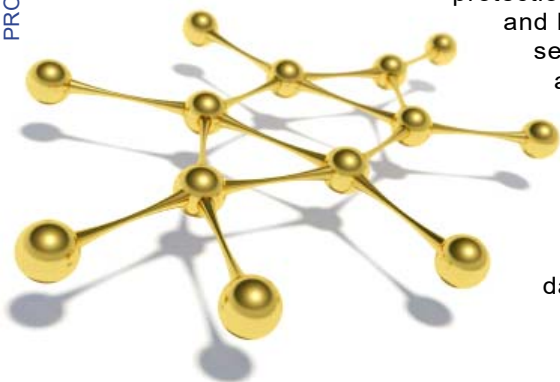




# Product Portfolio (2025)

**ALBEDO Solutions for Mission-Critical Communications provides state-of-the-art equipment** for verifying, installing, monitoring, troubleshooting, and upgrading mission-critical communications infrastructures for utilities, telecom operators, airports, railways, and military organizations.

Our expertise includes timing, synchronization, test, measurement, protection, GPON, WAN emulation and lawful interception. We serve power utilities, mobile and telecom operators, system integrators, manufacturers, R&D labs, universities, military forces, and railway networks - ensuring reliable voice, video, and data transmission.



## Telecom & Railways

Whether you're addressing an urgent network issue or planning future expansions, ALBEDO has a solution tailored to your needs. From customized on-site monitoring systems to advanced telecom testers, we help optimize network performance.

Our experts work with major telecom operators as well as small and medium-sized organizations, providing tailored insights and sharing industry best practices to enhance your system's reliability.

## Utilities & Military

ALBEDO solutions integrate seamlessly into mission-critical operations. We collaborate with you to answer key questions, such as:

- Do you need a next-generation PTP / NTP network clock?
- Are you testing PTP, SyncE, IP, VoIP, Datacom, T1/E1, C37.94, or IRIG-B?
- Do you need to qualify GPON, XGSPON, NG-PON, ONTs, and OLTs?
- Are you looking for a WAN emulator to validate new telecom services?
- Do you require a GbE tap capable of capturing 100% wireline traffic?
- Do you need to verify legacy IRIG-B synchronization with precision?

Our specialists help you identify vulnerabilities, explore alternatives, and implement the right solutions—on time and with confidence.

At ALBEDO, we understand the critical role of network communications in your operations. With a vast array of technology solutions available, we simplify decision-making, ensuring you choose the best fit for your needs..



# About ALBEDO Telecom (\*)

ALBEDO Telecom is a manufacturer of Synchronization Clocks, Telecom Testers, WAN Emulators, Ethernet Taps and OTDRs with core competencies in PTP, NTP, SyncE, GbE, 10GbE, T1/E1, PPS, IRIG-B, Jitter/Wander, C37.94 and Optical technologies. Most of our customers are utilities, telecom operators, railways, air traffic control, military and universities that use ALBEDO solutions all over the world.

At ALBEDO Telecom, we turn ideas into tangible, manufacturable solutions. With our understanding of telecommunications, quality control systems, test and measurement, engineering, production processes, and most importantly the end user - their behavior and needs - we seek to enrich the user experience at all levels. We develop projects from the ground up, with special emphasis on aesthetics and ergonomics. ALBEDO Telecom has always been an innovator in the field of synchronization, networking and testing.



## World Customers

ALBEDO has thousands of customers on all five continents. For example: ABB, ADVA, Airbus, Arbiter, Bahrat, Basin Electric Power, Bosch, BSNL, Bosch, China Telecom, CISCO, Claro, Disney, EON, EDP, First Energy, FIS-Naval Surface Warfare Center, FT, GE, General Atomics, Hitachi, Hydro-Quebec, Indra, MAN, Meinberg, MERALCO, Minnesota Power, MT, National Grid, NASA, NATO, Nokia, NorthWestern Energy, Orange, Pacific Gas & Electric, RTE, Sanyo, SEL, Scottich Power, Raytheon, Redia, San Diego Gas & Electric, Schweitzer Engineering Labs, SDG&E, Siemens, Tata, Telefonica, USAF, UTE, Vivo, Vodafone, Wind and +600 more.

## Milestones

- 1983: ICT 2017: world's first microprocessor-based PCM analyzer
- 1989: ICT 2045: portable multiplexer from 64 kbps to 140 Mbps
- 1991: ICT 2040: OEM to HP and then Agilent
- 1994: Flexacom: Multi-technology transmission platform
- 1999: Victoria: World's first handheld SONET/SDH tester
- 2004: Combo: World's first stackable SONET/SDH tester
- 2009: Net.Shark: world's first handheld tester with active filters
- 2012: Net.Storm: world's first handheld wirespeed WAN emulator
- 2014: Ether10.Genius: world's smallest 10Gb/s Ethernet tester
- 2017: Net.Sync: PTP Grand Master Clock
- 2018: xGenius: transmission & synchronization tester
- 2019: Zeus: Utility tester for legacy and IEC-61850 substations
- 2021: Net.Time: First PTP/NTP Boundary Clock
- 2022: World's first IRIG-B jitter and wander tester
- 2023: PTP boundary clock tester
- 2024: First OTDR manufactured in ALBEDO
- 2025: Modular PTP/NTP/SyncE/PRP clock with multiple ports

## Publications

We are also authors of several books.

- Triple Play: Building the Converged Network
- Installation & Maintenance of SONET & Synchronization Networks

(\*)ALBEDO, also known as reflection coefficient, is the ratio of the radiation reflected by a surface to the radiation incident on it.

since 1983



1994



1999



2006



2012



2017



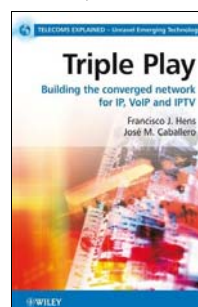
2016



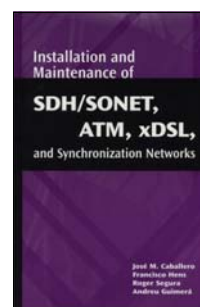
2025



Wiley - Boston



ArtecHouse - London





# Net.Time $\Omega$ modular timing

Net.Time  $\Omega$  is a network clock ideal for data centers, traffic control, financial, utility and military systems. Configurable as Master, Boundary or Slave, it supports PTP (Telecom + Power profiles), NTP, IRIG-B, SyncE, ToD, PPS, ToD, T1/E1, BITS and PRP.

## PTP / NTP Network Clock

Net.Time  $\Omega$  is a general purpose clock designed to synchronize clients connected to Ethernet / IP networks. Once locked to the reference, it provides highly accurate synchronization to all clients connected via optical or electrical links.



## Mission Critical

Armies, financial institutions, manufacturing plants, wireless operators, power utilities, land and air transportation are all migrating to the PTP protocol to meet the synchronization requirements of their mission critical applications. Time distribution over the existing Ethernet/IP backhaul is now a commodity to meet the required accuracy and redundancy levels of these new scenarios to manage real-time events over wide, cellular and metropolitan areas.

## Financial Services

Financial services rely on a high-performance transport layer capable of delivering high speed, availability, security and reliability. On the timing side, PTP, NTP, and GNSS are widely used to synchronize nodes and transactions and to log time-stamped events in chronological order.

## Military Systems

Military forces rely on accurate timing for secure communications, radar, and mission-critical operations. PTP synchronizers provide highly accurate, redundant time distribution in deployed environments, integrating GNSS and internal references for resilience to jamming and interference.

## Air Navigation

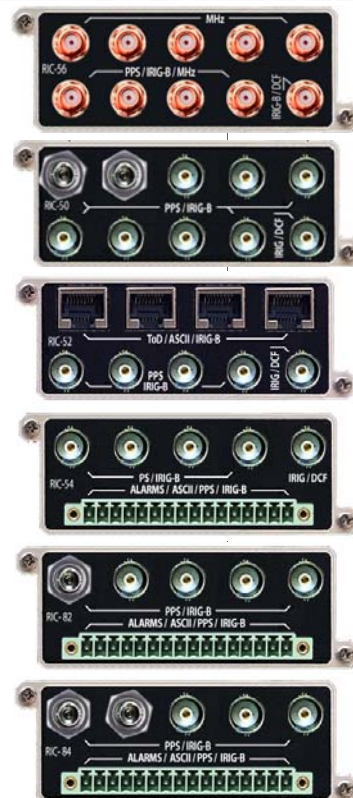
Timing is a key resource for ensuring the proper operation of air navigation systems. Legacy signals, such as IRIG B, NTP and TDM, are still in use, but are being gradually replaced by PTP time stamping to provide a unique, accurate and coherent synchronization signal based on atomic clocks.

