP, MPLS, PTP, SyncE, ToD, IRIG-B, T1 / E1, C37.94, G703, RS-232, GOOSE… used in the infrastructures of the utility substation.

# **Rogue** messages detection



Unauthorised messages are called **Rogue messages** because they can be disruptive and potentially dangerous to the substation. GOOSE Auditor alerts, captures and logs them according to several criteria:



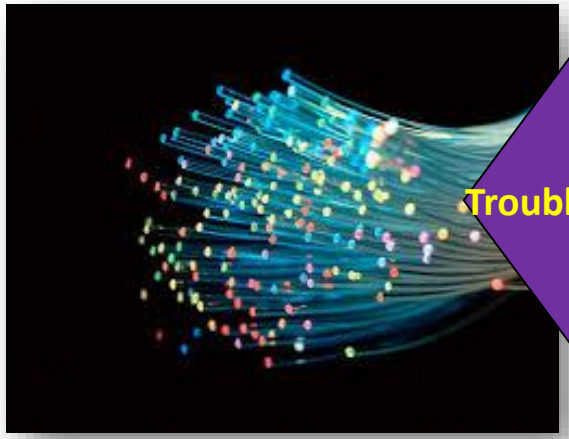

- Expired TAL
- Invalid StNum
- Missed StNum
- Out of Range StNum
- Out of Range SqNum
- Duplicate Frame
- Switched Simulation Mode
- Mismatched GoID
- Mismatched Dataset
- Unexpected ConfRev
- Bad Data
- Multiple Publishers
- Duplicate MAC/IP Address
- Non-unique Source IP

# GOOSE Auditor **Applications**



Utility Substations

Automation + Protection



Monitoring

Troubleshooting

**GOOSE Auditor**

Commissioning


Configuration

IEC-61850 deployments

IEDs & Relays

# Design & **Configuration**



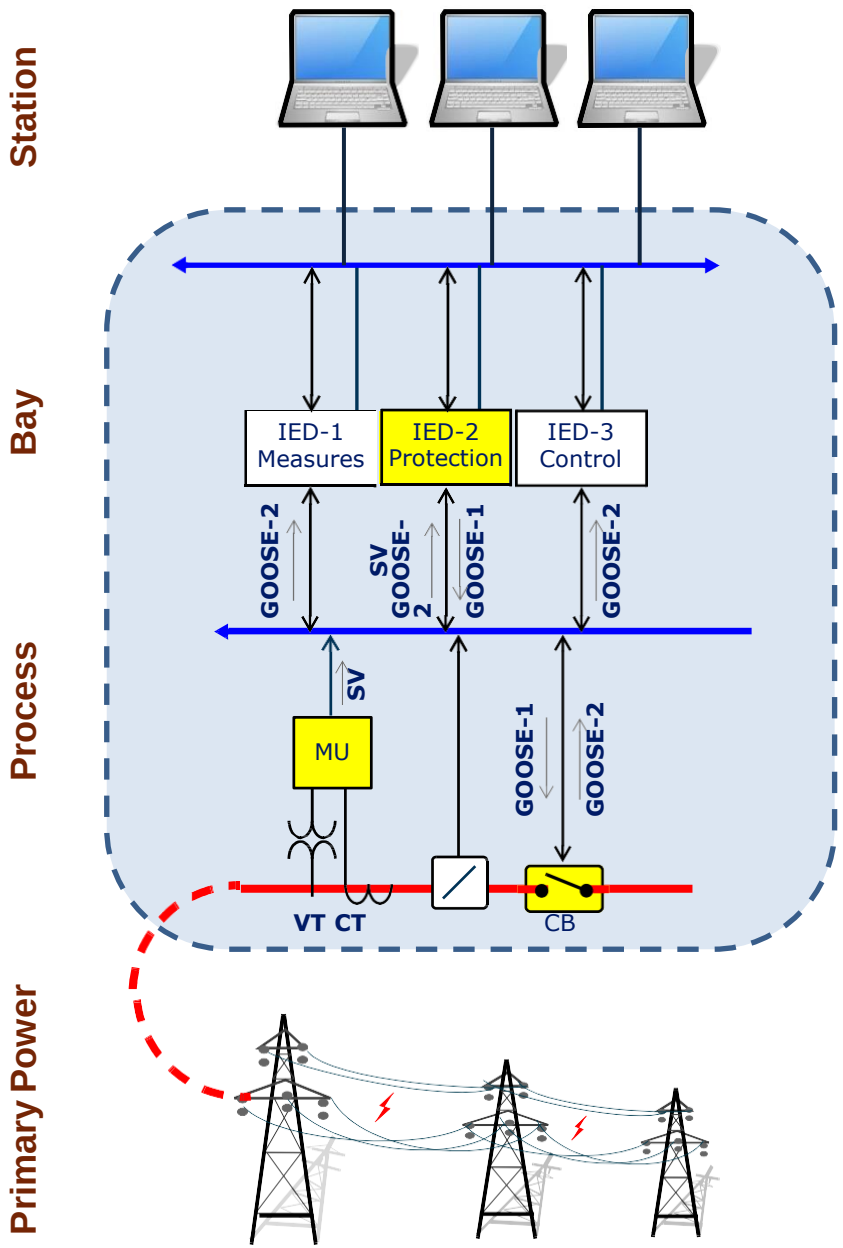
GOOSE Auditor facilitates the design of substations, the IEDs configuration and monitors the operation providing information on data structure, traffic, status and alerts:

- Unrecognised message
- Configuration error
- Invalid source or destination address
- Unpaired message due to invalid ID
- Block does not match definitions
- Message published from multiple sources
- Message out of range
- Missing message

All the messages and events can be are reported in the log.

