Overcoming IEC-61850 Challenges

ALBEDO

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

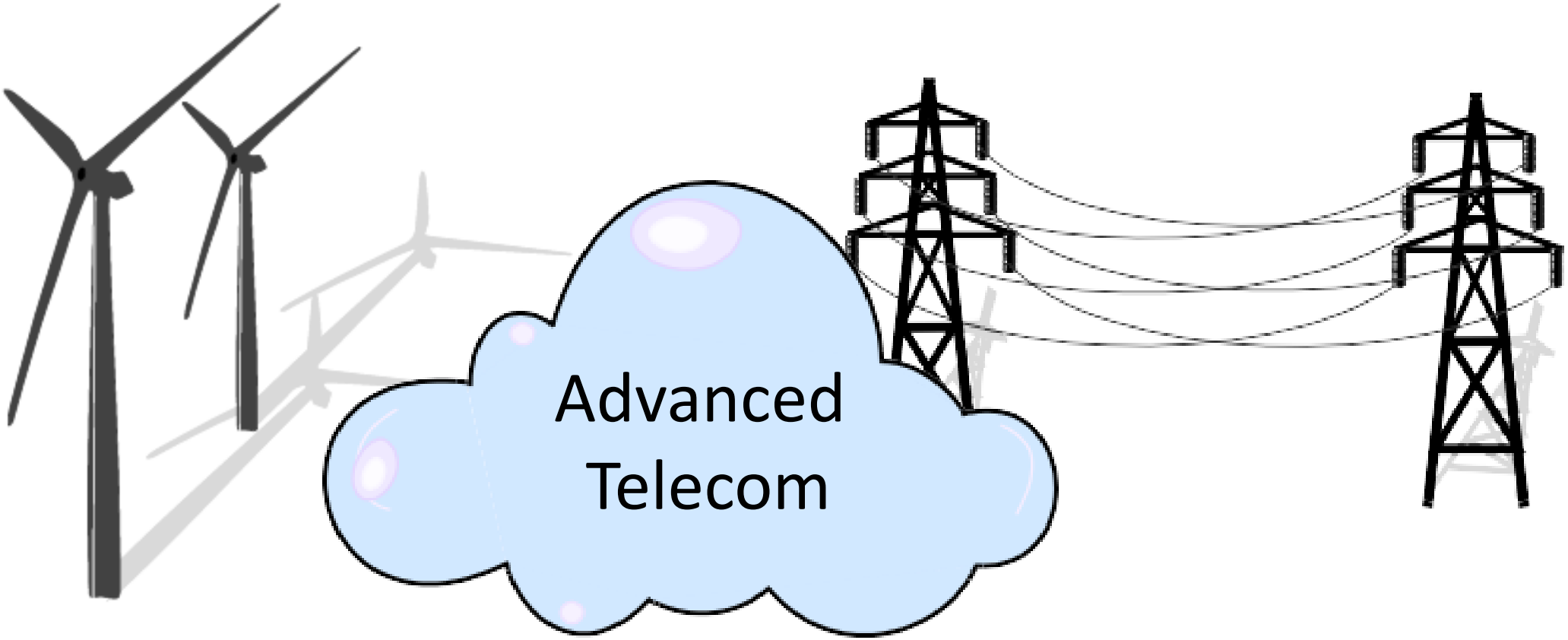
ICT electronics (1983)

Trend Comms (2001)

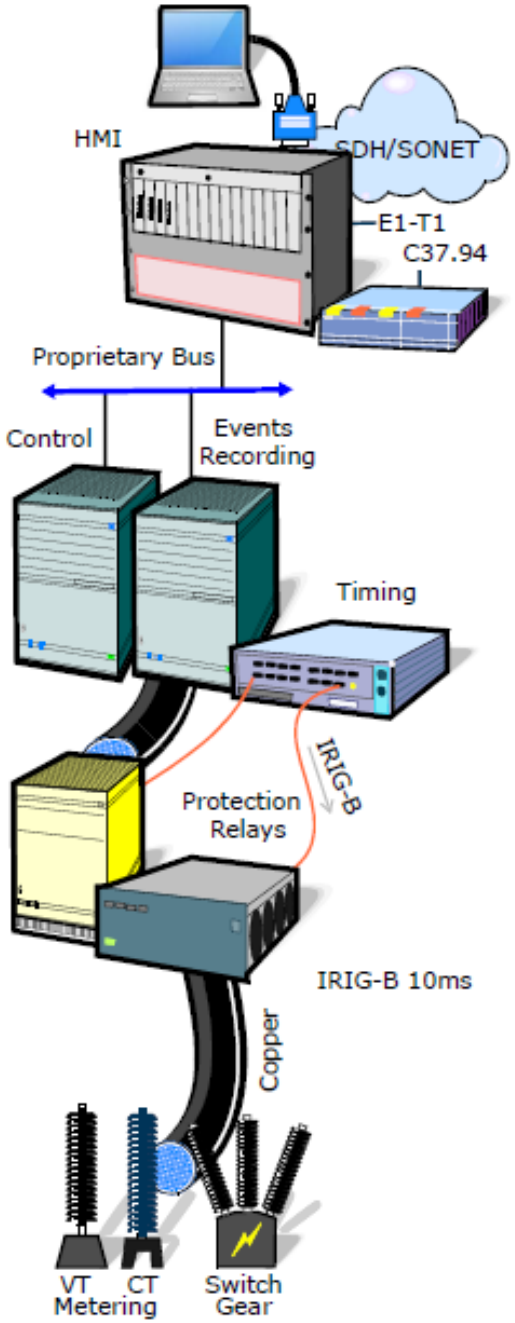
ALBEDO (2009-today)

