Net.Time Applications

Net.Time is a Grandmaster and Boundary clock that supports PTP and NTP over PRP and multiple input/output options such as IRIG-B, 1PPS, ToD and SyncE to satisfy all timing needs of power utility, enterprise and telecom applications

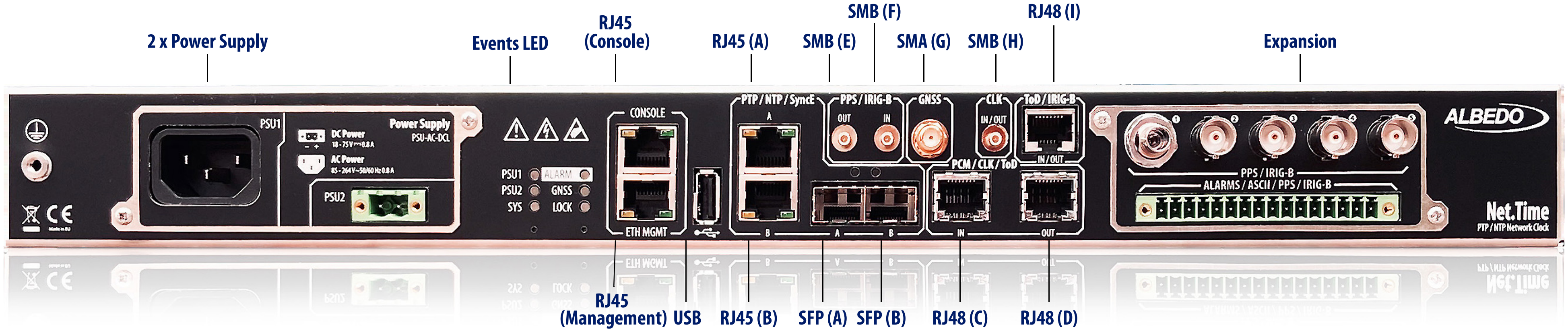
Just in Time

ALBEDO Telecom

ALBEDO a Global manufacturer of Testers & Timing appliances

www.albedotelecom.com

The **Net.Time**



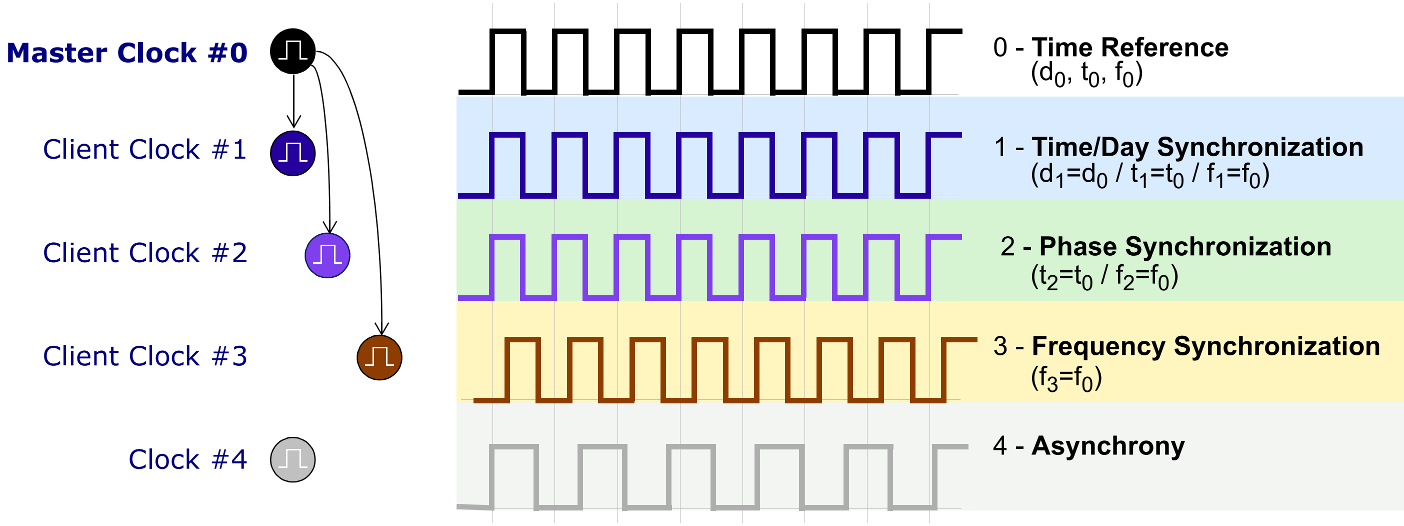
Net.Time is the state-of-art clock designed to deploy enhanced synchronization networks that are providing more precise and secure signals required by mission critical services like electricity and broadband wireless applications.

Net.Time has a built-in GNSS receiver, atomic Rubidium oscillator, redundant power supply and accepts a large variety of time references (GNSS, PTP, NTP, ToD, IRIGB, PPS, SyncE, T1/E1, MHz) that can be used as primary or backup references. Exactly the same time protocols are possible as output signal for distribution, moreover, protocol translation is possible in all directions.

Net.Time can be configured as Grandmaster, Edge, Boundary and Slave clock. Several PTP profiles are supported including Telecom, Power and Default, that can work simultaneously when the set up is Boundary facilitating the profiles translation and inter-operation.

As result of the above mentioned features Net.Time simplifies the migration to most advanced synchronization based on time, phase and frequency protocols offering seamless integration between different architectures and time technologies.

About **Synchronization**

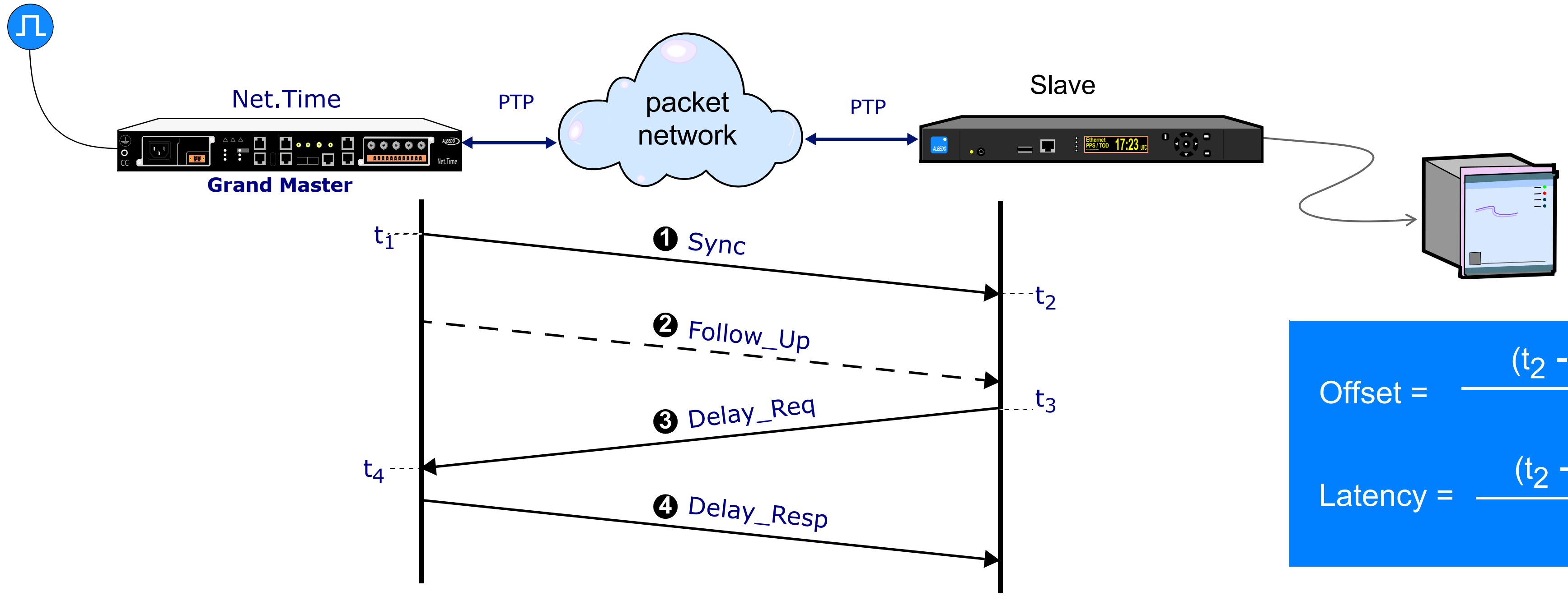


Synchronization aims to discipline clocks in a network to a common time reference.

