Brochure

VIAVI Solutions

VIAVI
One-Way Delay and PTP (IEEE v) Test Applications

Application Information

- PTP (IEEE 1588v2) connection, PDV and time error test
- Synchronous Ethernet, connectivity, frequency offset, ESMC message decode
- GPS Satellite constellation, signal quality
- Wander test (PTP, 1pps, T1/E1/10MHz, 1000M)
- Ethernet One Way delay test
- Test Applications

Solution Description

New wireless technologies (LTE-TDD, LTE-A Pro, 5G) require synchronization levels that are far more precise than those required on LTE networks. When sync fails on these new networks, radio towers interfere with each other resulting in dropped calls, decreased broadband service quality, and angry customers.

There are three primary means carriers employ to synchronize their networks:

- PTP (IEEE 1588v2)
- Synchronous Ethernet
- GPS

Use Cases

- Ensure connectivity to PTP Grandmaster, verify delay, PDV, and time error
- Test the connection to a Synchronous Ethernet master clock, measure receive frequency, and ESMC messages
- Check the number and signal quality of satellites visible at the GPS antenna
- Verify slave clock quality with wander analysis at PTP packets, 1pps/1PPS/T1/E/
- 10MHz/Synchronous Ethernet
- Accurately verify carrier Ethernet and mobile backhaul SLAs with one-way delay (OWD) measurements
- Measure OWD in vertical markets, such as financial and power industries

Intended Audience

- Field-service technicians and central-office technicians who install and troubleshoot faults for carrier Ethernet and Ethernet backhaul
- Professional service and managed-service engineers responsible for the continuous care, troubleshooting, and evolution of end-customer networks
- Application service providers who deliver service-level agreements (SLAs) for specific vertical-application markets such as financial applications and power-supply companies
- Support engineers who maintain, troubleshoot, and evolve end-customer synchronization services.
- Supported applications include Ethernet Layer 2 applications, IP Layer 3, PTP (IEEE 1588v2) Layer 2/Layer 4, Synchronous Ethernet, GPS, and wander application

Ensuring a network meets these tight sync levels necessitates proper test methodologies before activation of wireless services. VIAVI's T-BERD/MTS-5800 in conjunction with the Timing Expansion Module (TEM) deliver the complete range of functions for synchronization test. With these capabilities, they represent an all-in-one tool for backhaul, synchronization, front haul, and fiber test up to 10G (and 100G with the T-BERD/MTS 5800-100G).

Meeting PTP sync targets require verification of the PTP slave connectivity to a Grandmaster, and analysis of the PTP network quality which is determined by packet loss, delay, PDV, and time error. Synchronous Ethernet networks can be characterized by measuring the frequency offset of received signal and decoding of incoming ESMC messages. While packet measurements represent a powerful metric for the quality of synchronization networks, the synchronization quality is ultimately judged by the quality of the recovered clock at the network slave. It can be measured by performed wander measurements at the clock ports such as 1PPS.

