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Sync.Lab: PTP (+ SyncE) Laboratory

Sync.Lab is a synchronization laboratory that replicates accurately a complete PTP and SyncE architecture including the Master/Slave Clocks, WAN emulation and Testers.

A The basic configuration complies with the requirements for environment training and research of telecommunications professionals.

An enlarged configuration adds functionality for advanced users willing to have a comprehensive laboratory to verify synchronization nodes, modeling new network architectures and executing advanced verification tests on Ethernet, PTP and and SyncE

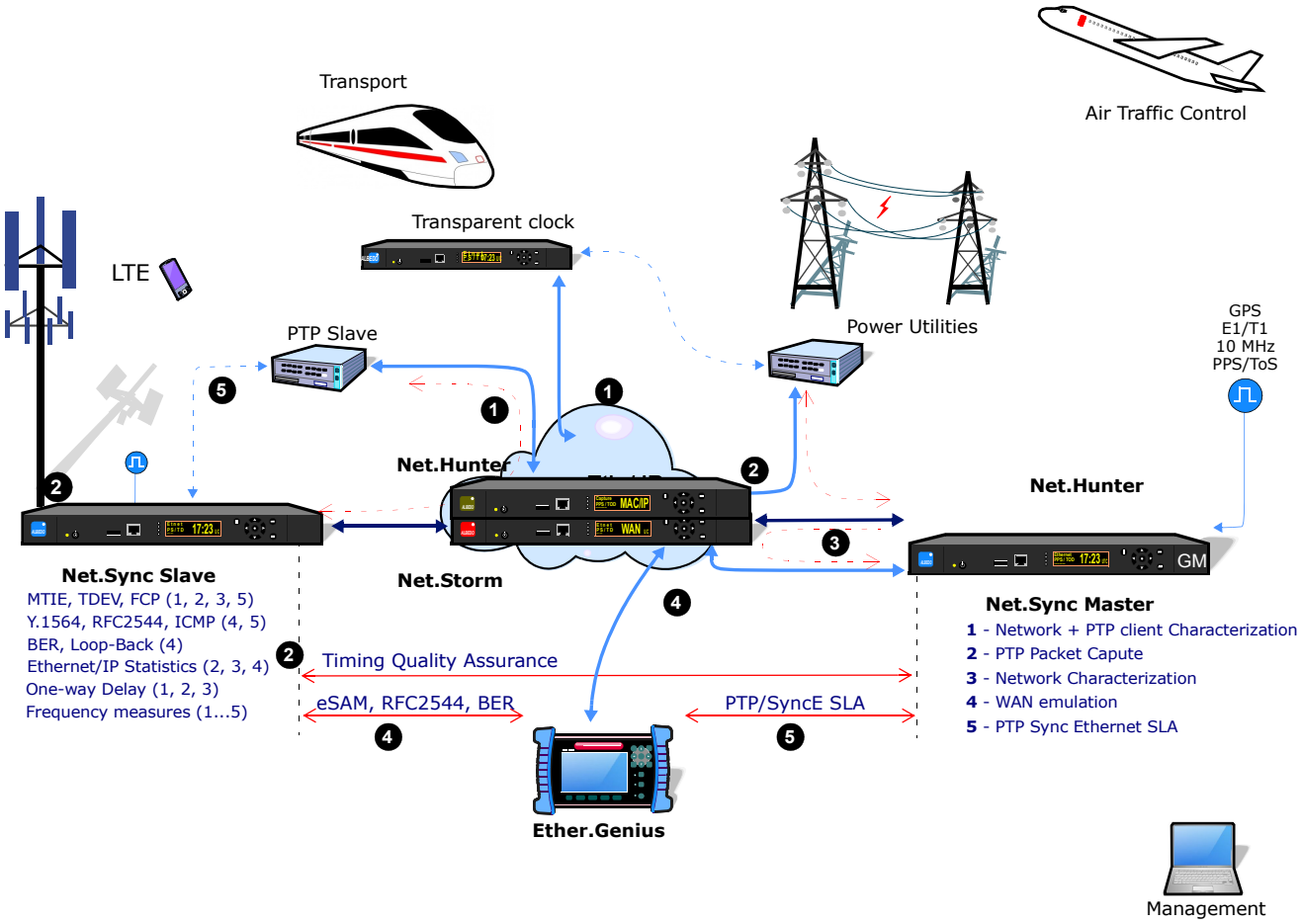

Figure 1 *ALBEDO Syncronization Lab reproduces a real telecom and syncrhonization network.*