THE NEW SMART GRID

Quality of Power Service



The shift to IEC-61850



Conventional

1985 → **2025**

Proprietary → Multivendor

Point-2-Point → Multipoint

Electrical → Optical

Analog → Digital

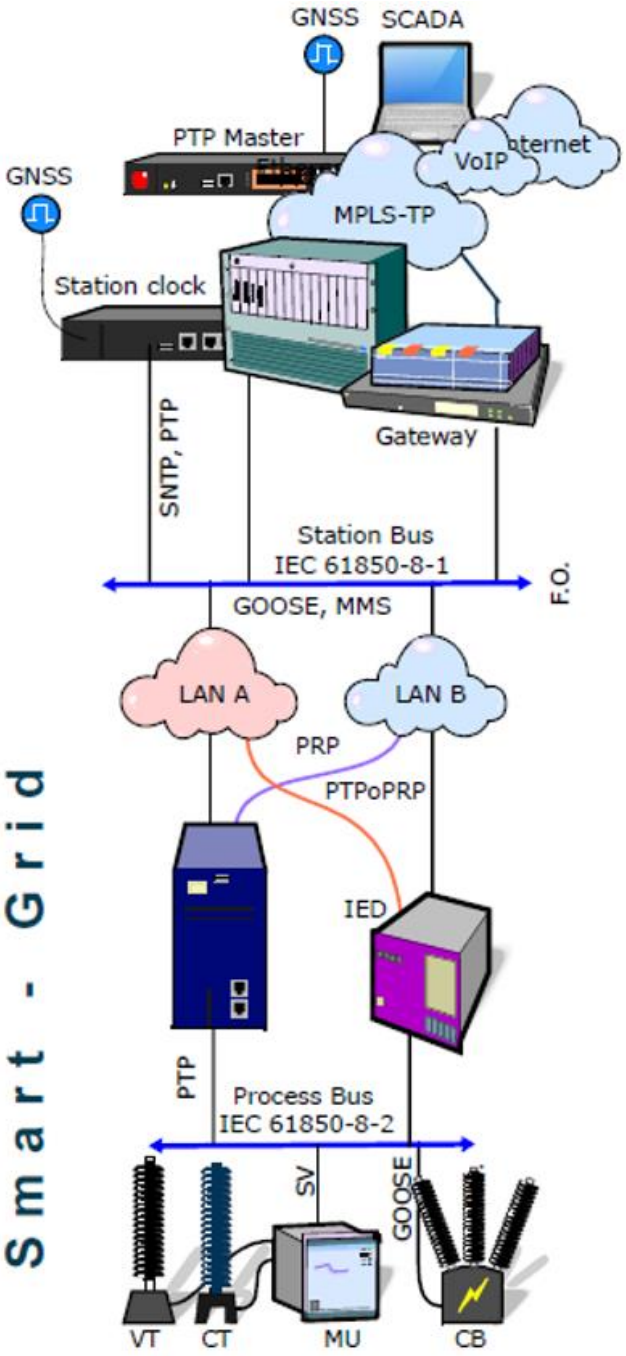
Serial → Ethernet

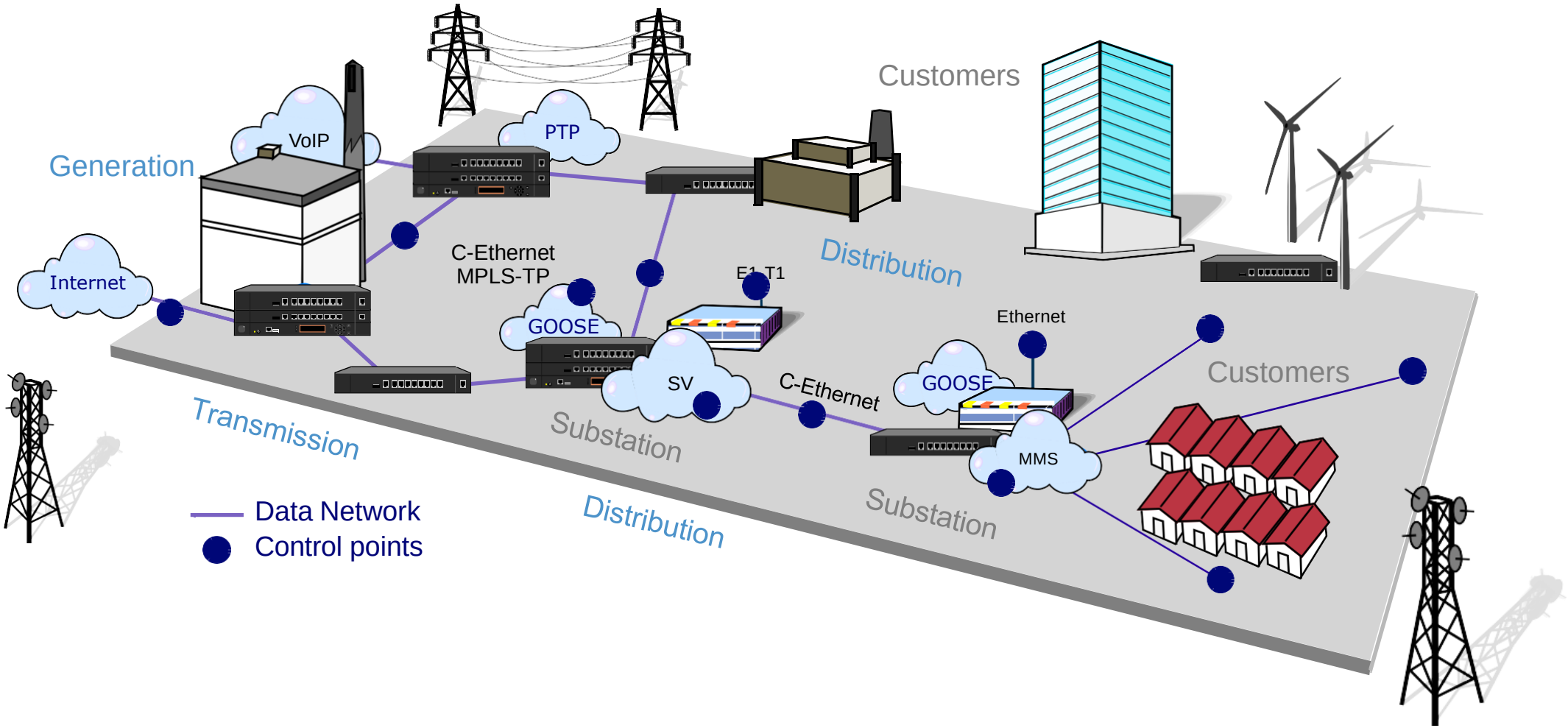
C37.94 → GOOSE

SDH → MPLS-TP

IRIG-B → PTP

Smart - Grid



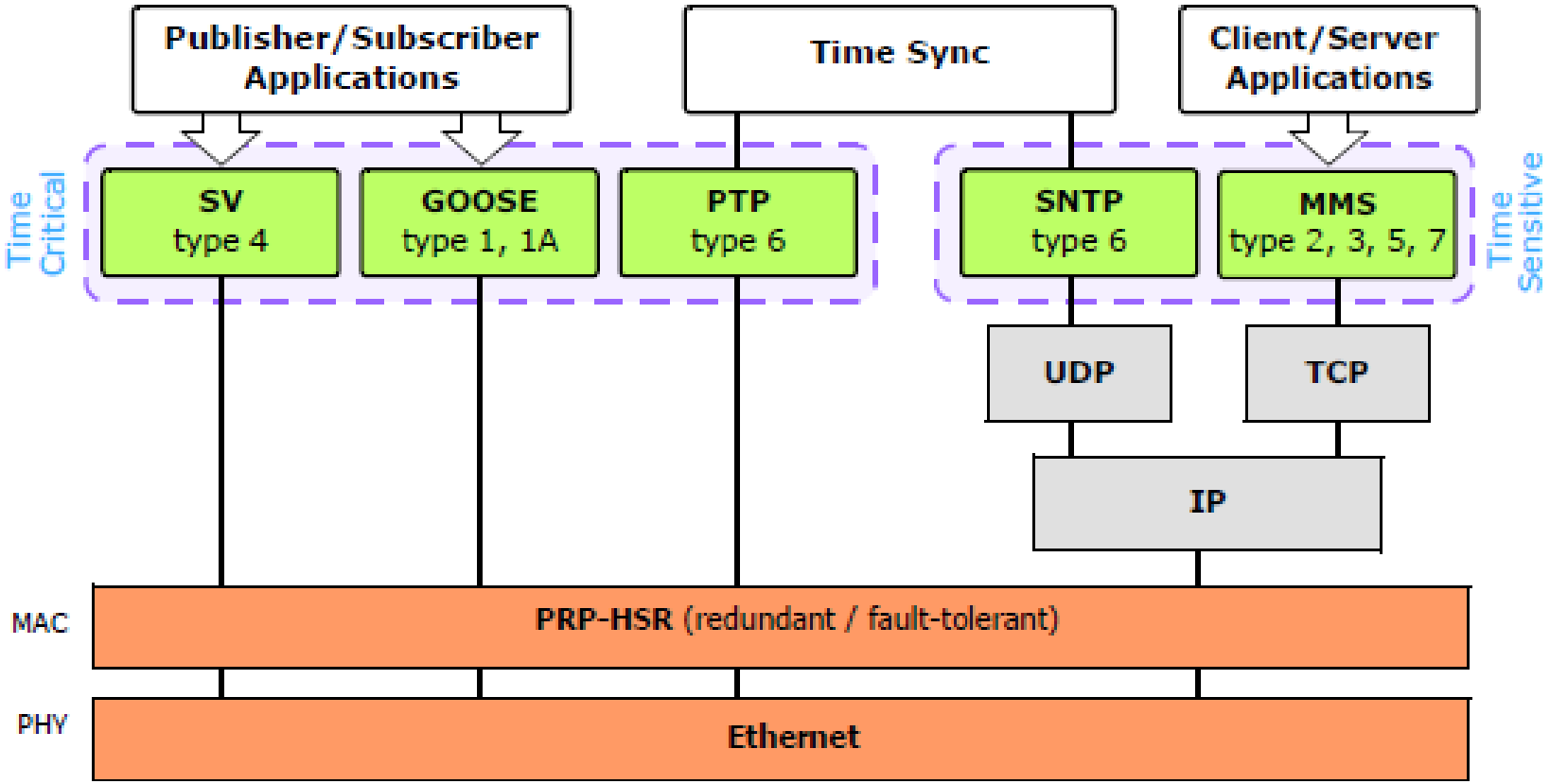


Smart Grid concept relays on telecom technologies that connect the resources to facilitate the **configuration, control**, **monitoring, management** while increasing the **efficiency, resilience** and **security**.

LEARN & PLAY

IEC-61850 is complex

After more than 20 years of refinement, IEC 61850 is finally entering in a deployment phase— combining control, protection with precision timing



Do not underestimate the challenge: study, learn, test and then deploy

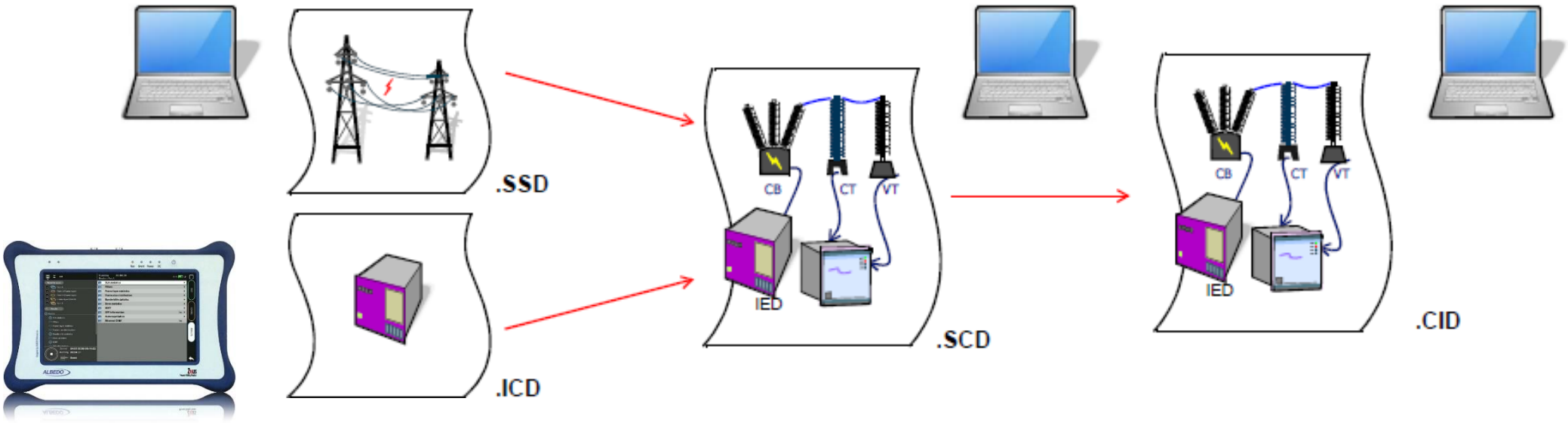
Knowledge of IEC 61850 is a must

Challenge: Engineers are skilled in electricity but lack knowledge in Ethernet architectures, Timing and Control protocols that are the base of IEC 61850.

Pain: Long commissioning times, misinterpretation of failures.

Solution: Use modern digital tool and test automation.

Engineering Data models



Challenge: Configuration using SCL Language, IED Descriptions, Substation Configuration… is powerful but hard to manage specially in hybrid environment.

Pain: Engineers struggle to validate or understand configurations.

Solution: Managing and understanding SCL files requires new skills.

Att!: Don’t rely only on vendor tools, consider testers and simulators for trials.

