atop Technologies

Precision Timing

Whitepaper

Engineered and manufactured in Taiwan

Contents

Network Timing

At its simplest, a network is a series of connections to exchange information between nodes. But although simple in theory, what today's networks underpin in practice is a vast complexity of industry and consumer activities. And as the number of consumer devices grows and industry applications become more advanced, the complexity of managing such networks is increasing.

Over several decades, different timing mechanisms have been established to synchronize devices on a network, such as Network Time Protocol (NTP) and IRIG-B. But a clear need has emerged for such mechanisms to provide better flexibility, ease of use, lower cost, and perhaps most importantly, a higher time accuracy for a range of new applications and industry demands.

A Dedicated Solution

Precision Time Protocol (PTP) is a relatively new protocol, with its specifications having been defined in 2008 in the IEEE-1588v2 standard. The protocol provides a mechanism by which to synchronize devices on a network with sub-microsecond precision, by using hardware-timestamped data packets and accumulated delay calculations. Where PTP also advances is in introduction of the concept of profiles.

Profiles allow other standards bodies to tailor PTP to particular applications, by defining a combination of options and attributing values for a given application. This is turn allows better interoperability between equipment designed for that purpose. Such profiles include ITU-T for telecoms, WIP for enterprises, and even 802.1AS for audio applications. And with PTP's ability to incorporate legacy hardware and protocols, it is look set to allow the next generation of possibilities, all while including yesterday solutions to today's demands. It is a dedicated solution for precise network ting.

How PTP Works

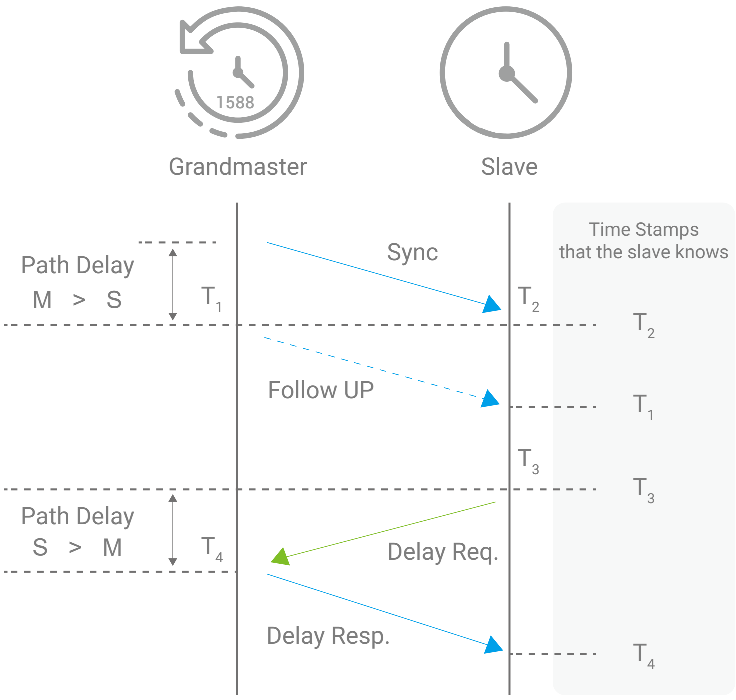
Defined in the IEEE 1588-2008 standard, Precision Time Protocol (PTP) version 2 is a two-way packet-based communications protocol designed to synchronize clocks in the sub-microsecond range, by using hardware-timestamped data packets and accumulated delay calculations.

PTP uses a master-slave hierarchy. A grandmaster clock acts as the primary time source to which all master clocks synchronize. Where PTP simplifies matters is in its use of Best Master Clock (BMC) algorithm. By continually polling for the most accurate time source, master devices automatically synchronize to the grandmaster clock; slave devices automatically synchronize to maser devices. Not only does this make the set-up process of a PTP-enabled network relatively quick, but it provides added reliability should a link or device failure occur, as devices then negotiate status and recognize the next best clock upstream.

PTP's sub-microsecond accuracy comes from the use of hardware timestamped packets. Because packets are timestamped when they enter and leave device, the inaccuracies that come from the time software processing are eliminated. Accumulated delay calculations are used to provide an accuracy with 1 µs.

With this accuracy, reliability, and relative easy of use, IEEE1588v2 is proving itself invaluable to industries such as Power Distribution, Telecommunications, and Industrial Automation. And in the emerging world of Industry 4.0 and IIoT, highly accurate timestamps will be critical for every step in processes.

