One-Way Delay and PTP (IEEE 1588v2) Test Applications

Application Information

Application	T-BERD/MTS-8000/ 6000A MSAM v1	T-BERD/MTS-8000/ 6000A MSAM v2	T-BERD/MTS-5800
OWD with CDMA receiver	Yes	Yes	Yes
OWD with GPS receiver	Yes	Yes	Yes
PTP (IEEE 1588v2) protocol installation/ verification	Yes	Yes	Yes
PTP (IEEE 1588v2) master-slave delay with GPS receiver	Yes	Yes	Candidate for development
PTP (IEEE 1588v2) 1 PPS wander with GPS receiver	No	Yes	No

Solution Description

The OWD test option lets wireline and wireless providers, mission-critical government agencies, and application-service providers, such as financial applications and power-supply companies, accurately verify the OWD metric for SLAs using external receivers, such as CDMA and GPS.

The delay for transmitted information may not equal the delay for received information. This difference can be attributed to the various paths the traffic takes as it transverses the network or by differences in the way network devices, such as routers and switches, buffer or prioritize the traffic.

In addition, combining the GPS receiver with the 1588v2/PTP option helps leading providers successfully verify and install PTP (IEEE 1588v2) links to ensure accurate characterization of master-slave delay measurements. It also helps validate 1 pulse per second (1 PPS) accuracy for eNodeB installations and handoffs at base stations.

Use Cases

1. Accurately verify Carrier Ethernet and Mobile Backhaul SLAs with one-way delay (OWD) measurements
2. Ensure master-slave delay and PDV accuracy in a PTP (1588v2) network
3. Verify slave installation with PTP (1588v2) 1 pulse per second (1 PPS) wander analysis
4. 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 applications, and PTP (IEEE 1588v2) Layer 2 and Layer 4 applications.

Value Proposition

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 10 times greater than most common SLAs, permitting service providers and operators to differentiate their offering and allowing network planners better understand delay tolerances affecting their applications.

