

Net.Time Power a clock for Utilities

Just in Time

Net.Time Power is a PTP boundary clock that can also be configured as stand-alone GPS clock that provide timing by means of PTP, NTP, SyncE, Pulses, ToD, IRIG-B and Hertz to satisfy needs of new and conventional substations. It also includes Power and Telecom PTP profiles and Rubidium oscillator. Net.Time simplifies the provision of timing facilitating the integration of the installed plant for perfect control, protection and data acquisition.

Multiple options of time refs minimize GNSS weakneses

The basic architecture of electricity distribution changed very little during the first 100 years. However, in the lasts decades, the concept of Smart Grid emerged thanks to the massive use of ICT technologies to increase the efficiency, resilience and quality of the service. Generation plants, substations and customers are now connected with telecommunication networks.Substation automation

Substation automation refers to using data from intelligent electronic devices to enable stability, increase security and maintain the system integrity. To make it possible a new standard was released, the IEC-61850 that facilitates the intensive use of digital technologies and guarantees the interoperability between vendors, appliances and processes.

Market most advanced clock for Digital Substations

Timing and Substations

Net.Time Power accepts GNSS time references in addition to and distributes precise time via multiple output protocols, including IRIG-B, PTP grandmaster as defined by IEEE 1588, and NTP. The

- SEL-2488 raises the bar for satellite-synchronized clocks by providing higher levels
- of accuracy, flexibility, dependability, and ease of use. The advanced capabilities of
- the SEL-2488 make it well-suited for demanding applications, like synchrophasors,
- sampled values, traveling wave fault location, and substations with multiple time
- synchronization requirements..

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Grid Automation

Challenge ONE: **Timing**

Grid automation requires precise and stable synchronization for many tasks:

- **Data acquisition**, for devices such as intelligent electronic devices (IED), remote terminal unit (RTU) and merging units (MU) measuring real-time Volts, Hertz, Ampers, Energy, Impedance...
- **Protection**. High voltage lines are supervised permanently with IEDs, Relays, Switchgears that require timing.
- **SCADA** applications using MMS are real-time process to supervise, control and analyze grid performance.
- **Events management**, all the incidents are time-stamped, recorded and transmitted to ensure operation.
- **Phasor Measurement Units** (PMU) are special IED deployed across the wide-area (C37.118) to monitor and prevent faults and ensure phase imbalance does not occur.
- **Virtual Power Plants** integrating a of renewable and distributed energy units into existing energy systems.

There are more application requiring timing such as peak-hour billing or outage management that go beyond the substation needs.

Synchronization Systems

Among the alternatives to provide timing the most common are:

- <u>Conventional timing</u>: stand-alone clocks, fed by GPS, that distribute signals using dedicated cable links.
- <u>Smart Grid timing</u>: clocks are part of a wide-area system while signals are distributed through the LAN by means PTP/NTP time-stamped packets.

GPS/GNSS weaknesses

At the industry many companies continue using stand-alone GPS clocks despite its vulnerability to human and natural disruptions that may perturb normal operations by raising false alarms, delaying actions, and lowering system efficiency. However, it is important do not underestimate the threats such as antenna failures, or intentional jamming that draw out legitimate positioning, navigation and timing frequency using signals that cause the loss of satellite lock. Not less important is the intentional spoofing that deliberate emitting of legitimate-appearing false signals to shift the computed position or time of a victim's receiver.

PTP/NTP time-stamped packets

This option has important benefits. For instance it does not require dedicated cabling making the installation simpler and more efficient. SNTP was included in the first edition of IEC-61850 standard however, SNTP only achieves 1-10 ms of preciseness which is good at the station bus to synchronize SCADA but does not meet the level needed by IECs and MUs that, using GOOSE and SV messages, may require accuracies better than 1 µs at the process bus. The solution arrived in 2011, with the second edition of the standard, when was adopted PTP (IEEE 1588) to address and satisfy these demands. A particular PTP Utility profile was defined (IEC 61850-9-3) to improve the deterministic behaviour and ensure continuous operation.