PTP Sequence



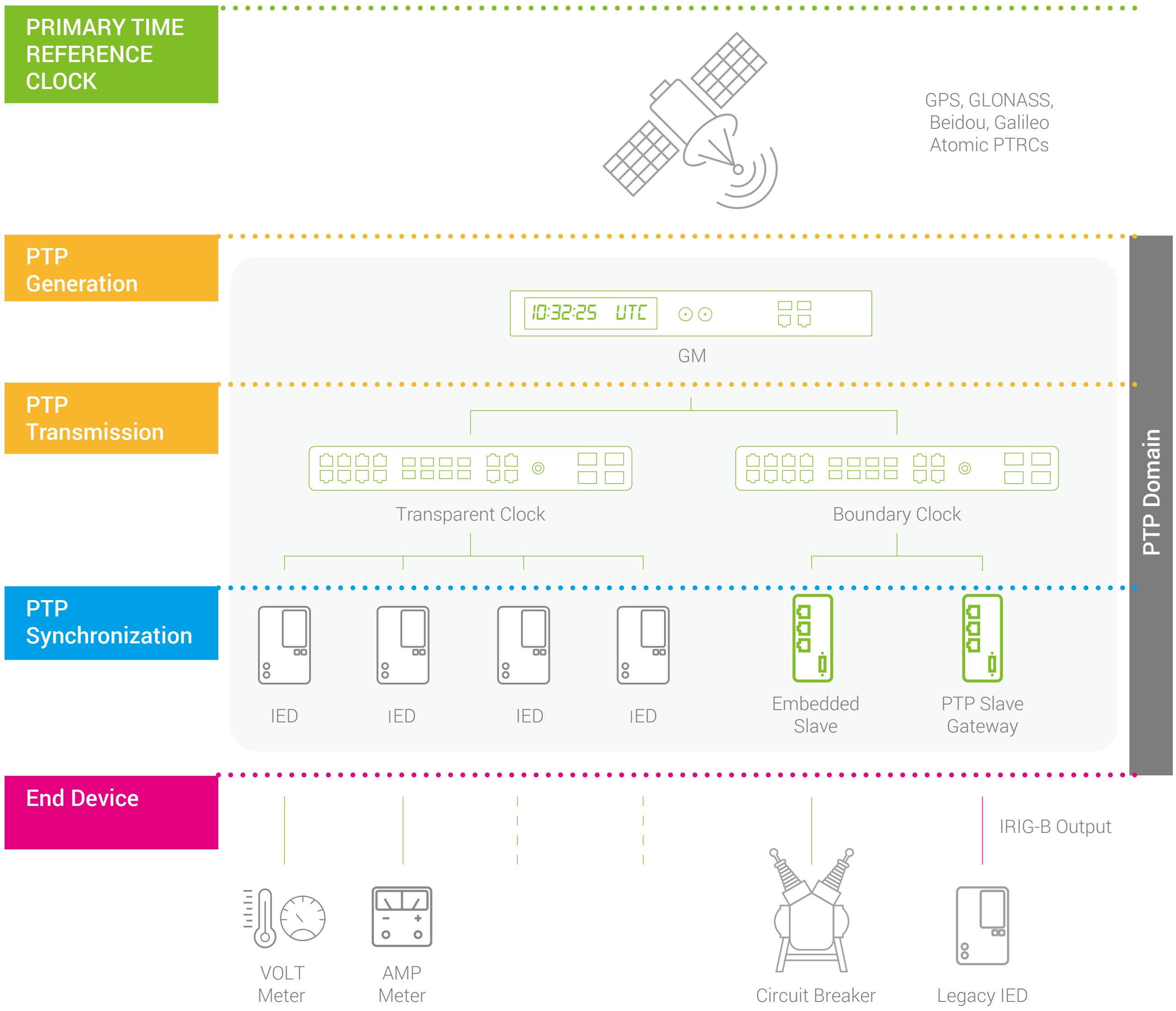
Time Stamp Sequence

The PTP event messages are: Sync, Delay_Req, PDelay_Req and PDelay_Resp. The PTP general messages are: Follow_Up, Delay_Resp, PDelay_Resp_Follow_Up, Announce, Management and Signaling.

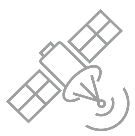
- Once elected Grandmaster by BMCA, the master clock sends the **Sync** message. The time that Sync messages leaves the master is the timestamped as t1. For one-step operations this can be embedded in the **Sync** message itself; for two-step operations, it can be embedded in the **Follow_Up** message.
- The slave receives the **Sync** message; t2 is the timestamp that the slave receives the in Sync message. In order to be able to compute the exact time, the slave will have to know the link delay.
- In End-to-End link-delay calculation, the slave sends the **Delay_Req** message. This as timestamped as t3 when it leaves the slave. It is then timestamped as t4 when is it received by the master. The master responds with a **Delay_Resp** message that contains the t4 timestamp.
- The Peer-to-Peer link-delay is calculated in a similar way, with different messages, but from hop to hop

By knowing timestamps t1, t2, t3, and t4, the slave is able to compute accurate timing by calculating for accumulated link delays. In Peer-to-Peer mode, the link delay is calculated between each hop by assuming that packets use the same path during transmission and that the delay is symmetric.

How PTP Delivers
Accurate Network Timing



PTP Elements

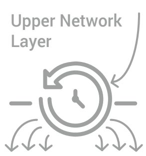


GNSS

As an external clock source, GNSS' Atomic Clock provides highly accurate absolute time to the GM.

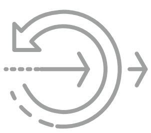
Grandmaster

Highly accurate clock that is the ultimate source of time for network synchronization using PTP.



Boundary Clock

Located between two or more network segments, it acts as a slave clock to devices upstream, and as a master to devices downstream.



Transparent Clock

Ethernet switch that forwards PTP packets transparently, only modifying selected fields during pass-through.

Slaves

A slave clock uses IEEE 1588 protocol to Synchronize its internal System Time to the BMC selected master clock.

PTP from ATOP

Turn to page 12 for our Industrial solutions for brining PTP to your industry.

Delivering The Next Revolution

Industry initiatives such as the Internet of Things (IoT) and Industry 4.0 have already fundamentally changed consumer behavior, with the proliferation of devices like smartphones penetrating everyday habits and providing total connectivity to an array of industry and consumer services. To maintain command and control of mission critical data and responses, Industries, too, have been developing their equivalent, with the Industrial Internet of Things (IIoT), by using greater connectivity for insights, visibility, and more intelligent automated actions, with the of ultimate goal of Industry 4.0 being the creation of the Smart Factory these interconnected devices that offer deeper insights and more control. The potential of such practices will be eliminating efficiencies and responding to individual consumer demand with the use of interconnected advanced robotics, Big Data Analytics, and Industrial Connectivity and Services.

As industries become more interconnected between consumers, suppliers, and produces, IEEE 1588 PTP will become increasingly vital for delivering accurate timestamps for every process step for the functioning of these networks, affecting industries such as manufacturing, telecommunications, power generation, finance, aerospace and defense, and the scientific enterprise itself in the field of testing and data acquisition.

Telecommunications

With the proliferation of devices like smartphones and high bandwidth cellular network technologies such as 3G and 4G the telecommunications industry has undergone a revolution. Originally conceived for communications alone, the industry has become the backbone for streaming online music and video services to providing remote access and control to wind farms. And as the industry moves towards 5G, these services will undergo more demands, as consumers begin to take advantage of faster speeds and industries develop and implement IIoT applications such as embedded Machine-to-Machine communications for use at remote locations and factory floors. This will require interconnected base stations and cells to function together with nanosecond-accurate network timing with both frequency and phase (time-of-day) synchronization.

The PTP Telecom profile was created by ITU-T for targeting accurate time and phase distribution, frequency, and signal failure – for both existing and new-build networks – and all with a target accuracy of with 1.5μs for time synchronization. So PTP is a protocol that is a must for today's cellular networks for distributing time, and for future proofing networks for tomorrow's more advanced applications that will require highly accurate timestamps for every step in processes.