1. SYNC.LAB ARCHITECTURE

Designed for any Ethernet traffic up to 10Gbit/s. It includes a summary of the characteristics team (see Table 1) . See below the most relevart features of generation and analysis..

Table 1
Summary of features

Features	*Key points*
PHY Interfaces	• Dual Ethernet Interface, includes two electrical ports and two optical (SFP) • Supports 10BASE-T, 100BASE-TX and 1000BASE-T RJ-45 • Supports 10BASE-T, 100BASE-TX, 100BASE-FX, 1000BASE-T, 1000BASE-SX, 1000BASE-LX • 1000BASE-ZX , and 1000BASE-BX SFP interface (requires specific SFP transceivers)
Frames	• L2: DIX, IEEE 802.1Q (VLAN), IEEE 802.1ad (Q-in-Q) • L3: MPLS, IPv4, IPv6 (analysis) • The computer allows to set all fields of the frames above
Traffic Profiles	• Continuous random generation, bursty, ramp and Throughput generation up to 1 Gb/s • Generation with multi-flow specifies dithering and traffic profile for each of the flows

Testing at the transmisión en Ethernet (see Table 2)

1.1 IEEE 1588 frames Analysis and Edition

Net.Sync and Ether.Genius have the ability to emulate PTP devices including Slave and Master clocks. Here are some details on the characteristics of emulation and analysis included included. (see Table 3)

Figure 2 *Net.Sync is a PTP clock configurable as Master or slave, Net.Hunter is a packet capture appliance, Net.Storm is a WAN emulator and Ether.Genius is an Ethernet, IP, PTP tester. All of them designed and manufactured l ALBEDOTelecom*

Table 2
Ether.Genius Features

Feature	*Description*
RFC 2544	• Tests: Throughput, latency, frame loss, back-to-back frames and retrieval system (IETF RFC 2544) • Ability to run collaborative testing between two teams to assess end-to-end parameters • Ability to perform measurements of one-way delay with GPS synchronization.
ITU-T Y.1564 (service activation)	• Verification of up to eight services (without color mark) and four services (color mark) • Performance measurement services in terms of: Frame Total delay (FTD), Frame delay variation (FDV), Frame loss ratio (FLR) link availability • Ability to run collaborative testing between two teams to assess end-to-end parameters • Ability to perform measurements of one-way latency to GPS synchronization
QoS analysis	• Verification of the quality of service of configurable data in terms of Frame Total Delay (FTD) (maximum, minimum, average values, standard deviation, range) • Frame delay variation (VSF) (max, avrg), Frame loss ratio (FLR), lost frames, coefficient of lost frames. • Statistics reordering, duplication and availability • Possibility of performing measurements on up to eight independent data streams

For more detail see **DS-Net-Sync.pdf** and **DS-Ether-Genius.pdf**

Table 3
Net.Sync Features for IEEE 1588

Feature	*Description*
IEEE 1588v2	• PTP profiles: Default profile 1588 IEEE, ITU-T G.8265.1 frequency profile, ITU-T phase G.8275.1 profile (available in 2016 Q1), Power profile. • PTP emulation Grandmaster possibility of distributing the time obtained in time scale TAI using the GPS receiver included within the unit. • Slave emulation similar to a commercial but including comprehensive statistics on traffic and device performance characteristics. • Pseudo-slave mode behaves like a slave receives synchronization of an external signal such as the GPS system. This is the right way to measure quality in terms of PDV, FPP, asymmetry, TE, TIE, MTIE and TDEV.

For more detail see **DS-Net-Sync.pdf**.