INTEROPERABILITY

Conformance Test



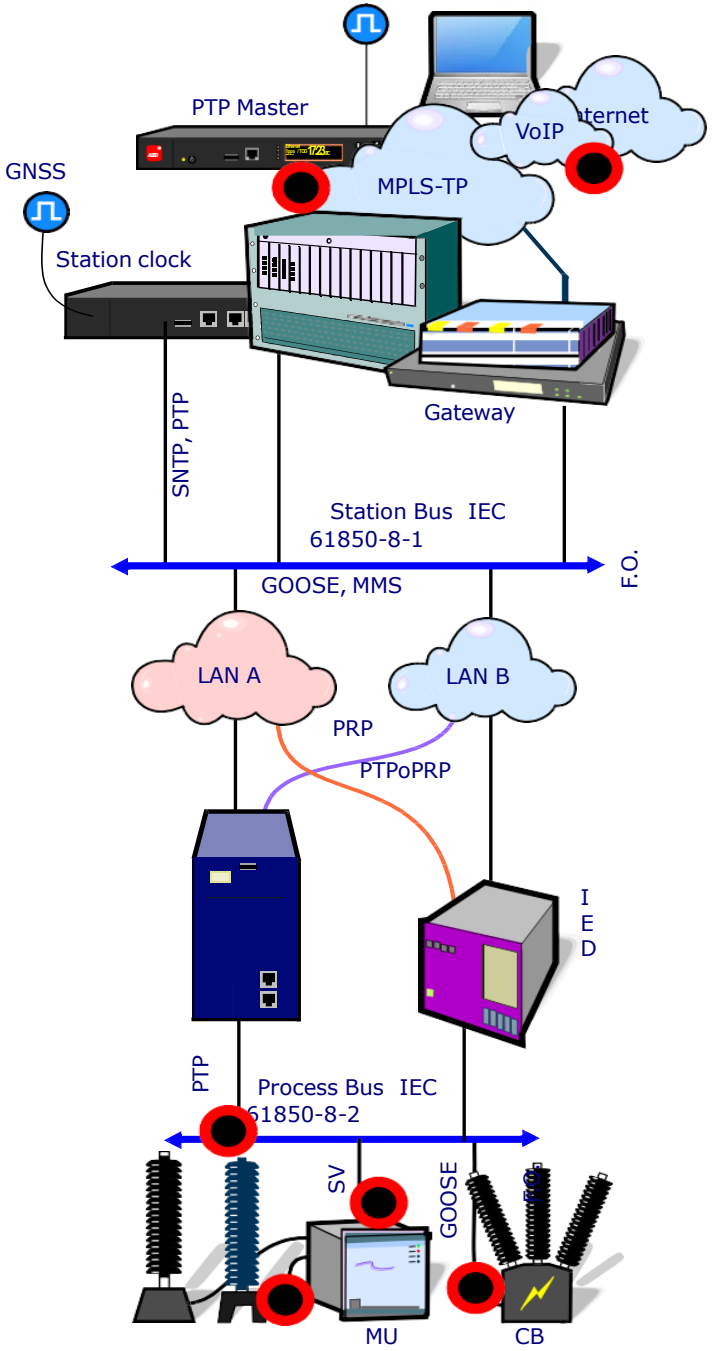
Challenge: IEC 61850 is one standard however it is required to verify its implementation because vendors have a lot creativity: PTP extensions, GOOSE variations...

Conformance tester

Pain: Some IED, Clocks, MU, do not meet or go beyond.

Solution: Conformance test is required to ensures that an IED correctly implements GOOSE, MMS, SV, etc. or a Clock meets the precise timing and packet structure of IEEE 1588 or specific PTP power profiles.

Acceptance Tests



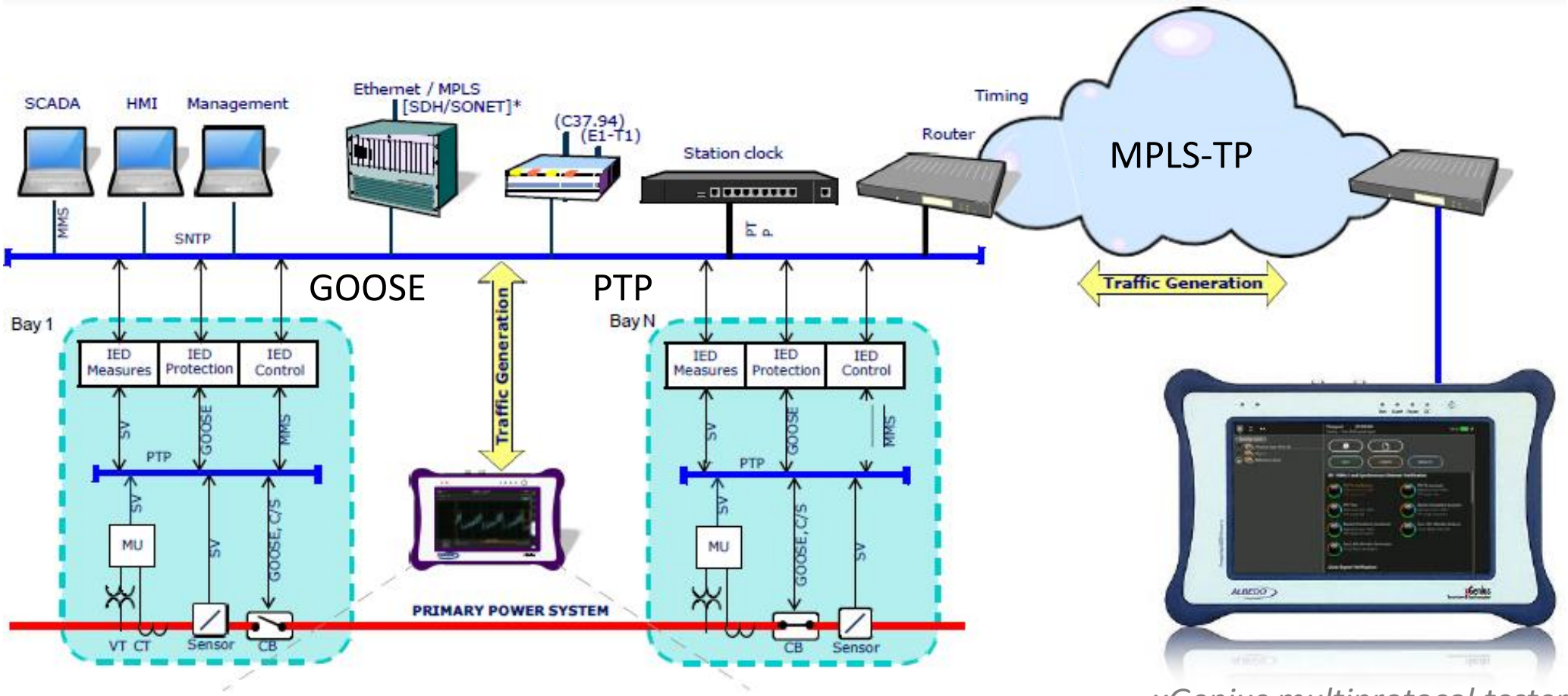
Challenge: conformance does not guarantee Plug-&-Play it is necessary to verify the device performance in the intended environment.

Pain: Lack of Interoperability!!

Solution: Acceptance confirm the operational requirements under real context to verify IEC, MU, Clocks… It may include traffic conditions, network topology, interoperability, performance under load, failover scenarios, etc.

Net.Storm a WAN simulator for Acceptance test produces real traffic conditions and QoS