- **Master Clock #0** is the time reference defined by a Day (d_0), Phase (p_0) and Frequency (f_0)
- **Client Clock #1** is disciplined to the Master on Day (d_0), Phase (p_0) and Frequency (f_0)
- **Client Clock #2** is disciplined to the Master only on Phase (p_0) and Frequency (f_0)
- **Client Clock #3** is disciplined to the Master only on Frequency (f_0)
- **Clock #4** is not disciplined at all

Even when initially set accurately, real clocks will differ after some amount of time due to clock drift, caused by clocks counting time at slightly different rates.

PTP - Precision Time Protocol (IEEE 1588)



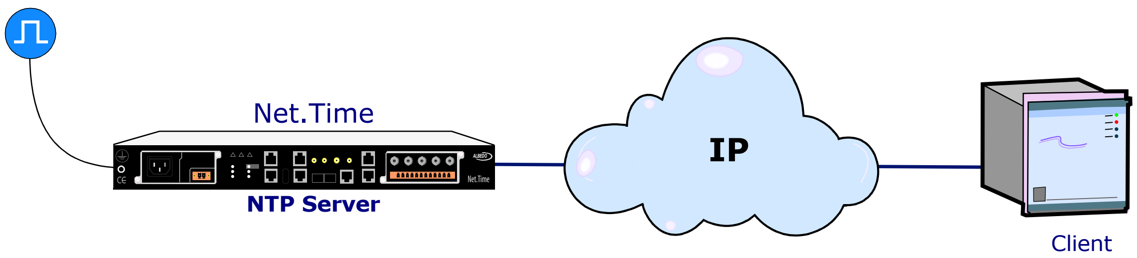
$$\text{Offset} = \frac{(t_2 - t_1) - (t_4 - t_3)}{2}$$

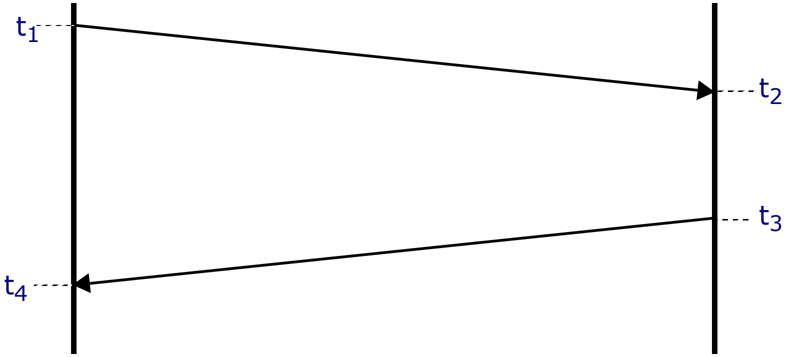
$$\text{Latency} = \frac{(t_2 - t_1) + (t_4 - t_3)}{2}$$

It is a cost-efficient solution and can be applied on the basis of the existing Ethernet network in a substation. PTP (IEEE 1588) applies master/slave time synchronization mechanisms and supports hardware time stamps. The basic parameters of Latency / Offset are computed from the $t_{1...4}$ stamps.

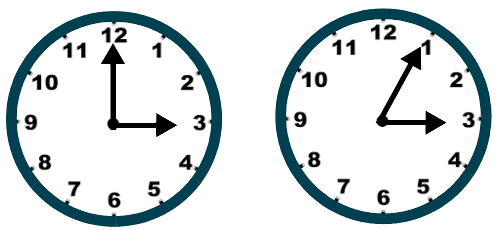
- Grandmaster sends a series of messages with date and time to client-clocks
- Client-clocks compensate the delays and get synchronized with the Master
- Frequency is then recovered with a precise time-of-d
- PTP prevents error accumulation in cascaded topologies, fault tolerance and enhances the flexibility and PTP can use an existing Ethernet reducing cabling costs and requires just a few resources.

NTP (Network Time Protocol)





Offset: difference between clocks



$$\text{Offset} = \frac{(t_2 - t_1) + (t_3 - t_4)}{2}$$

$$\text{Round Trip Delay} = (t_2 - t_1) + (t_4 - t_3)$$

NTP can provide a milisecs range of precision which is good enough for most of enterprise applications.

- Network Time Protocol (NTP) is an Internet protocol for synchronizing the clocks of computer systems over packet network with variable latency.
- The clock frequency is then adjusted to reduce the offset gradually, creating
- Precision 1 - 10 ms. in Internet, (0,5 - 1 ms for LAN ideal conditions)

NTP server

Network Time Protocol support)

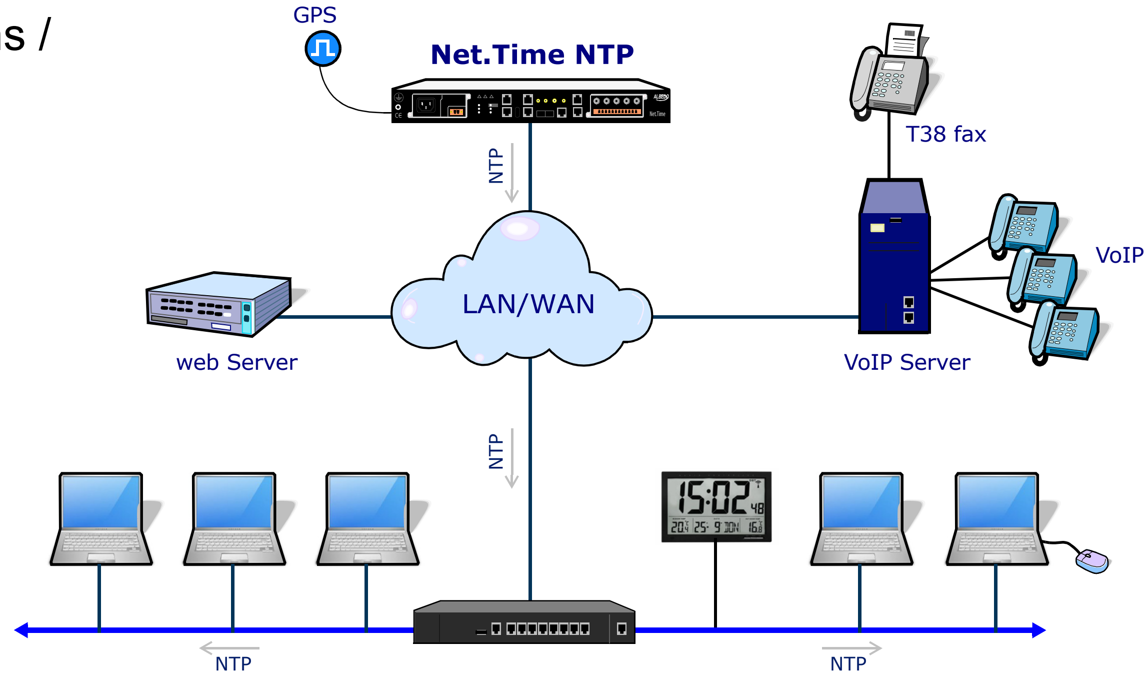
- Port A: NTP server @ 1000 transactions / sec.
- Port B: NTP client and time ref.