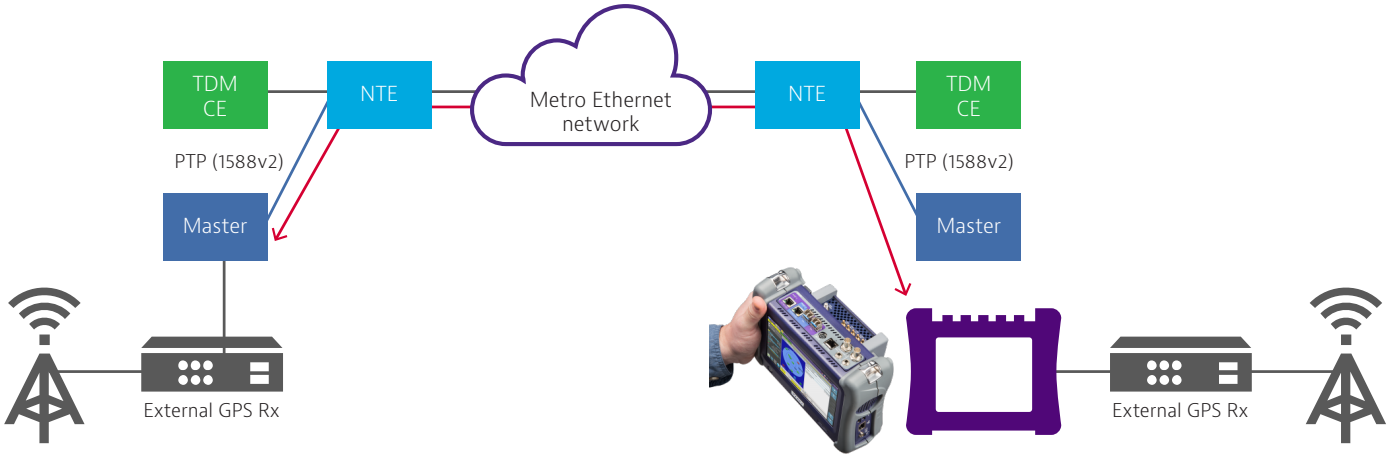
GPS antennas are installed in cell towers and roof tops across the world. While some locations may have clear visibility to the sky, many other locations are surrounded by buildings or may be temporarily blocked by construction cranes or other obstacles. An analysis of the number of visible satellites and their signal strength over time ensures that the antenna is located at its optimal location with sufficient visibility of satellites over long periods of time as they rotate around the earth.

Finally, the quality of the backhaul network is also impacted by any asymmetries that can be caused by different interface rates or packet throughput rates to and from the cell sites. The One-Way Delay test helps identify asymmetry issues in any Ethernet network such as backhaul, wireline, mission-critical government agencies, and networks commissioned for financial services applications and power-supply companies.

Use Case: Connectivity, packet loss, PDV and Time Error in a PTP (1588v2) Network

The T-BERD/MTS-5800 provides a valuable option for testing PTP (IEEE 1588v2) links for use in delivering time/phase synchronization between a master and slave device in mobile backhaul networks. Each test instrument can be configured as a master or slave device when connecting them to a peer device over the PTP link. The link is qualified by measuring parameters such as packet loss and packet delay variation, among others.

One key parameter for characterizing the PTP link performance is packet-delay variation (PDV). Excessive PDV directly impacts slave clock time-synchronization accuracy. Another critical parameter is the Time Error (TE) that characterizes any asymmetries between Grandmaster and respective slaves. With synchronization targets in the range of several microseconds, it is critical to measure PDV and TE in sub microsecond range. This in turn requires an accurate reference device that can hold its time and phase data obtained from GPS satellites, an application for which VIAVI's Timing Expansion Module (TEM) was specifically designed. It can easily be connected to a GPS antenna to retrieve the location and time/phase information. The TEM contains a rubidium oscillator that can hold the time/phase information for several hours. Excellent holdover performance is critical for many applications inside buildings where there is no line of sight to GPS satellites.



PTP (IEEE1588v2) master-slave delay test using the T-BERD/MTS-5800 with Timing Expansion Module (TEM)