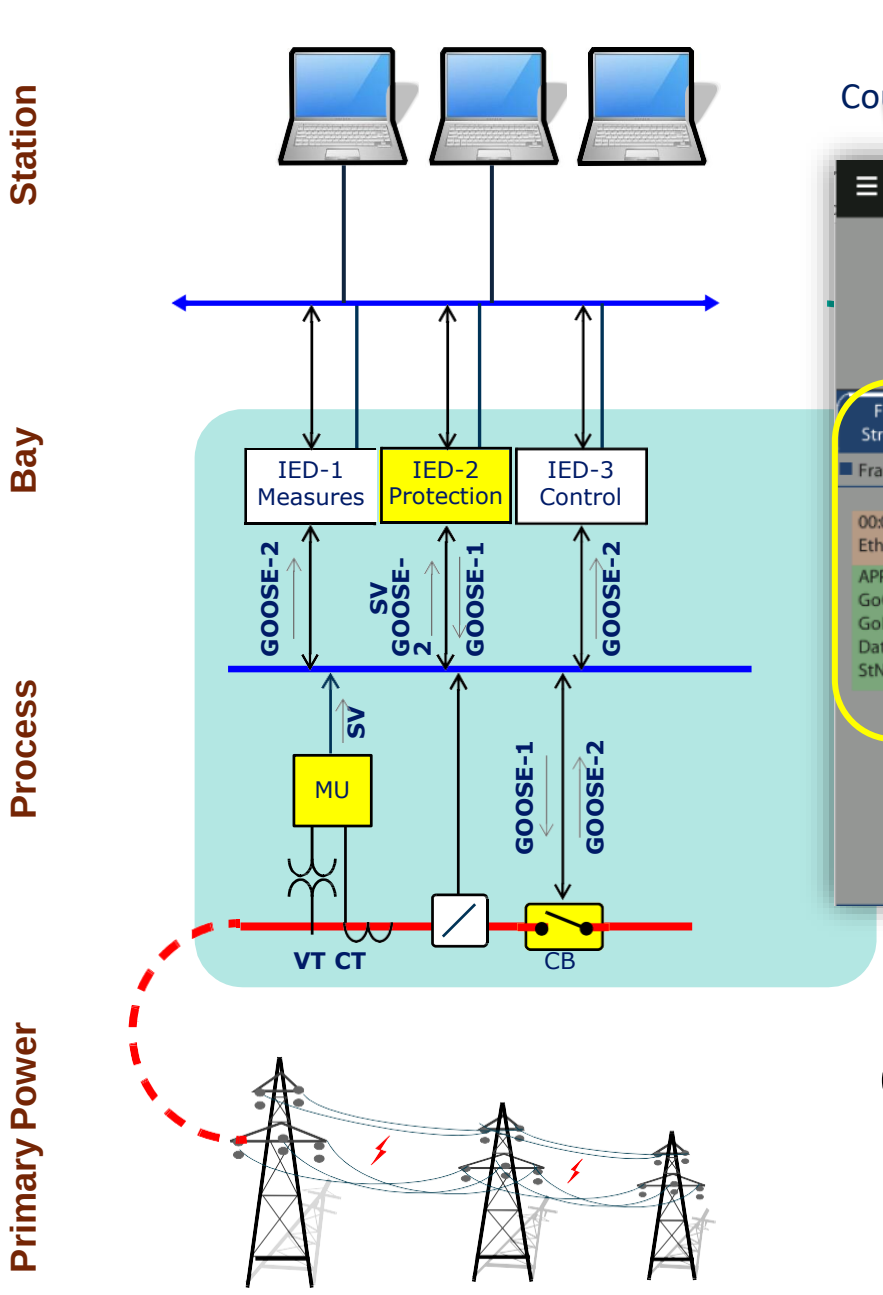
Commission the installation

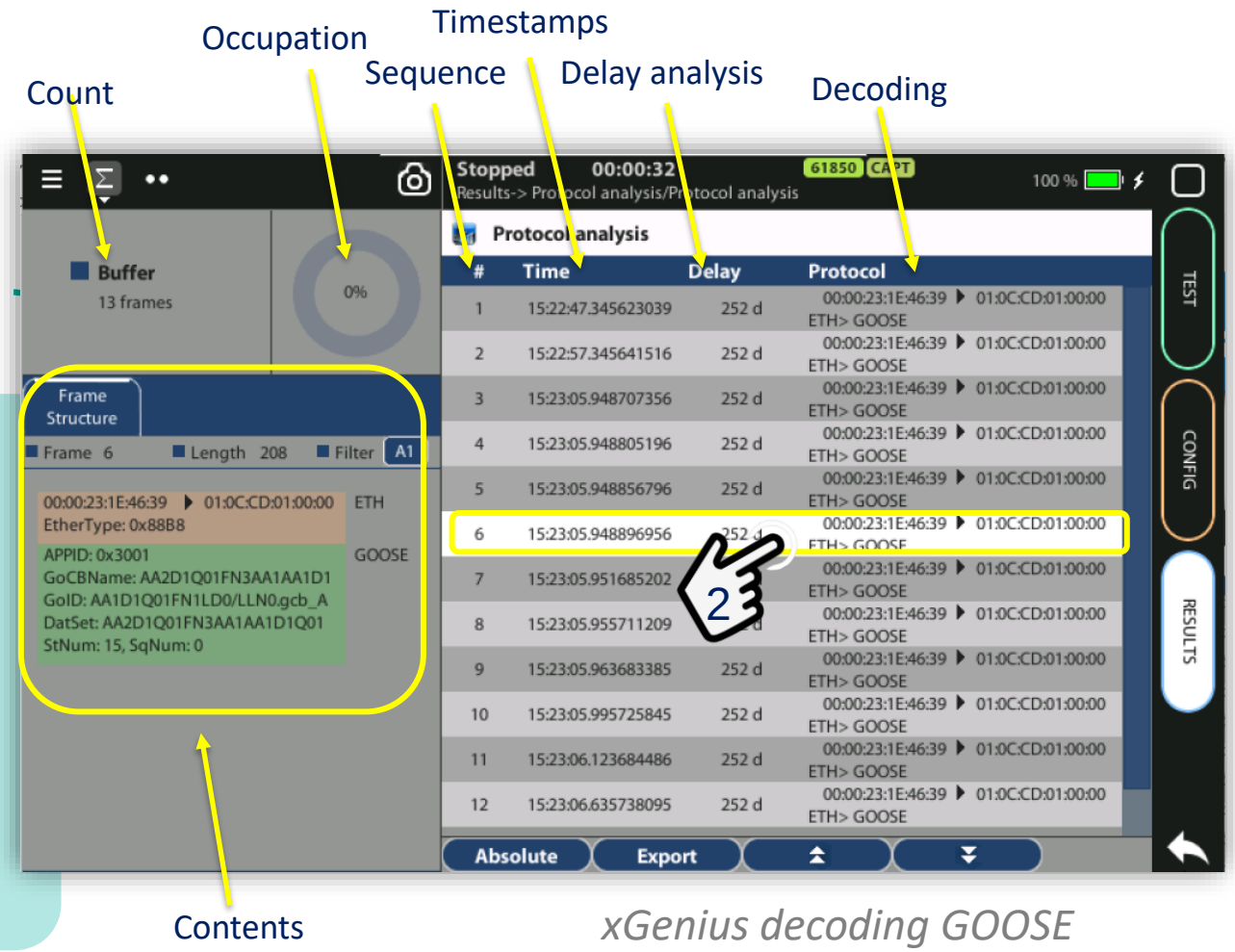


xGenius multiprotocol tester

Commissioning will be the final process that brings together conformance and acceptance testing ensuring that meet customer needs verifying that everything from protocols and timing to communications and security—works as intended in the live environment.

GOOSE conformance





xGenius decoding GOOSE

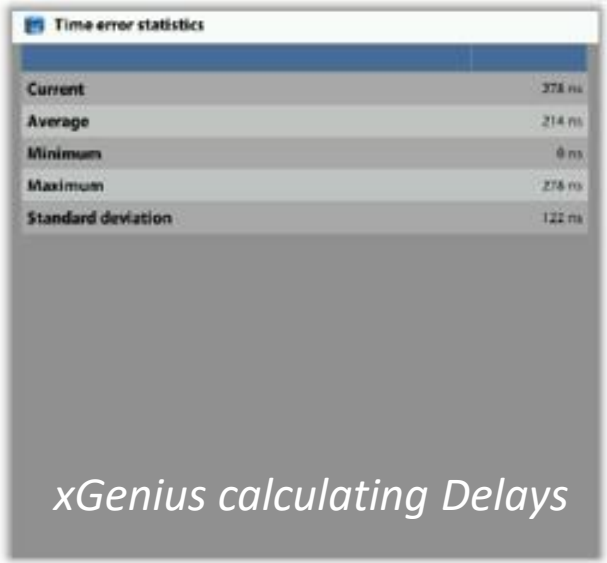
Objectives

- Decoding of faults in GOOSE protocol
- Facilitate interconnection multivendor
- Verify and adjust the latency of GOOSE packets

GOOSE, SV, PTP delay conformance

Type	Message	Protocol	Layer	BWidth	Delay	Priority	Bus	Model	Application
1A	Trip	GOOSE	L2 - Multicast	Low	< 3 to 10ms	High	Process	Publisher	Protection
1B	Other	GOOSE	L2 - Multicast	Low	< 20 to 100ms	High	Process	Publisher	Control
2	Med Speed	MMS	L3 - IP/TCP	Low	< 100 ms	Medium Low	Process & Station	Client/Server	Data collection
3	Low Speed	MMS	L3 - IP/TCP	Low	< 500 ms	Medium Low	Process & Station	Client/Server	Data collection
4	Raw Data	SV	L2 - Multicast	High	< 3 to 10ms	High	Process	Publisher	Analysis, Protection
5	File Transfer	MMS	IP/TCP/FTP	Medium	< 1000 ms	Low	Process & Station	Client/Server	Management, Data
6	Timing	PTP	L2 - PTP	Low	Protection < 0,1 to 3ms Transformers ±1 to ±25us	Medium High	Process & Station	Unidirectional	Timing, IED, Synchrophasors
7	Command	MMS	L3 - IP	Low	< 500 ms	Medium Low	Station	Client/Server	Cconfiguration

IEC-61850 protocols to synchronize, configure, manage, control, protect, measure and data collection.