NTP versions

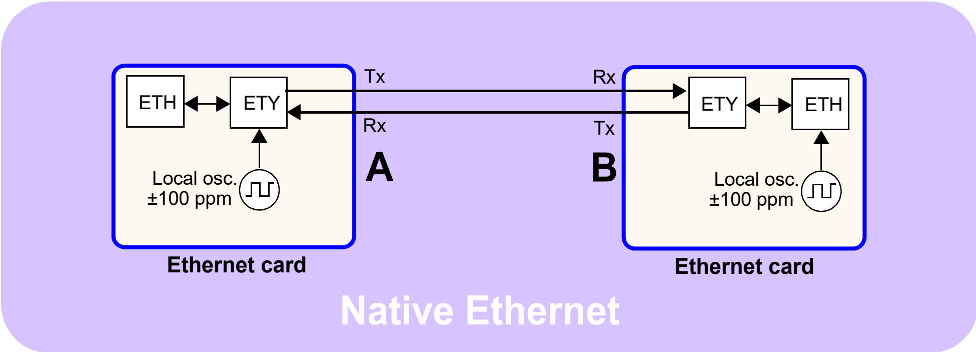
- NTPv3 (RFC 1305) server & client
- NTPv4 (RFC 5905) server & client
- SNTPv3 (RFC 1769) server

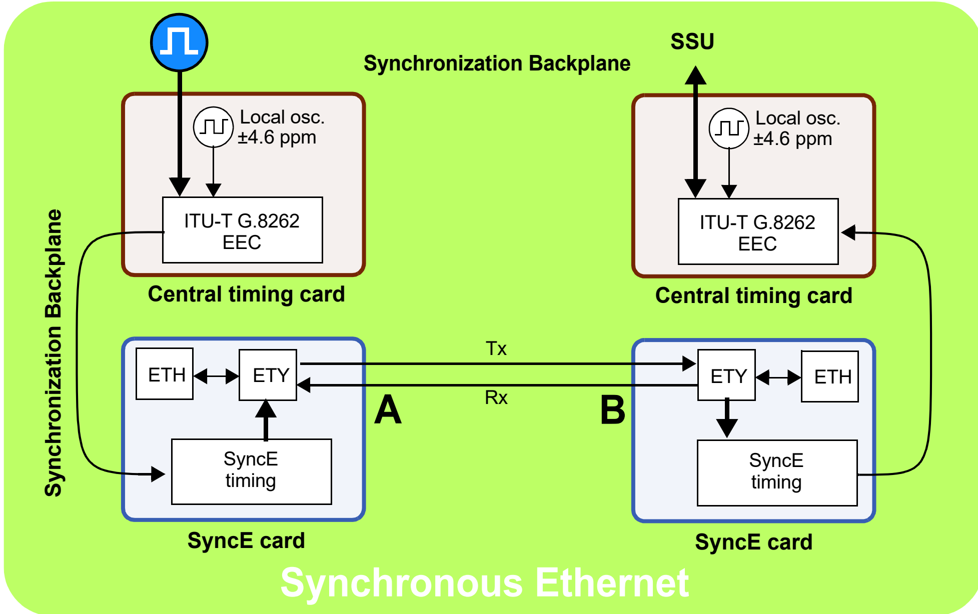
Configuration

- Maximum/ Minimum polling interval



SyncE (Synchronous Ethernet)





SyncE is not part of the IEC 61850 but is being used in the Power industry

1. PHY Ethernet

- Rx gets synchronized using the input line [Tx (port B) >>> Rx (port A)]
- BUT there is no time relation between the Rx and Tx of the same Port

2. **SyncE PHY** (physical layer)

- Rx gets synchronized using the recovered clock
- Tx uses a traceable reference clock

IRIG-B signals

IRIG - Xabc

Rate
- A: 1000 PPS
- **> IRIG-B: 100 PPS <**
- D: 1 PPM
- E: 10 PPS
- G: 10000 PPS
- H: 1 PPS

Modulation
- 0: Unmodulated DCLS
- 1: AM (Amplitude Modulated)
- 2: Manchester Modulated

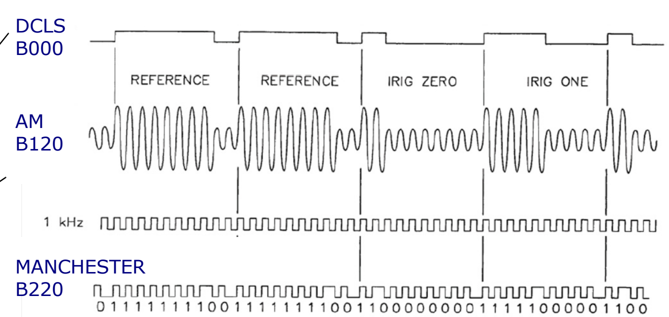
Carrier
- 0: No carrier (DCLS)
- 1: 100 Hz
- 2: 1 kHz
- 3: 10 kHz
- 4: 100 kHz
- 5: 1 MHz

Coding
- 0: BCD, CF, SBS
- 1: BCD, CF
- 2: BCD
- 3: BCD, SBS
- 4, 5, 6, 7: others

BCD	
0000	= 0
0001	= 1
0010	= 2
0011	= 3
0100	= 4
0101	= 5
0110	= 6
0111	= 7
1000	= 8
1001	= 9

BCD - Binary Coded Decimal, coding of time (HH,MM,SS,DDD)
SBS - Straight Binary Second of day (0....86400)
CF - Control Functions depending on the user application

IRIG SAMPLES: B000, B120, B220

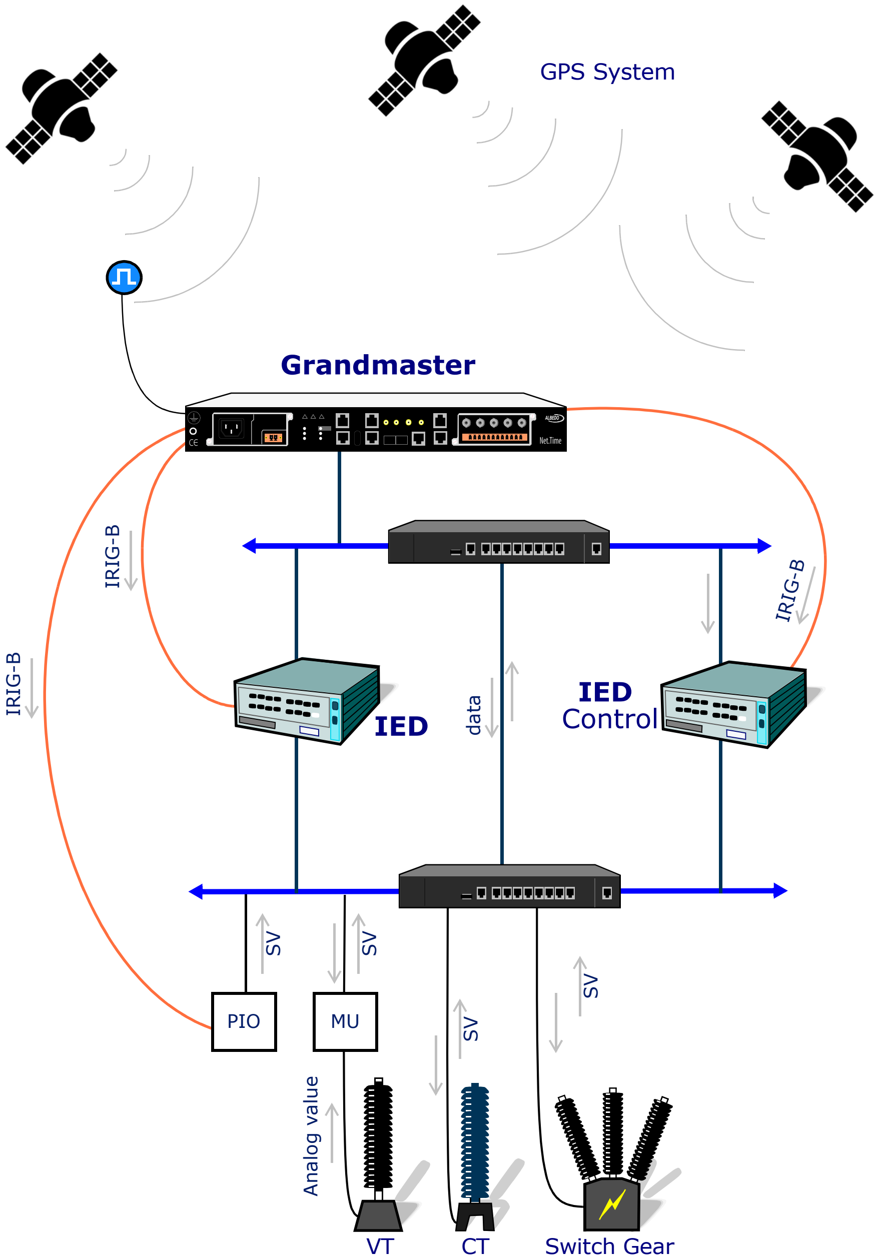


IRIG-B sends a timing signal at 100 pulse/sec rate including Year, Day, Hour, Min, Sec data with an update rate of one second direct or over a Carrier:

Unmodulated DCLS IRIG-B offers several transmission alternatives

- TTL-level signal over coaxial cable or shielded twisted-pair cable
- Multi-point distribution using 24 Vdc for signal and control power
- RS-485 differential signal over shielded twisted-pair cable
- RS-232 signal over shielded cable (short distances only)
- Optical fiber

IRIG-B protocol



A veteran on duty

Developed for the US Army (1960) is still is widely used in the power and in the aerospace industries:

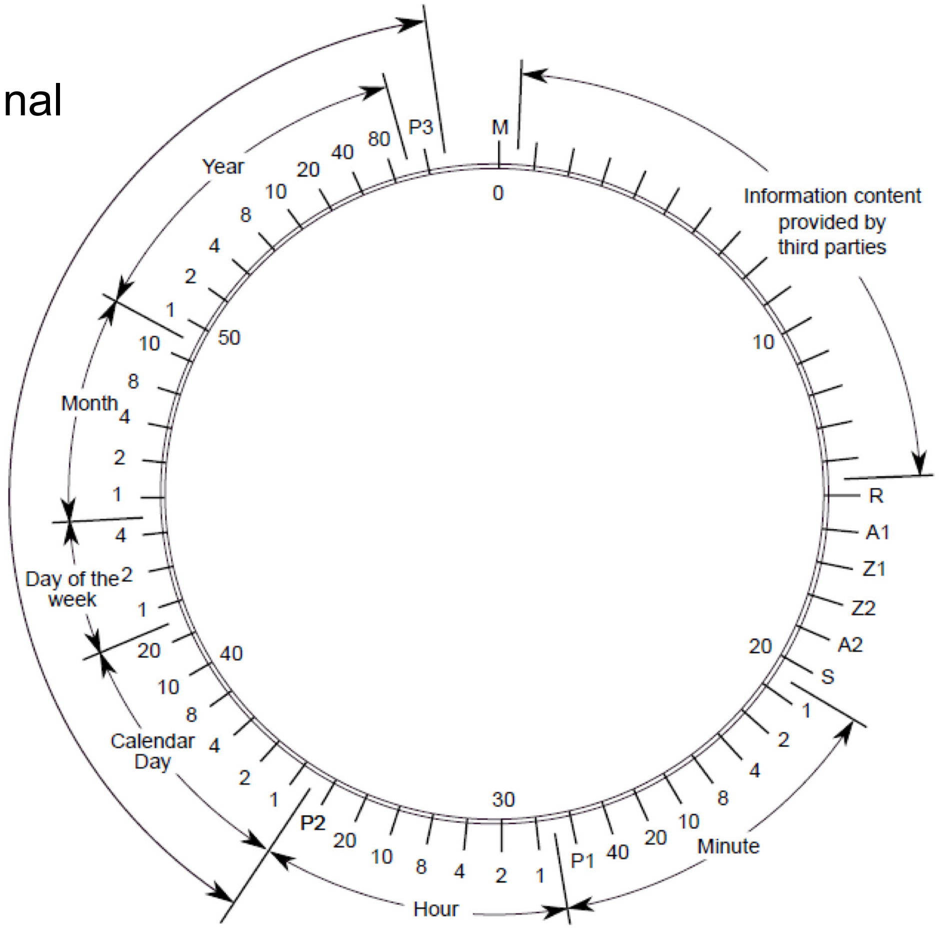
- Consists of 100 bits generated every second, 74 bits of which contain time information
- Various time, date, time changes and time quality information of the time signal
- IEEE-1344 extension included year data information

Net.Time supports IRIG-B as a synchronization signal and as a time reference as well.

DCF77 signal

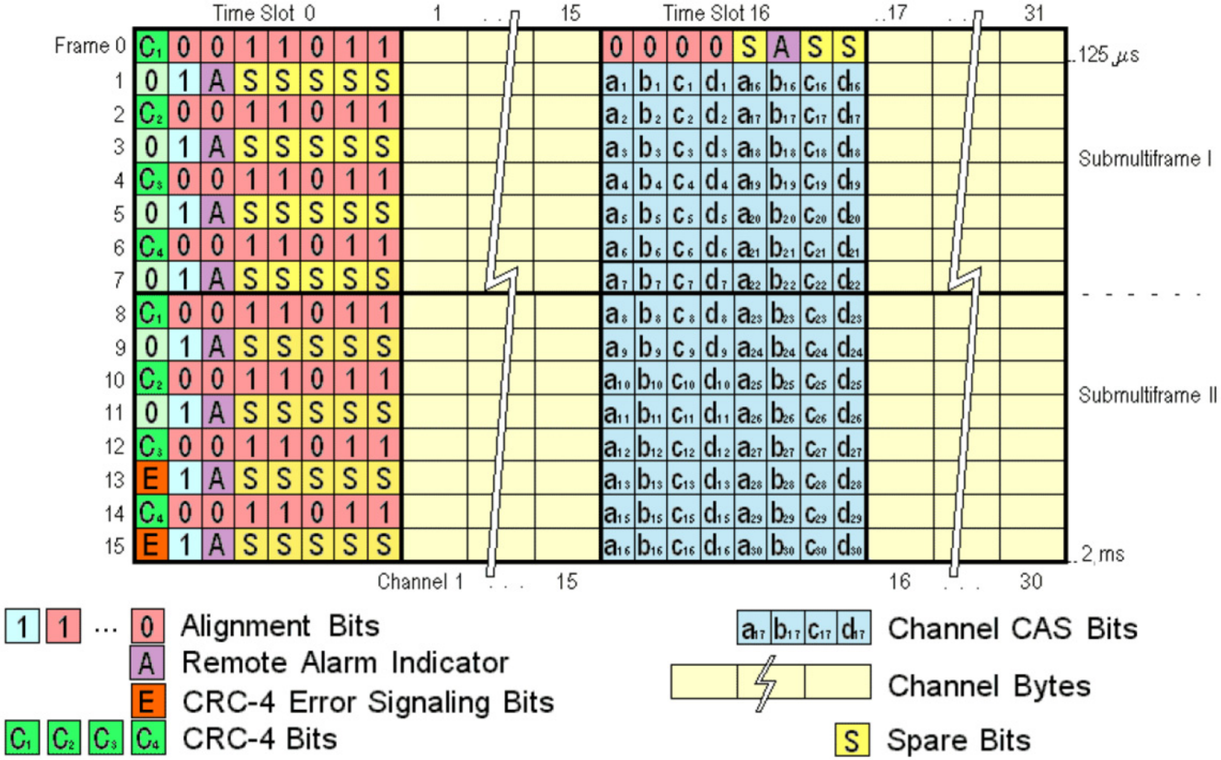
Originally DCF77 is a German long-wave time signal and standard-frequency radio station that carries an amplitude-modulated data signal repeated every minute.