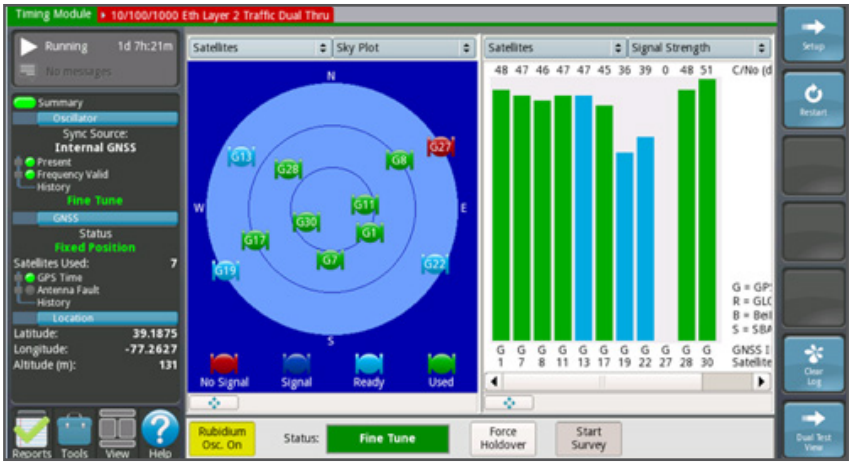
Use Case: Synchronous Ethernet Test

Synchronous Ethernet delivers a stable frequency reference to downstream switches and ultimately the end application such as an eNodeB. It does that by providing a SONET/SDH-like stratum 3E oscillator in each switch, delivering a clock recovery and transmit on each switch, and carrying an Ethernet Synchronization Messaging Channel (ESMC) for notifying the downstream nodes of the clock quality of the upstream node. Failing to deliver these functions will cause the Synchronous Ethernet switch or applications to lose frequency synchronization which leads to cell interference and means dropped calls.

Measuring the frequency offset of the incoming signal and decoding the ESMC channel ensure that there is sufficient clock quality at the respective node or slave.

Use Case: GPS Installation Test

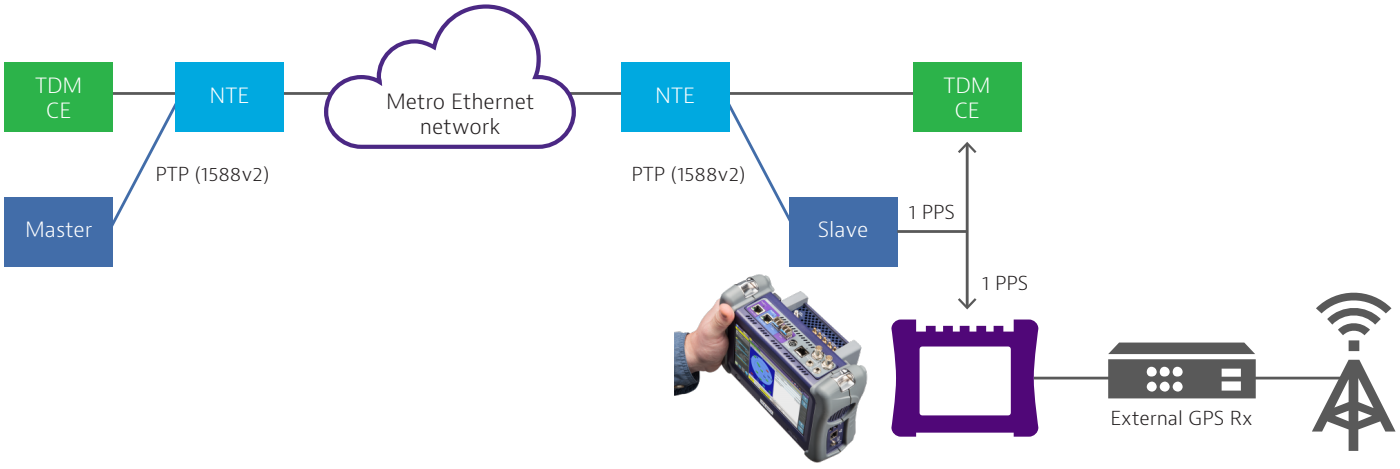
GPS receiver and antenna systems provide synchronization services to many cell sites around the world. Their operation is dependent on line of sight to a sufficient number of satellites with a minimum signal to noise ratio. This visibility must be given not only at one point in time, but over a complete 24 hour of period as satellites rotate around the earth. While higher tower installations in rural areas have no issues with obstruction in their surrounding environment, locations in urban areas on roof tops and larger venues have their limitations. Construction projects can impose additional temporary obstructions. Proper installation of GPS antennas requires a measurement of the number of visible satellites and analysis of their signal-to-noise ratios.