# GOOSE **Installation**



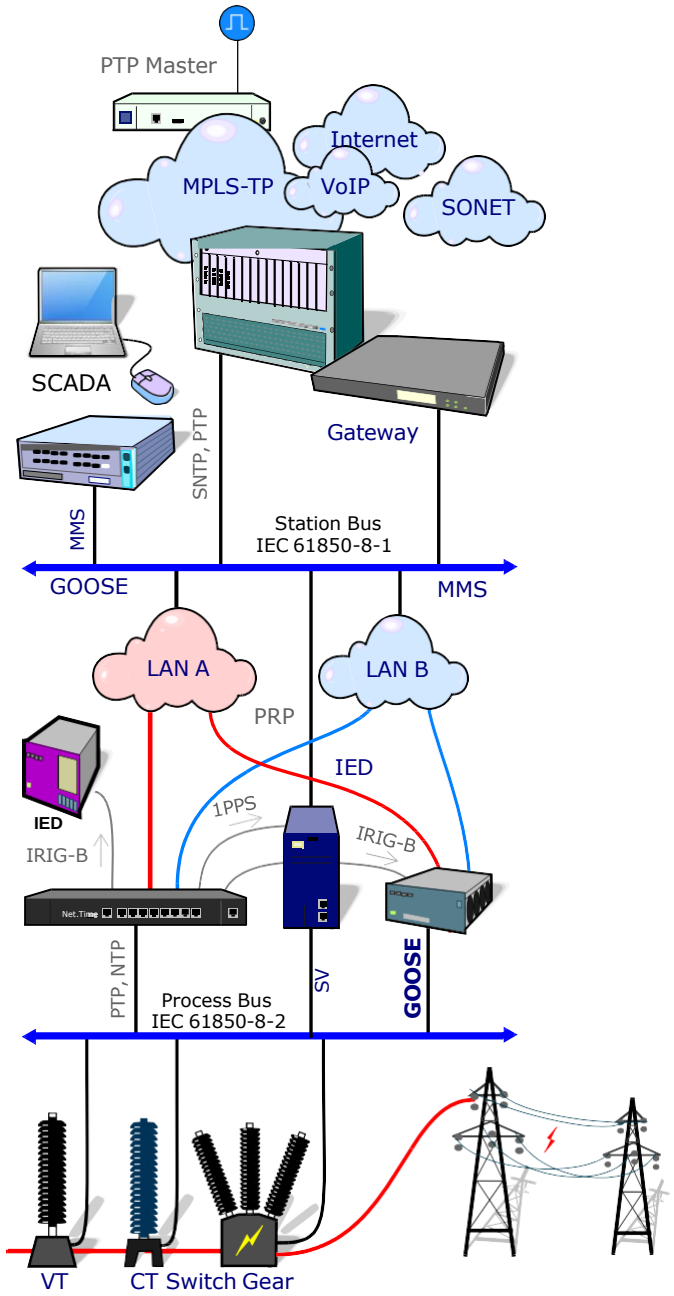



GOOSE Auditor can support GOOSE deployment by decoding messages, checking latencies, detecting rogue and invalid messages, generating special commands that are key factors to consider when verifying:

1. **Device Compatibility**: Ensure that all devices are compatible and support the GOOSE standard.
2. **Network Topology**: Determine the requirements such as bandwidth, latency, redundancy required by GOOSE.
3. **Message Configuration**: Configure the messages with the appropriate data attributes and types of events that will trigger the transmission of GOOSE messages.
4. **Security**: Ensure protection against unauthorised access, hacking, or other security breaches.