- M: Start
- R: service request to the DCF77 system
- A1: forthcoming change CET to/from CEST
- Z1, Z2: time zone indication
- A2: Leap second warning bit
- Pi: parity bits
- S: Start of time information minute, hour, day, week day, months, year



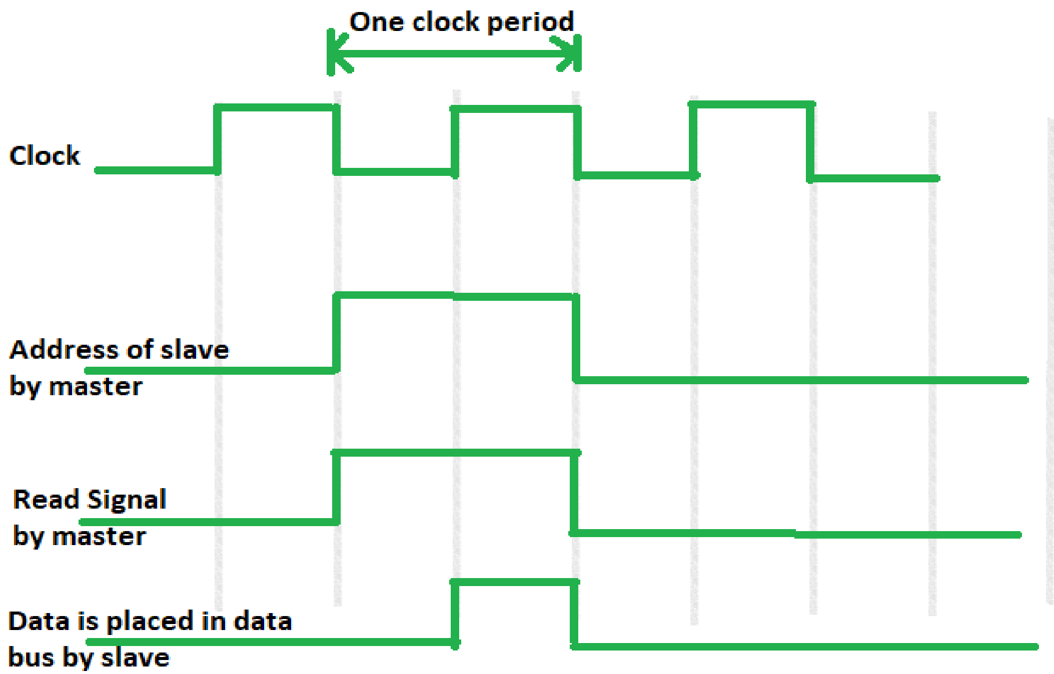
A lot of substations generate the DCF77 signal synchronized with GNSS (or the time reference used in the node). The accuracy of DCF77 is good enough for SCADA and wall clocks and is still used.

T1/E1 signals



- The T-carrier is a hardware specification for carrying multiple time-division multiplexed (TDM) telecommunications channels over a single four-wire transmission circuit. It was developed by AT&T at Bell Laboratories ca. 1957 and first employed by 1962 for long-haul pulse-code modulation (PCM) digital voice transmission with the D1 channel bank.
- The E-carrier is a member of the series of carrier systems developed for digital transmission of many simultaneous telephone calls by time-division multiplexing. The European Conference of Postal and Telecommunications Administrations (CEPT) originally standardized the E-carrier system.

Mbit/s & **MHz** signals



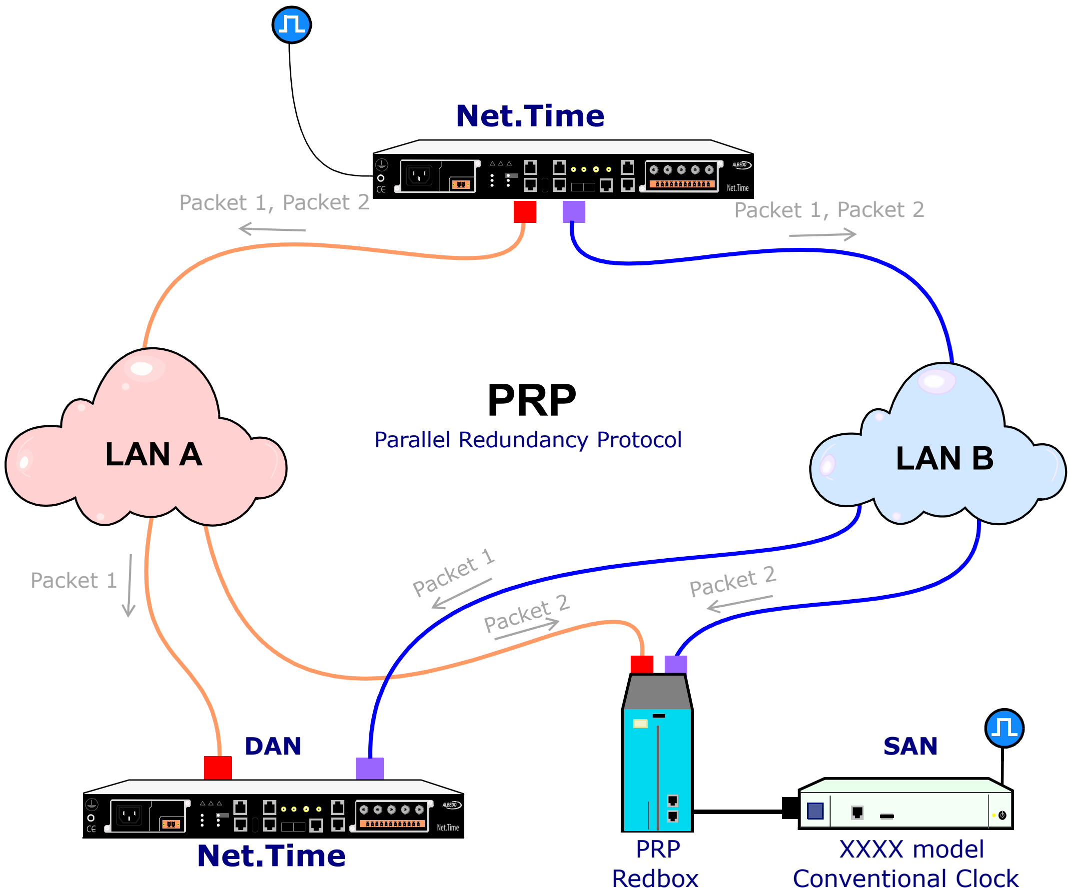
Often known as BITS (Building Integrated Timing Supply) describe a building-centric timing system, the BITS system efficiently manages the number of timing interfaces within a structure providing external timing connections typically deployed as T1 or E1 frequencies but also can refer to MHz and then distributing timing to all circuits that require it.

There are several signals suitable for transporting synchronization:

- Analog, of 1,544 and 2,048 kHz
- Digital, of 1,544 and 2,048 kbit/s

In both cases it is extremely important for the clock signal to be continuous.