1.2 Frame edition

It allows the manipulation of frames, modify fields, introducin latency and jitter. To meet this requirement Net.Storm can generate of impairments in electrical or optical Ethernet interface speeds up to 1Gb / s. Below its most important features are detailed. (see Table 4).

More details in **DS-Net-Storm.pdf** .

1.3 Packet Capture

Data capture requires a Net.Hunter in rack or hand-held format. This unit incorporates a storage SSD device and up to 500 GB which allows capture at wirespeed (1Gb / s + 1 Gb / s) without any limitation. In addition, Net.Hunter

Table 4
Net.Storm Features

Feature	Description
PHY Interfaces	• Dual Ethernet Interface, includes two electrical ports and two optical (SFP) • Supports 10BASE-T, 100BASE-TX and 1000BASE-T RJ-45 • Supports 10BASE-T, 100BASE-TX, 100BASE-FX, 1000BASE-T, 1000BASE-SX, 1000BASE-LX • 1000BASE-ZX , and 1000BASE-BX SFP interface (requires specific SFP transceivers)
Impairments	• Latency and Jitter: deterministic delay, random delay with uniform or exponential probability distribution • Possibility to inhibit rearrangements in random modes • Packet loss: single event, random, burst, burst periodic, two states (Gilbert-Elliot model) • Bandwidth Control: Filters: Policing and Traffic shaping set in frames/s or bit/s • Mirroring frames, frame error insertion • Disturbance number of blocks per port: 16
Filters	• Allows to select which is the traffic flow to be modified depending on several custom parameters • 16 blocks are arranged for filtering per each port (32 filters in total). • Filters based on IP address, MAC, Ethertype, VLAN, UDP port address and many others

can be used to "tap" which allows you to filter traffic from a network and forward the result to an external device such as a protocol analyzer mode. Here are the key features of Net.Hunter detailed (see Table 5).

Table 5
Net.Hunter features

Feature	Description
PHY Interfaces	• Dual Ethernet Interface, includes two electrical ports and two optical (SFP) • Supports 10BASE-T, 100BASE-TX and 1000BASE-T RJ-45 • Supports 10BASE-T, 100BASE-TX, 100BASE-FX, 1000BASE-T, 1000BASE-SX, 1000BASE-LX • 1000BASE-ZX , and 1000BASE-BX SFP interface (requires specific SFP transceivers)
Filters	• Allows to select which is the traffic flow to be modified depending on several custom parameters • 16 blocks are arranged for filtering per each port (32 filters in total). • Filters based on IP address, MAC, Ethertype, VLAN, UDP port address and many others
More	• Performance of the capture is 100% of the nominal traffic of an Ethernet link operating at 1 Gb/s • Bidirectional while simultaneous capture(Rx,+Rx, Tx+Rx, Tx+Tx) • Modes: termination or pass through • Tap function: retransmits captured packet to an external device through a mirror port • Ability to add two directions of transmission in tap mode • Precision timestamps assigned during capture 10 nss

More details in **DS-Net-Hunter.pdf**

2. TIME AND PHASE MEASUREMENTS

Time measures, including phases and frequencies lies on Ether.Genius that may also perform PTP protocol emulation. Here are some details on the measurement capabilities of this equipment (see Table 6).