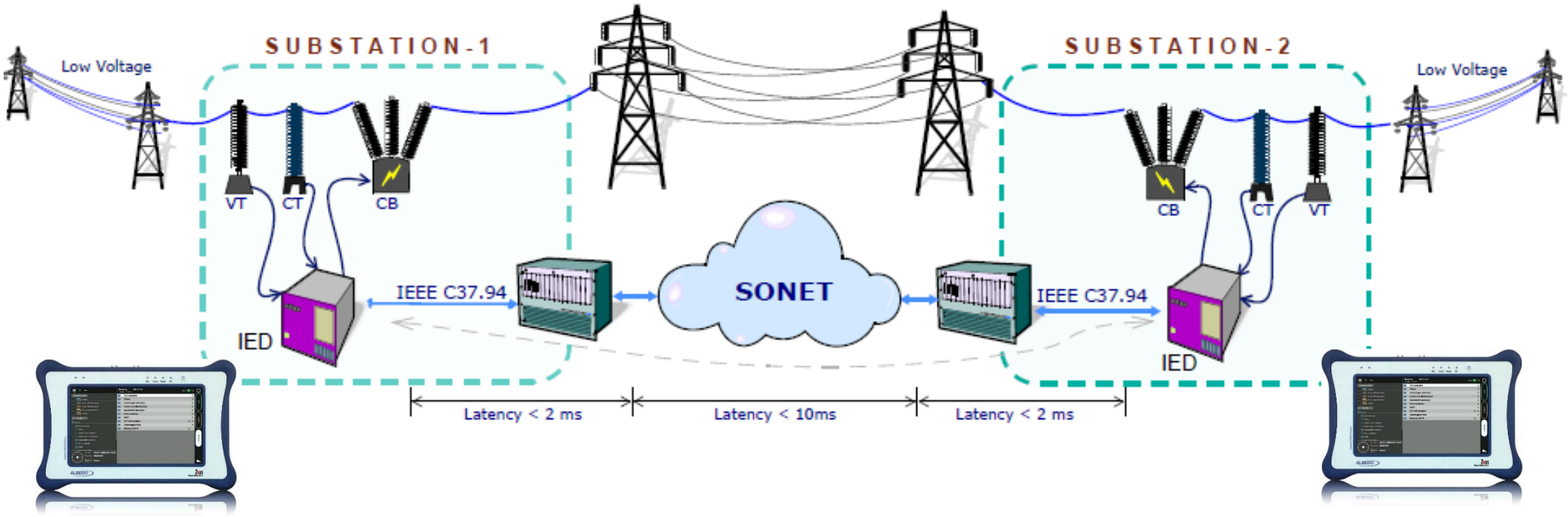


xGenius calculating Delays

NOTE: delays on all interfaces and protocols according IEC-61850

PROTECTION

Verification of **C37. 94** for teleprotection

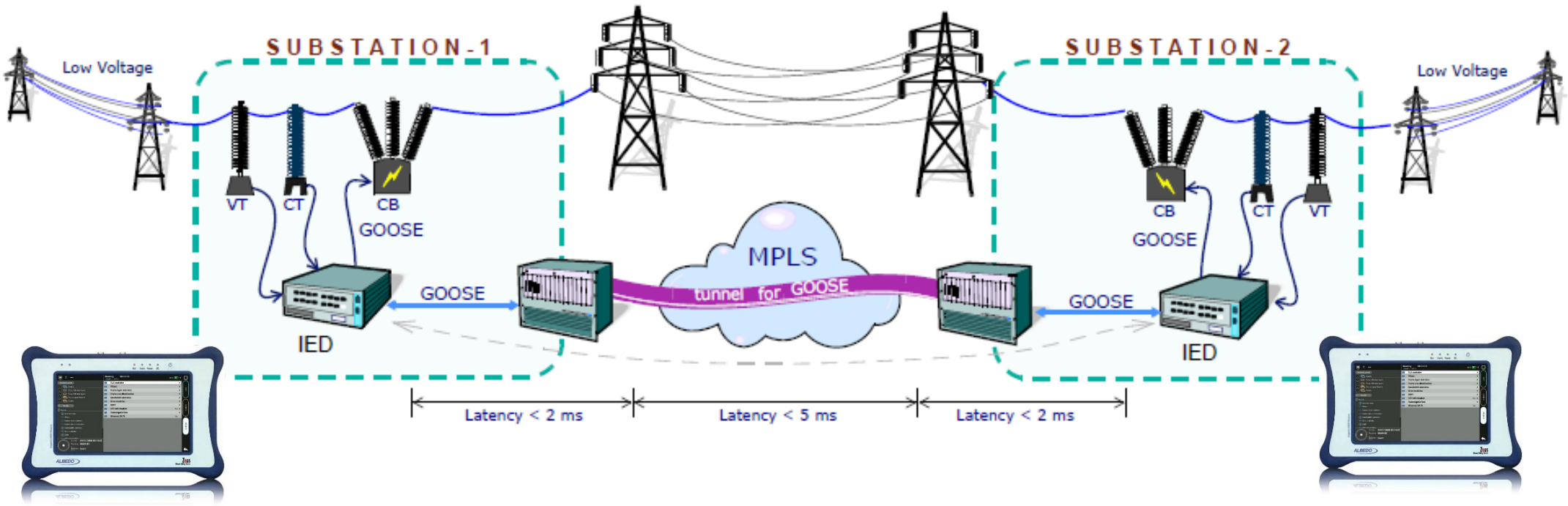


Challenge: commissioning of teleprotection architectures .

Pain: black-outs.

Solution: verify performance with Zeus tester including asymmetric delays, jitter / wander, simulate events and protection activation.

Verification of **GOOSE** for teleprotection

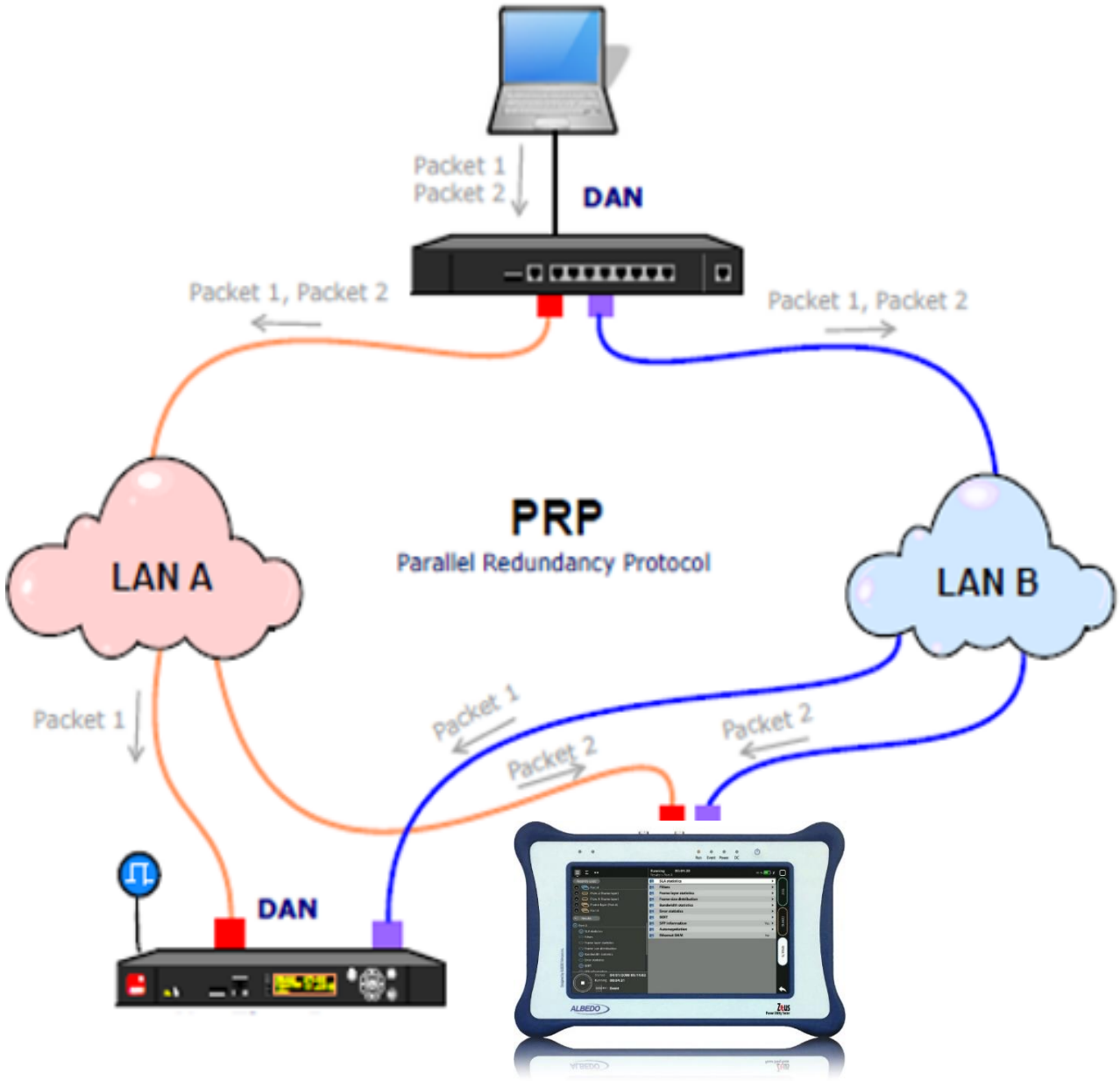


Challenge: commissioning of teleprotection architectures.

Pain: black-outs

Solution: verify performance with Zeus tester capturing and analizing GOOSE protocol, mesarue one-ways delays, simulate events and protection activation.

PRP for Fault tolerant architectures



Challenge provide a fault tolerant network.

Pain: GOOSE or PTP are mission critical that make sense to assure redundancy

Solution: PRP to provide seamless fail-over from a single point of failure. PRP implements redundancy by packet duplication over two independent networks that operate in parallel.

NOTE: native PRP devices

SYNCHRONIZATION

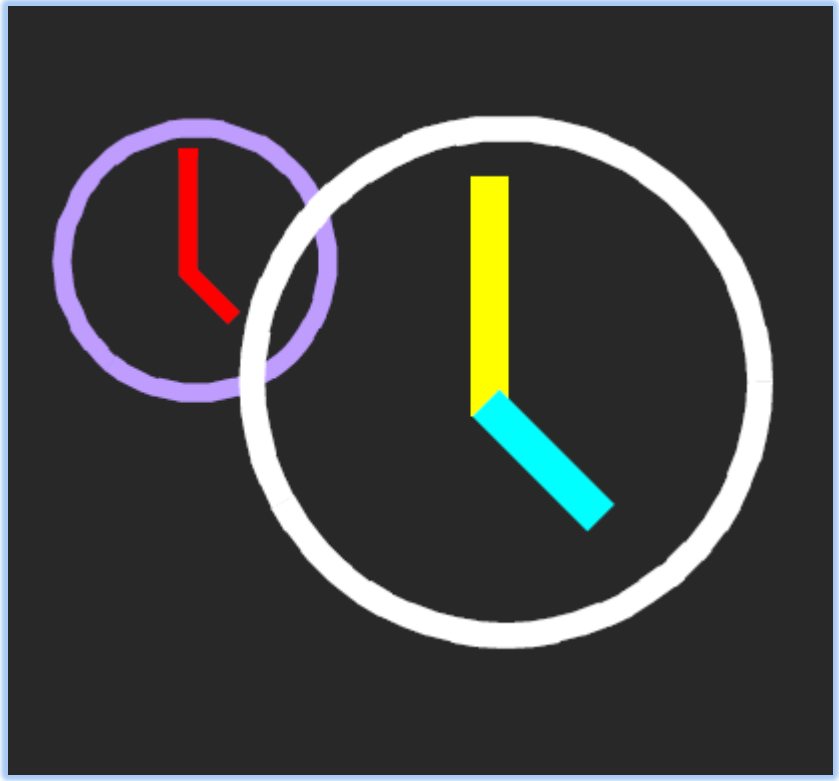
Why Timing?