PRP Network redundancy



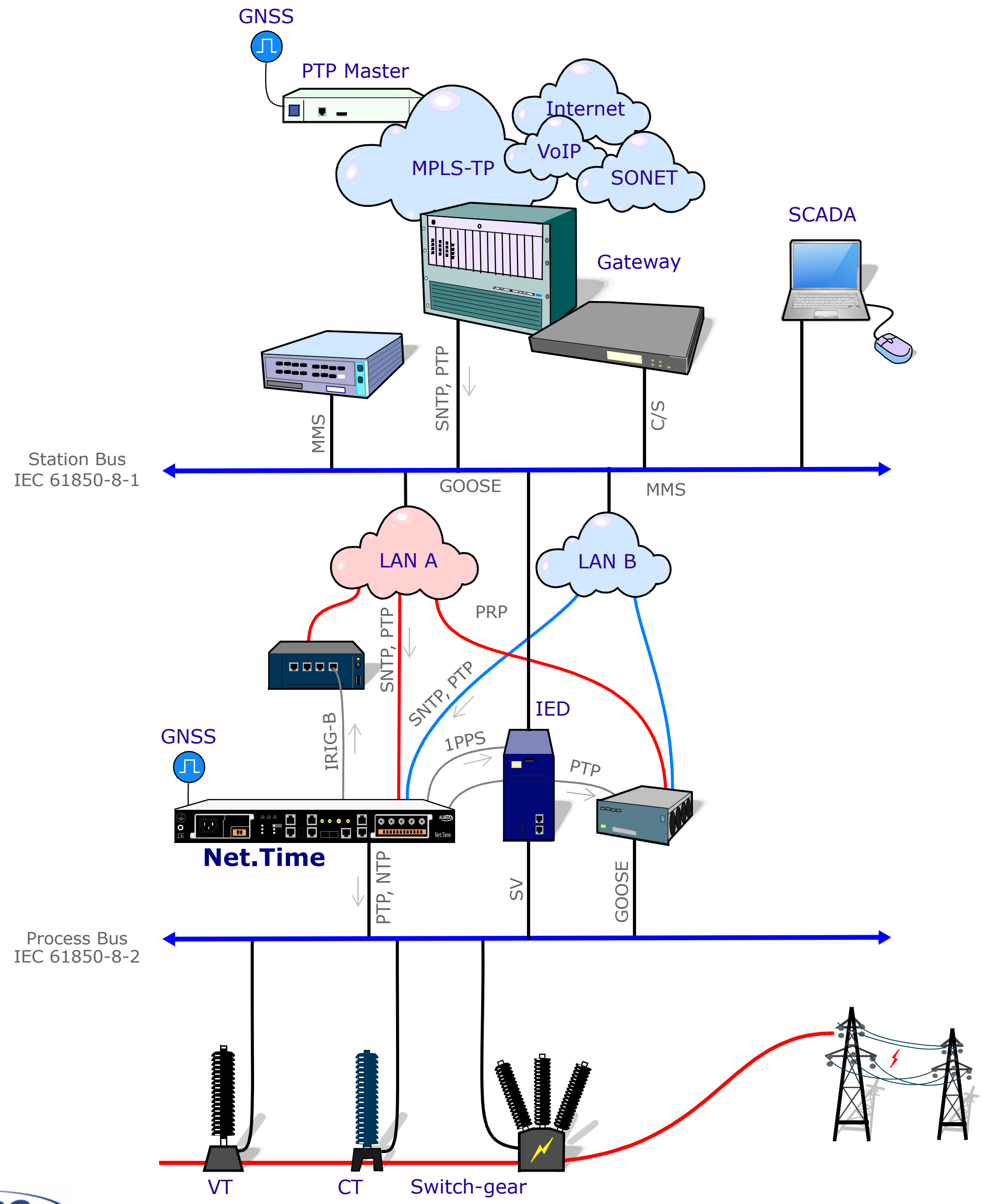
PRP is based on the use of two independent networks. The sender **must send each packet twice** (to LAN A and LAN B) through two separate ports. There are two types of devices:

- **DAN** (Double Attached Node) if has PRP support is integrated, can be attached directly
- **SAN** (Single Attached Node) conventional device without PRP support a Redundancy Box (redbox) is required to be connected.

PRP in Net.Time

- PRP extension for IEEE 1588 / IEC 61588
- Link Redundancy Entity (LRE) IEC 62439-3
- Generation of RCT trailers
- Duplicate discard mode
- PRP supervision frame generation / decoding

Evolution to **Fault Tolerant** architecture

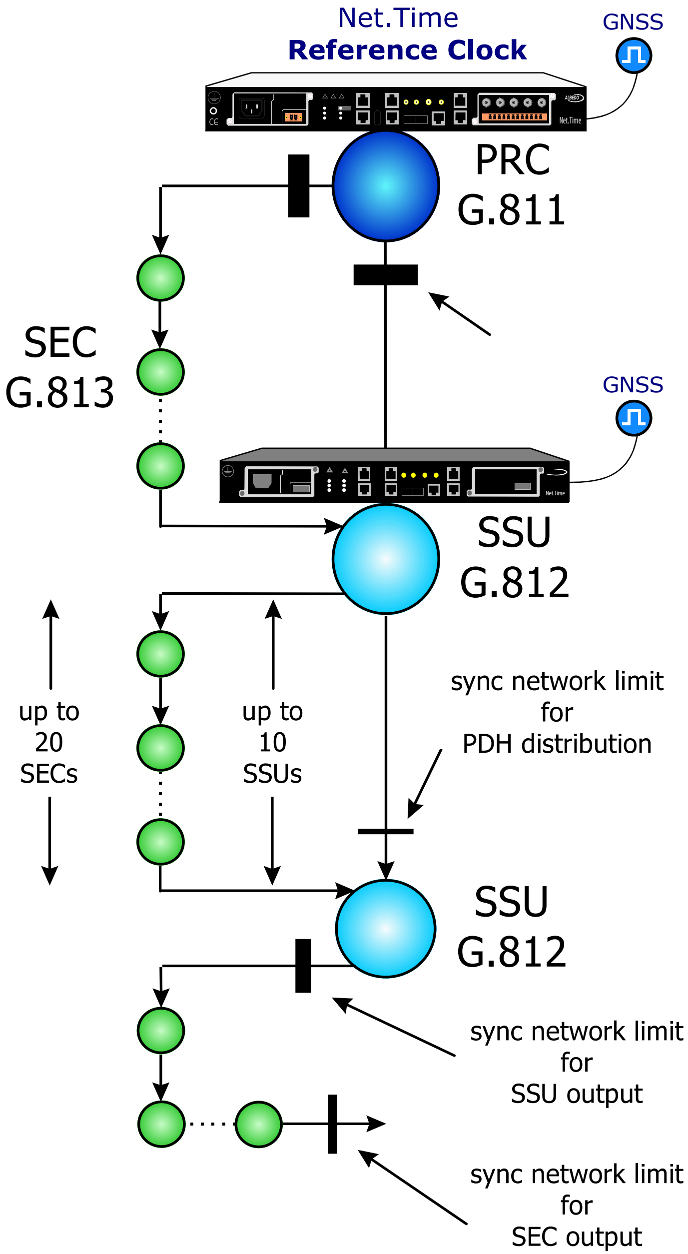


Network redundancy is crucial for maintaining **high network availability**, and many redundancy technologies can provide millisecond-level recovery. However, some mission-critical and time-sensitive applications **cannot tolerate** even **a millisecond** of network interruption without severely affecting operations or jeopardizing the safety of on-site personnel.

Parallel Redundancy Protocol (**PRP**) provide **seamless fail-over** from a single point of failure. PRP realizes active network redundancy by packet duplication over two independent networks that operate in parallel.

Based on these two seamless redundancy protocols, a redundancy box (**Redbox**) can quickly activate non-HSR or non-PRP devices connected to HSR or PRP networks with zero switch-over time.