## Wireless turn-up

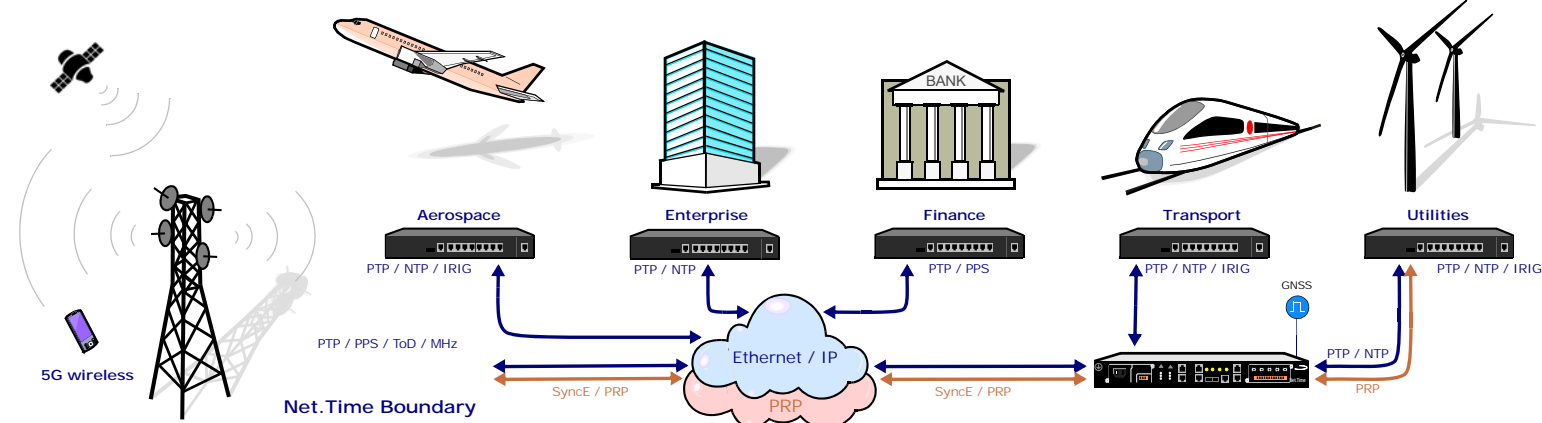
For many years, TDM signals have met the frequency synchronization requirements of cellular networks. New deployments have strong frequency and phase requirements to reduce cell size, reuse available frequencies, and share up/downstream channels to wireless terminals.

## Power Grid

Power grid systems use phasors as a timing source for network monitoring, while automatic protection systems require a high degree of accuracy and redundancy. PTP synchronization units are deployed at remote locations of the power grid with internal time references and GNSS receivers.



(C) ALBEDO TELECOM



# Net.Time $\phi$ a substation clock

Net.Time  $\phi$  (Phi) is a PTP/NTP over PRP clock designed to facilitate the integration of conventional substations based on GPS and IRIG-B with the new IEC 61850 standards by offering all kinds of interconnection possibilities.

Net.Time  $\phi$  is an IEC 61850 compliant synchronization node that supports PTP, PRP and multiple clock options such as NTP, SyncE, 1PPS, ToD and IRIG-B to meet all the timing needs of utility substations. It also includes the Power PTP profile and Rubidium to simplify timing provisioning and facilitate the integration of installed equipment for perfect control, protection and data acquisition.

## PTP / NTP over PRP Timing

The basic architecture of power distribution has changed very little in the first 100 years. In recent decades, however, the Smart Grid has emerged thanks to the massive use of ICT technologies to improve efficiency, resilience and quality of service.



## Substation Automation

Automation refers to the use of data from intelligent electronic devices to enable stability, increase security and maintain system integrity. To enable this, a new standard, IEC-61850, has been released to facilitate the intensive use of digital technologies and ensure interoperability between vendors, devices and processes.

- Supports PTP Telecom and Power profiles to interconnect both types of clocks, a common necessity in power grids.
- It is a native PRP (DAN-P clock) with double interface, then it does not need a redundancy box, reducing costs and simplifying installation.
- OCXO / Rubidium are internal oscillator options to match any hold-over.
- Supports 1PPS, MHz, Mb/s, PTP and SNTP, enabling features such as NTP-to-PTP translation to facilitate the coexistence of legacy new equipment and migration.
- Provides SNTP, PTP, 1PPS and IRIG-B signals to protect all devices.

There are partial solutions out there, but none of them address all of the energy industry requirements listed above in the same way that Net.Time  $\phi$  does.

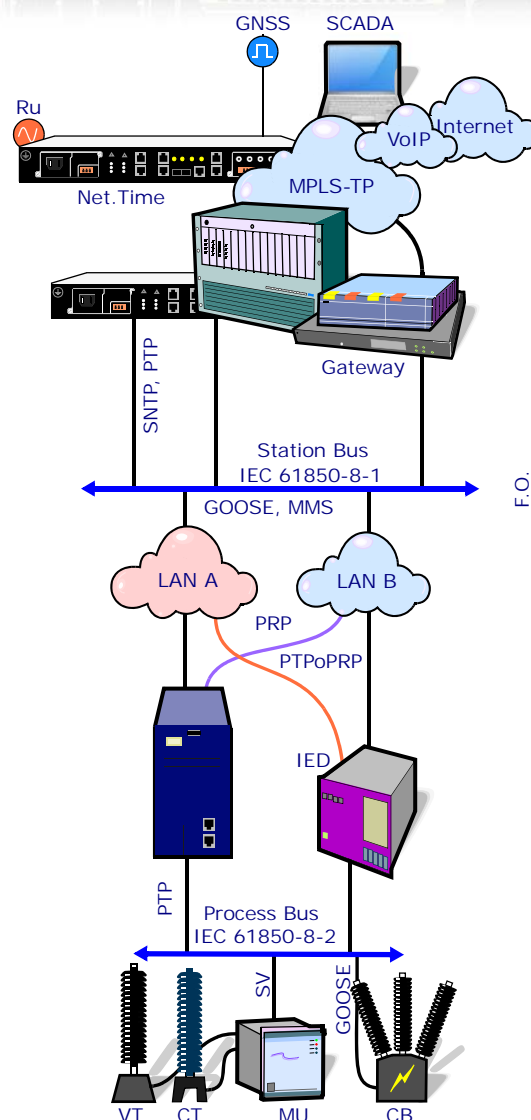
## Advantages

There is no doubt about the benefits of the new standard IEC-61850, which facilitates interoperation, but adoption will be a gradual process. Net.Time facilitates a smooth migration to the new and legacy protocols, thus improving the ability to integrate any device of the substation. All technologies will coexist for a long time, so versatility is a valuable aspect offered by Net.Time  $\phi$  that also has interesting advantages:

- Improved availability of NTP/PTP timing services through standard buses
- Supports installed base using IRIG-B, SNTP and 1PPS
- Provides more reliable synchronization for mission-critical infrastructures

Of particular note is the support for PRP, which requires careful consideration. In theory, any PTP clock could be connected to a PRP-protected network by adapting a RedBox. However, this is not an optimal solution because it requires the deployment of a new device that adds complexity and cost. By implementing PRP in the Time Node, the device is connected directly to the network. The Net.Time node includes multi-protocol and redundant operation features.

It simplifies migration to PTP by providing NTP synchronization to legacy nodes. NTP and PTP services work in parallel, so network administrators do not have to choose which to enable and install two or more boxes for each protocol.





# Net.Time $\tau$ a telecom clock

*Net.Time  $\tau$  (Tau) is a PTP/NTP/SyncE clock for the Telecom industry. Configurable as Master, Boundary or Slave, it supports PTP, NTP, ToD, PPS, ToD, T1/E1, BITS and SyncE.*

## PTP / NTP network clock

Net.Time  $\tau$  is a network clock ideal for ensuring the delivery of quality time, phase and frequency across a network of base stations or microcells. It accepts a wide variety of time references and provides the widest range of timing signals to facilitate network integration.

Net.Time  $\tau$  can be configured as master, slave and boundary clock, as well as redundant in/out clock references. Multiple options for input (GNSS, PTP, SyncE, ToD, PPS, T1/E1, MHz) and output (PTP, SyncE, ToD, PPS, T1/E1, MHz) references allow for many combinations, facilitating the translation of timing protocols to integrate new and legacy architectures in the telecom industry.

Net.Time  $\tau$  represents the state of the art in timing as it is designed to provide the most accurate and secure synchronization networks for infrastructures used in telecom applications. Net.Time  $\tau$  is fault-tolerant, has a built-in GNSS receiver, Rubidium oscillator, redundant power supply, and accepts a wide variety of time references that can be used as primary or backup signals, in this way, it provides compatibility between timing signals for distribution via protocol translation in all directions. Accurate and reliable synchronization is an essential resource for maintaining stability and security in mobile telecommunications and other relevant industries such as finance, broadcasting, IoT, automation and air traffic control.

## Smooth migration

The industry as a whole is migrating from previous timing architectures to PTP for clock distribution over the existing Ethernet/IP backhaul to meet the required accuracy levels that are particularly important in these new scenarios.