Power Distribution

Past experiences such as the North American Blackout of August 2003 past show just how difficult it can be to align data with timestamps that are produced with inaccurate time references, with such blackouts or power failures incidents taking longer to align data than analysing the data itself. As an innovative protocol with hardware-based timestamps, PTP makes it much easier to align data, by reaching time resolutions in the sub-microsecond range. By contrast, NTP as a time distribution mechanism provides an accuracy only in the range of milliseconds, and although time codes like IRIG-B provide much better performance than NTP, they require the installation of additional, specialised cabling to distribute time.

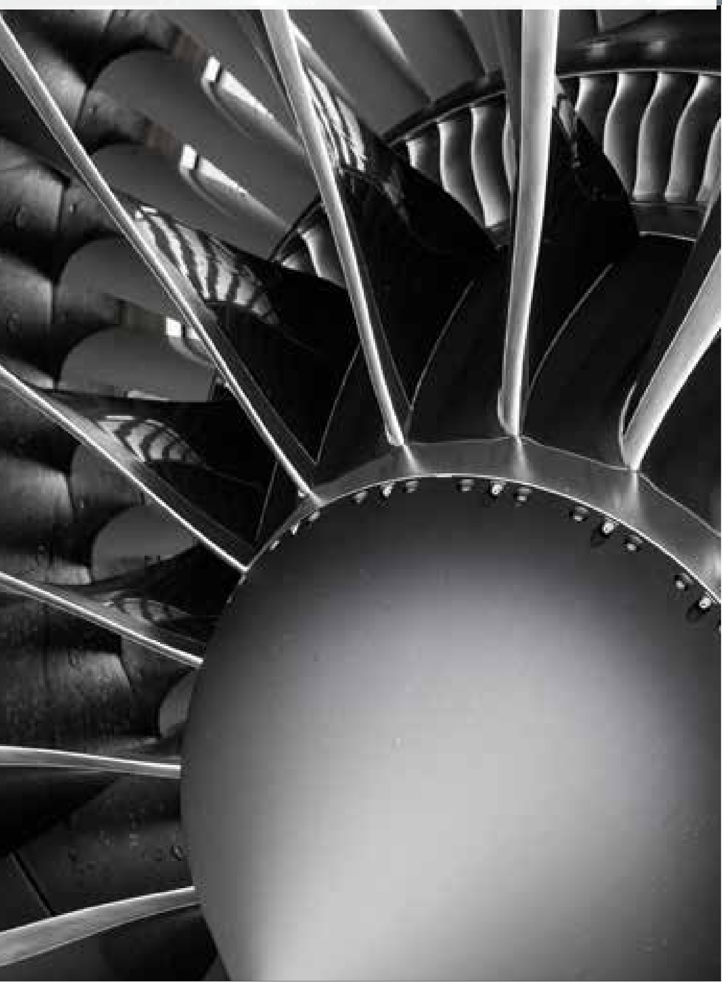
These accuracies are important to maintain. The power industry deals in one of the few commodities that has transmission speeds that are as fast as the communication speeds that control the operation. So at the substation level, every IED has to be accurately synchronized to ensure that failures are handled in a way that doesn't jeopardize the integrity of the whole grid. And the grid itself, being so interconnected, needs to keep frequency and phase of the AC power line aligned perfectly. So PTP's specific Power Profile address such issues: ensuring seamless interoperability of PTP equipment for applications in the power industry; synch accuracy not being affected by network traffic, fiber optic or twisted pair, meaning it's a matter of selecting the right Ethernet switch for port configuration.

Dedicated Industrial Precision

Industrial Automation

Real-time Industrial Automation Protocols such as Profinet, IRT, EtherCat, and Powerlink were conceived to handle the motion control of units that are act together in a series of coordinated actions, requiring frequent energy and position data. These updates can take place up to 40,000 time per second.

Traditionally, sensor signals have been used to coordinate such devices, which introduce jitter into a system. But because IEEE 1588 PTP is based on timestamps instead of sensor signal, jitter can be reduced, enabling tighter system coordination and making throughput more predictable. Also, when there are instances of fault occurrence, IEEE 1588 PTP use of timestamping makes much easier and simpler to detect where fault occurs -- such as a camera being triggered too early or a part arriving late. With IEEE 1588 PTP, the exact sequence of events can be identified.



Aerospace and Defense

GPS was originally developed by the US military for high-end military communication applications. But although GPS can deliver somewhat convenient accurate frequency, phase, and time, its setbacks stop it from being fully embraced today. GPS antennas can be cumbersome, and poor weather conditions can lead to signal degradation, not to mention poor GPS signal reception from limited sky view. And this is on top of vulnerability to jamming and spoofing. Its these setbacks in many aerospace and defense applications that has turned attention away from GPS and towards Ethernet.

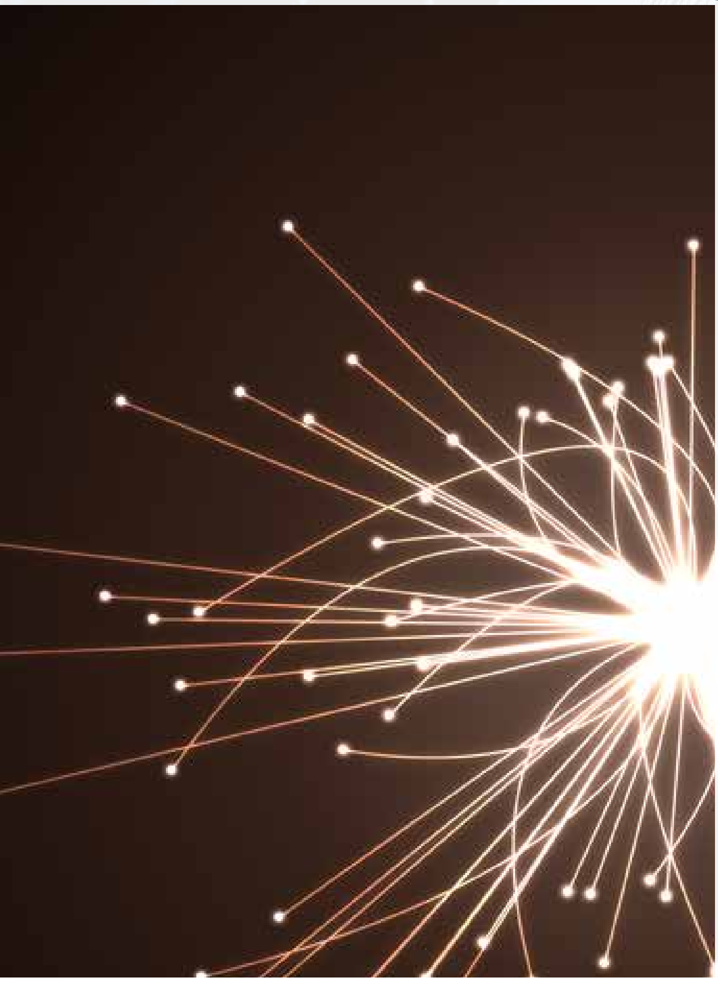
Based on Ethernet, IEEE 1588 PTP has become ideal today's modern mobile military units, which utilize interconnected networked devices for reconnaissance, coordination, and the execution and deployment of weapons systems. Ethernet is faster and more flexible and offers greater functionality than the legacy systems such as serial.