# IEC-61850 **Acceptance** & **Commissioning**



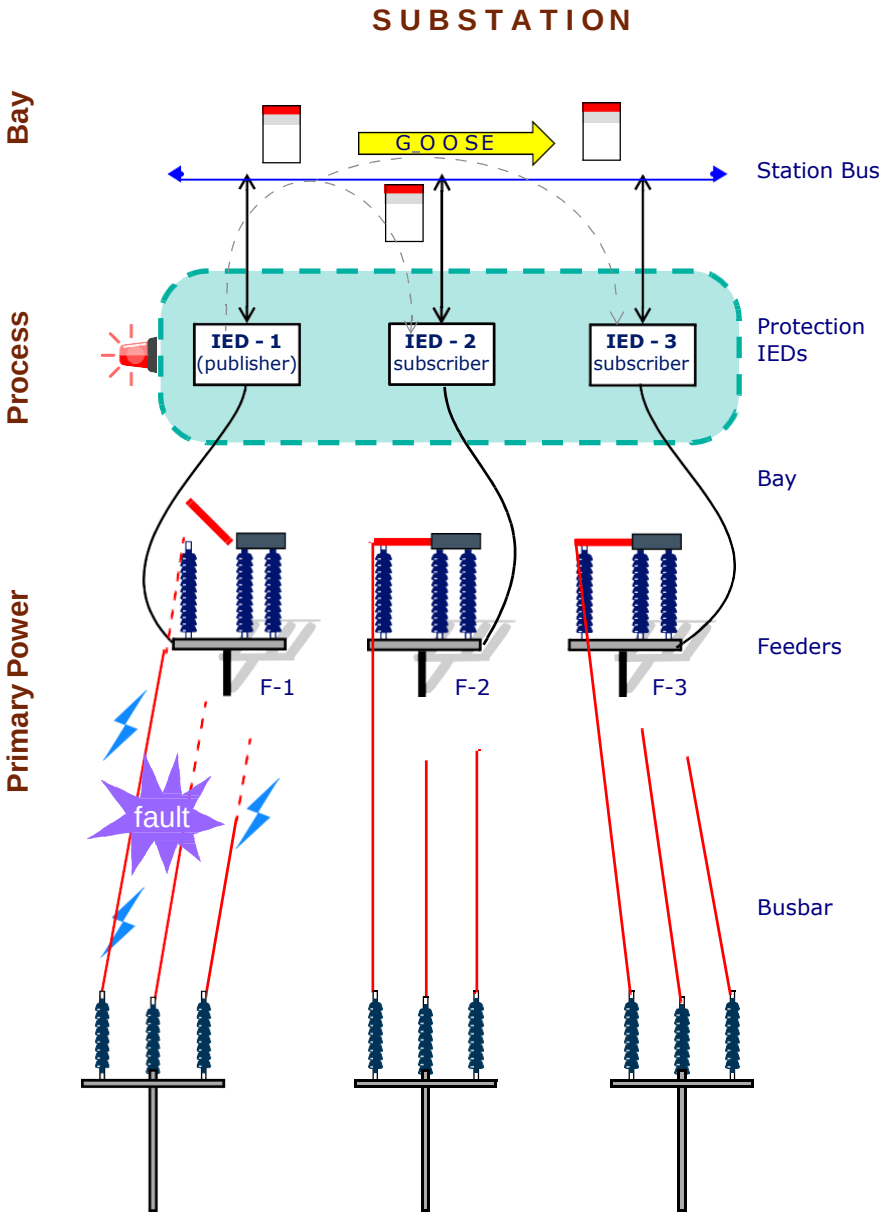



IEC-61850 acceptance and commissioning requires a detailed and rigorous testing process using GOOSE Auditor:

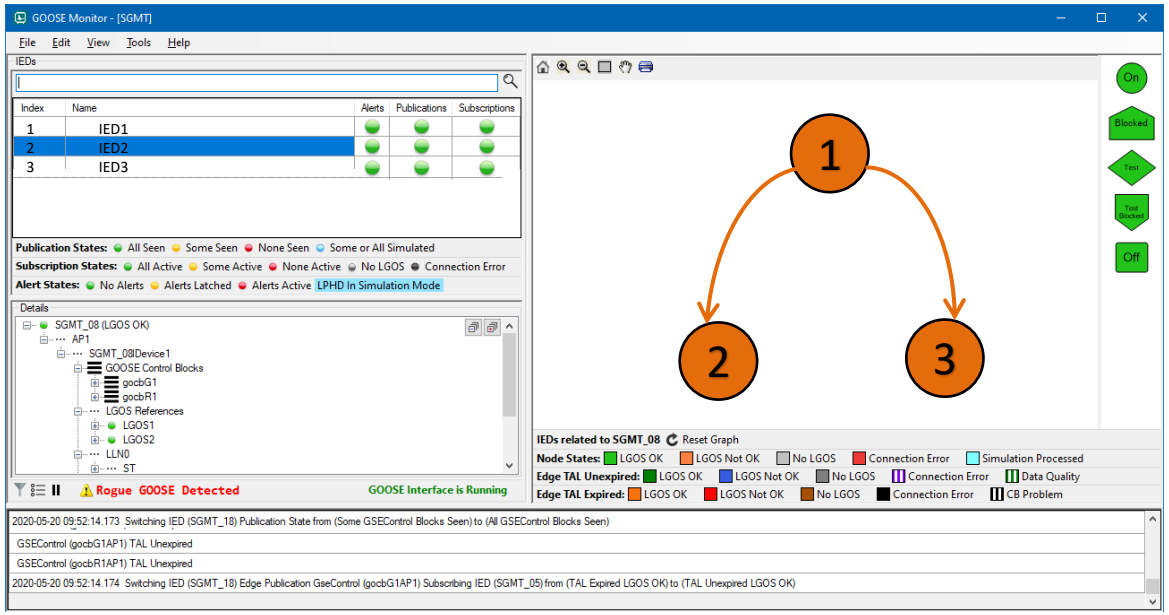
1. **Documentation**: Verify details and ensure that all required documentation, including manuals, datasheets and test reports are available and complete.
2. **Configuration**: Verify that the IED is correctly configured, including GOOSE messages (data attributes, data type, data length, etc).
3. **Test**: Verify that the IED is functioning correctly and that the GOOSE is functioning as intended. Perform functional, interoperability and performance tests.
4. **Communication**: Verify that the topology is appropriate and then ensure that the Publisher and Subscriber IEDs communicate properly.
5. **Security**: Apply security measures to prevent unauthorised access and detect rogue messages.
6. **Commissioning**: Verify that all connections are secure, and that settings are well configured.

# **Troubleshooting** sample: Sympathetic Trip Logic






IED-1, which protects Feeder-1, detects a fault and then sends a GOOSE message to indicate that an inrush condition will occur as a result of a voltage recovery. On receiving the message, IED-2 and IED-3 adjust their settings in anticipation of the inrush.