GPS Installation Test

Use Case: Perform 1 PPS Wander Analysis

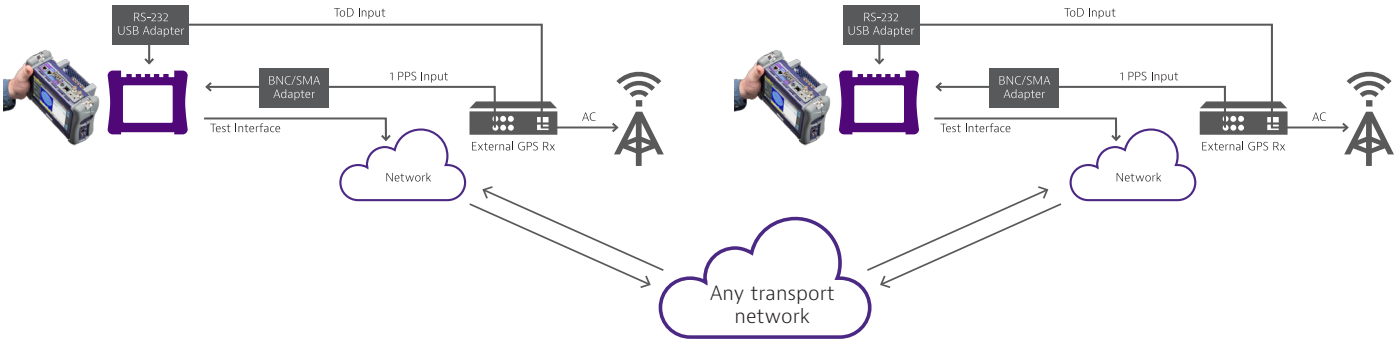
In this use case, the provider must verify that the 1PPS service provided by the PTP slave is accurately traceable to external reference equipment. This step requires the analysis of the 1PPS signal against an external reference that is sufficiently accurate and stable for the application. LTE-TDD, LTE-A and 5G applications expect accuracies in the range of sub-microseconds. This accuracy range necessitates a reference that can be synchronized to GPS satellites and can maintain its accuracy for a sufficient amount of time in absence of line-of-sight to GPS satellites. VIAVI's Timing Expansion Module (TEM) delivers these functions. In conjunction with T-BERD/MTS-5800, it can be used to accurately measure wander of slave clocks and thus deliver a final judgment on the quality of the clock signal from the master through the whole synchronization network including the slave recovery mechanism.



1PPS measurement with T-BERD/MTS-5800 with TEM

Use Case: One-Way Delay Test

For technicians and engineers who must install carrier Ethernet, Ethernet backhaul, and PTP (IEEE 1588v2) circuits, combining the OWD option and 1588v2 option with CDMA and/or GPS receivers can save hours of troubleshooting by detecting asymmetric traffic delays, verifying PTP PDV/master-slave measurement accuracy, and ensuring proper handoffs for time-sensitive service-critical (mobile) applications. This solution can attain accuracies ten-times greater than most common SLAs, letting service providers and operators differentiate their offering and helping network planners better understand delay tolerances affecting their applications.



One-Way Delay Test

Feature/Benefit Summary

Feature	Description	Benefit	The VIAVI Advantage
PTP (IEEE 1588v2) connectivity	Establishes a connection to a PTP Grandmaster and measures packet loss	Validates proper installation of PTP switches/routers and slaves	Ensures proper configuration of all Ethernet switches/routers and PTP slave to/from PTP Grandmaster
PTP PDV and Time Error	Measures packet delay variation and time difference between master and slave in both directions (Time Error)	Ensures configuration of PTP networks	Checks adequate configuration of Ethernet virtual circuits for PTP packets, cabling and SFP delay asymmetries
Synchronous Ethernet Test Suite	Measures Synchronous Ethernet receive signal frequency offset, and decodes incoming ESMC messages	Delivers a stable frequency reference	Tests the stability of receive frequency and displays the clock quality of upstream clocks
1 PPS wander analysis	Measures TIE/MTIE at 1 PPS test interface against a reference signal	Accurately verifies packet-based clock quality	Characterizes the performance PTP network and PTP slave clocks by accurately comparing the recovered 1PPS clock against a stable reference signal
GPS receiver test	Delivers number of visible satellites and their signal strengths	Deliver optimal signal quality from GPS systems	Ensures optimal placement of GPS antennas and wiring to GPS receiver
One Way Delay measurements	Measures the delay between two Ethernet points	Eliminates asymmetry issues	Characterizes asymmetries between upstream and downstream links

FAQ

Q: What is 1 PPS?