## Wireless turn-up

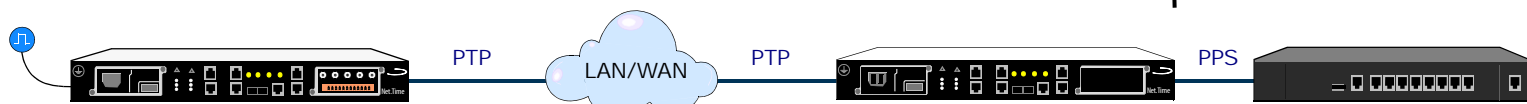
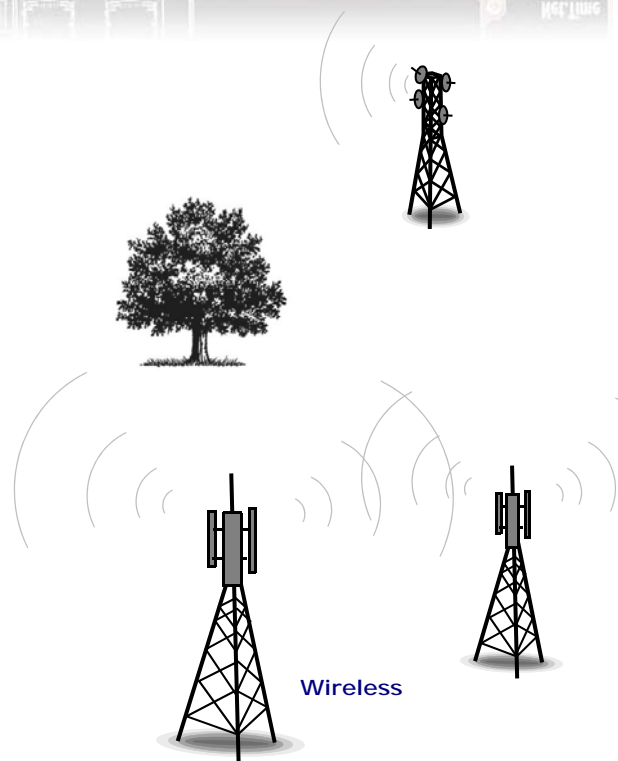
For many years, the frequency synchronization requirements of cellular networks were met using TDM signals. New deployments have stringent frequency and phase requirements to reduce cell size, reuse available frequencies and share up/downstream channels to wireless terminals. Synchronization is a critical function in mobile networks to prevent messages from interfering with each other and to enable smooth cell-to-cell transmissions, especially in 5G, which increases speeds, lowers latency, and increases cell density.

## Timing services

Synchronization enables many services, including assisted navigation, location, and emergency calls. In addition, synchronization is fundamental to any cellular technology, or it would not work at all. Base stations must constantly calculate the distance to every single mobile operating in their cell and in neighboring cells. Base stations and mobiles must generate accurate up/down frequencies and have access to transmission slots. If the radio clock loses synchronization accuracy, the framing will drift outside the guard period and interfere with adjacent cell sites and increase interference.

## PTP Telecom Profile

Synchronization technology is a fundamental building block for all wireless communication networks, and with the introduction of wireless technology, we've reached a new level in terms of frequency phase and frame synchronization that can only be provided by PTP network clocks such as Net.Time to meet more stringent synchronization requirements, ensure compliance with industry standards and quality of service.



# xGenius timing & transmission

*ALBEDO xGenius is a multi-technology tester equipped with an 8" screen and all the features you need to install and maintain telecom networks up to 10 Gigabit Ethernet.*

xGenius supports legacy and new generation interfaces to verify Ethernet / IP, PTP, SyncE, ToD, IRIG-B, T1 / E1, C37.94, RS-232, G703 and protocols such as G00SE, SV or MMS. It is suitable for testing legacy and next-generation networks because it has the most common interfaces. Field engineers no longer need to carry multiple testers or multiple modules to troubleshoot and monitor telecom infrastructures.

## Applications

### Mobile Networks

Those focused on wireless see the impending need for distributed phase synchronization and also want to avoid having to install GPS receivers at every single cell site.

### Power Utilities

Power utilities need to protect and constantly monitor high-voltage transmission lines. Communication between substations using the C37.94 standard is essential to ensure proper operation while controlling each and every alarm.

## Platform

- A:B ports: 2 x SFP/SFP+ (100MbE, 1GbE, 10GbE, 10G WAN)
- A:B ports: 2 x RJ45 (10MbE, 100MbE, 1GbE)
- C:D ports: Balanced 2 x RJ45 (T1/E1)
- C:D ports: Unbalanced 2 x BNC (T1/E1)
- GNSS Port: SMA female
- PPS Ports: 3xSMB female (i/o)

### Hot swappable modules

- C37.94 interface
- Datacom DTE/DCE: V.11/X.24, V.24/V.28, V.24/V.35, V.24/V.11 (V.36/RS449)
- VF Port
- Codirectional - G703
- IRIG-B optical and electrical
- T1/E1 additional port

### Operation / Results

- Graphical and tabular wander results in standard pdf files
- Large memory capacity, more than one week of results
- Export: results in pdf/txt/csv through USB interface or SD card
- Time stamped data capture up to 10Gb/s

### Ergonomic design

- Size: 260 x 160 x 63 mm. Weight: 1.9 kg
- Light and easy to carry in a small bag
- Batteries: Two pack of Lipo batteries included

### Internal Oscillators

- Default better than  $\pm 2.0$  ppm
- OCXO better than  $\pm 0.1$  ppm
- Rubidium better than  $\pm 5.0 \times 10^{-11}$  (GNSS disciplined, warm-up: 600s)

### SyncE and PTP testing

- PTP profiles: Telecom and Power
- Clock emulation: Master / Slave, Unicast/Multicast, 128 packets/s
- PDV capture, protocol analysis and correction field support





# Zeus substation engineering

*Zeus provides in-depth insight into the design, installation, maintenance, troubleshooting, and engineering of Smart Grid communications infrastructures, particularly in substations.*

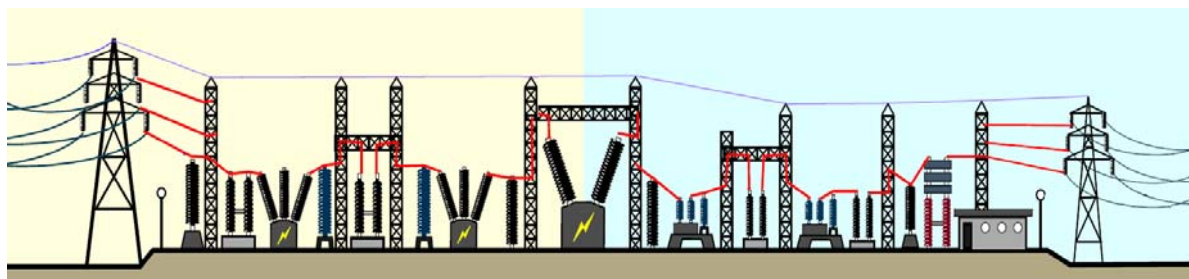
It can test Ethernet/IP, PTP, GbE, IRIg-B, T1/E1, G703, C37.94, GOOSE, SV and MMS protocols. One-way delay testing with GPS support is available on all interfaces, and it has a set of programmable filters to capture live, wire-speed traffic.

## IEC 61850 Support

As proprietary architectures are gradually replaced by standards based on optical Ethernet, there is a clear need for tools that can manage both old and new interfaces. This is Zeus, a tester capable of verifying, activating, and troubleshooting all types of communications infrastructure, including those installed over the past few decades and the latest that will be installed in the coming years. All of this is transforming substations into more flexible, robust and scalable systems, thanks to the interconnection of different manufacturers using fiber and standardized protocols.

## Applications

- Engineering communications at the Power Substation
- PTP/NTP/IRIG-B timing
- IEC 61850 Migration
- Protocol Analysis
- Substation Maintenance
- C37.94 Teleprotection
- Serial Communications
- PTP Clock Emulation
- GOOSE Capture + Analysis
- One-Way Delay
- IED Acceptance
- Certification



## GOOSE, SV, MMS

Zeus has a set of programmable filters to capture live traffic at wire speed. Now you can analyze GOOSE, SV, MMS and other protocols to decode and store them in PCAP format or calculate propagation delay from local or remote substations.

## PTP Synchronization

Utilities have strict timing requirements that Zeus can test and adjust with advanced features that allow measurement and emulation of PTP, IRIg-B, 1PPS, ToD, T1/E1. The tester's internal oscillator can be an OCXO or Rubidium, depending on the accuracy you require, especially if you need to operate in hold-over.

## C37.94 Protection

An uninterrupted power supply requires protection functions to ensure reliable operation of the power system. With Zeus you can fully test C37.94 systems, measuring frequency, events, one-way delay and all types of events.