During the test of this procedure, GOOSE Auditor displays the IED and the sequence of messages and changes of the IED to block the sensitive overcurrent. It will also display any events that may eventually occur.

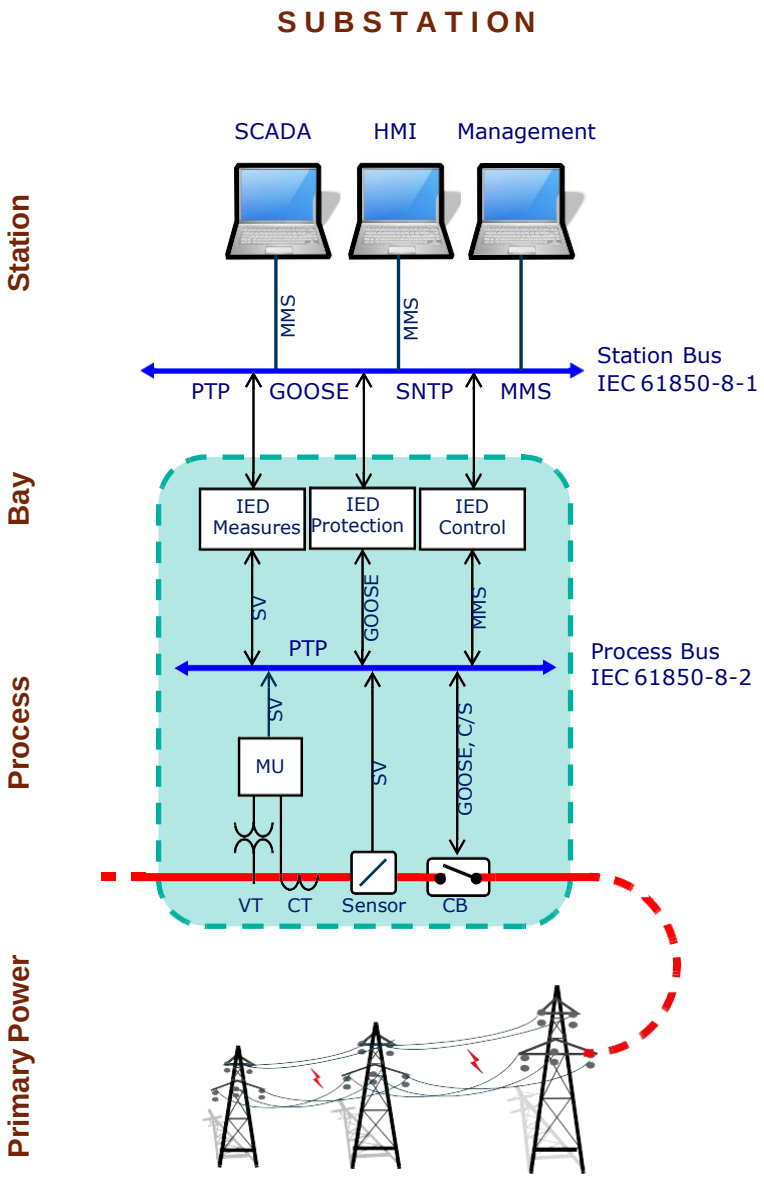
# GOOSE Auditor **Benefits**



- Comprehensive tool
  - Supports local or remote monitoring of faults and potentially harmful conditions, enabling proactive maintenance of the protection system.
  - Flexible configuration environment supports a variety of configuration methods, enabling use in any IEC 61850 system, even with incomplete or missing Substation Configuration Language (SCL) files.
  - Support for Ethernet GOOSE and Routable GOOSE (R-GOOSE) enables use in both LAN and WAN.
  - Hand-held, battery-powered tap for filtering and capturing in hard-to-reach locations without losing messages or affecting IEC 61850 traffic.
- Advanced Graphical Interface
  - Visualisation enables substation engineers view the complete  architecture of the network
  - Instantly representation of the events, errors or alarms that may occur
  - Display of the messages flows and state changes of devices