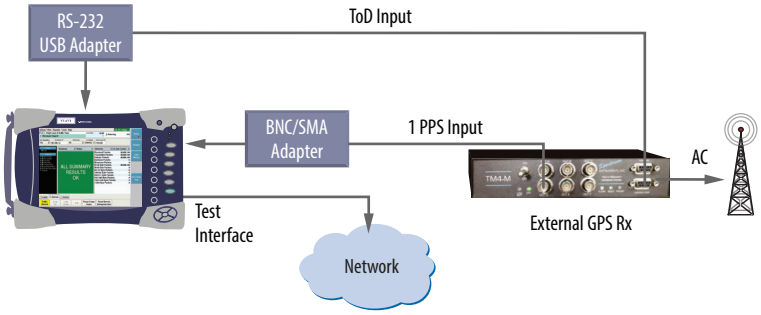


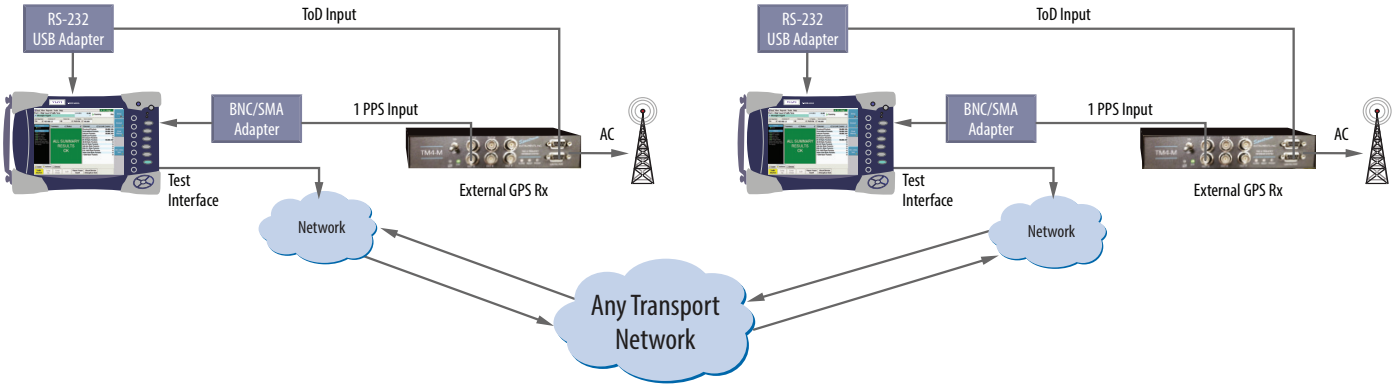
Diagram of basic connectivity

Feature/Benefit Summary

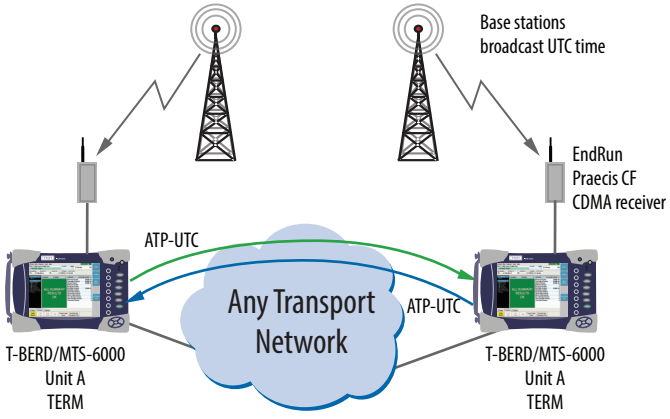
Feature	Description	Advantage	Benefit
UTC timestamp for OWD measurement (via USB/ RS-232 connection for time-of-day [ToD] input)	Use CDMA and GPS derived time for ToD input	Both ends use same ToD timestamp in test	Accurately calculates delay based on timestamp
Bits/Sets clock input (via BNS/SMA connection for 1 PPS input)	Accurate clock from CDM/GPS receiver	Global clock synchronization between test sets	Reliable timing source for test
PTP (IEEE 1588v2) master-slave delay	Measures master-slave delay in the PTP network	Ensures accurate characterization of PDV and master-slave metrics	Confirms accurate installation of packet-based timing network
PTP (IEEE 1588v2) 1 PPS wander analysis	Measures TIE/MTIE at 1 PPS test interface against a reference signal	It characterizes the performance of packet-based transport networks and PTP slave clocks by accurately comparing phases between the test signal and reference signal	Accurately verifies packet-based clock quality
CDMA receiver	CDMA receiver provides time and accurate clock input	Tests any Carrier Ethernet network within cell phone range	Tests in the widest geographic footprint
GPS receiver	GPS receiver provides time and accurate clock input	Tests any Carrier Ethernet network in the world	Tests in the global geographic footprint
Minimal configuration with CDMA receivers	No additional configuration needed	Plugs into CDMA receiver to run the test	Requires minimal training without the need to learn special configurations
Configuration guidance for GPS receivers	Provides the preparation times required to achieve certain test durations without connecting the GPS antenna	Shows the user required synchronization time and power-on time for GPS receiver to achieve certain test durations	Resolves complex setup challenges involved with GPS receiver for field application
Graphical results – OWD metrics versus time	Depict stressed situation for each direction, independently (East-West, and West-East)	Provides packet-delay behavior to characterize per direction network performance. Results are depicted in max., min., avg., and current values	Operators can easily locate delay-related performance issues in the network

Use Case: Carrier Ethernet and Mobile Backhaul SLAs with OWD Measurements

Measuring highly accurate one-way metrics, including OWD and packet jitter, in an Ethernet/IP backhaul scenario improves application troubleshooting and ensures thorough testing and verification of SLAs. Devices at the very edge of the network still can experience asymmetric delays. For example, in a mobile-voice application, increased delay may cause edge devices to buffer the information, thus smoothing out the speech. Unfortunately, unequal or asymmetrical delay can cause one side of the conversation to sound perfectly clear, while the other side appears to constantly talk over the speaker. Avoiding this requires verifying the OWD metric during installation and recording the measurement for future monitoring and troubleshooting as necessary.