TDM networks TIMEING



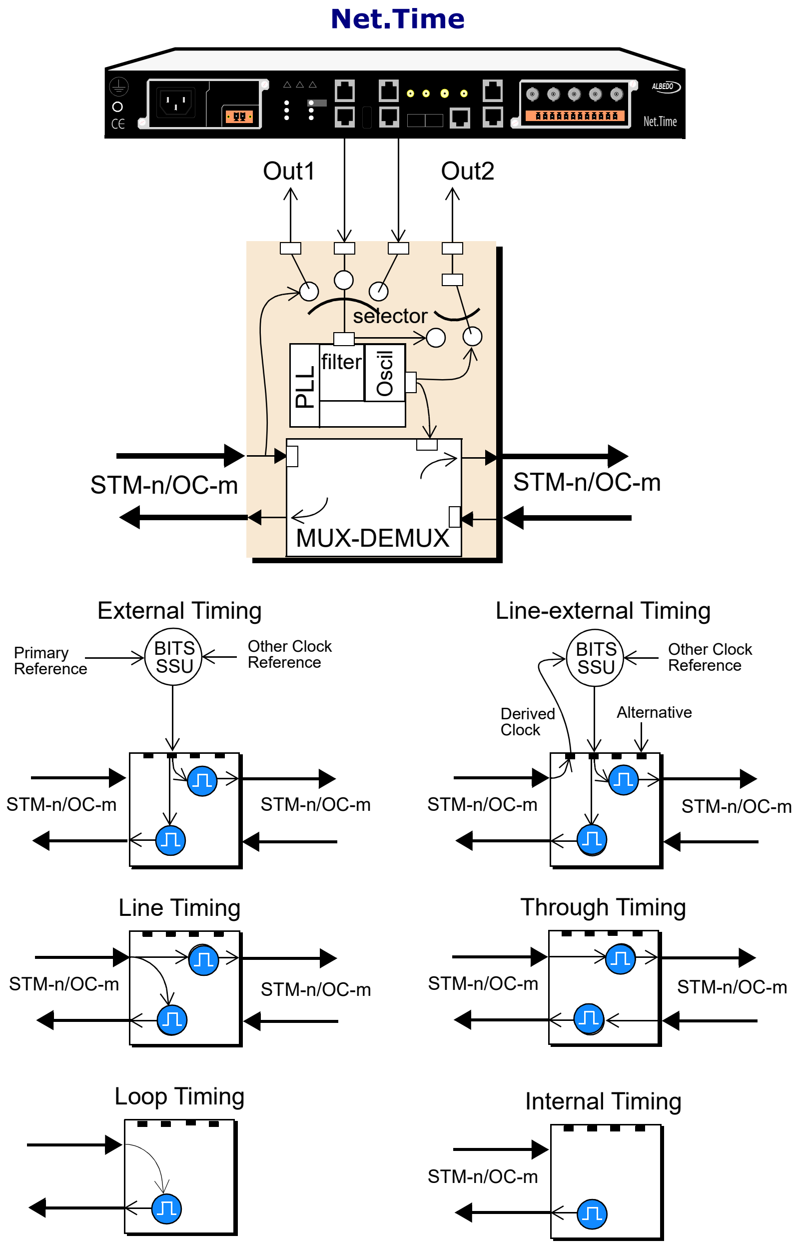
Net.Time configured as PRC is equipped with Rubidium oscillator providing timing to the SSU that can be a Net.Time with OCXO oscillator.

SSUs receive the signal (typically T1/E1 or BITS) and filter them to avoid degradation. In the event of a loss of timing signal SSU become primary clock and must continue working:

- High-quality transit SSUs used as reference for other SSUs
- Local SSU last link to synchronize network elements

A number of standards (ITU-T G.803, G.822, G.823, G.825, G.783, G.810, G.811, G.812, G.813, G.958, O.171, etc.) define the clock quality, functionality and limits of the synchronization tree to maintain the quality of the signals.

Frequency for SONET/SDH



In SDH/SONET there are four ways to synchronize ADM and digital cross connects (DXC):

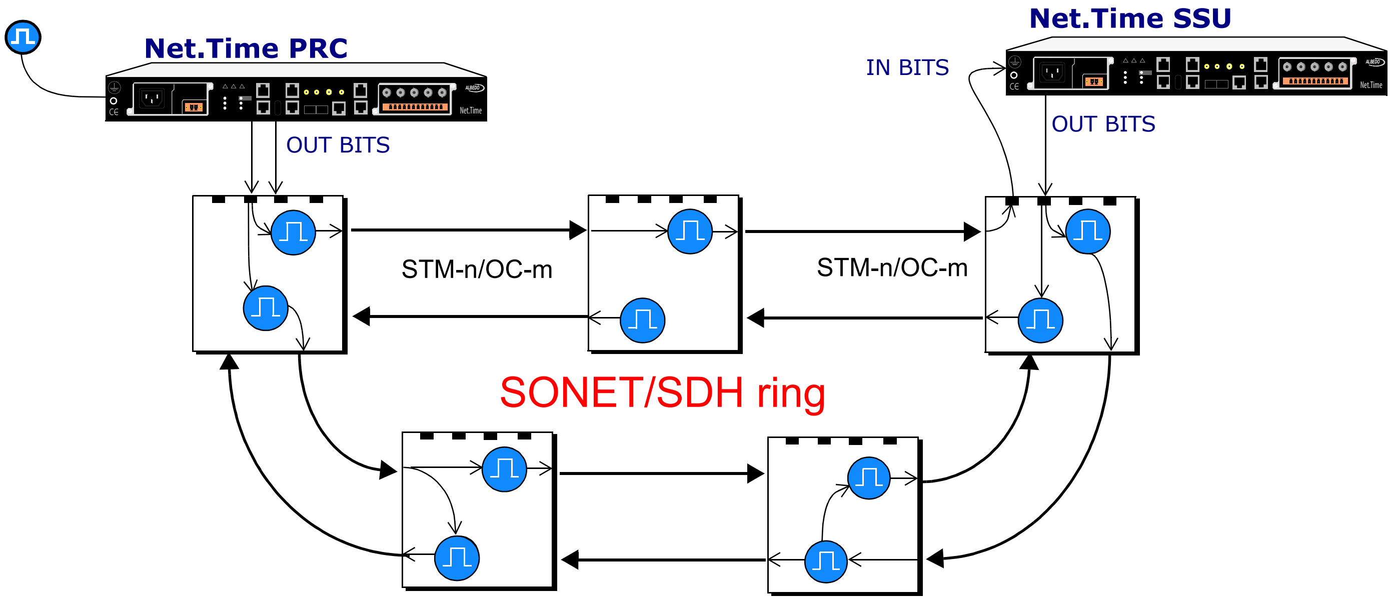
1 - External timing: The NE obtains its signal from a BITS or stand-alone synchronization equipment (SASE). This is a typical way to synchronize, and the NE usually also has an extra reference signal for emergency situations.

2 - Line timing: The NE obtains its clock by deriving it from one of the STM-n/OC-m input signals. This is used very much in ADM, when no BITS or SASE clock is available. There is also a special case, known as loop timing, where only one STM-n/OC-m interface is available.

3 - Through timing: This mode is typical for those ADMs that have two bidirectional STM-n/OC-m interfaces, where the Tx outputs of one interface are synchronized with the Rx inputs of the opposite interface.

4 - Internal timing: In this mode, the internal clock of the NE is used to synchronize the STM-n/OC-m outputs. It may be a temporary holdover stage after losing the synchronization signal, or it may be a simple line configuration where no other clock is available.