# About GOOSE



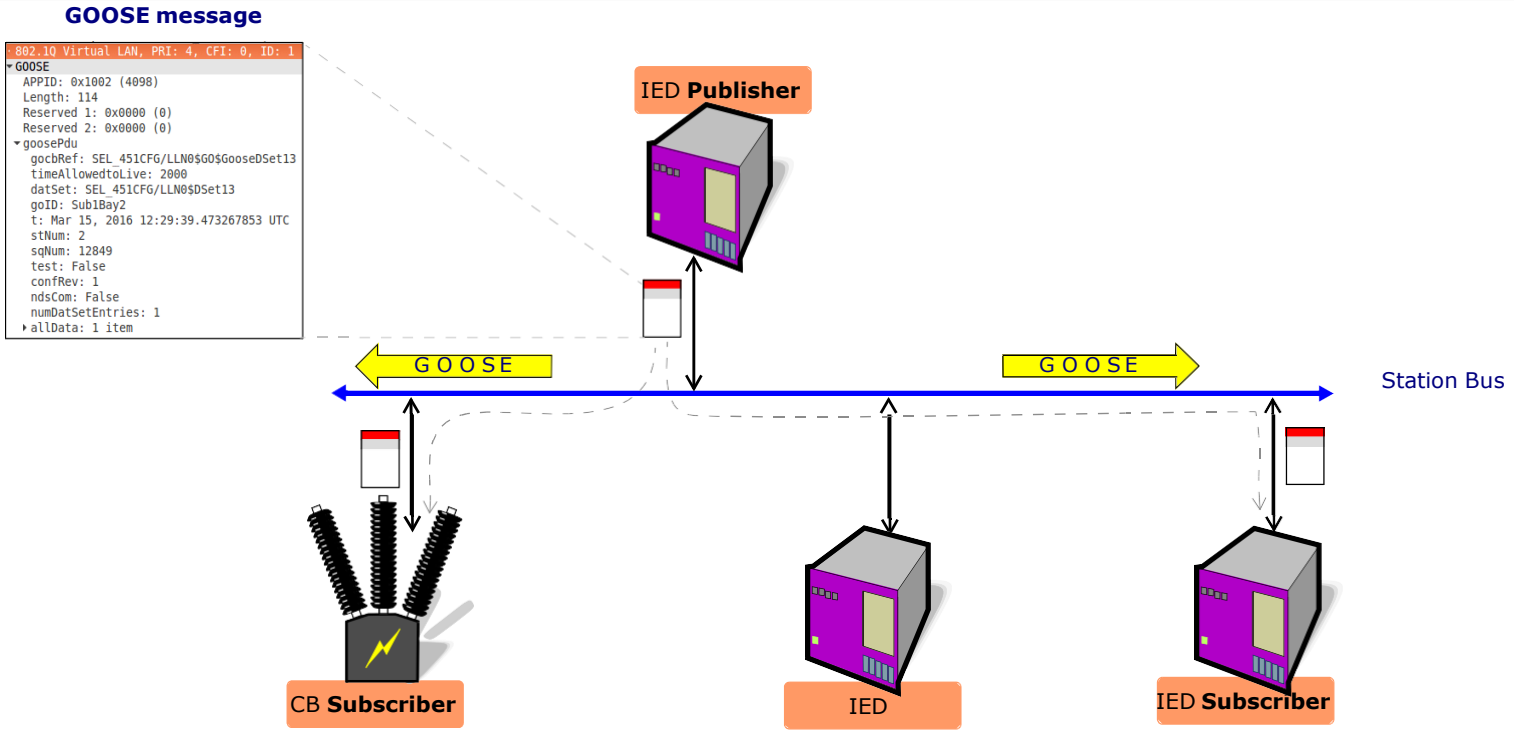



GOOSE is a messaging system used by IEDs and mission critical applications to communicate substation events such as commands, alarms, indications and measurements:

- Applications include switchgear tripping, disturbance recorder starting, interlocking position indication and teleprotection.
- As an L2 protocol, GOOSE operates in a real-time Ethernet context and is used for fast / reliable data distribution.
- The publisher/subscriber method is used: an IED sends a message that can be read by N receivers.
- The response of each receiver depends on its functionality and configuration. For example, a message indicates the position of the circuit breaker (open, closed, intermediate).
- No ACK mechanism, but messages are repeated cyclically for a certain time, even if there are no changes. The idea is to stay connected as a polling.
- Simplifies cabling, while the use of fibre optics unifies the traffic, dramatically reducing metallic cables.
- GOOSE is vendor interoperable and scalable.