Stand-alone GPS clocks are vulnerable while PTP are quality solutions

Challenge TWO: **Resilience**

The second objective in substation automation is to design a fast recovery time network for the traffic flows to recover them in the event of a link or node failure. Mission-critical and time-sensitive applications cannot tolerate a network disruption without severely affecting operations or jeopardizing the safety of on-site personnel. Then networks must be fault-tolerant for maintaining highest network availability.

Alternatives for redundancy

Schemes like Rapid Spanning Tree Protocol (RSTP) or Resilient Ethernet Protocol (REP) are not solutions but the ones provided by IEC-61850 can deliver zero micro-sec. fail-over recovery:

1. **Redundancy Protocol** (PRP). Based on the use of two independent networks the sender must send each packet twice through two separate ports. Supports either tree or ring topologies with no limits on node counts, but PRP native clients must have duplicate ports.
2. **Highly Available Seamless Ring** (HSR). requirement but is only available in a ring topology. HSR scales to a limited number of devices based on application requirements. It does not need LANs duplication like PRP but requires HSR aware nodes.

PRP has the benefit of using standard LANs compared with HSR which is simpler but needs the support of all network elements to be part of the HSR ring.

Net.Time Power

This device is conceived as a boundary clock intended to pave the transition to smart grid substations. With this purpose in mind Net.Time offers seamless translation between SNTP and PTP presenting a wide variety of inputs / outputs for primary or backup time references.

Solution: **PTP over PRP**

Net.Time Power is a PTP over PRP clock that also has additional features:

1. Supports PTP Telecom and **Power profiles** to interconnect both type of clocks, which is a common necessity in power grids.
2. It is a **PRP native** (DAN-P clock) with Double interface, then it does not need a Redundancy Box reducing costs and simplifying installation.
3. **OCXO / Rubidium** are internal oscillator options to match any hold-over.
4. Supports 1PPS, MHz, Mb/s, PTP and SNTP enabling features such as **NTP-to-PTP translation** facilitating the coexistence of legacy and new equipment, and seamless migration.
5. Delivers SNTP, PTP, 1PPS and IRIG-B signals to protect all appliances.

There are partial solutions but none satisfies simultaneously all the above-mentioned requirements of the power industry as Net.Time does