Dedicated Industrial Precision

Finance

When one thinks of finance, Wall Street is an image that is not too far one's mind. But practices have shifted away from on-floor trading and the out-cry. Instead, much of today's stock, futures, and options are handled electronically over the internet. Not only has this sped up buying and selling, but it has opened up trading to more individuals and trading platforms. And so with more transactions happening ever more quickly between more users and individuals, tracking when exactly transactions has become vitally important.

Trading regulations have also caught up with high frequency trading. For instance, approved by the European parliament, MiFID II will take effect in January 2018, which stipulates a time synchronization of 100 microseconds and a timestamp resolution of 1 microsecond. And this is in world in which new payment methods like BitCoin and micropayments from devices like smartphones and even smartwatches are fast becoming common ways to purchase items online and in stores. This sort of precision is simply not offered by previous protocols like NTP over the internet, nor can they offer the same level of security as IEEE 1588 PTP.



Control and Measurement

As the world's largest and most powerful particle collider, the Large Hadron Collider (LHC) is the world's most complex experimental facility yet built. Since it went live September 10, 2008, it has generated vast quantities of data, which are streamed to laboratories around the world for distributed processing. For instance, by 2012 data from over 6 quadrillion (6 x 1015) LHC proton-proton collisions had been analysed; LHC collision data was being produced at approximately 25 petabytes per year.

The value of PTP in such high-speed, event-driven data acquisition applications is in making it much simpler to compare data sets from multiple independent systems: sample data that is synchronized to absolute time becomes much easier to analyze, which is especially important for data with time resolutions in the sub-microsecond range. Besides the performance advantages, PTP offers more practical implementations, by reducing the weight and complexity of wiring installations, which is becoming increasingly important as large systems become more commonplace.

NTS7700 Series

IEEE1588v2 Telecom and Power-Grade IEC61850-3 certified Industrial Grandmaster Clock

FEATURE HIGHLIGHTS

- Support for multiple GNSS systems: GPS, GLONASS, and BEIDOU
- Wide support for PTP Telecom and Power Profiles (over L2 and IPv4)
- Holdover <1.5us/day time-drift when disconnected from GNSS
- Industrial fanless design for -40~85°C operation; IEC61850-3 protection
- Flexible modular configuration; 2 dedicated Output Module slots
- 2 x 10/100/1000 Mbps RJ45 and 2 x 100/1000 Mbps Combo SFP slots
- Embedded NTP/SNTP server
- Support for Legacy Protocols: IRIG-B, BJT, BCD, ST, ST with checksum
- Redundant power input; low-Voltage DC or high-Voltage AC/DC

PRODUCT DESCRIPTION

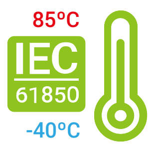
A Powerful Grandmaster

The NTS7700 1U 19" Rack-mount Modular Grandmaster Clock is a high-powered, rugged IEEE1588v2 PTP device that offers high industrial precision and reliability. Suitable for almost any environment and complying with the harshest Industrial EMC conditions, ATOP's GMC satisfies all stringent industry requirements for Substation, Telecom and Industrial-grade networking timing applications. Its modular architecture provides power-input redundancy and up to 16 different outputs for legacy time Protocols – such as IRIG-B, BCD, ST, ST with CRC and TTL outputs such as 10MHz and PPS.

Highly Accurate Time Precision: NTS7700 satisfies the requirements specified by ITU for Telecom Grandmasters. For instance, when disconnected from a GNSS time source, its high-precision Oven-controlled Oscillator (OCXO), combined with hardware timestamping, ensures time drift (1PPS output) does not exceed 1.5 µs per day (less than 62ns/hour). So in the event of an Antenna or a GPS System failure, it will guarantee time and frequency to be accurate and precise as demanded by LTE network requirements for proper operation.

Wide PTP Standard Support: The possible PTP configurations are endless. NTS7700 supports Layer-2 and Layer-3 over IPv4 transport; VLAN Tagging; and Multicast, Unicast and Unicast Negotiation in both End-to-End and Peer-to-Peer delay calculation modes. NTS7700 fully supports IEEE C37.238-2011 and IEEE/IEC 61850-9-3 – 2016 Power Profiles; and ITU-T G.8265.1 and ITU-T G.8275.1 G.8275.2 Telecom Profiles for Frequency, Time and Phase Synchronization.

Industrial and Substation Hardware : Designed to satisfy EMC requirements for Substation-Grade equipment, NTS7700 has a minimum EMC Level 4 rating and is designed to function between -40°C and 85°C with passive cooling only, allowing it to avoid the risk of having moving parts breakdown from constant operations. Also, its powerful CPU supports up to 3,000 PTP packets per second, allowing endless applications and a large number of slaves to be supported simultaneously.