# Publisher/Subscriber **method**

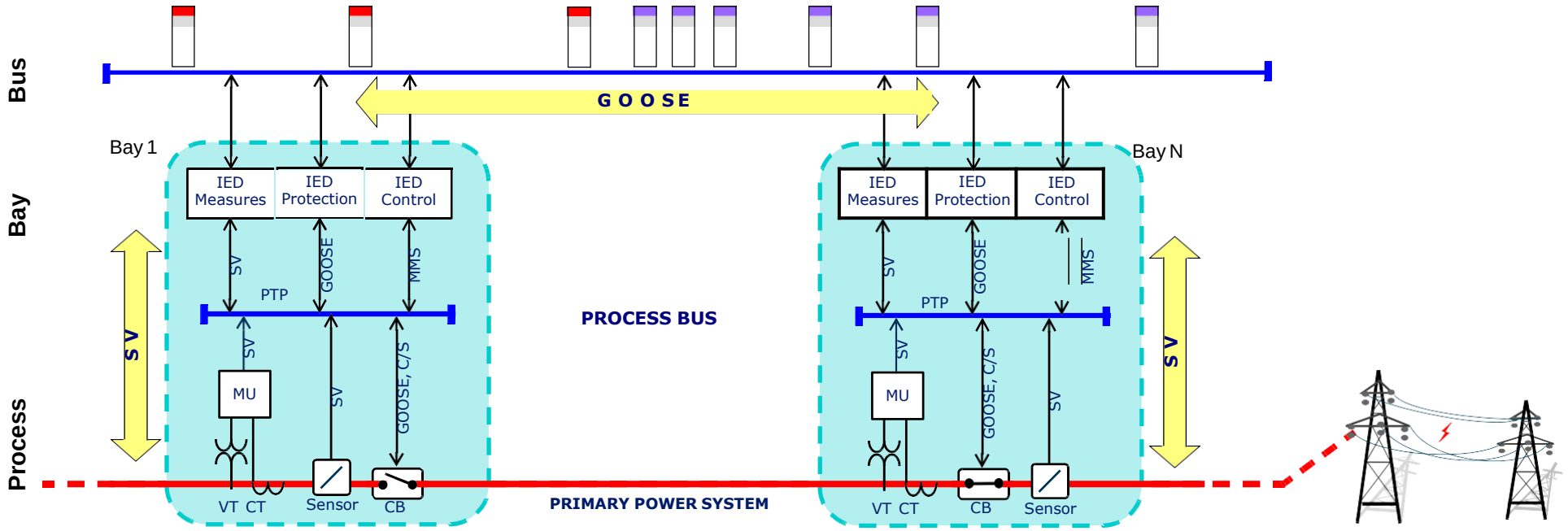





- GOOSE mapped directly to Ethernet for real-time communication
- Point-to-Multipoint connection or Multicast Application Association (MCAA)
- This method provides efficient information exchange between IEDs
- Circuit breaker tripping: short information that must be sent without loss within msec
- The Publisher IED sends a message that only the subscribers receive; the reaction of each receiver depends on its configuration and functionality

# Heartbeat






Under normal operating conditions, the IED transmits and retransmits GOOSE messages cyclically - this is the heartbeat of the substation. The health of the GOOSE messages is closely monitored to ensure timely delivery. A missing message is an indication to subscribers that communication from the publisher has been disrupted.

GOOSE messages are repeated to account for possible lost datagrams due to congestion or failure scenarios. The IEC 61850 architecture prioritises GOOSE and SV traffic to guarantee high speed and avoid degradation of Layer 3 traffic used for normal Ethernet LAN traffic.

# Message **Decoding**



```
802.1Q Virtual LAN, PRI: 4, CFI: 0, ID: 1
GOOSE
  APPID: 0x1002 (4098)
  Length: 114
  Reserved 1: 0x0000 (0)
  Reserved 2: 0x0000 (0)
 goosePdu
   gocbRef: SEL_451CFG/LLN0$GO$GooseDSet13
   timeAllowedtoLive: 2000
   datSet: SEL_451CFG/LLN0$DSet13
   goID: Sub1Bay2
   t: Mar 15, 2016 12:29:39.473267853 UTC
   stNum: 2
   sqNum: 12849
   test: False
   confRev: 1
   ndsCom: False
   numDatSetEntries: 1
  allData: 1 item
```

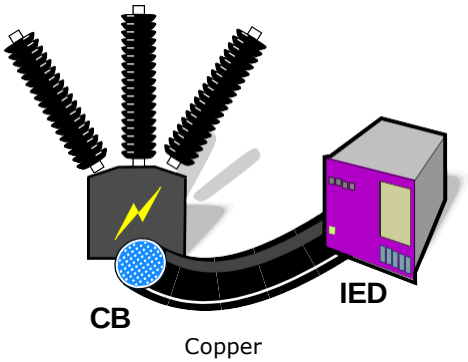
GOOSE Messages have the following data structure:

- **gocbRef**: address of the information
- **timeAllowedtoLive**: time to the next retransmission
- **datSet**: contents description
- **goID**: message identifier
- **t**: actual time
- **stNum**: state number is a message counter
- **sqNum**: sequence number of repetitions
- **test**: test message not a true value
- **confRev**: compatibility verification
- **ndsCom**: tells about the configuration
- **numDataSetEntries**: number of DataSet entries
- **allData**: data of the GOOSE message

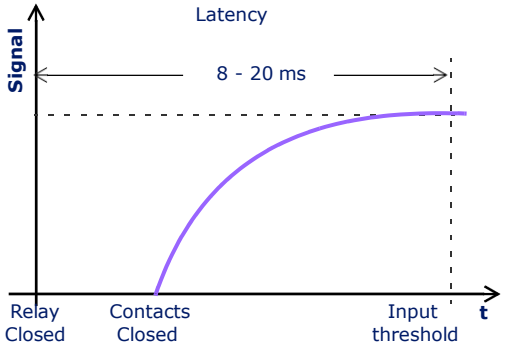
1. if timeAllowedtoLive is greater subscribers can assume a communications failure
2. StNum + SqNum can be used to detect intrusion (cybersecurity without encryption)
3. if test = true indicates that the message is used only for test and simulations

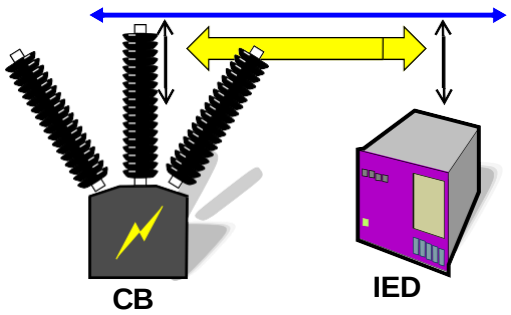
# GOOSE vs. Hardwired



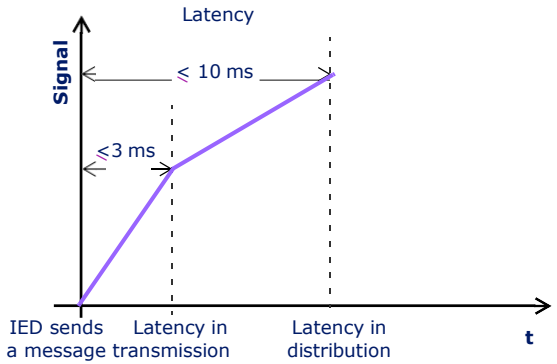



**Hardwired Performance**




**GOOSE Performance**




The performance of hardwired solutions is based on relays that, in the worst case, the IED transmission time can be 3/4 of the cycle (15ms), which is improved with the GOOSE alternative to less than 3ms.