OWD with GPS receivers



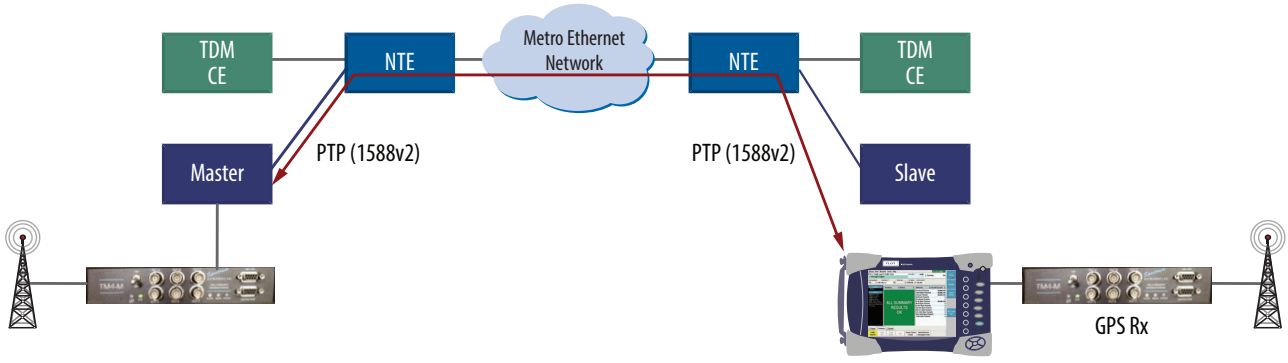
OWD with CDMA receivers

Use case: Master-Slave Delay and PDV Accuracy in a PTP (1588v2) Network

Currently, the T-BERD/MTS-6000A Multi-Services Application Module (MSAM) and T-BERD/MTS-5800 provide an 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. The initial release of the PTP feature set delivered a PDV-measurement result using the internal clock of the tester.

While the current PDV result is appropriate for many applications, its accuracy has limitations due to effects of internal oscillator variations and a lack of grandmaster clock reference. This accuracy can be improved using the external GPS and/or CDMA receiver. Using these external receivers, ToD and 1 PPS inputs as references, the PTP timestamps time/phase in the test instrument can be accurately assigned and referenced to a standard clock. Furthermore, using a GPS/CDMA receiver lets users measure one-way delay for PTP packets replacing the current mean-path-delay measurement based on a round-trip delay measurement (as described in the OWD measurements use case, above). This measurement lets users accurately determine the delay between a slave and the grandmaster, eliminating the impact of link asymmetries on the delay value between the master and slave. The functionality of measuring more accurate PDV and performing master-slave delay is available on the T-BERD/MTS-6000A and 8000 MSAMv2.



PTP (IEEE1588v2) master-slave delay test using the T-BERD/MTS-6000A and 8000 MSAM

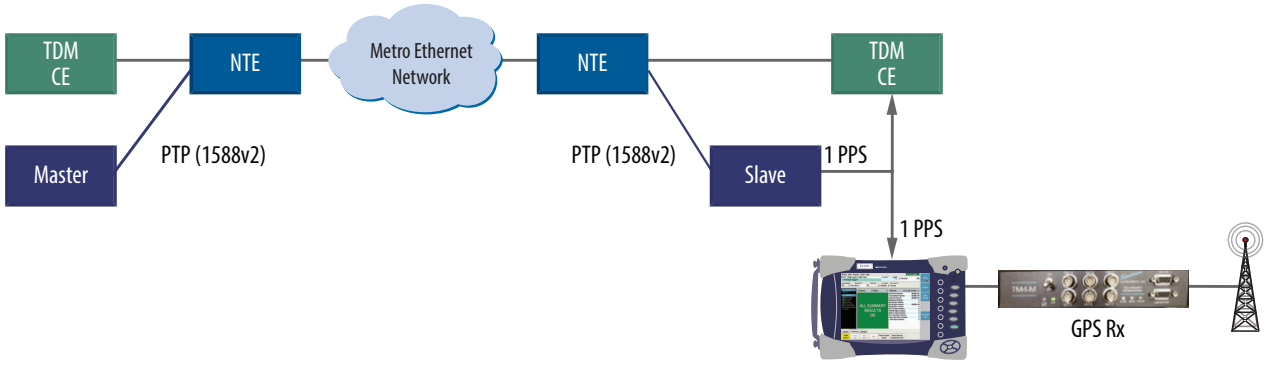
Use Case: Perform 1 PPS Wander Analysis

In a successful mobile backhaul transition, it is important to verify the network and new Ethernet synchronization deployments (1588v2 and SyncE) to guarantee successful mobile handoff between cell sites, and thus avoid service degradation. As such, using the PTP application required development of a new test interface 1 PPS and a new external test capability for measuring 1 PPS wander using a GPS receiver.

The PTP protocol is used to transfer timing synchronization from a timing master (possibly located in a mobile switch center) to slaves (located in cell sites). Many new IP-based eNodeB network elements contain a PTP slave inside the network element. Others depend on an external PTP slave element to process the PTP protocol. In the latter scenario, the PTP slave processes the PTP protocol and delivers a 1 PPS signal to the (e)NodeB with ToD and phase information that they can use to accurately synchronize their ToD. Accurate synchronization of (e)NodeBs helps wireless operators provide call handovers while users move between respective cell sites.