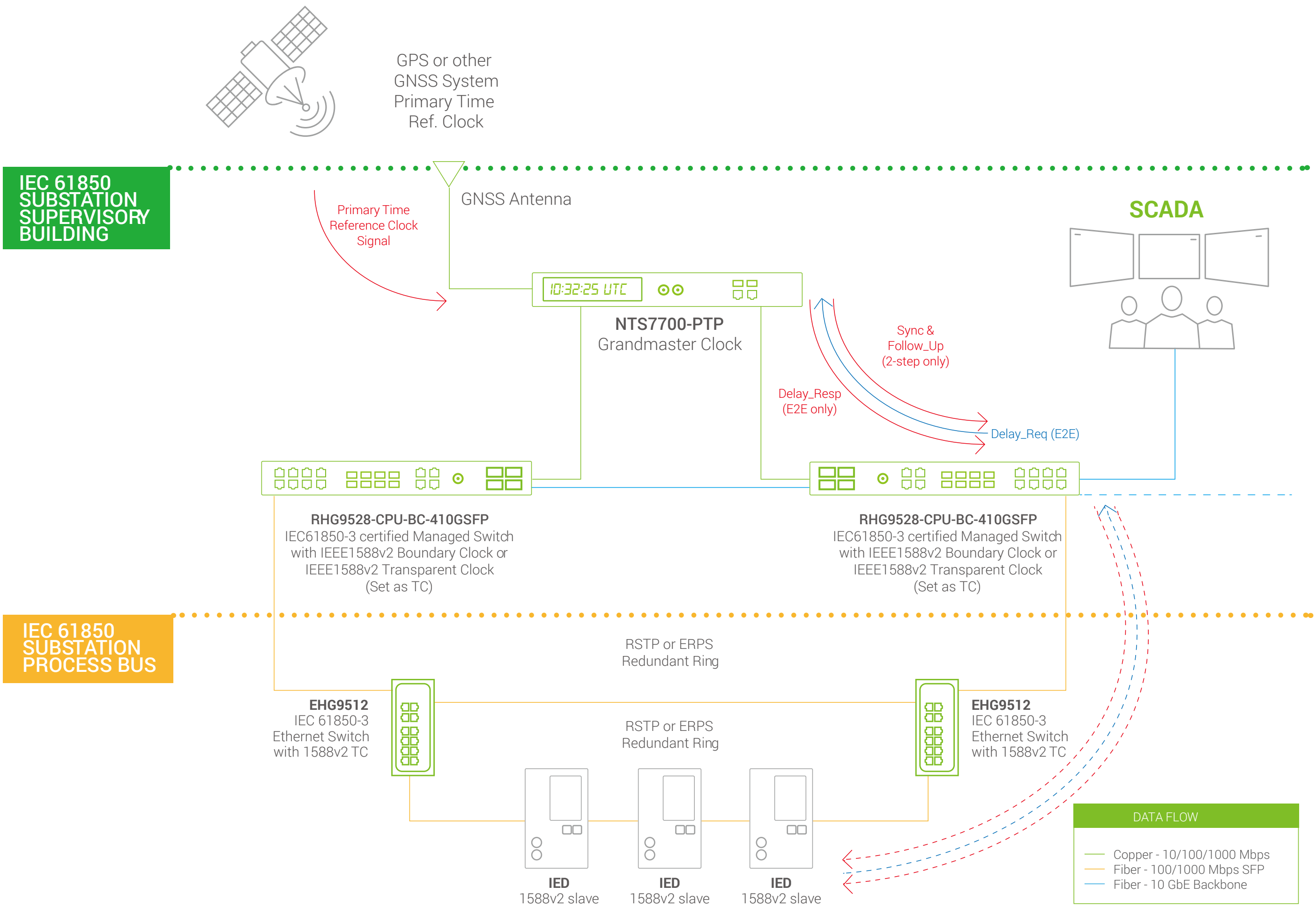
Proven design: No standardized testing procedure for PTP devices exists. So ATOP tests its products yearly in ISPCS Plugfests to demonstrate their reliability. NTS7700 was successfully tested in Stockholm in 2016 and in Monterey in 2017. More information available on www.ispcs.org.

APPLICATION

IEEE1588v2 Precision Time Protocol

PTP is the only protocol that allows network time synchronization in the nanosecond-range. Current networking protocols nor legacy protocols allow such a timestamp resolution. IEEE1588-2008 (v2) derives from an earlier version issued by IEEE in 2002 that is not backward compatible. Being so exact about timestamp resolution and timekeeping, IEEE1588v2 timestamps are required to be hardware-generated, since no software could keep up with some stringent requirements, no matter the processing power. PTP is a hierarchical protocol, in which Grandmaster Clocks (Stratum 1 Clocks) are directly synchronized with reference clocks (Stratum 0 Clock) such as GNSS or Atomic Clocks, with subsequent layers reaching slaves devices. PTP packets are timestamped with a nanosecond resolution.

To achieve such accuracy, PTP works well only on Local Area Networks without passing through the internet: latencies and paths would introduce variables latencies that couldn't be accommodated for in the accumulated delay calculations. PTP packets should always travel the same path during each synchronization phase to preserve such high accuracy. PTP is designed to work on Ethernet transport, Layer-2 (Data-link Layer) or Layer-3 over IPv4. And there are two methods to calculate link delay: in End-to-End mode, link delay is calculated from the source of the PTP packet until its destination, while in Peer-to-Peer mode, link delay is calculated as between each network node.



Application example

This network diagram shows the use of ATOP's NTS7700 in a substation environment. The GMC is usually located in the office building adjacent to the substation. On one side, it is connected to the GNSS Antenna, with the other side being the Substation backbone connection. IEC61850 substations require all hardware to be comply with stringent EMC compatibility and wide temperature requirements. Every switch connected to the Grandmaster should be able to handle all Precision time Protocols by hardware, in order not to affect the synchronization quality. Packets are delivered downstream through Boundary or Transparent clocks, where they'll reach PTP slaves – such as substation IEDs.

RHG9528 Series

IEC61850-3 Certified Rack-Mount High-Availability Managed Modular Gigabit Switch - PTP Boundary Clock

FEATURE HIGHLIGHTS

- Supports HSR (IEC 62439-3), PRP (IEC 62439-4) for high-availability
- IEC 61850-3 and IEEE 1613 DNV.GL certification (pending)
- Integrated IEEE 1588v2 hardware-based BC and TC (BC version)
- Maximum 128Gbps switching capacity, 95.24Mpps throughput
- Rugged industrial design for harsh environments between -40~85°C
- Flexible modular configuration; 3 Module-dedicated slots
- Up to 24 Gigabit ports, and 4x10 Gigabit SFP Uplink slots
- ITU-T G.8032 ERPS Ring, RSTP, or MRP (client) redundancy
- Advanced management features such as QoS and VLAN
- Supports Synchronous Ethernet for Telecom Applications

PRODUCT DESCRIPTION

Flexibility: ATOP's high-density RHG9528 Rack-mounted managed switch provides the flexibility needed for your application demands. You can choose from among six different Core versions: based on power supply, uplink port configurations and embedded Hardware-Assisted Boundary Clock feature. And you can choose from six different 4- or 8-Port modules to customize your device in a very simple way.