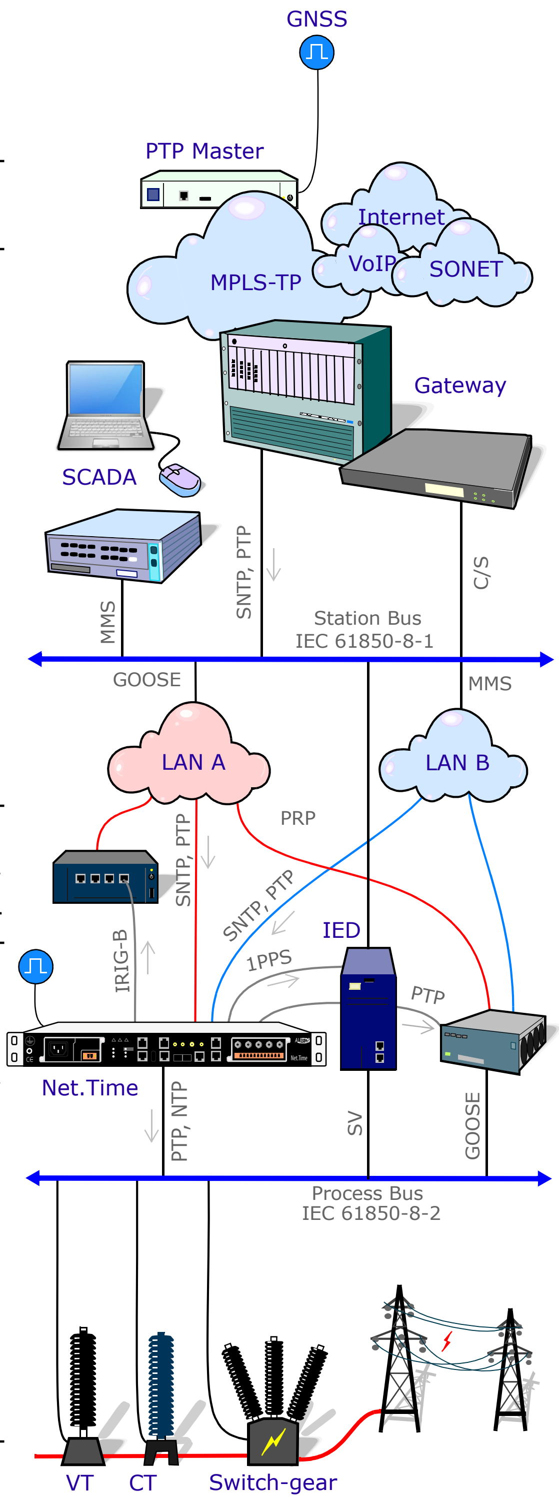
Benefits

No doubts about the advantages of the new standard that facilitates interoperation but the adoption will be a gradual process. Net.Time Power facilitates a smooth migration to the new and legacy protocols improving on this way the capacity to integrate any appliance of the substation. All technologies will coexist for a long time therefore the versatility is a valuable aspect offered by Net.Time Power that also has interesting advantages:

1. Improves availability of NTP/PTP timing services through standard buses to all devices.
2. Support installed base using IRIG-B, SNTP and 1PPS.
3. Provides a more reliable synchronization for mission-critical infrastructures.
4. PTP over PRP offers better accuracy, simplifies wiring and maintenance.
5. Facilitates interoperability between Utility and Telecom profiles.

It deserves special mention the support of PTP protocol in redundant PRP which requires careful considerations. Theoretically, any PTP clock could be attached to a PRP-protected network adapting a Redundancy Box (RedBox). However, this is not an optimal solution because it involves deploying a new device adding complexity and price. By implementing the PRP in the timing node the equipment is directly attached to the network.

Net.Time node includes multi-protocol and redundant operation features. It simplifies the migration to PTP by providing NTP synchronization to legacy nodes. The NTP and PTP services work concurrently so that network administrators do not need to choose which one to enable and install two or more boxes for each protocol. The unified Net.Time approach has then a direct effect in CAPEX but also OPEX will be reduced. ❑



Smart Grid

KEY FEATURES

- Rubidium oscillator
- PTP boundary clock
- Full NTP/SNTP support
- Simultaneous PTP and NTP
- PTP over PRP (DAN-P)
- Power and Telecom profiles
- SNTP, NTP, IRIG-B, 1PPS, 1PP2S, ToD, MHz, T1/E1
- 256 PTP clients per port
- 20 ns accuracy (Rubidium)
- ±8 ns time stamp resolution
- Carrier-class: 2xAC or 2xDC
- Fan-less operation

BENEFITS

- Seamless fail-over
- Legacy IEC integration
- No RedBox required
- Profiles translator
- Protocol translator
- Power fault tolerant

APPLICATIONS

- Grandmaster or Boundary
- Mission-Critical Telecom
- IEC-61850 Substations
- Railways
- Synchrophasors
- Virtual Power Utilities