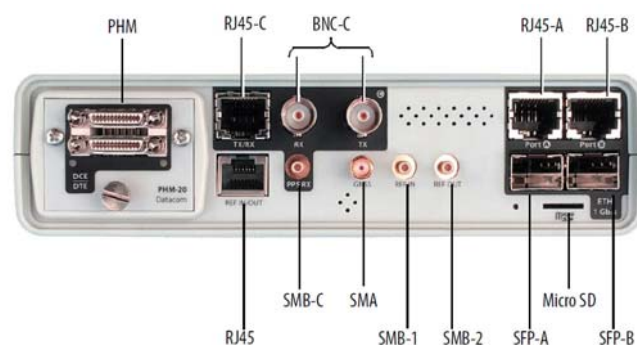
## Full IRIg-B testing

Fully test IRIg-B signals including jitter & wander measurements with GPS.

## Resilience

A flexible and resilient network is at the heart of intelligent substations that can ensure the control and operation of mission-critical applications. Therefore, it is important to have advanced instruments to verify, measure and adapt each protocol according to the strict requirements defined by IEC 61850 regarding interconnectivity, latency, symmetry and redundancy.

An additional challenge is how to design reliable and redundant networks, capable of quickly restoring data flows after a failure, in order to support applications that cannot tolerate even a millisecond of network interruption, without severely affecting operations, which could eventually lead to blackouts that could jeopardize the safety of the company's employees. As a result, an acceptance procedure is a must to verify the health of all mission-critical systems and protections deployed across the power grid.



# Ether.Genius all-in-one tester

*This is a multi-technology tester equipped with all the features you need to install or maintain networks based on Ethernet*

Synchronous Ethernet (SyncE), T1, E1, Datacom, Precision Time Protocol (PTP IEEE 1588), Jitter/Wander, C37.94 and one-way delay testing. For accurate time and synchronization measurements, it can also be equipped with a built-in GPS receiver and an atomic rubidium clock to operate in hold-over mode without external time references. It is a device that can be managed with both, touch screen and keyboard.

## All Included - No Modules

Hardware is getting cheaper, smaller and more powerful every day. So there is no need for external modules, everything fits on a modern handheld. What I mean is that all the electronics including the line interfaces can always be there and you only pay for what you really need. It's simple - there's no need for connectors to connect modules, ensuring perfect operation every time. In other words, you can concentrate on your work because you will never lose, forget or break any module.

### Timing Features

- Built-in Atomic Rubidium Clock
- Built-in GPS / GLONASS receiver
- Internal: better than  $\pm 2.0$  ppm, OCXO better than  $\pm 0.1$  ppm
- External: SyncE, 1544, 2048 Mb/s, 1544, 2048 10 MHz, 1 pps
- Output: 2048 kHz, 1 pps

### GbE Features

- FTD, 2-way FDV, FDV, 2-way FTD, FLR, SES, PEU and PEA
- Symmetric & asymmetric RFC2544 and Y.1564 (e-SAM) testing
- Multi-stream for IPTV, VoIP and critical data verification
- Ethernet line frequency (MHz), offset (ppm), drift (ppm/s)

### PTP / SyncE Features

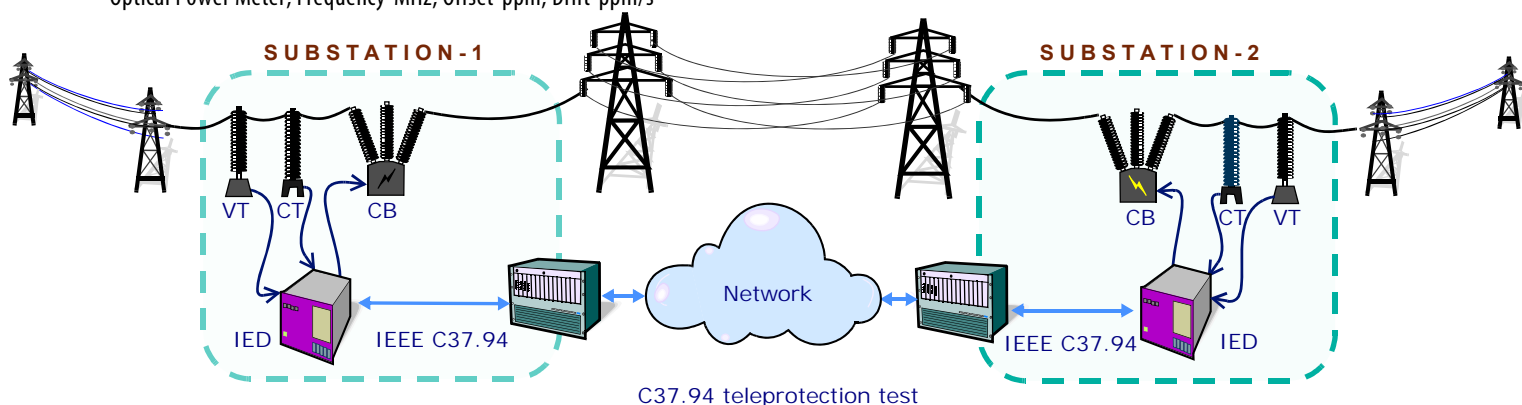
- PTP / IEEE 1588v2 decoding support
- PTP support / master or slave generation
- Master clock operation on each port with internal/external ref.
- Analysis / Generation of ESMC messages and SSM count and rate
- External clock input including 2048 kb/s, 2048 Hz and Synchronous Ethernet

### MTIE / TDEV / TE measurement

- T1, E1 and Datacom features
- G.826, G.821 and M.2100. RTD One-Way Delay (GPS Accuracy)
- Jitter Level/Tolerance/Transmission, Wander Generation and TIE, MTIE, TDEV
- V.11/X.24, V.24/V.28, V.24/V.35, V.24/V.11, V.36/RS449, EIA530(A)
- DTE, DCE Emulation and Monitor

### C37.94 Measurement

- Rate: Nx64 kb/s, N = 1 to 12, G.821 performance: ES, SES, UAS, DM
- Round trip delay (ms) One way delay synchronized with GPS (us)
- Optical Power Meter, Frequency-MHz, Offset-ppm, Drift-ppm/s





# Ether.Giga Ethernet/IP tester

*Ether.Giga is a dual port tester equipped with all Ethernet verification features to quickly install, validate or troubleshoot Ethernet and IP networks while verifying the quality of applications.*

Real field tool designed with rugged case and hardware that makes it a secure in harsh environments. It is controlled by a GUI very easy to navigate and learn. We have made a serious effort to make it suitable for any technical skill.

## Network installation & maintenance

Carrier-Ethernet providers have to face the maintenance of unhappy customers that often do not differentiate between their internal issues and service provider problems. Now thanks to Ether.Giga is possible to measure at customer demarcation points that separate LAN/WAN, that is customers and operator networks. Test can be executed addressing both capacity and quality parameters simultaneously to prove where the issue is. Field engineers can save setups and results for a given application and then, via a USB port or VNC.

## Ethernet/IP Activation

This hand-held unit is ideal for installation and commissioning because it supports all new generation capabilities, and traffic analysis under various conditions. The instrument also provides facilities for BER testing of the lines, performance statistics and QoS statistics

## ITU-T.Y.1564 (e-SAM test)

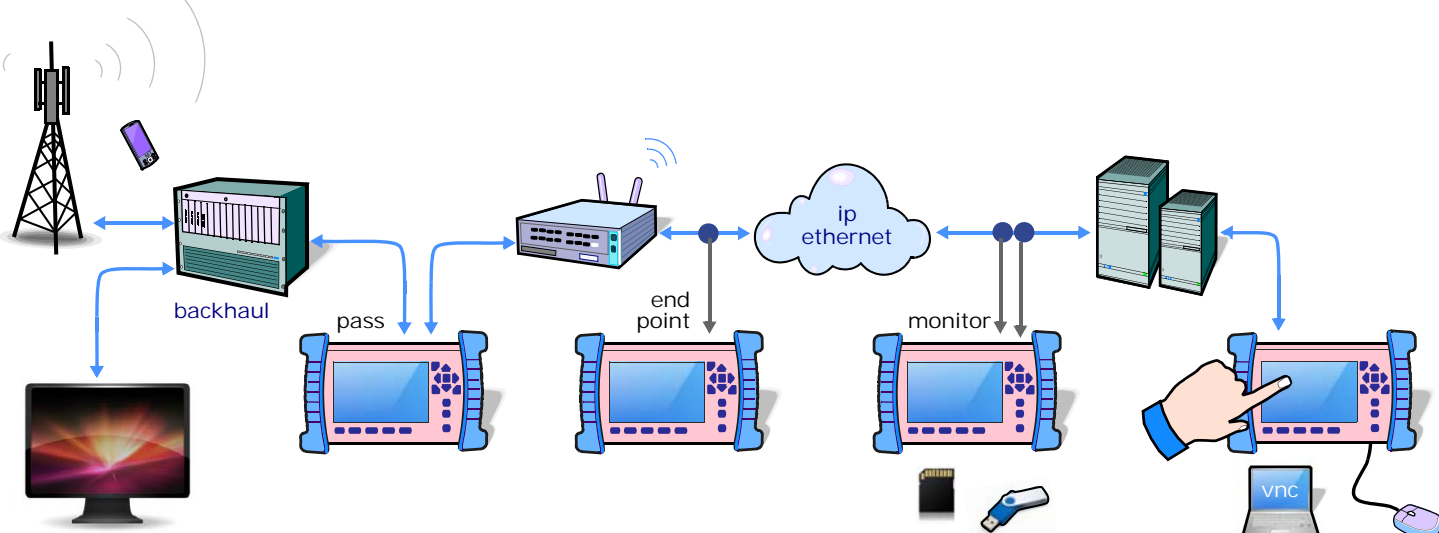
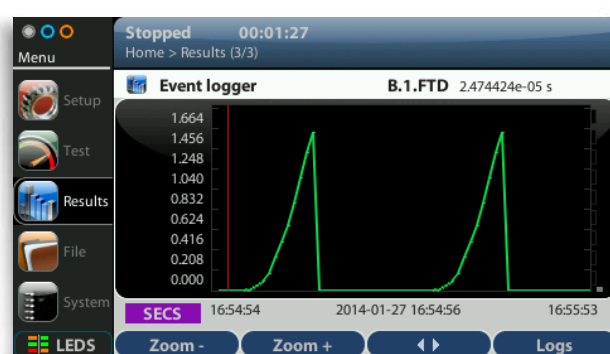
This methodology runs multiple traffic streams in two phases:

- Service Configuration, confirms end-to-end setup while quickly verifying Information Rate (IR), Frame Delay Variation (FDV), Frame Loss Ratio (FLR), Frame Loss Ratio at Service Acceptance Criteria (FLRSAC).
- Service Performance, transmits all configured traffic streams at the CIR, confirming that all traffic is able to traverse the network under full load while verifying IR, FDV, FLR and Availability.

## Features & Applications

Suitable for QoS and SLA certification in telecom and enterprise centers thanks to

- Y.1564 FTD, 2-way, FTD&/FDV, FLR, SES, PEU and PEA
- Y.1731 QoS statistics
- 2 x SFP + 2 x RJ45 interfaces
- Symmetric & asymmetric RFC2544 test
- FCS error insertion in pass-through mode
- Multistreams for IPTV, VoIP and critical data testing
- Q-in-Q for demarcation testing and MPLS support
- MAC/IP/VLAN/QinQ scanning



## AT-One T1+E1+Data analyzer

*The ultimate and world's most comprehensive BER Analyzer / Generator for T1, E1, Datacom, Jitter, Wander, Pulse Mask, Frame Relay, VF and more. T*

Designed with the latest technology, it is light, fast, friendly and comprehensive. Believe it or not, it is the envy of our competitors who dream of one day having a similar unit. Ideal for field technicians installing, commissioning and troubleshooting T1, E1 links, voice and data services, SONET/SDH synchronization and circuits.

### 24 hour non-stop battery operation

This instrument is entirely designed and manufactured by ALBEDO Telecom, because we love to control the entire process to ensure first class quality. This tester uses a brand new platform. Take a look and try this innovative and flexible tool, you will love it after discovering how the latest FPGA can overcome previous limitations



in accuracy, space or performance. Frankly, nothing else can really compare to this outstanding update for T1/E1/Datacom/Jitter/Wander testing.

### State of the Art T1, E1 and Datacom Testing

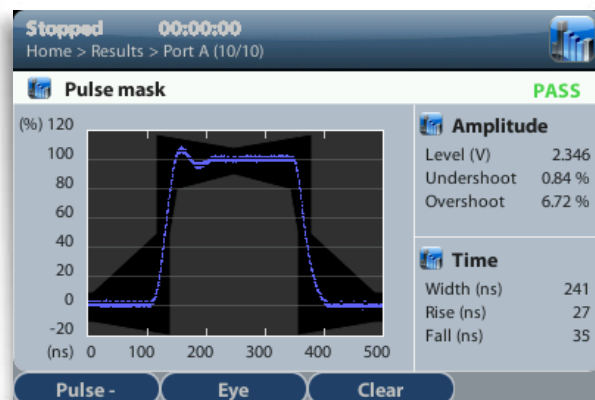
The AT-One is an excellent tester for network operators, contractors and enterprise users who need to manage fixed and mobile networks using T1, E1 and datacom backhaul circuits.

- Latest technology: very fast!
- Linux based, no Windows, no problems
- Dual port BNC and RJ45
- Extra rugged but lightweight
- Jitter measurement, Wander measurement (with all masks)
- Pulse mask
- Handheld 1 kg / 2.2 lb.

### Applications and Users

- Installation and Maintenance
- Jitter / Wander / Pulse Mask Measurement
- Mobile Synchronization
- Mobile, Digital Voice and Data Operators
- Laboratories and Central Office plants

Air Traffic Control, Military and Power Utilities links



## AT-2048 E1+Datacom analyzer

This is probably the most comprehensive E1 tester in the market that includes BER Analyzer / Generator for E1, Datacom, Jitter, Wander, Pulse Mask, Frame Relay, VF and more. The AT-2048 is truly rugged and ideal for field engineers installing and maintaining E1 and Datacom circuits.

Designed with the latest technology, it is light, fast, friendly and comprehensive. Believe it or not, it is the envy of our competitors who dream of one day having a similar unit. Ideal for field engineers installing, commissioning and troubleshooting E1, ISDN, Voice Services, Synchronization Networks and Datacom circuits.





# Net.Storm WAN emulator for labs

This device emulates ANY link/network based on VLAN, VPN, MPLS, etc. in terms of bandwidth & traffic impairments. Bandwidth control is done by Traffic Shaping & Policing, while impairments are inserted on the MAC/IP/TCP/UDP flows.

## Arbitrary Network Dynamics

Yes, modeling arbitrary network dynamics to verify any IP-based solution is now possible. Because Net.Storm can simulate any network condition to verify how tolerant your services, protocols, and devices are to quality/capacity degradation. It accurately replicates combined effects such as packet delay, errors, loss, bandwidth variations, traffic shaping and traffic policing.

## Features and Benefits

Net.Storm permits the exact replication of any traffic condition

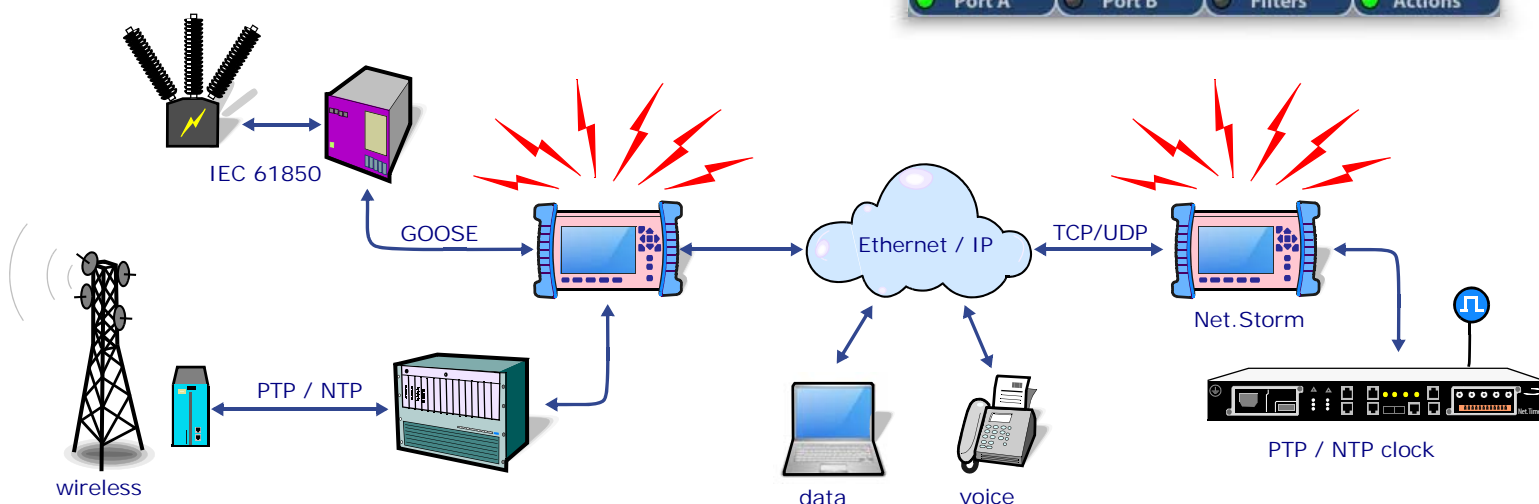
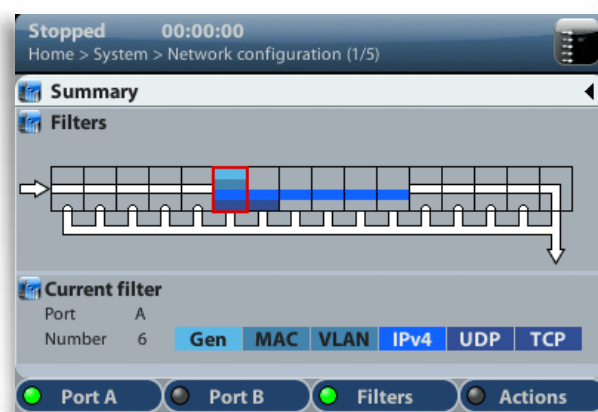
- Delay, jitter, loss, error, duplication
- Traffic Shaping & Policing like routers
- Multiple patterns (uniform, exponential, burst, random, two-state random,...)
- Strict bandwidth control in fr/s or bit/s
- 16+16 filters: MAC, IP, TCP, UDP...
- Full duplex wire speed performance
- Accuracy better than  $< 1\mu s$  at FDX Gbps