Table 6

Net.Sync (slave mode) and Ether.Genius frequency and phase

Feature	*Description*
PDV	• PDV measure allows to determine the amount of noise being generated inter-media elements in the PTP domain as a result of network congestion or any other reason. • Measures latency and variation in latency in PTP Sync messages in terms of the following quality metrics: Current PTD, half PTD, PTD max/min, PTD std dev., PTD range, PDV current/max/min/med • Measures latency and variation in latency in PTP messages or Peer Delay Request Delay Request in terms of: PTD, Current / half, PTDmax/min, PTD std dev., PTD range. • Arrival time statistics PTD Sync messages, statistics on the field correction PTD Sync messages. • Tests can be performed both in PTP slave emulation mode and pseudo-slave mode (a) Slave: determine the amount that would detect a standard PTP slave (b) Pseudo-wire: results are based on a precise timing reference
FDP	• Floor Delay Population determines the PDV in terms of parameters defined in ITU-T G.8260 the standard for exclusive use in frequency distribution applications in packet networks • Measurements: Floor Population Count (FPC) curr/min, Floor Population Rate (FPR) curr/min, Floor Population Percentage (FPP) curr/min
MTIE, TDEV	• Determines the behavior of a PTP clock with special emphasis on long-term disturbances • Real-time Measurements according to ITU-T G.8260: pktFilteredTIE, pktFilteredMTIE, pktFilteredTDEV • Ability of linear filtering and nonlinear data user configurable according to ITU-T G.8260
TE	• Tiem Error (TE) Measurement of the asymmetry in the uplink and downlink assisted GPS for determining one of the essential components in the phase error induced in a PTP slave • TE measure and max |TE| that directly determines the phase error caused by asymmetry paths as perturbations in both PTP grandmaster.

3. CASE STUDIES

3.1 Boundary, Transparent and Ordinary Clocks

The basic verification schemes include Boundary Clock (BC), Transparent Clock (TC) and Ordinary Clock (OC) . It should be noted that some of the measures require one Ether.Genius and Net.Sync at the remote end, both included in the Sync.Lab architecture.

As schemes I, II, III apply to OCs. In case you want to test a Grandmaster, and its network distributing its synchronization signal, then Net.Sync and Ether.Genius can be used either in Slave mode (II), without external time reference, either as in pseudo-Slave mode (III) using an external time reference (see Figure 3).