AC Stability

Connections

Event Logs

Forensic



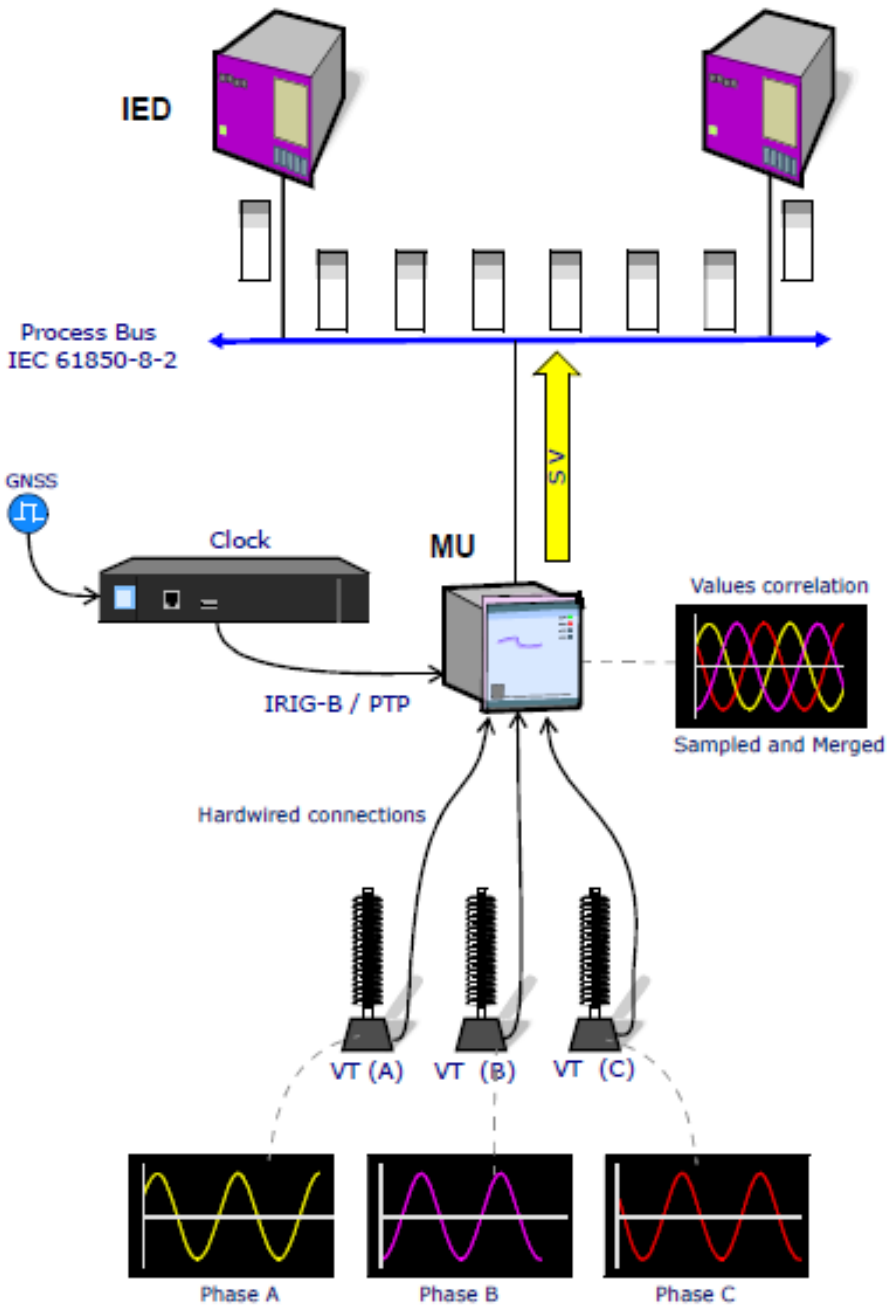
Correlation

Security

Protection

Regulations

Timing impact in IEC 61850



Challenge IEC 61850 protocols rely heavily on accurate PTP, NTP, IRIG-B timing.

Pain: bad timing causes SV/GOOSE delays, inconsistencies, IEDs loss of sync and hard-to-diagnose problems in hybrid deployments.

Solution: Invest in good clocks like Net.Time and precise timing diagnostics tools such as xGenius to play a strategic role.

NOTE: use xGenius to verify sync health on and measure latency.

Install **modern** Clocks

Net.Time simplifies migration/integration of legacy and IEC 61850 timing

Net.Time delivers **sub-microsecond precision** is a modular 4-port PTP/NTP/PRP network clock supporting telecom and power profiles to meet the timing requirements of all industries including utilities, data centres, broadcast, transportation and air traffic control. The result is a reliable and fault-tolerant solution to reference loss, network outages and power failures. At the same time, Net.Time simplifies migration to PTP without abandoning investments in NTP, IRIG-B, MHz or BITS, facilitating the integration, interaction of any kind of signals, profiles and protocols

CYBERSECURITY

Face the threats

Challenge: The IEC-61850 wasn't designed with cyber threats. Adding secure profiles IEC 62351 authenticated access, prevention of spoofing and intrusion.

Pain: IEC 62351 increase latency then GOOSE fails, PTP suffers

Solution: Balance determinism and security. Explore segmentation or gateways but don’t compromise real-time performance.

NOTE: Use tester to simulate traffic measure delays in GOOSE Net.Time ensures secure time delivery using PTP over segmented networks

GNSS Cybersecurity

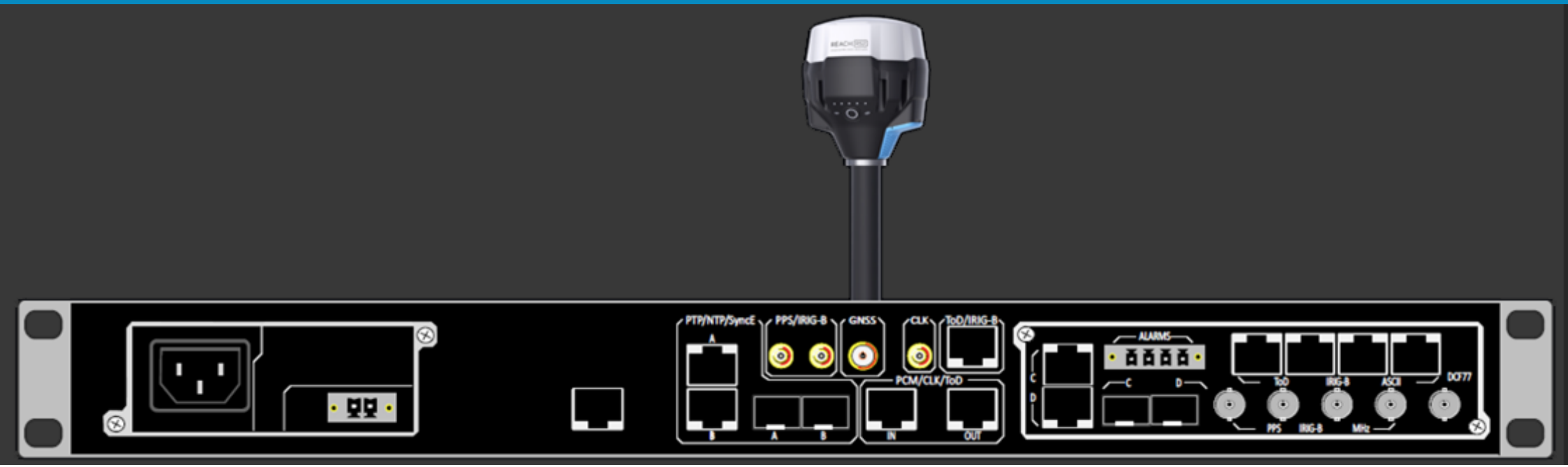
Challenge: attacks has become a major concern

Pain: clocks can easily go down and the substation …

Solution: use more secure architectures (a) multiband receivers, (b) PTP as reference, (c) detect attack as use back up references..

NOTE: Net.Time ensures secure time delivery using PTP over segmented

Jamming & **Spoofing** Protection



Threats are posing serious risks automation, disrupting critical operations

- Multi-GNSS Support: GPS, Galileo, GLONASS, BeiDou for enhanced resilience
- Jamming / Spoofing Detection: detects RF interference, monitor anomalies
- Signal Authentication (RAIM, OSNMA)
- Time Validation (e.g. GNSS input = PTP input?)
- Multi-band receivers (L1 + L2 + L5)
- Holdover– OCXO/Rubidium
- Backup – PTP, NTP, SyncE, IRIG-B, E1

Security Management

- Encrypted Communication – HTTPS, SSH, SNMPv3, and secure APIs
- Access Control & Authentication – Role-based user access
- Centralized RADIUS / TACACS+ AAA
- Firewall & Traffic Filtering –to block unauthorized access
- Event Logging & Monitoring – Real-time alerts for suspicious activities

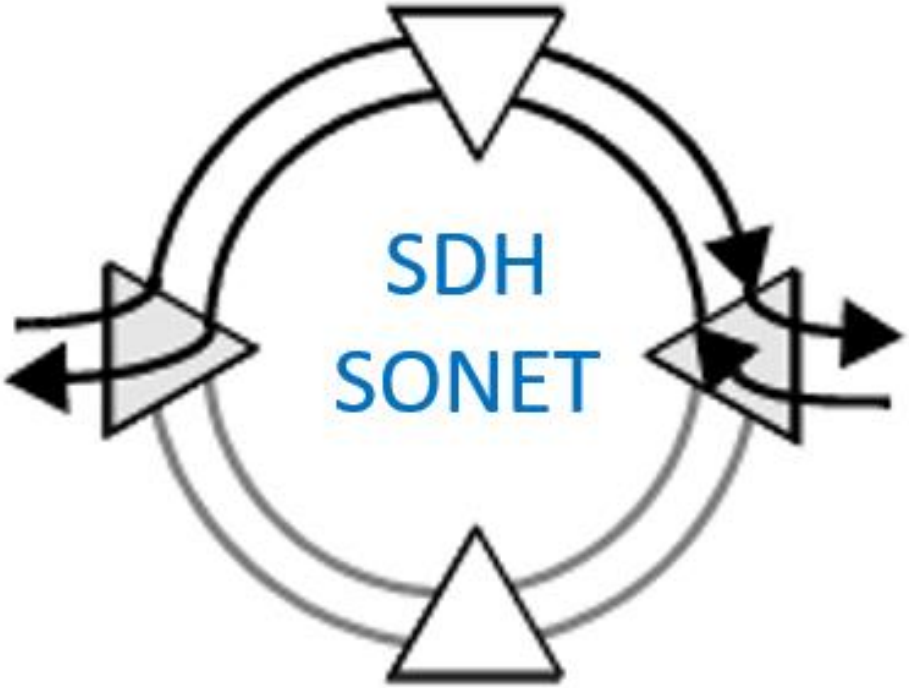
MIGRATION or INTEGRATION?