## Power Utilities & Telecom labs

- Laboratories willing to emulate network conditions
- Deployment of IEC 61850
- Approval and Acceptance Tests of IED and MU
- Synchronization networks based on PTP, NTP and SyncE
- Verify the tolerance to one-way delays
- Check critical protocols such as GOOSE
- Check Tolerance to QoS degradation
- Identification of degraded sources

## Users

- Power Utilities Labs
- Communication Dpts.
- Substation Engineers
- Control Centers
- Emulation Wireless errors and delays
- Emulation of Satellite conditions
- Military to simulate extreme conditions



## Net.Hunter spot, capture & store

*This packet capture device is ideal for professionals who need real-time analysis of 100% of the IP packets transmitted over an Ethernet link.*

Troubleshooting, security and forensics are typical applications for Net.Hunter. Interestingly, it includes an embedded TAP that forwards those packets that match any of the 16+16 programmable filters. Suspicious packets can either be stored on the internal SSD disk or tapped to a LAN. Net.Hunter is undetectable as it has no IP or MAC address, while operations are performed in FDX mode [Tx+Rx] with ZERO delay and ZERO loss of customer traffic.

### A tireless packet sniffer

Net.Hunter filters, captures, sniffs & stores packets on a local SSD disk at wirespeed, wherever you are. It is a stream-to-disk device that can filter, copy, store, and eventually tap packets at wire speed to assist those who need to monitor, tap, and record any data without disrupting live traffic or causing any delay or loss.

#### Top Featured

Built as a field device, Net.Hunter can be used to capture data at any point, including

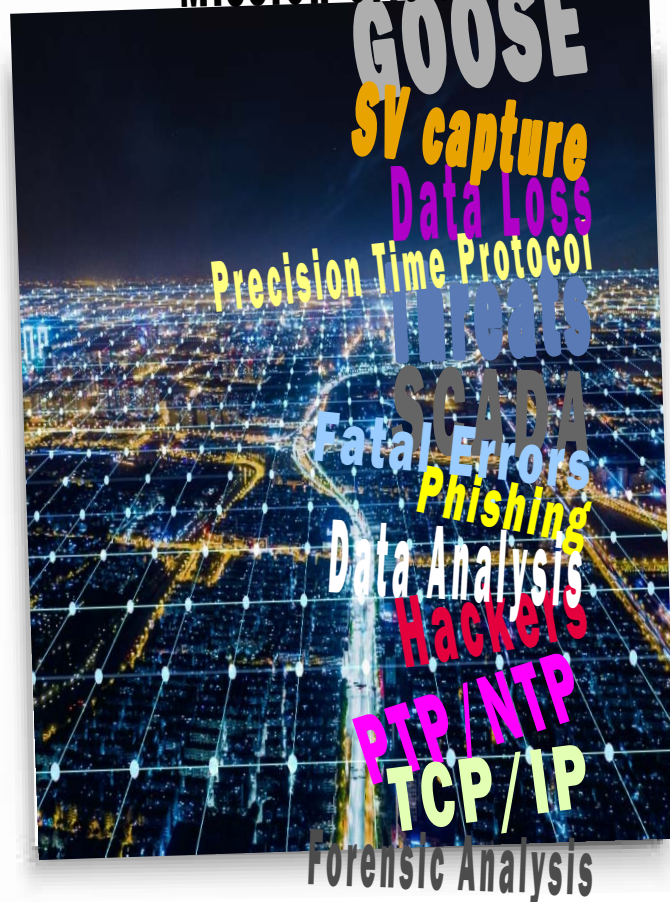
- Non-stop packet capture 24/7/365
- Filter/Capture/Tap at full duplex GbE
- FPGA Filtering, Capture, Decoding & Aggregation
- Wire-speed capture & recording (2Gb/s)
- Smart Capture: Filter first, record later
- NTP synchronized PCAP timestamp
- No MAC, no IP means undetectable
- Monitor and pass-through modes
- Captures CRC erroneous frames
- Wi-Fi Multi/Broadcast Capture & Record
- 16+16 programmable filters
- 4.5h battery operation

#### Applications

- Acceptance testing in substations
- IEC 61850 protocol capture
- WireShark friendly for protocol analysis



## Mission Critical Data



## Net.Shark a tap in a hand

This is a true tap, equivalent to Net.Hunter without the hard drive, therefore it is quite unique in being able to filter traffic, capture, store and tap at wirespeed in a small, compact and battery powered device. They support ALL the features of high-end taps and capture devices in a small, battery-powered device to provide mobility and storage capacity to reach any point on the network.

Net.Shark includes ALL the features of active taps, so you can connect your favorite protocol analyzer as usual, or go anywhere to filter, capture, and store packets. It includes 2x16 programmable filters to identify flows by MPLS, TCP, UDP, VLAN, IP, MAC, etc. working at wirespeed without generating any delay, loss or jitter.

#### Net.Hunter & Net.Shark Applications

- Utilities to capture GOOSE, SV, MMS, PTP, NTP protocols
- 5G operators to capture PTP, NTP and Ethernet IP protocols
- Financial and banking organizations for security
- Enterprise forensic analysis
- Cybersecurity, defense and intelligence agencies
- Law/police/intelligence applications
- Telecom troubleshooters
- Complement firewalls





# GPONDoctor 4K7/9K7 PON test

*GPON Doctor 4K7 model is a analyser for GPON deployments while the 9K7 model is indicated for XGS-PON deployments.*

Both are a portable, passive, chipset-less xGPON FTTH protocol sniffer and analyzer. Connected to any location within your PON distribution network (ODN), it will capture downstream and upstream bit-level information, providing comprehensive analysis of the GPON/XGS-PON TC layer including OAM, PLOAM and OMCI. GPON Doctor is mainly designed for troubleshooting, certification and interoperability testing. It is a perfect tool for lab application engineers involved in GPON/XGS-PON deployment phase or GPON/XGS-PON active element developers/integrators.

GPONDoctor is a complete and self-contained solution: It consists of a GPON/XGS-PON capture + evaluator card, a state of the art chassis and processing software capable of analyzing and evaluating the captured data. Based on our own implementation, the capture hardware includes latest-generation optical modules and high processing power. It is capable of synchronizing with the downstream and upstream data flow of the PON fiber, performing automatic calibration, and enabling long-length captures.

## Troubleshooting xPON

With the goal of reducing the price of ONTs, it is important that any OLT be able to interact with any ONT, regardless of its manufacturer. However, GPON/XGS-PON has a number of inherent characteristics that can make interoperability difficult:

- Commercial implementations of earlier versions of the standard
- Issues during the activation process
- OMCI, a very broad standard open to interpretation
- Heterogeneity between operators
- Attenuation in a GPON / XGS-PON path can be very high due to the sum of fiber splitting, splicing (insertion loss), fusion splicing and distance in the fiber.
- All of these factors present a significant challenge to the deployment of PON.

## Non-invasive detection

GPONDoctor solutions transparently analyze traffic within a FTTH network. In addition, its automatic calibration and built-in touch screen makes it possible to perform a full capture of the network traffic with just one click. The capture can be very long and allows to export the captured data in XML format for later analysis.

## Smart Network Analysis

The Smart Analysis software interprets the captured data and translates it into a graphical format for in-depth analysis of GPON/XGS-PON protocol compliance, interoperability evaluation, bandwidth allocation, and troubleshooting in the field.

The data captured by the GPONDoctor is analyzed to provide a view of:

- GPON/XGS-PON topology: ONTs detected, ONT and OLT status
- Entities created and relationships including errors and alarms generated
- Bandwidth allocation graphs per ONT and TCONT and their evolution over time
- Degree of conformance by applying a dynamic rules-based scoring system for ITU-T G.984.x, G.9807.x/G.987.2/G.989.3/G.988 based on dynamic rules.