Net.Time Power technical data

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Synchronization features	
PTP function	• Boundary, Grandmaster, and Slave clock • Up to 256 unicast clients at 128 packets/sec • PTP profile translation from Port A to Port B
PTP profiles	• Default profiles (IEEE 1588-2008 Annex J) • Telecom frequency profile (ITU-T G.8265.1) / Telecom phase and time profile (ITU-T G.8275.1) • PTS / APTS profile (ITU-T G.8275.2) • Utility Profile (IEC 61850-9-3) • Power Profile (IEC C37.238)
NTP function	• Port A: NTP server / Port B: 1000 transactions per second • NTPv3 (RFC 1305) and NTPv4 (RFC 5905) server and client • SNTPv3 (RFC 1769) server
SyncE function	• Interfaces: RJ45 and SFP • Full ESMC / SSM support as per ITU-T G.8264 and G.781
GNSS	• GPS, GLONASS, Beidou, Galileo support / Single and Multiple constellation • Cable delay compensation
Time Inputs / Outputs	• Frequency: 544 kHz, 2048 kHz, 5 MHz, 10 MHz, 1544 kb/s (T1), 2048 kb/s (E1), SyncE • Phase: 1PPS, 1PP2S • Time: PTP, NTP, ToD (ITU-T G.8271, China Mobile and NMEA), IRIG-B (B00X, B12X, B13X, B14X, B15X, B22X)
Rubidium / OCXO oscillators	Internal Oscillator • Default OCXO better than ±0.1 ppm • Optional Rubidium better than ±5.0 e-11 Rubidium features • Aging: ±4 e-11(1 day, 24 hours warm up), ±1.5 e-9 (1 year) • Warm-up time (time to <1.5 e-9): 15 minutes (typical 25° C) Locked Accuracy • To UTC (24 h locked to GNSS, peak value, ±2° C): ±40 ns • To reference (24 h locked to 1PPS / ToD, peak value ±2° C): ±10 ns Hold-over Accuracy • Holdover output time accuracy (2 hours, ±2ºC): ±100 ns • Holdover output time accuracy (24 hours, ±2ºC): ±1.0 us / 1 day • Accuracy on shipment at 25ºC: ±5 e-11
PRP resilience	• PRP extension for IEEE 1588 / IEC 61588 • Link Redundancy Entity (LRE) / IEC 62439-3
Ports	• 2 x RJ45: 10BASE-T, 100BASE-TX, 1000BASE-T • 2 x SFP: 100BASE-FX, 1000BASE-LX,1000BASE-T, 1000BASE-ZX, 1000BASE-BX • 1 x SMA port: GNSS (in) • 3 x SMB ports: IRIG-B (in/out), 1PPS (in/out), 1PP2S (in/out), 10 MHz (in/out), 5 MHz (in/out), 2048 kHz (in/out), 1544 kHz (in/out) • 2 x RJ48: ToD (in/out), 10 MHz (in/out), 5 MHz (in/out), 2048 kHz (in/out), 1544 kHz (in/out)

Platform	
Operation	• Fan-less operation ETSI 1U rack mountable (1¾" x 10" x 19" / 240 mm), weight: 3.4kg / 8.7lb • Temperature / Humidity range: -10ºC ~ +65ºC, 10% ~ 90% Redundant power supply (AC, DC, AC+AC, AC+DC, DC+DC) • AC: 85 ~ 264 VAC, 47 - 63 Hz (IEC 60320 C13/C14) • DC: 18 ~ 75 VDC (2-pin 5.1 mm) • AC/DC: 85 ~ 264 VAC or 100 ~ 370 VDC (2-pin 5.1 mm)
Front/Back Panel	• LEDs: Platform (PSU1, PSU2, system), Application (alarm, GNSS, locked), Port (link, activity) • Network and Time interfaces. Management Interfaces. USB software and firmware upgrade
Management	• Local console by CLI (RJ-45) • SSH through management interface (RJ-45, 10/100BASE-T) • RFC 3164 Syslog event reporting (device role) • TFTP software and firmware upgrade

Expansion Interfaces	
Module 1 (RIC 82)	• 5 x BNC or ST for IRIG-B or PPS (out) • Connector 16 pins: Alarms or ASCII or PPS or IRIG-B
Module 2 (RIC 52)	• 5 x RJ48 for ToD or ASCII or IRIG-B • 4 x BNC for PPS or IRIG-B or MHz • 1 x BNC for IRIG-B or DCF77
Module 3 (RIC 54)	• 1 x BNC for IRIG-B or DCF77 • 4 x BNC for PPS or IRIG-B or MHz • Connector 16 pins: Alarms or ASCII or PPS or IRIG-B

Net.Time is a boundary clock conceived to simplify transition from NTP and IRIG-B synchronization to the more accurate IEEE 1588 / PTP protocol. With this purpose in mind, Net.Time offers seamless translation between both protocols. Net.Time also offers a high variety of clock reference inputs and outputs that could serve as primary or backup references, used for monitoring purposes or used to synchronize legacy equipment.