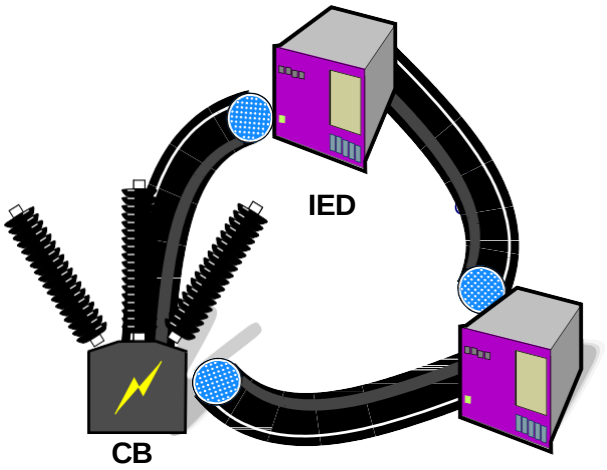
When a GOOSE message is generated by the IED (IEC 61850 server), it uses a layer 2 multicast transmission to send the event on the network. Receiving devices, called subscribers, subscribe to the multicast address of the message to quickly filter the information and perform the required task(s).

The requirements for a GOOSE message are stringent - no more than 4 ms should elapse between the time an event occurs and the time the message is received.

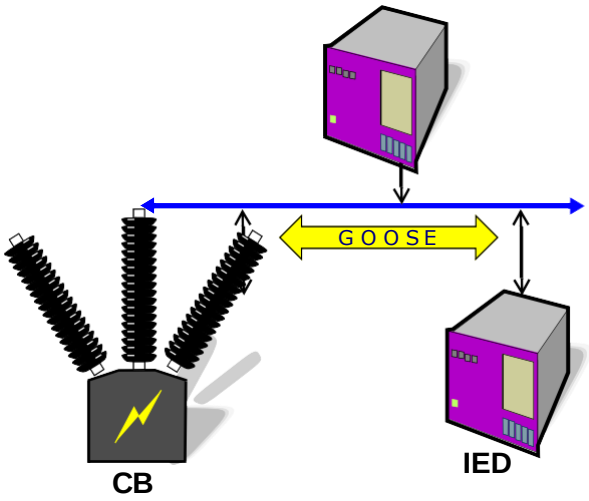
# GOOSE **Benefits**



Hardwired Signals



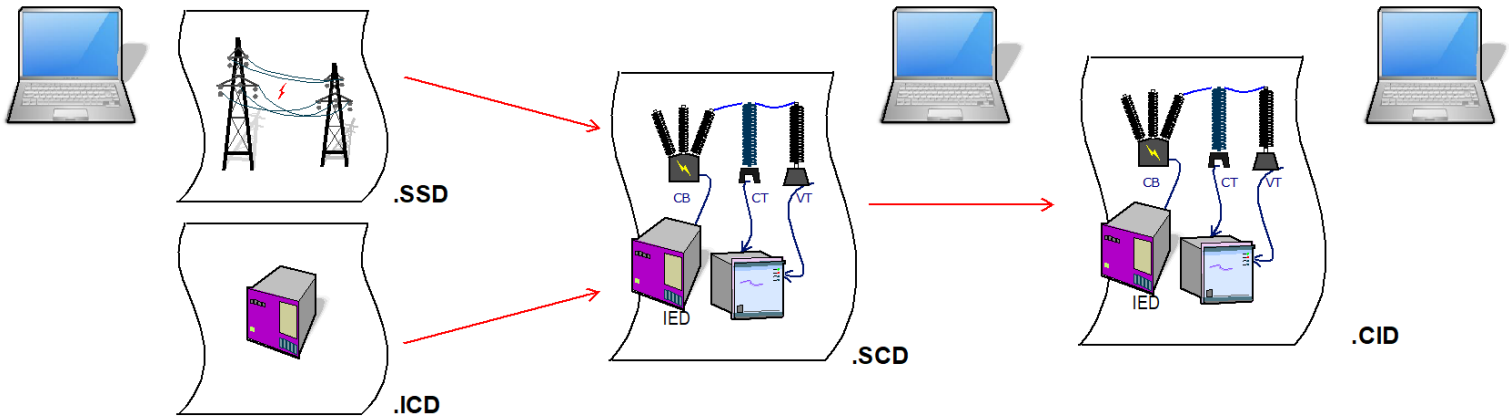

Communicating via GOOSE




- **Installation costs**: by replacing thousands of individual copper control cables with a limited number of fibre optic cables from the terminal blocks to the relay terminals with a single pair of fibres.
- **Test costs**: by simplifying the testing of all hardwired interfaces against Ethernet GOOSE messages.
- **Flexibility**: GOOSE messages and SCL virtual signals can be used without the need to be physically present in the substation.
- **Multipoint**: a single message can reach multiple subscribers, simplifying interconnection, especially when multiple IEDs are involved, for example in a protection operation.
- **Interoperability**: the use of a standard improves the reliability of both IEDs on each side of a multi-manufacturer subscription.
- **Reduced maintenance:** If hard-wired connections cannot be monitored, then verification of all interfaces between individual components of the protection and control system is expensive.
- **Remote testing:** of protection systems in a digital substation allows testing to be performed remotely using GOOSE and SV messages.