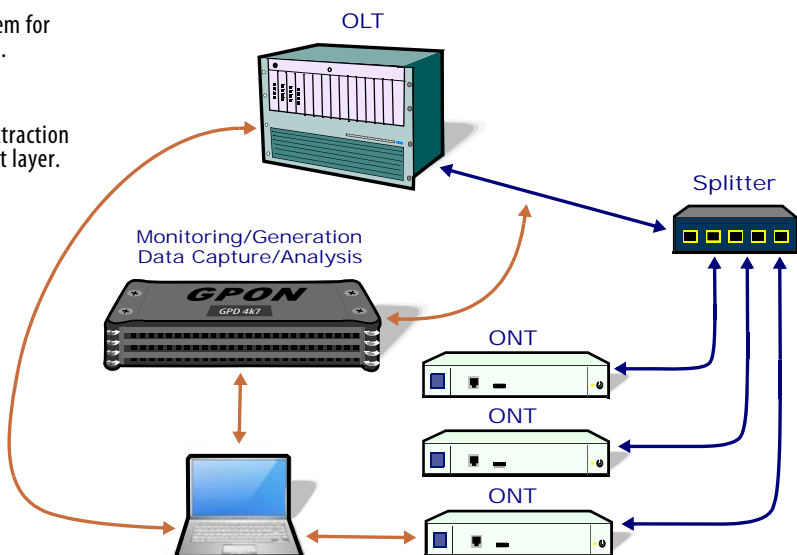
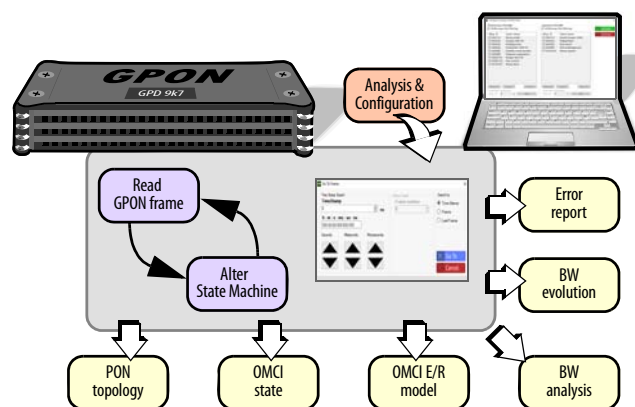
## Real-time Ethernet Traffic Extraction

GPONDoctor 4K7 and GPONDoctor 9K7 provide real-time clear text traffic extraction for both upstream and downstream. The traffic is extracted on the Ethernet layer. This traffic can be further analyzed by upper layer protocol analyzers.

## Users and Applications

GPON/XGS-PON network deployment, equipment and certification

- Inter-vendor interoperability troubleshooting
- Diagnosis and analysis of events and anomalies for deployed xPON
- Compliance during OLT and ONT development
- User traffic analysis and quality of service evaluation in the xPON network
- GPON/XGS-PON auditing and optimization
- Real-time monitoring of the network health and all its active elements (ONTs).



# GPON Doctor 10K7 simultaneous GPON and XGS test

*GPONDoctor 10K7 is a chipset-less passive portable dual analyzer of FTTH XGS-GPON and GPON protocols.*

Once connected to a point in the distribution fiber of the network, it captures data at the downstream and upstream bit level and interprets all control information at the PLOAM and OMCI levels. Designed for troubleshooting, certification and interoperability analysis, the analyzer is ideal for operators and installers of XGS-GPON / GPON deployments as well as manufacturers.

It is a complete and self-contained solution: consisting of an XGS-GPON and GPON data acquisition hardware board, a high performance chassis/equipment and analysis and evaluation software for the acquired data.

The acquisition hardware is self-implemented with the latest generation optical modules and high processing capacity. It can be synchronized and automatically calibrated with the upstream and downstream links at any point in the XGS-GPON or GPON network, enabling long-term captures.

Optionally, it also extracts and decrypts traffic from the upper layer in real time, allowing regeneration of services such as video or VoIP. The analysis software interprets the captured data and allows you to review the trace from the first to the last control frame. It is able to provide an estimate of the XGS-PON / GPON network topology: ONTs, state machine status of ONTs and OLTs, established data channels, exchanged configuration, E / R OMCI diagrams, analysis and graphs of bandwidth for each ONT per T-CONT.

## Key Features

### Capture + Analyze + Evaluate in 1 Click

From the captured data, GPONDoctor 10K7 deduces the network topology and applies a set of rules to certify whether the ITU-T G.9807.x or ITU-T G.984.x recommendation is met. Its automatic adaptive timing and calibration and intuitive interface make it easy to use from day one. Dual equipment: XGS-PON or GPON Analyzer (in-app selectable) Portable, ruggedized equipment that allows the analysis mode to be selected in the same device: XGS-PON or GPON protocol. Accurately detects problems in an XGS-GPON or GPON network. It evaluates and detects problems, identifying the devices that may be causing them and the failure.

### Capture XGS-GPON or GPON

GPONDoctor 10K7 captures OMCI and XGS-TC / GTC messages on the fiber in real time to facilitate the monitoring of negotiation processes and configurations, showing the status of ONTs, XGEM / GEM ports and T-CONTs in real time. Real-time extraction of upper layer (Ethernet) traffic, enabling real-time extraction and decryption of user traffic for monitoring and external analysis. The decoding hardware implements fully automatic AES decryption combined with FEC encoding.

### Service Regeneration and QoS

It is possible to regenerate the services established in a PON network. For example, you can extract and reassemble multicast video in real time and display it on the GPONDoctor screen. This feature is perfect for evaluating the QoS and QoE of the services configured on a PON.

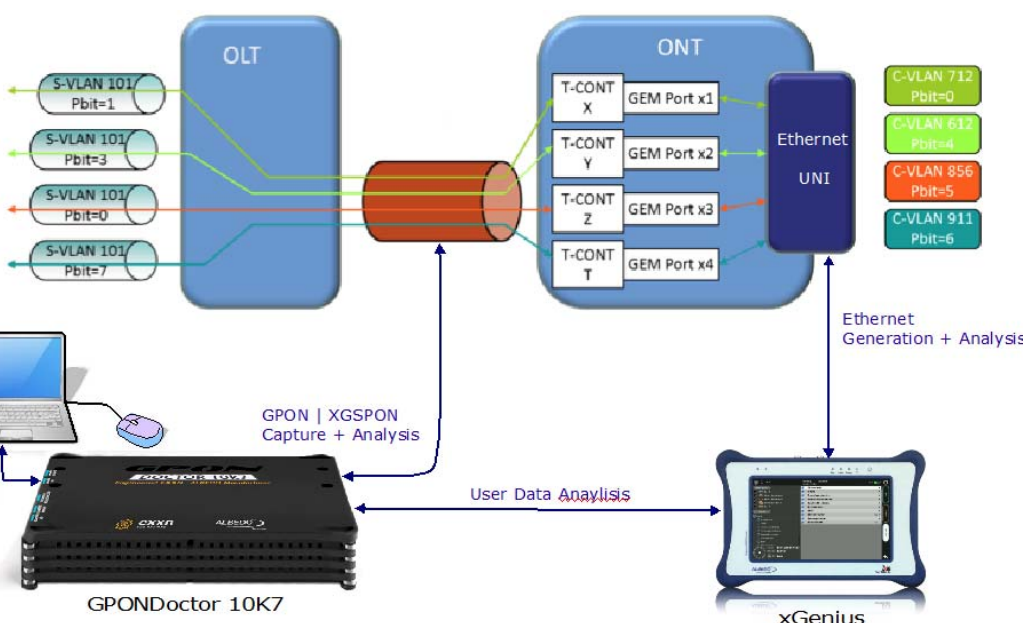
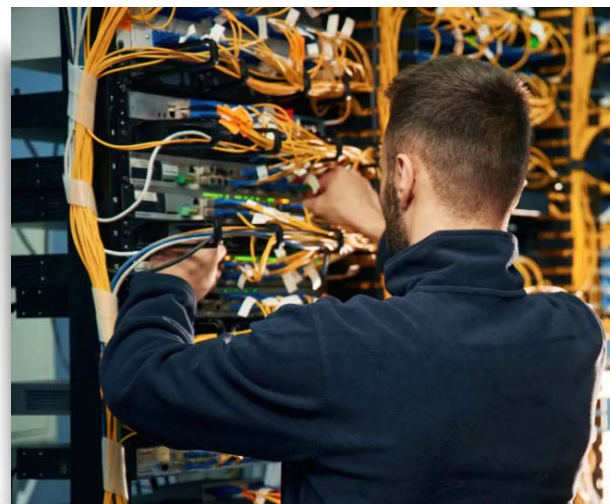
OMCI Entity/Relationship Diagrams and Bandwidth Analysis Displays a detailed OMCI Entity/Relationship diagram including alarms and errors, bandwidth allocation diagrams by ONT and T-CONT, and optional graphs of bandwidth allocation evolution over time.

### Optical Power

GPONDoctor 10K7 offers two new licensed functionalities with the ability to act as an optical power meter and to detect and generate online error reports.

### Chipset-less implementation

Detection of hardware manufactured exclusively for this device. The results are independent of the proprietary implementation of the XGS-GPON and GPON equipment manufacturer.





# OLTe the smart OLT

*GPONDoctor OLTe is an OLT emulator that behaves like a normal OLT acting as the termination point of the PON. It is connected to the ODN (with the ONTs connected to the other end of the ODN).*

Designed primarily for ONT/ONU conformance and network interoperability testing, the GPONDoctor OLT-e is a perfect tool for lab application engineers involved in the GPON pre-deployment phase, as well as GPON network element vendors. As an OLT emulator the GPONDoctor OLTe is completely flexible, allowing users to configure as many different provisioning models as desired.