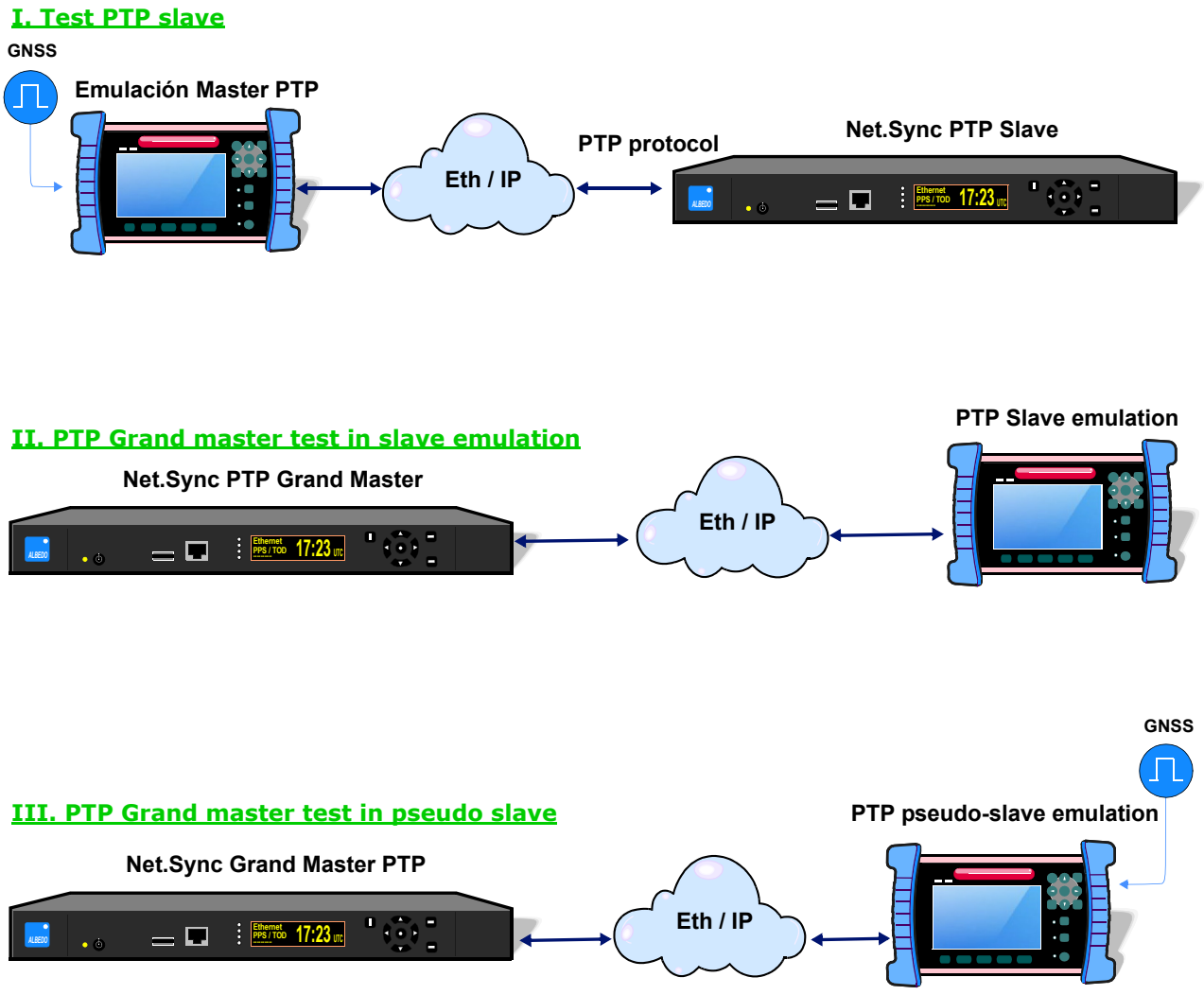

Figure 3 *Ordinary Clock (OC) schemes*

The measurement scheme IV allows to know the quality of 1 pps output (or any other time output) from PTP slave clock. Comparing II, III vs. IV tests can be deduced PTP slave performance (see Figure 4).

IV. Output test PTP slave

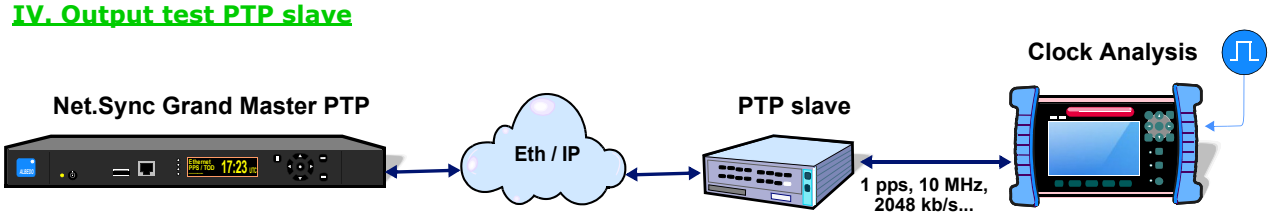

Figure 4 *The measurement scheme IV allows to know the quality ourt put in 1pps format or any other from PTP slave.*

Finally, V (see Figure 5) and VI (see Figure 6) schemes apply to BCs and TCs. For these tests two units that can be synchronized through a cable at 1 pps interface (see Figure 5) or if the computers are in different locations can be synchronized using GPS .

It is important to highlight that Scheme VI may not be available if the master and slave are integrated within the same testing appliance.