Designed for Substations: RHG9528 supports up to **24 Gigabit ports in any 8-port multiple configuration**. Specifically designed for IEC61850 substation backbone use, it is fully certified to meet all IEC61850-3 hardware requirements – such as EMC Level 3, 4 and 5 requirements, Wide temperature range and High availability. ATOP is proud to be applying for DNV.GL (KEMA) certification, the most prestigious one in Power Utilities.

Award-winning Performance: RHG9528's IEEE1588v2 Hardware-PTP version received recognition for nanosecond-level accuracy, high-performance and an astonishing holdover performance of less than 1 Microsecond/hour. This makes RHG9528 one of the most reliable GMC backups. And being embedded with Synchronous Ethernet and with full support for Telecom PTP profiles over both IPv4 and IPv6, RHG9528 is also ideal for Telecom applications.

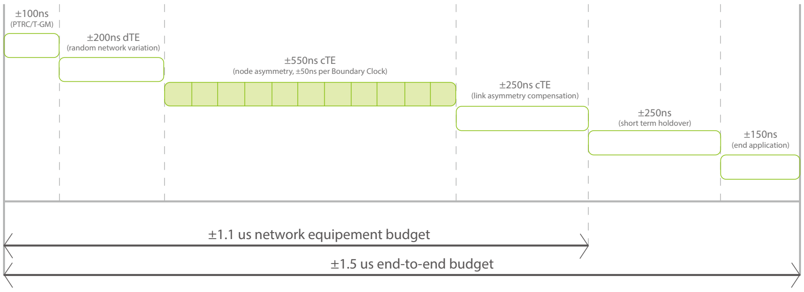
High-availability, versatility and power: When equipped with ***High-Availability HSR/PRP modules***, RHG9528 complies with the most stringent redundancy requirements, ensuring no packet loss and guaranteeing GOOSE packets arrive at their respective destinations. RHG9528's high performance provides a network redundant self-recovery mechanism of under 20ms on full load. This enables you to build a reliable network through almost any redundant ring topology. RHG9528 supports ITU-T G.8032 ERPS Ring, IEEE802.1D-2004 RSTP, STP, MSTP, MRP (Client), iA-Ring, iA-Chain and many other compatible ring protocols for network redundancy. With a Multifunctional web dashboard, its offers intelligent features such as Quality of service (QoS), IGMP, port mirroring, and security.

It is available in two power input variants: one for low-DC voltage (redundant 24~48VDC input) and one for the more popular High-Voltage applications in the distribution grid (redundant 100~240VAC or 100~370VDC input). Additional 4 x 10 Gigabit uplink SFP slots allow RHG9528 to be the backbone of the substation.

BOUNDARY CLOCK APPLICATION

High accuracy delivered, even in holdover mode

A boundary clock, mainly used in Telecom applications, is normally a switch that doesn't act transparently to the slaves in the network. Directly connected to the Grandmaster, large networks with thousands of slaves would overload the Grandmaster. So the need for a device that acts as a slave towards the master and as a master towards slaves is achieved with a boundary clock. ATOP's RHG9528 Boundary clock, once synchronized, achieves the 50ns precision set forth in the ITU-T G.8271.1 recommendation. And it is equipped with a high-precision OCXO to guarantee that precision in the event of a link or device failure, with a maximum time-drift of 250ns per from from GNSS time. All this can guarantee a maximum 1.5us end-to-end time deviation budget from the GNSS to the end-application, up to 10 BC hierarchies.