A: 1 PPS is a pulse that is repeated every second and has a very accurate phase. It synchronizes several geographically-dispersed clients (for example, cell sites) to the same time and phase of 1 µs.

Q: Is this just another throughput test?

A: No. This testing capability is specifically designed to measure Ethernet, IPv4, and IPv6 one-way metrics (specifically OWD), and to accurately and correctly install and verify PTP (IEEE 1588v2) networks for Ethernet backhaul migration.

Q: How is this feature different from our Ethernet test options?

A: This feature complements our Ethernet, IPv4, IPv6, and IEEE 1588v2 testing capability. It extends our expertise to provide additional metrics such as one-way delay and accurate PTP (IEEE 1588v2) PDV/1 PPS results.

Q: Based on these use cases, who would benefit the most from this feature?

A: Those who do not own 100% of their network backhaul infrastructure and Ethernet backhaul providers who must meet OWD and PTP (IEEE 1588v2) requirements for mobility applications realize the most benefit from this feature.

Q: Are there prerequisites for this feature?

A: Yes. T-BERD/MTS-5800 requires any of the C10M1GE, CT10GELAN, or CT10GEWAN test options.

Q: Is this test supported for SONET/SDH links?

A: No. This feature is specifically for Ethernet, IPv4, IPv6, and PTP (IEEE 1588v2) circuits.

Q: Does this feature work for Ethernet traffic encapsulated in VLANs or Q-in-Q?

A: Yes.

Q: Is 1 PPS wander the same as E1 or synchronous Ethernet wander?

A: The 1 PPS wander is similar to E1/SyncE wander in terms of the measurement results (TIE/MTIE) produced; however, 1 PPS wander is not measured at an E1 or SyncE interface, but rather at a 1 PPS interface. Whereas E1 or SyncE wander characterizes the perfor- mance of a TDM or synchronous Ethernet clock, the 1 PPS wander typically represents IEEE 1588v2/PTP slave clock quality in con- junction with a packet-based transport network.

Q: Can this feature be provided as a software option on existing instruments in the field?

A: Yes, it can.

Ordering Information

Description	Products	Part Number
OWD software option OWD software option field upgrade	T-BERD/MTS-6000A/8000 MSAM	CTOWD CTOWD-U1
OWD software option OWD software option field upgrade	T-BERD/MTS-5800	C5OWD C5OWD-U1
OWD software option OWD software option field upgrade	T-BERD/MTS-6000A/8000 CSAM	CC10GOWD CC10GOWD-U1
1588 (PTP) software option 1588 (PTP) software option field upgrade	T-BERD/MTS-6000A/8000 MSAM	CTLS1588 CTLS1588-U1
1588 (PTP) software option 1588 (PTP) software option field upgrade	T-BERD/MTS-5800	C5LS1588 C5LS1588-U1
1 PPS software option 1 PPS software option field upgrade	T-BERD/MTS-6000A/8000 MSAM	CT1PPS CT1PPS-U1
1 PPS software option 1 PPS software option field upgrade	T-BERD/MTS-5800	C51PPS C51PPS-U1
CDMA receiver kit new units CDMA receiver kit field upgrade	T-BERD/MTS-6000A/8000 MSAM T-BERD/MTS-5800	CCDMA-RCVR-KIT CCDMA-RCVR-KIT-U1
GPS receiver kit new units GPS receiver kit field upgrade	T-BERD/MTS-6000A/8000 MSAM T-BERD/MTS-5800	CGPS-RCVR-KIT CGPS-RCVR-KIT-U1
Timing Expansion Module	T-BERD/MTS-5800	C5TEM-R

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