V. Local BC / TC test

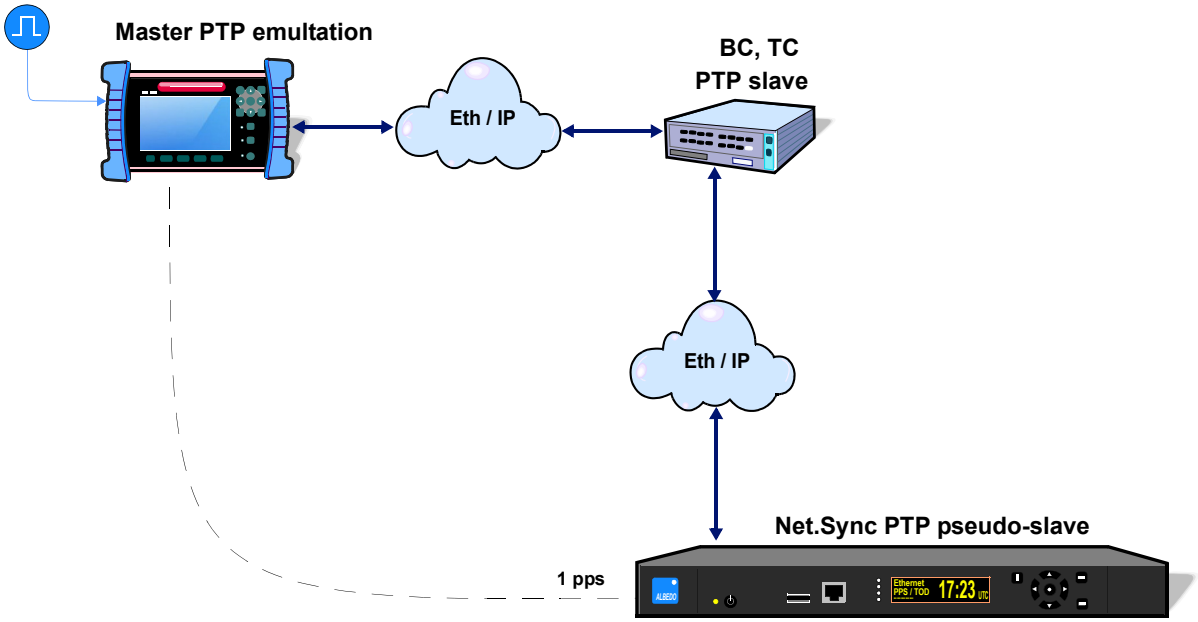

Figure 5 *Schemes V for Boundary Clock (BC), Transparent Clock (TC)*

VI. Remote BC / TC test

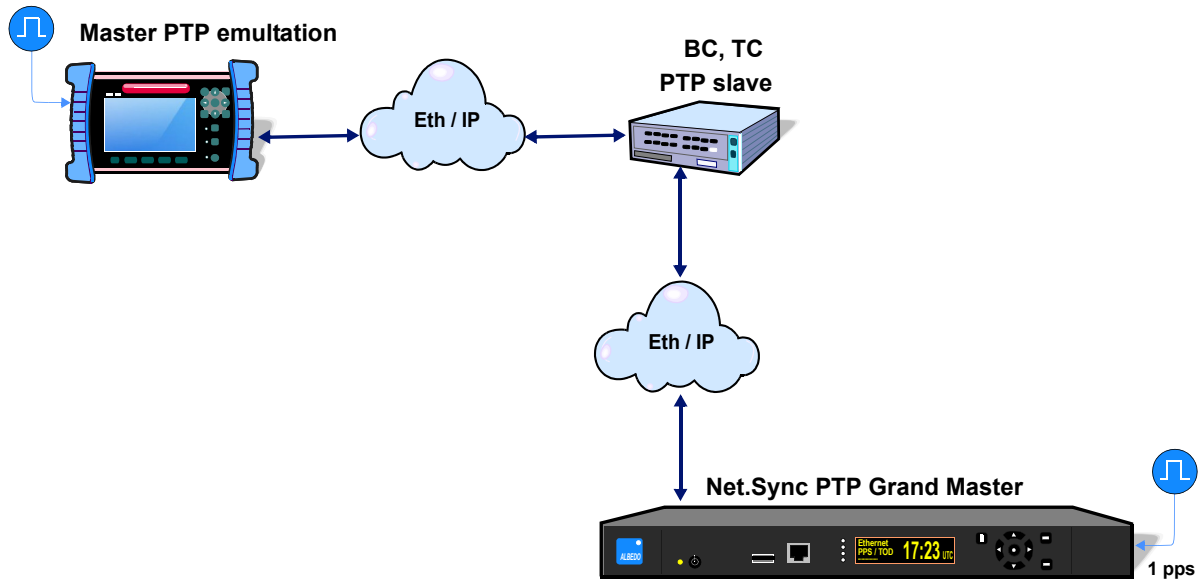

Figure 6 *Schemes VI for Boundary Clock (BC), Transparent Clock (TC)*

3.2 ITU-T G.826x and G.827x verification

Testing PTP functionality using Ether.Genius is primarily intended to allow verification of ITU-G standards. G. 8261.1 and G.8271.1 that define the operating limits for distribution profiles for PTP frequency and phase defined in other Recommendations ITU-T.