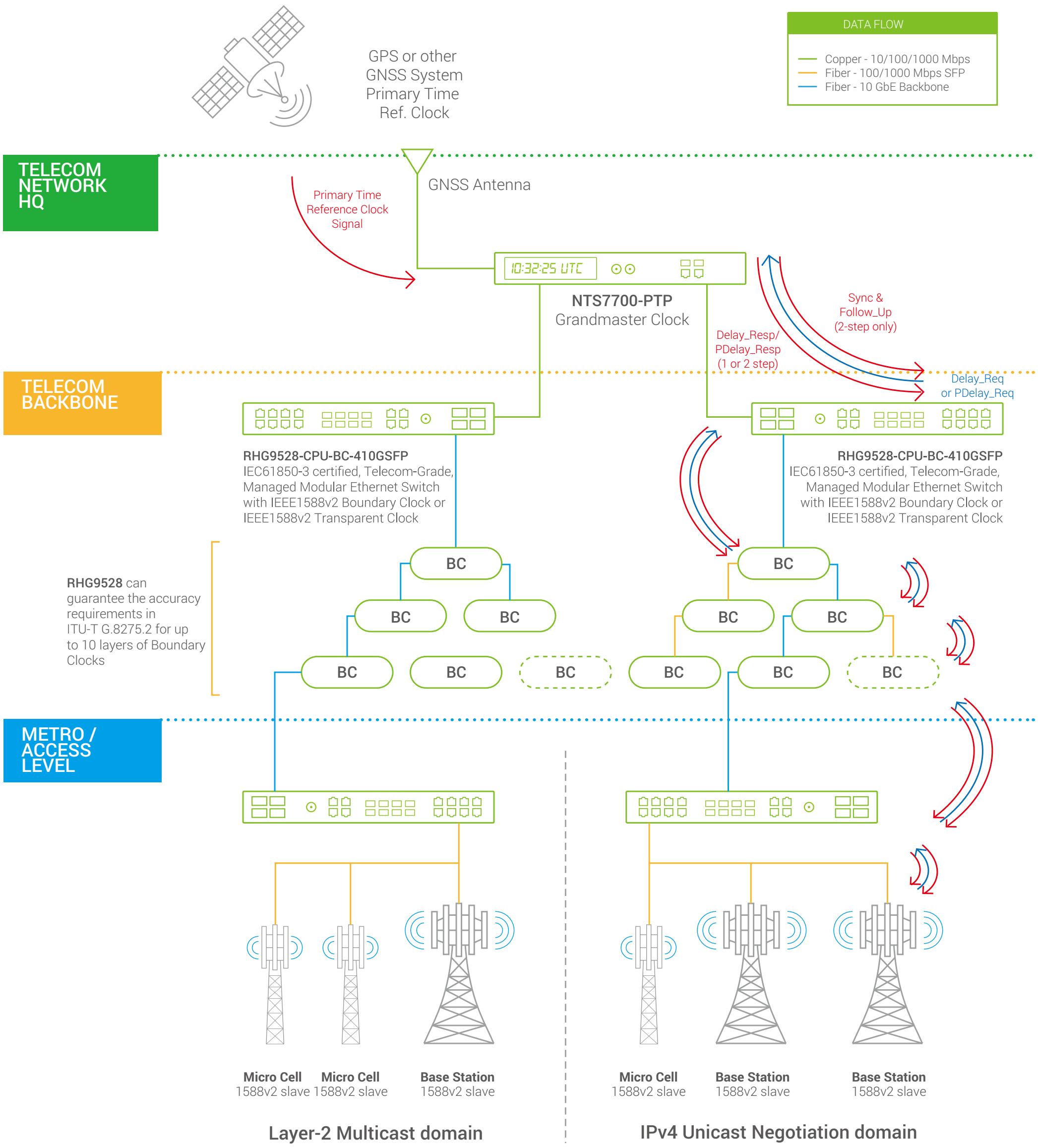


Application Example

The network diagram shows the use of ATOP's NTS7700 Grandmaster Clock and RHG9528 Boundary clock in a telecommunication application.

RHG9528 can easily function as a both Access/Aggregation switch with up to 4x1/10Gbps SFP slots and as a PTP boundary clock. Up to 28 ports can be individually configured to run different instances of IEEE1588v2. For example, the switches shown on the left hand-side will work on an L2 ITU-T G.8275.1 multicast End-to-End configuration, while the Boundary Clocks shown on the right hand-side work on IPv4 Unicast Negotiation End-to-End configuration that is fully compatible with ITU-T G.8275.2 Telecom Profile.

A wide variety of settings are allowed within profiles – such as the Power, Telecoms, and Enterprise profiles. RHG 9528-BS supports Synchronous Ethernet, allowing the transport of time and frequency, which is important for legacy networks such as SDH-SONET.



EHG9508 EHG9512 Series

8 or 12-Port IEC61850-3 Certified Industrial Managed Gigabit Switch

FEATURE HIGHLIGHTS

- IEC61850-3 and IEEE1613 Certified
- Up to 8 x 10/100/1000 BASE-T(X) ports; and up to 4 x 1000 BASE-X SFP ports
- Supports IEEE 1588v2 PTP, with nanosecond-accurate Hardware-based End-to-End Transparent clock and Software Boundary Clock
- ERPS and Compatible Ring (recovery time < 20ms @ 40 switches), STP/RSTP/MSTP/MRP (Client) for network redundancy
- Remote management over Web browser, Telnet, and Serial console
- PROFINET v2 Class B compatible
- Provides Generic Station Descr. file for integration with SIMATIC Step 7

PRODUCT DESCRIPTION

The EHG9508/EHG9512 Series is a highly reliable Gigabit Managed Ethernet Switch. Its IEC61850-3 compliance allows it to be core part in IEC 61850 networks power substations and control centers.

With its PTP capabilities, the EHG9508/EHG9512 Series can be utilized in networks with stringent time synchronization requirements. It can act as **hardware-assisted, End-to-End transparent clock,** providing nanosecond accuracy for field packet, and it can act as a software-assisted boundary clock.

The EHG9508/EHG9512 Series can be equipped with **up to 8 10/100/1000BASE-T(X) RJ-45 ports and up to 4 1000BASE-X SFP ports**. With its high performance, it provides network redundancy self-recovery mechanisms under 20ms, even on full load, enabling you user to build a **reliable network through a redundant ring topology**. ERPS/STP/MSTP/RSTP/MRP (Client) and many other compatible rings are supported. With a Multifunctional web dashboard, its offers intelligent features such as Quality of service (**QoS**), Virtual LAN (**VLAN**), IGMP, IGMP Snooping, Port mirroring and security.

The EHG9508/EHG9512 Series is designed to be used in core power utilities. It provides dual redundant power inputs with Reverse Polarity Protection and two sets of relay that allow you to build up a stand-alone fault alarm system. Its **wide operating temperature of -40°C to 85°C** and DIN-Rail mounting capacities make it suitable to be used in remote substations, where reliability in harsh environments is a concern for long-term operations..

FEATURE HIGHLIGHTS

- Support for multiple GNSS systems: GPS, GLONASS, and BEIDOU
- NTP v2, v3, v4 SNMP v3, v4 Client-Server support
- Holdover performance: <36 us time-drift when disconnected from GNSS
- Industrial fanless design for -40~85°C operation. IEC61850-3 protection
- Flexible modular configuration; 2 dedicated Output Module slots
- 2 x 10/100/1000 Mbps RJ45 and 2 x 100/1000 Mbps Combo SFP slots
- Support for Legacy Protocols: IRIG-B, BJT, BCD, ST, ST with checksum
- Redundant power input; Low-Voltage DC or High-Voltage AC/DC

PRODUCT DESCRIPTION

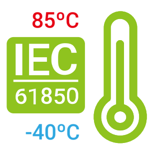
The NTS7500 1U 19" Rack-mount Modular NTP Server is a high-power, rugged NTP Server that offers high precision and reliability.

Suitable for almost any environment and complying with the harshest Industrial EMC conditions, ATOP's NTP Server can guarantee safe Network Time distribution, achieving a holdover performance of <36us/day. NTP/SNTP Synchronization usually happens over the internet, and it achieves 10+ ms accuracy, at best. With ATOP's NTS7500, it would take more than 9 months to have its internal clock accumulate a delay that is only comparable to a best-case scenario of NTP synchronization over the internet.

A high-performing NTP/SNTP Server
With its powerful CPU and its 2 Gigabit Combo ports, NTS7500 is ideal for providing time reference in large Local Area Networks, which allows your organization to become independent from Third Party Servers, ISPs and Internet Backbone latency. By the time the device is powered on, it will retrieve its Time Reference from the Internet by using its embedded NTP client, until time is successfully synchronized with a GNSS source. When GNSS synchronized is achieved, time information from the NTP Client will be ignored.

Modular Gateway to Legacy
If you need to Synchronize Legacy Equipment without NTP/SNTP Client Support, then our NTP Server's modular architecture will allow you to customize the Physical Output needed. ATOP provides optional TTL and RS-485 differential modules that, once configured, can provide many additional supporting outputs – such as IRIG-B, PPS, PPM, PPH, 10MHz, BCD.