# SCL: Engineering & Information structures



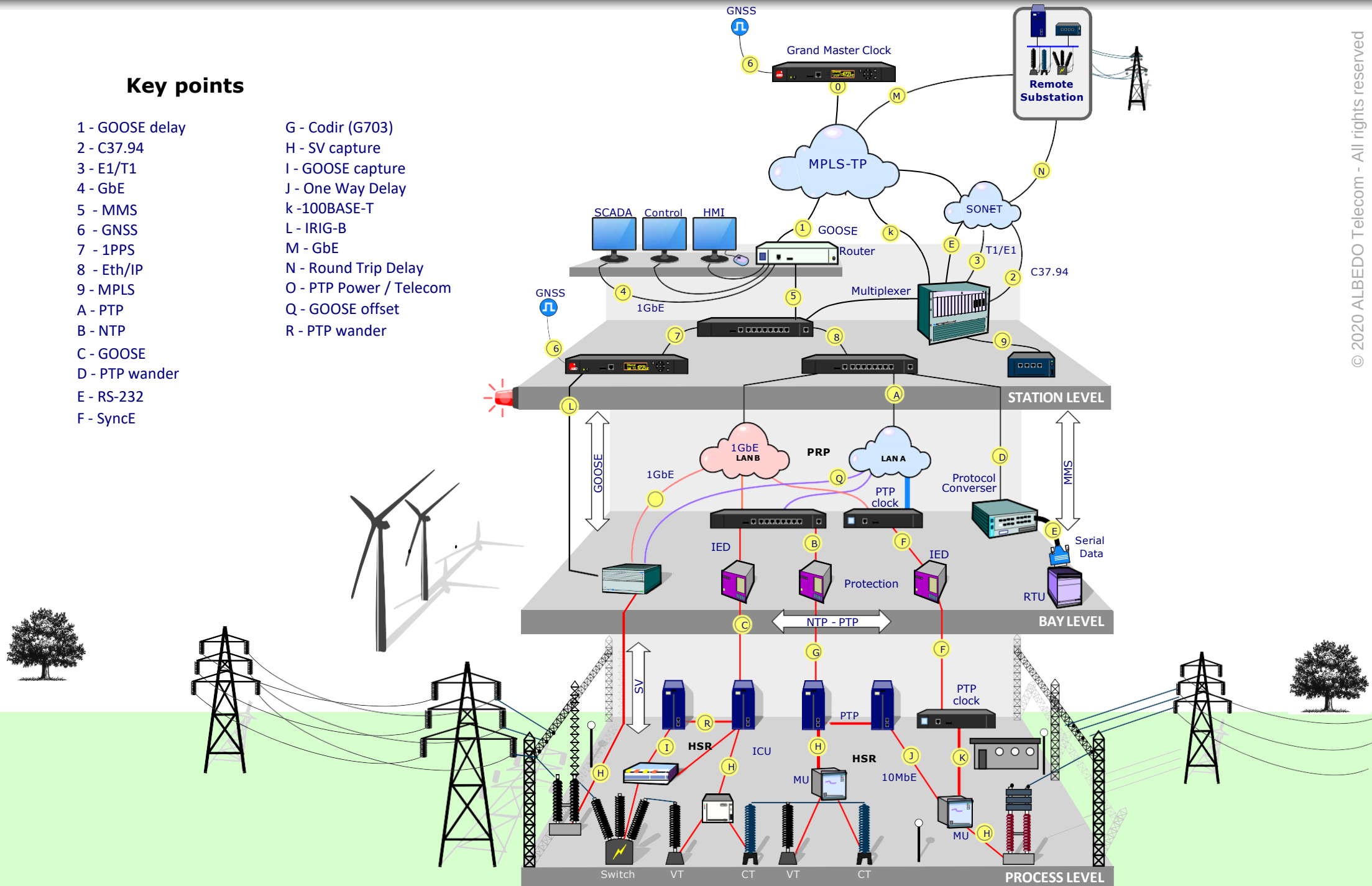



The Substation Configuration Language (SCL) allows the configuration of substations to be described in terms of data structures and protocols that are used to exchange information between IEDs. SCL includes import/export files to simulate and facilitate vendor interoperability. SCL terms:

- **Logical node**: the smallest part of a function that can exchange data. For example, an XCBR has a data structure called POS that indicates its position (closed, open, intermediate).
- **Logical device**: a group of logical nodes. For example, we can group PIOC (instantaneous current) with PIOTC (time current) and a logical IED groups several logical devices.
- **ECL language**: the description of the SSD substation.
- **ICD capabilities**: description of the substation as an addition of all IEDs.
- **SCD**: Substation Configuration Description is the combination of SSD
- **IEDs.CID**: Individual configuration of each IED that can be transferred to individual IED.

## Key points

1 - GOOSE delay
2 - C37.94
3 - E1/T1
4 - GbE
5 - MMS
6 - GNSS
7 - 1PPS
8 - Eth/IP
9 - MPLS
A - PTP
B - NTP
C - GOOSE
D - PTP wander
E - RS-232
F - SyncE
G - Codir (G703)
H - SV capture
I - GOOSE capture
J - One Way Delay
k -100BASE-T
L - IRIG-B
M - GbE
N - Round Trip Delay
O - PTP Power / Telecom
Q - GOOSE offset
R - PTP wander



That' all

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