As essential parameters are MTIE, max |TE| and FPP. The first profile applies frequency and phase to the second phase profile and only the last to only the frequency (see Table 7). .

Table 7

Verification of compliance to TU-T G.826x y G.827x

Feature	*Description*
MTIE	• Verification of MTIE mask defined in ITU-T G.8261.1 (MTIE modified G.823) • Verification error dynamic time in terms of MTIE defined in ITU-T G.8271.1
max |TE|	• Check time error as defined in ITU-T G.8271.1
FPP	• Limit confirmation of 1% for a 150ms delta as defined in ITU-T G.826.1

However, the ability to measure is not limited to these cases. For example, you can perform the MTIE and TDEV masks defined in ITU-T G.823 or the asymmetry test to determine the part of max |TE| which can be attributed solely to the network.

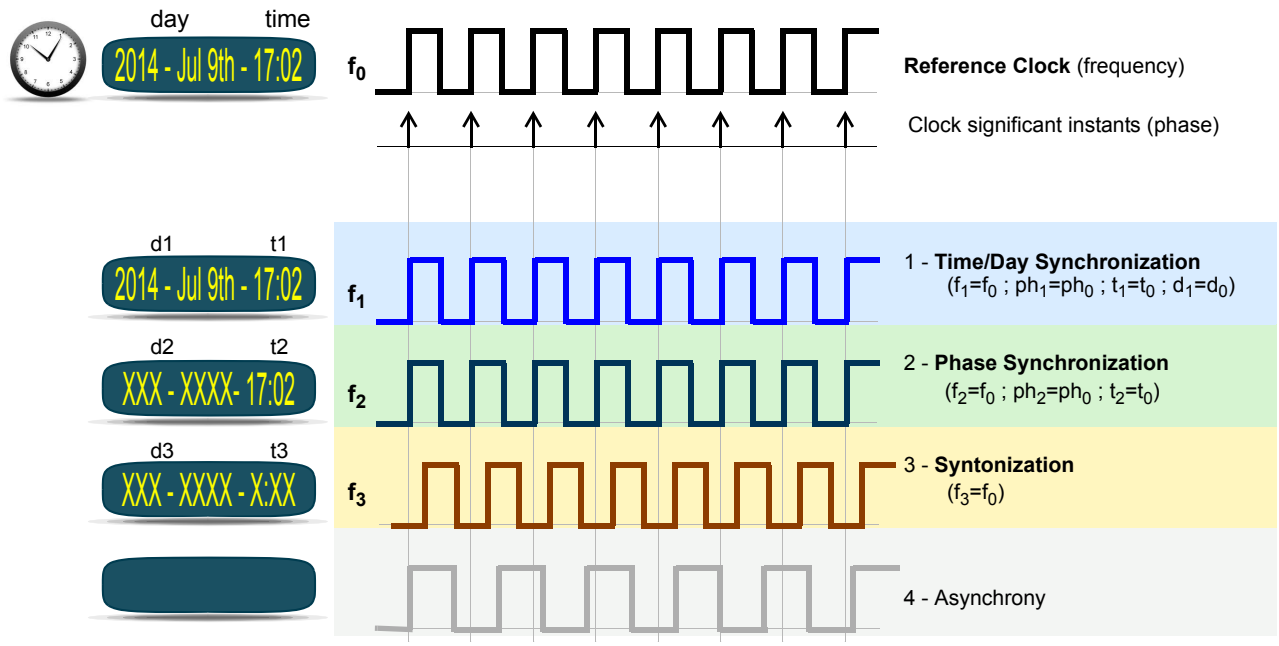

Figure 7 *Synchronization of Frequency and Phase error of a signal in relation to its Reference Clock.*

3.3 Master and Slave PTP emulation

Net.Sync can be configured in emulation mode as PTP grandmaster and slave PTP as well. Sync.Lab includes two identical Net.Sync units that normaly will be configured one as Master and the sencond as Slave.