In this use case, the provider must verify that the 1 PPS service that the PTP slave provides is accurately traceable to external reference equipment. The users' primary job remains the service activation test of the Ethernet virtual circuit (EVC) from mobile switch centers to cell sites. Users must verify SLAs mandated by the wireless service provider, including the OWD metric described previously). Viavi is adding 1 PPS service verification to the installation test following the service activation test. An example application is transferring timing synchronization to TDD-based 4G/LTE networks, which requires a 1 PPS signal better than 3 µs. For this application, users must attach an external device to measure 1 PPS/ToD accuracy, for example a GPS receiver.

The tester is expected to decode the ToD information, use it as a reference for the tester's ToD (similarly to its use for OWD metrics described previously). Additionally, the tester must measure the phase difference between the 1 PPS device under test and the reference signal, which represents a typical wander measurement. Wander measurements are defined in the ITU-T O.17x series and are performed on 1 PPS, PDH/T1/T3, SONET/SDH, OTN, and now synchronous Ethernet interfaces. This application is available with T-BERD/MTS-6000A MSAMv2.



1 PPS measurement with T-BERD/MTS-6000A and 8000 MSAM

Use Case: OWD Measurement in Vertical Markets, such as Financial and Power Industries

In a financial environment where receipt of information is critical for successful data transactions, one-way delay differences can make some devices appear to receive information before others when, in fact, the problem is a delay in receiving the acknowledgment of the data. Highly accurate OWD measurements now give network planners of financial networks the tools needed to optimize their networks and improve quality of service and overall customer satisfaction.

In addition, power supply companies are using Ethernet for their management networks. Switching high-electrical energy requires exact timing to synchronize power-switch activations, which is especially important when simultaneously enabling multiple power switches. Therefore, the delay from the control center to the various electrical switches must be measured and taken into consideration when sending control messages for power-switch activation.

The OWD option for Viavi portables and external receivers help technicians measure the delay and correctly optimize networks for both applications.

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 cites) 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 SLA results, 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 typically do not own 100 percent of their network back-haul infrastructure and Ethernet backhaul providers who must meet OWD and PTP (IEEE 1588v2) SLAs for mobility applications would realize the most benefit from this feature.

Q: Are there pre-requisites for this feature?

A: Yes. A T-BERD/MTS-6000A MSAM and T-BERD/MTS-5800 both require 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: Do you plan to provide wander analysis for synchronous Ethernet, PDH/T1/T3, or SONET/SDH/OTN?

A: Marketing is investigating business/product plans; however, no committed plan exists at this time.

Q: What options are required for PTP (IEEE 1588v2) PDV and master-slave delay and 1 PPS measurements?

A: This feature is only supported on the MSAMv2 hardware, because it requires a dedicated 1 PPS test port. The T-BERD/MTS-6000A MSAMv2 requires these options: CTLS1588, CT1PPS, and CGPS-RCVR-KIT. Field upgrades require the -U1 versions for these options.

Q: Are the PTP (IEEE 1588v2) PDV and master-slave delay and 1 PPS measurements available with the CDMA receiver kit?

A: No. The 1 PPS application requires the accuracies of the external clock, which the CDMA receiver cannot provide. Adding the master-slave delay application to the CDMA receiver is on our roadmap; however, it is not committed at this time.

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 performance of a TDM or synchronous Ethernet clock, the 1 PPS wander typically represents IEEE 1588v2/PTP slave clock quality in conjunction with a packet-based transport network.

Q: Do we measure TDEV?

A: No. TDEV is not supported in this release.

Q: Can the TIE/MTIE results be stored on an external storage device for analysis using external wander analysis software?

A: No; however, we are considering this storage capability for a future release.

Q: Is this feature planned for the MSAMv1 or the T-BERD/MTS-5800?

A: No, this feature requires a dedicated test port (1 PPS) that is not available on the MSAMv1 or the T-BERD/MTS-5800.

Q: Can this feature be provided as a software option on existing MSAMv2s in the field?

A: Yes, it can; however, it requires the purchase of the CT1PPS-U1 option for MSAMv2

Ordering Information

Description	Products	Part Number
OWD SW Option OWD SW Option Field Upgrade	T-BERD/MTS-6000A/8000 MSAM	CTOWD CTOWD-U1
OWD SW Option OWD SW Option Field Upgrade	T-BERD/MTS-5800	C5OWD C5OWD-U1
1588 (PTP) SW Option 1588 (PTP) SW Option Field Upgrade	T-BERD/MTS-6000A/8000 MSAM	CTLS1588 CTLS1588-U1
1588 (PTP) SW Option 1588 (PTP) SW Option Field Upgrade	T-BERD/MTS-5800	C5LS1588 C5LS1588-U1
1 PPS SW Option 1 PPS SW Option Field Upgrade	T-BERD/MTS-6000A/8000 MSAM Only	CT1PPS CT1PPS-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

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