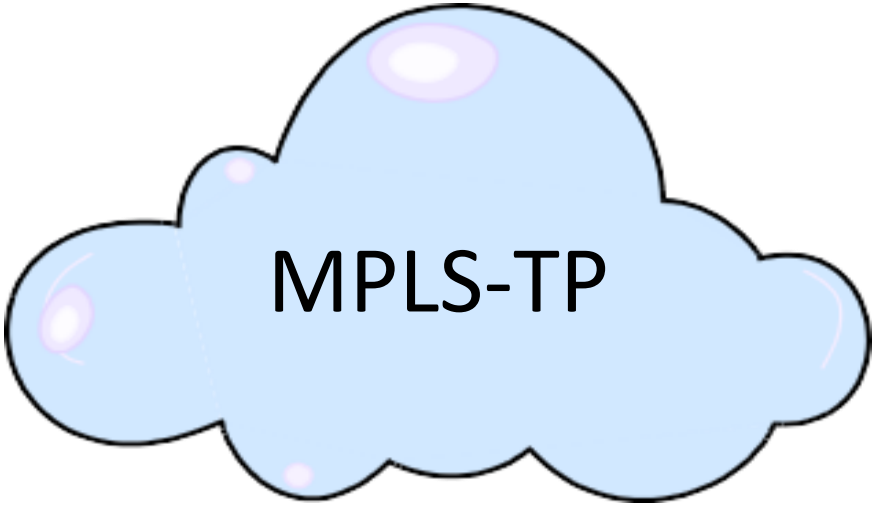
Evolution or Revolution?

Challenge: should the legacy resources such as SDH, IRIG-B, C37.94, hardwired signals be integrated or replaced?

Pain: Doubts… what to do?

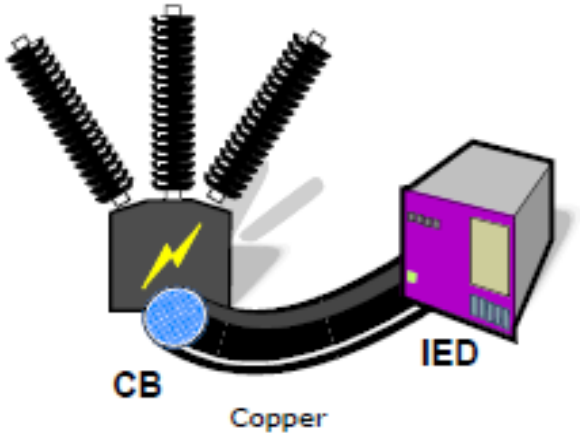
Solution: IEC 61850 is often layered *on top* rather than replacing, the answer depends on many things, some are clearer that others. A good exercise is to define transitional architectures.

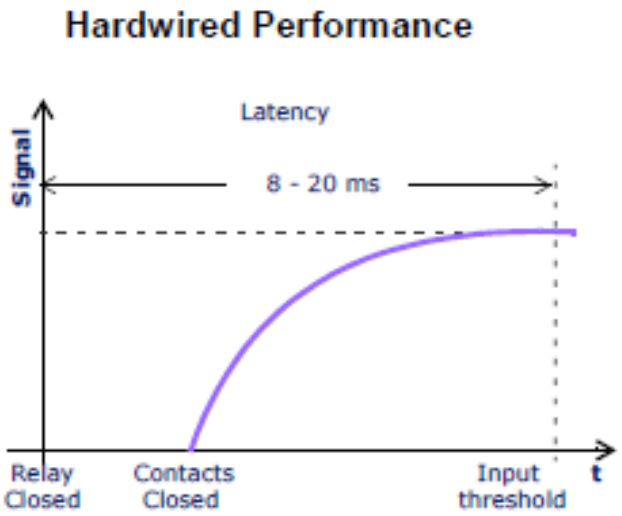




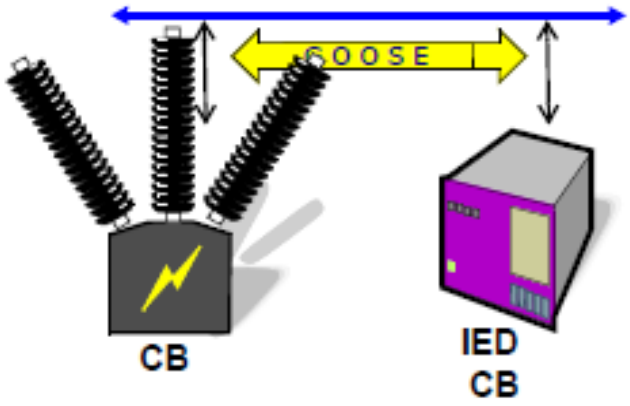
Migration!

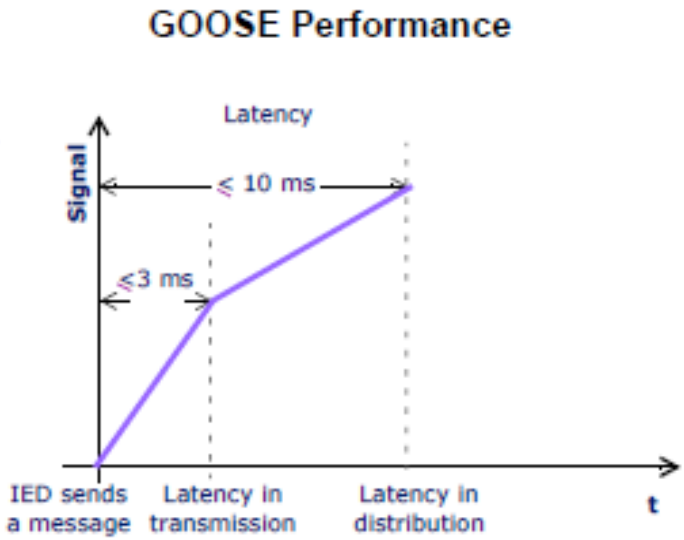
Migration!


CB
IED
Copper


Hardwired Performance
Latency
Signal
8 - 20 ms
Relay Closed
Contacts Closed
Input threshold
t

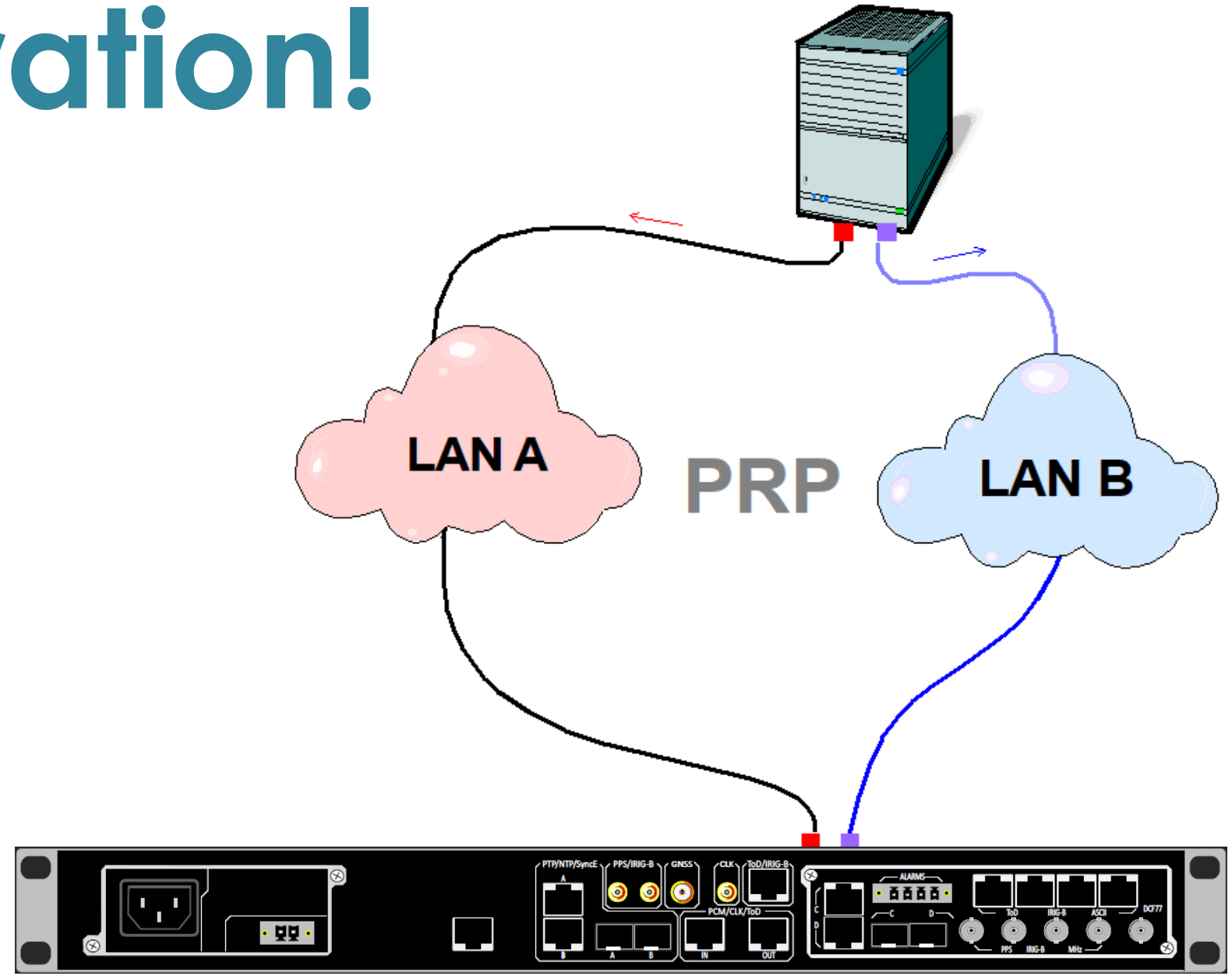
Migration (?)