So to have two Net.Sync allows the full configuration of a transmission and a synchronization network in order to increase the number of tests and reliability to perform a greater number of tests as described in Scheme VI (see Figure 5).

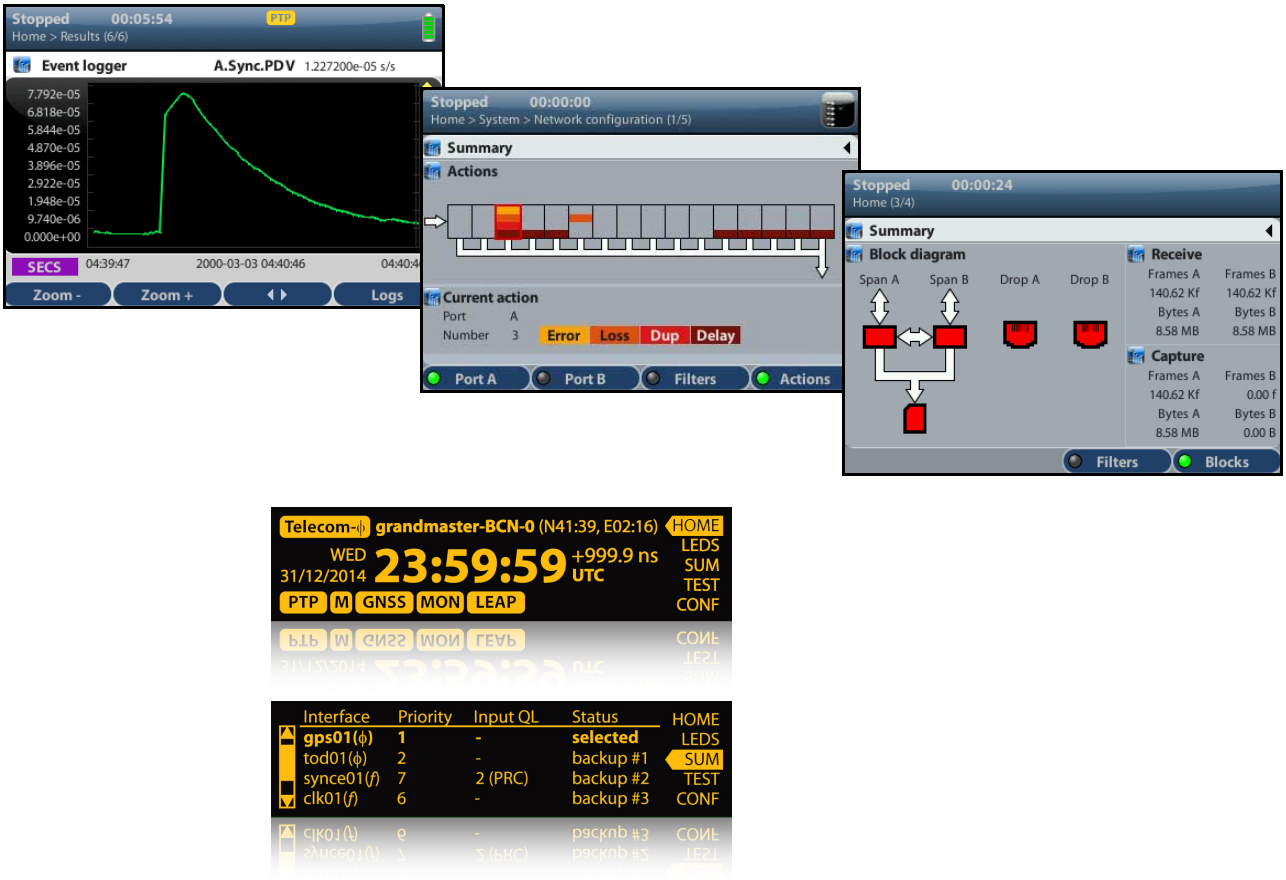

Figure 8 *Sync.Lab screen-shots.*

ALBEDO Telecom

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+ LEARN from experts by means of professional services and consultancy