## Flexibility

Fully configurable OLT that can receive and report events, messages and alarms associated with the responses to each of the OMCI messages sent to the ONUs. As well as acting as an OMCI master.

## OLT Emulation

GPON Doctor OLTe is capable of emulating various commercial OLT behaviours. It allows the creation of specific deployment models and the individual and sequential configuration of OMCI units.

## Features & Benefits

### Capture and Replay

Captures from any of the GPON Doctor network analysers can be imported into the OLT Emulator to replicate PON behaviour. GPON Doctor OLT provides full control of PON parameters including: 802.1ad/802.1Q/802.1p compliant with BBF TR-156 VLAN scenarios, Implements DBA algorithm, Allows FEC coding in both directions, 128-bit AES encryption, IGMP snooping and Multicast.

### OLT emulation

The GPON Doctor OLT-e provides the same functionality as a GPON OLT. It is fully configurable and can emulate any commercial OLT behaviour by using different templates. This feature enables the replication of any Optical Line Terminations and the execution of advanced functionalities:

- It involves receiving and reporting events, messages and alarms in response to each OMCI message that is sent to the ONT.
- The emulator can be programmed with scripts or manually at the OMCI level. Messages are used to configure OMCI entities in each ONT.
- Generation of PLOAM message to perform different functions at GTC level: Enable and Configure the GEM OMCC port and password authentication tests.

OLT-e manages traffic in GEM frames, carrying real Ethernet traffic through a 10Gbps or 4 x 1Gbps interfaces.

## GPD applications

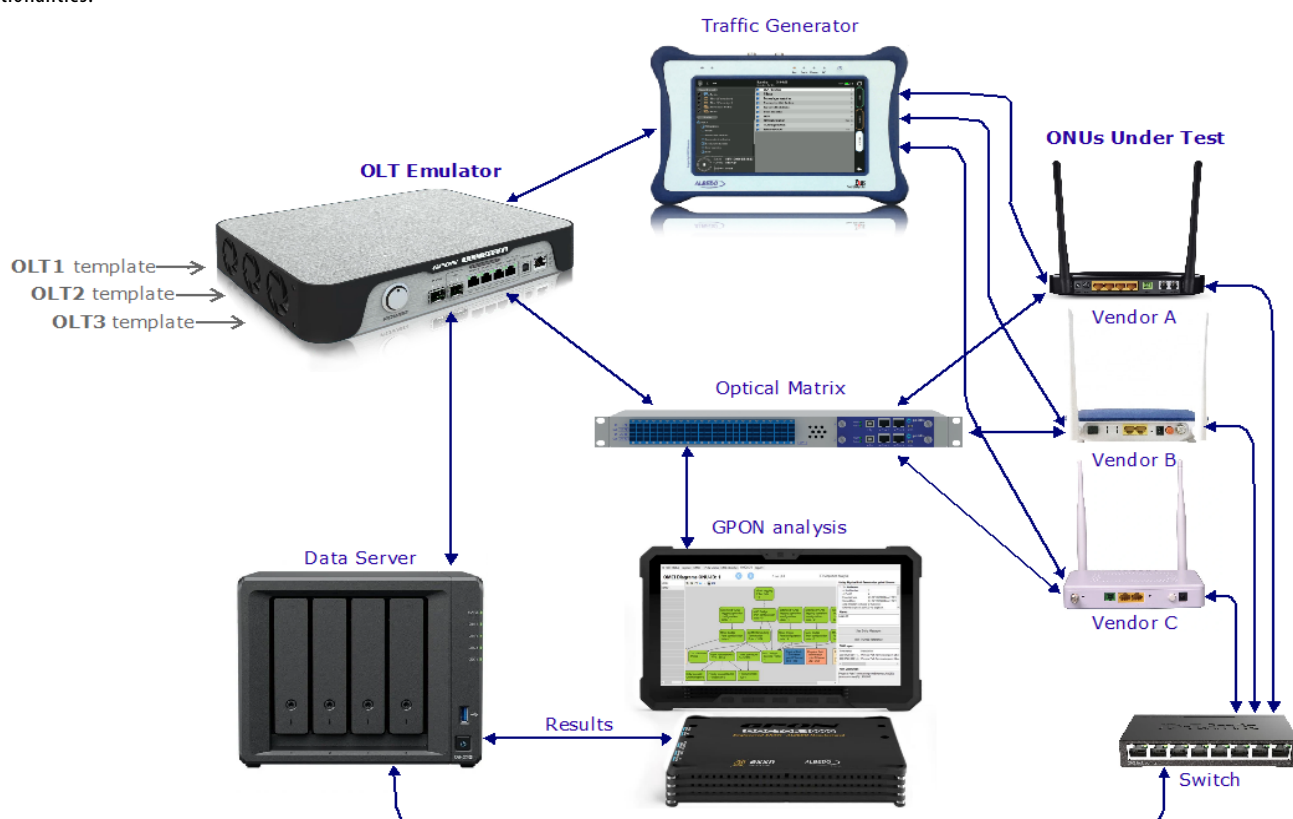
### ONU Conformance test

GPON Doctor OLTe serves as an OLT, designed specifically for ONT/ONU interoperability testing. It is a reference tool for laboratory engineers involved in the planning phase of GPON networks and manufacturers of active GPON elements.

### Lab appliance

A laboratory may require various configurations and testing methods, which cannot all be listed. However, here are some examples:

- The interoperability test is intended to pinpoint any potential errors in the negotiation and transmission between devices resulting from non-compliance.
- The process involves diagnosing and analyzing events and deviations in already deployed GPON networks, assessing protocol compliance during the development of GPON ONTs, and identifying poor performing or erratic ONTs.



# 2025 Buyer' Guide

## by Protocol

	10GE	OWD	T1/E1	Eth/IP	PRP	SyncE	PTP	NTP	Tap	OTDR	VoIP	Serial	Codir	IRIG-B	Goose	SV	C37.94	GPON	XGSPON
AT-One			★									★	★						
AT-2048			★									★	★						
Ether.Genius		★	★	✓		★	★	★				★					★		
Ether.Giga				★															
GPON 4K7																		★	
GPON 9K7										○									★
GPON 10K7									○									★	★
Net.Hunter				✓			○	○	✓						○	○			
Net.Shark				✓			○	○	★						○	○			
Net.Storm				○			○	○							○	○			
Net.Time ○			★	★	★	★	★	★						★					
Net.Time φ			★	★	★	★	★	★						★					
Net.Time τ			★	★	★	★	★	★											
xGenius	★	★	★	★		★	★	★	✓	○	○	★	★	★	○	○	★		
Zeus		★	★	★		★	★	★	✓	○	○	★	★	★	★	★	★		

★Best

✓Good

○ Partial

Tap: Packet Capture

Cntrdir: Codirectional / Contradirectional

SV: Sampled Values

Serial: Serial data / Datacom

## by Application

	10GE	OWD	T1/E1	Eth/IP	PRP	SyncE	PTP	NTP	Tap	OTDR	VoIP	Serial	Cntrdir	IRIG-B	Goose	SV	C37.94	GPON	XGSPON
AT-One			R,U									R,S	R						
AT-2048			R,U									R,S	R						
Ether.Genius		U, W	R,U	all		S,U	all	all				R,S					S,U		
Ether.Giga				all															
GPON 4K7																		T	
GPON 9K7																			T
GPON 10K7																		T	T
Net.Hunter				S,L			S,L	S,L	S,L		E,L				S,L	S,L			
Net.Shark				S,L			S,L	S,L	S,L		E,L				S,L	S,L			
Net.Storm				S,L			S,L	S,L			E,L				S,L	S,L			
Net.Time ○			A,M	A,M	all	T	all	S,L						A,S					
Net.Time φ			S	S	S	U,S	S	all						A,S					
Net.Time τ			T,E,D	T,E,D		T	T,E,D	S											
xGenius	T,U	U	S	U,T		S,T,U	all	S,T,U	S			R,S	R	A,S	S	S	S,U		
Zeus		U	S	S,U		S,U	S,U	S,U	S,U			R,S	R	A,S	S	S	S,U		

A: Aerospaceal D: Data Centers E: Enterprise F: Finance L: Labs M: Military R: Railways S: Substation T: Telecom U: Utilities W: Wireless



ALBEDO, an ISO 9001-certified company, is committed to being the premier technological partner for our customers. We provide advanced solutions to install, synchronize, monitor, and troubleshoot transmission resources. Our products are designed with precision and reliability in mind, delivering high sophistication and added value in an evolving technological landscape. Customer satisfaction is our priority and the key driver of our continuous improvement.

**3 Years  
WARRANTY**

This warranty applies only to the original purchaser or end-user of an ALBEDO Telecom authorized reseller and excludes batteries or products that, in ALBEDO Telecom's judgment, have been misused, altered, neglected, or damaged due to accidents or improper handling. The Software is warranted to function according to its specifications for six months, though uninterrupted or error-free operation is not guaranteed.

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