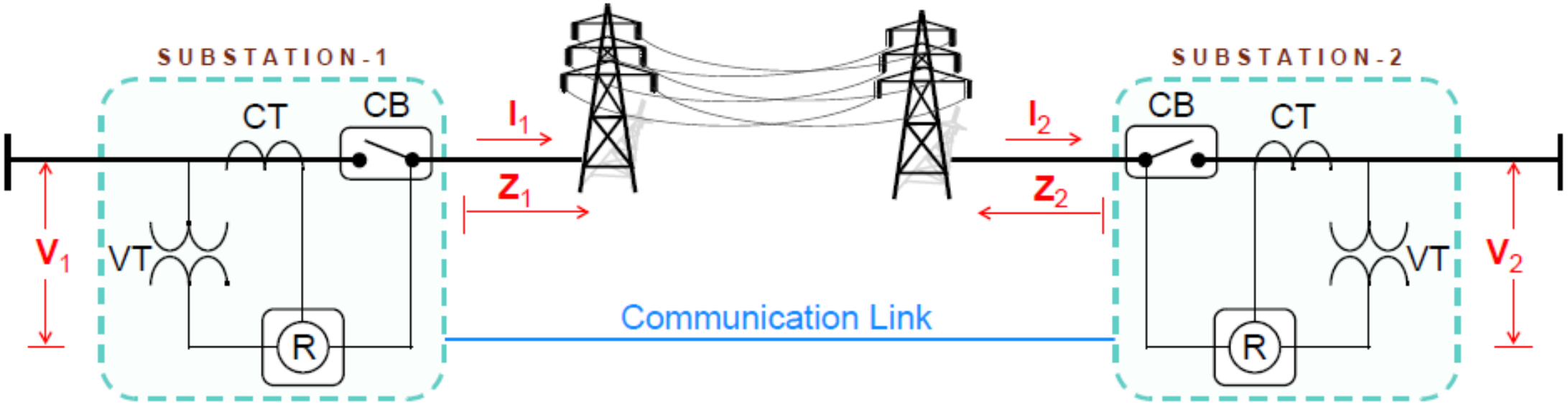

GOOSE
CB
IED
CB


GOOSE Performance
Latency
Signal
≤ 10 ms
≤3 ms
IED sends a message
Latency in transmission
Latency in distribution
t

Integration!

Integration!





C37.94 or GOOSE

Coexistence (?)

About us...

ALBEDO's Unique **Value Proposition**

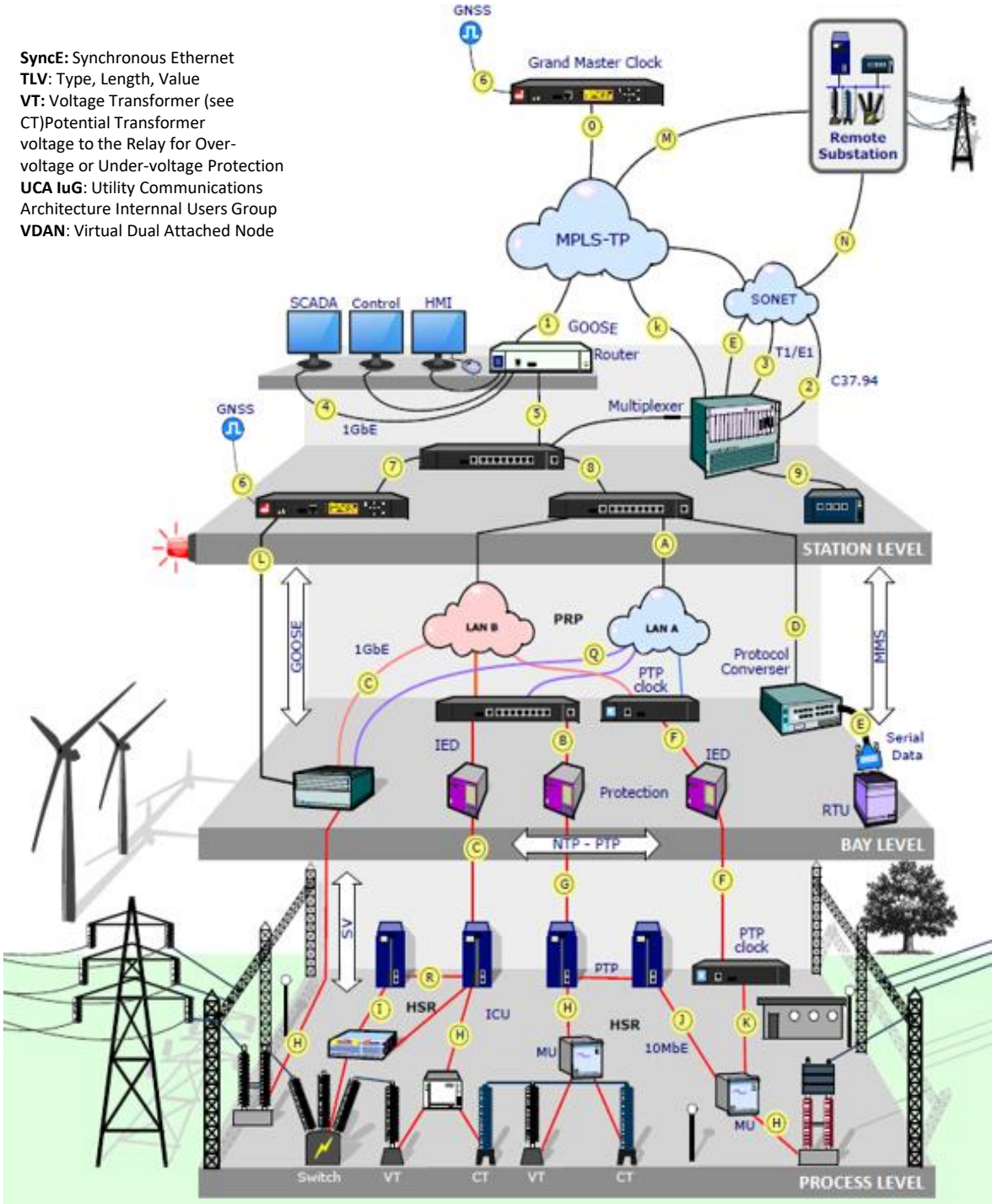
ALBEDO is an ecosystem of IEC-61850 Testers, WAN emulators and Clocks

- **xGenius / Zeus**: Multi-protocol testers for MPLS, PTP, NTP, SyncE, E1, T1, BITS, PPS, GOOSE, SV, MMS, IRIG-B, C37.94, RS-232, V35, V36, PRP...
- **Net.Storm**: provides real traffic conditions for Acceptance test
- **Net.Time**: a modular multiport PTP/NTP/PRP/SyncE/IRIG-B clock for utilities

+800 Customers in 5 continents

Glossary

AAA: Authentication, Authorization, and Accounting
ACL: Access Control List
AP: Access Point
Busbar: Metallic strip or bar, typically housed inside switchgear, panel boards, and busway enclosures for local high current power distribution
C37.94: TDM interface devoted for teleprotection
CB: Circuit Breaker designed to close or open electrical circuit under normal or abnormal conditions. It operates on relays command.
CBWFQ: Class-Based Weighted Fair Queuing
CG: Connected Grid
CID: Individual configuration of each IED
CIP: Critical Infrastructure Protection
CLI: Command-Line Interface
CorpSS: Corporate Substation
CT: Current Transformer, used for measurement of current, if too high to apply directly to measuring instruments, a CT produces a proportional
current which can be measured and recorded, CT are used in metering and protective relays
DAN: Doubly Attached Nodes implementing HSR or PRP
DAU: Data Acquisition Unit
Disconnector: isolates physically and visually the lines
DMZ: Demilitarized Zone
DCB: Directional Comparison Blocking
DCS: distributed control systems
DSC: Differentiated Services Code Point
ESP: Electronic Security Perimeter
Feeder: Transmits power to the distribution points
GM: Grandmaster
GNSS: Global Navigation Satellite System
GOOSE: Generic Object-Oriented Substation Events is a control model defined as per IEC 61850 which provides a fast and reliable mechanism of transferring event data over entire electrical substation networks. When implemented, this model ensures the same event message is received by multiple physical devices using multicast or broadcast services
HMI: Human Machine Interface
HQoS: Hierarchical Quality of Service
HSR: High-Availability Seamless Redundancy
IA: Industrial Automation
ICS: Industrial control systems
ICU: Intelligent Control Unit
IEC: International Electrotechnical Commission
IEC 61850: Standard defining communication protocols for intelligent electronic devices at electrical substations
IED: Intelligent End Device, microprocessor-based controllers of power
system equipment, such as circuit breakers, transformers and capacitor banks to enable advanced power automation.
IRIG: Inter-Range Instrumentation Group
ISE: Identity Services Engine
L3VPN: Layer 3 Virtual Private Network
LA: Lightning Arrester protects the power grid from electric storms
MQC: Modular QoS Command-Line Interface
MMS: Manufacturing Message Specification, messaging system for exchanging real-time data and supervisory control information. Allows client such as SCADA, an OPC server or a gateway to access all IED objects
MPLS: Multi-protocol Label Switching
MU: Merging Unit connected to the process bus converts analog data(ie. volts, currect...) into digital information
NERC: North American Electric Reliability Corporation
NIST: National Institute of Standards and Technology
NMS: Network Management System
OAM: Operations and Maintenance
PCP: Priority Code Point
PIOC: Instantaneous overcorrent Protection
PLC: Programmable Logic Controller
PMU: Phasor Measurement Unit
POTT: Permissive Overreach Transf Trip
PP: Primary Power
Process Bus: Connects primary units and control equipment to the IEDs
PRP: Parallel Redundancy Protocol
PT: see VT
PTP: Precision Time Protocol
RedBox: Redundancy Box
Relay: is automatic device which senses an abnormal condition of electrical circuit and closes its contacts and complete the circuit breaker trip.
REP: Resilient Ethernet Protocol
RCT: Redundancy Control Trailer
RTU: Remote Terminal Unit
SA: Substation Automation
SAN: Singly-Attached Node
Secondary Lines: lower voltage side at the substation
SCADA: Supervisory Control And Data Acquisition, transmits and receives data from events of controls, measuring, safety and monitoring. Power
system elements can be controlled remotely over. Remote switching, telemetering of grids showing voltage, current, power, direction, consumption in kWh, synchronization.
SCD: Substation Configuration Description
SCL: Substation Configuration Language
SNTP: Simple Network Time Protocol
Station Bus: Connects the entire substation and helps provide connectivity
between central management and individual bays
STP: Spanning Tree Protocol
SV: Sampled Values, is a method to read instantaneous values such as currents, voltages, impedances, etc. from CTs, VTs or digital I/O and then transmitted to make them are available for those IED sbscribed.
Switchgear: combination of switches, fuses or CB to control, protect and isolate electrical equipment
SyncE: Synchronous Ethernet
TLV: Type, Length, Value
VT: Voltage Transformer (see CT)Potential Transformer
voltage to the Relay for Over-voltage or Under-voltage Protection
UCA IuG: Utility Communications Architecture Internnal Users Group
VDAN: Virtual Dual Attached Node



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THANKS
どうもありがとう
GRACIAS
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OBRIGADO

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Just in Time

That's all

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