Industrial and Substation-grade Hardware
Designed to satisfy EMC requirements for Substation-Grade equipment, NTS7500 has a minimum EMC Level 4 rating and is designed to function between -40°C and 85°C with passive cooling only, allowing it to avoid the risk of having moving parts breakdown from constant operations. NTS7500 can be equipped with up to two Power Input modules, into which Low Voltage DC or High-Voltage AC/DC can be fed.



RHG7528/ 7528 Series

INDUSTRIAL Rack-Mount Layer-2 or Layer-3 MANAGED Modular Gigabit Ethernet PoE SWITCH

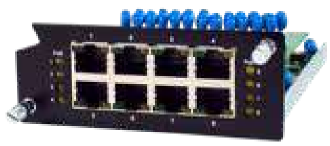
FEATURE HIGHLIGHTS

- IEEE 1588v2 Hardware-assisted End-to-End Transparent Clock
- Maximum 128Gbps switching capacity, 95.24Mpps throughput
- Rugged industrial design for harsh environments between -40~75°C
- Flexible modular configuration: 3 module-dedicated slots
- Up to 24 PoE ports; maximum 720W of PoE power budget
- 4 x 1 Gigabit or 4 x 10 Gigabit SFP Uplink slots
- Available in Layer-2 (RHG7528) and Layer-3 versions (RHG7628)
- ITU-T G.8032 ERPS Ring, RSTP, or MRP (client) redundancy
- RIP, OSPF, Static Routing, and PIM supported Layer-3 switching
- PROFINET v2.33 Conformance Class B Certified; provides GSD Description file

PRODUCT DESCRIPTION

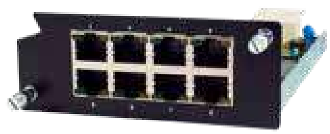
Flexibility
ATOP's high-density RHG7528/628 Rack-mounted managed switch provides the flexibility needed for your application demands. You can choose from among 12 different Routing Core versions – based on power supply, Software Bundle Layer-2 or Layer-3 and uplink port configurations. Five different 4- to 8-Port modules are available as well for you to customize your device in a very simple way.

Designed for PoE, in wide temperature
The RHG7528/628 Series supports up to 24 Gigabit ports – in any 8 or 4-port multiple configuration. Specially designed for bringing power over Ethernet to virtually anywhere, a **maximum PoE output of 720W** over the 24 ports can be achieved (PoE/PoE+ configuration - 802.3af/at). Available in 4 power input variants, it is UL 60950-1:2006 certified and designed to handle the harshest environments. Its fanless design and EMC Level 3 protection guarantee operations between -40°C and +75°C. With it 24 PoE ports running full power, it is suitable for use in almost any application.



Precision Time Protocol on Hardware
Both Layer-2 and Layer-3 version support IEEE1588v2 End-to-End TC supported by Hardware.

Powerul and versatile
The Layer 2 and Layer 3 versions support advanced protocols for adding a layer of network redundancy to your Network – such as ITU-T G.8032 ERPS Ring, IEEE802.1D-2004 RSTP, STP, MSTP, MRP (Client), iARing, iA-Chain. There is an endless list of additional features, ranging from VLAN to QoS. With 4 x 10 Gigabit ports, Profinet CC-B v2.33 Certification, and Ethernet/IP-readiness, the RHG7528/628 Series is the best candidate for your industrial network backbone.



Layer-3 Switching
Another additional feature is that the Layer-3 version supports IPv4 Static Routing, RIPv1/v2, OSPFv2, IGMP, IGMP Snooping, PIM Dense Mode and Sparse Mode, DVMRP and VRRP for Routing Redundancy.

Secure
The first Industrial Managed Secure Switch! Protect your LAN from Eavesdropping and impersonation with 802.1AE MACsec. No additional latency and up to 99% Gigabit Throughput guarantee (*)

EHG7504/ EHG7508/ EHG7604/ EHG7608

4 or 8-ports Gigabit Layer-2 or Layer-3 Managed Switch

- IEEE 1588v2 PTP Hardware-based End-to-End Transparent clock
- Up to 8 x 10/100/1000 BASE-T(X) RJ45 ports or 1,000 BASE-X SFP slots
- Up to 8 x 802.3af/ 802.3at Power over Ethernet ports, with maximum 30W per PoE port and maximum 240 W device power budget
- Layer-2 Redundancy, with ERPS, RSTP, STP, MRP (Client) and more
- Powerful Layer-3 Switching, supporting IPv4 Static, RIPv1/v2 and OSPFv2
- Profinet Conformance Class B v2.33 certified; Ethernet/IP Ready
- Operates between -20~70°C, and up to 4000m in elevation
- NEMA TS-2 certified for Traffic Control Applications; EN50155 and EN50121-4 certified for Railway trackside and rolling stock Applications

EHG7512/ EHG7516/ EHG7520/ EHG76XX

12, 16 or 20-ports Gigabit Layer-2 or Layer-3 Managed Switch

- IEEE 1588v2 PTP Hardware-based End-to-End Transparent clock
- 4 x dedicated 10G Uplink SFP slots and up to 16x 10/100/1000BASE-T(X) RJ45 ports or 100/1,000 BASE-X SFP slots
- Up to 8 x 802.3af/ 802.3at PoE/PoE+ Power over Ethernet ports, with maximum 30W PoE power per port and up to 240W power budget.
- 24 Gbps High-Performance non-blocking Switching Fabric
- Redundancy through ITU-T G.8032 ERPS Ring, RSTP, STP, MRP (Client), compatible rings and compatible chains. PLUS Multiple Layer-3 Protocols
- Profinet Conformance Class B v2.33 Certified & Ethernet/IP Ready
- Operates in environments between -40°C~70°C

EMG8508/ EMG8510

8 or 10-ports EN50155 IP67 Gigabit Layer-2 Managed Switch

- IEEE 1588v2 PTP Hardware-based End-to-End Transparent clock
- 8 x 10/100/1000 BASE-T(X) ports, M12 + 2 1000 Base-X SFP slots
- Up to 8 x 802.3af or 802.3at compliant PoE ports
- EN50155, EN50121-4 and UL 61010-2-201 certified
- Redundant power input, DC or High Voltage DC
- Ruggedized IP67 aluminum enclosure
- Operates in environments between -40°C~75°C
- 2 x Relay outputs; 5-pin M12 A-Coding
- Profinet Conformance Class B compatible
- Ethernet/IP Compatible

atop Technologies

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