Frenquency timing

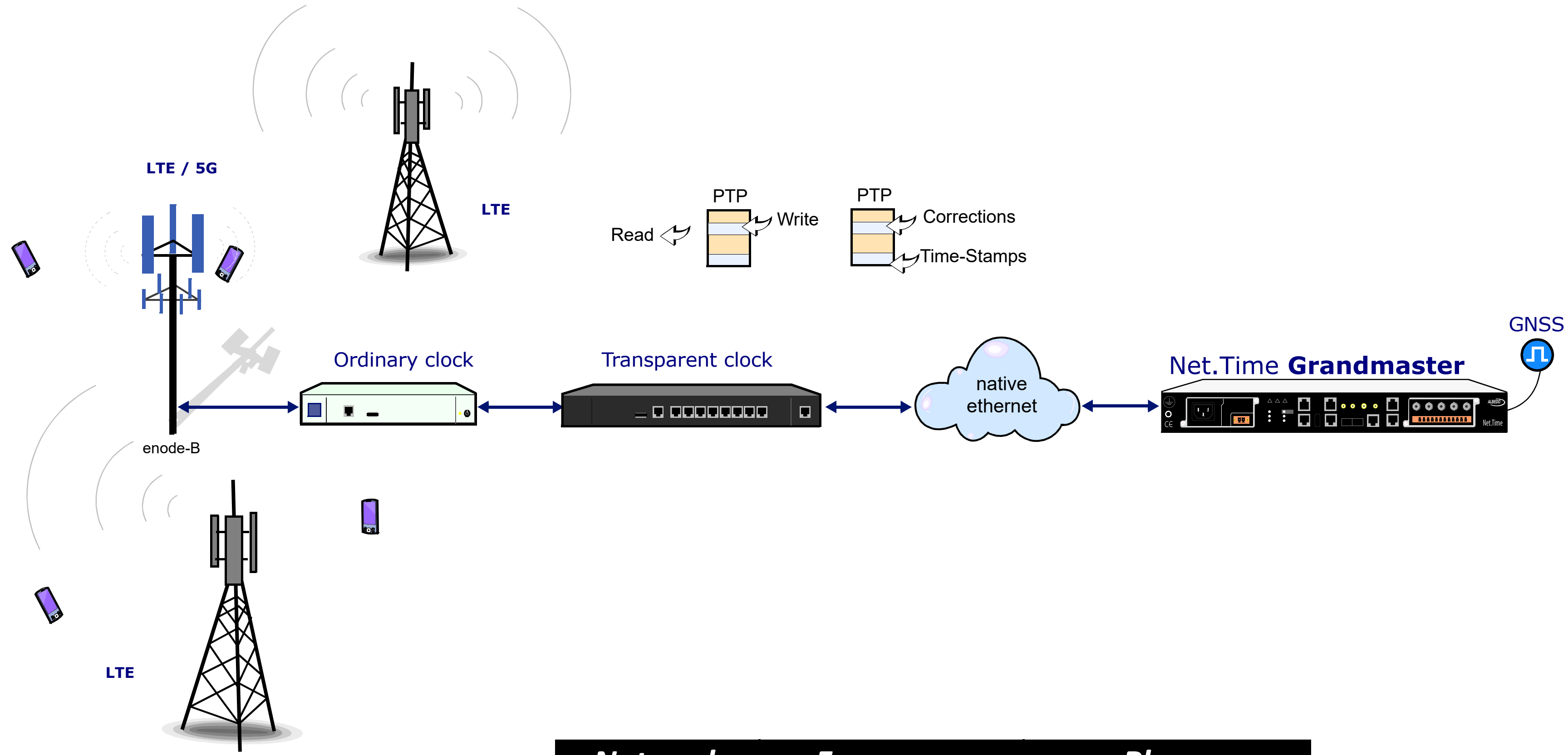


Often known as Building Integrated Timing Supply (BITS) there are several signals suitable for transporting synchronization:

- Sinusoidal: 1,544 and 2,048 kHz
- Digital: 1,544 and 2,048 kbit/s (T1 and E1)

In both cases it is extremely important for the clock signal to be continuous.

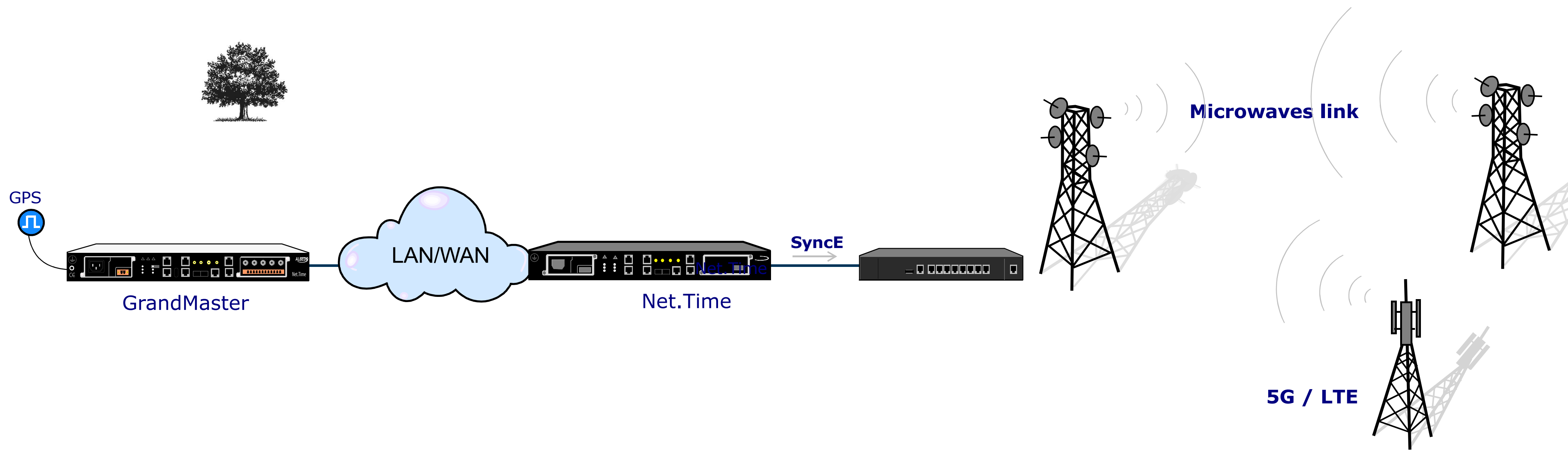
Wireless time requirements



Network	Frequency		Phase
3G, LTE-FDD	16 ppb	50 ppb	Not required
CDMA-TDD	16 ppb	50 ppb	±3 µs to ±10 µs
LTE-TDD	16 ppb	50 ppb	±1 µs to ±5 µs
5G	16 ppb	50 ppb	±0.5 µs to ±5 µs

Frequency & Phase requirements of wireless networks.

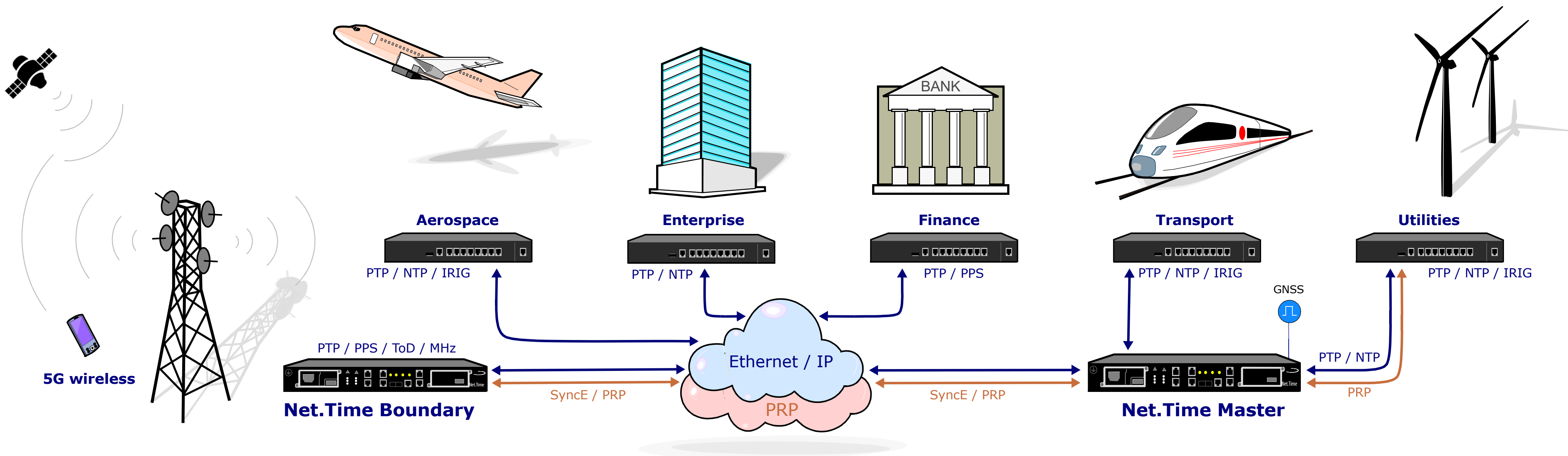
Wireless & SyncE



Net.Time supports Synchronous Ethernet over a copper and optical connections. This allows operators to utilize cables on SFP ports and still meet timing and synchronization requirements for demanding applications like LTE in mobile networks and microwaves links.

- Interfaces: RJ45 and SFP
- SyncE input/output
- Full ESMC / SSM support as per ITU-T G.8264 and G.781
- Heart-beat and event SSM messages
- QL to be transported by the SSM

Industries & Synchronization



NTP clock

- NTP v2
- NTP v3

PTP

- Customized profiles

PPS

IRIG-B

- Several options

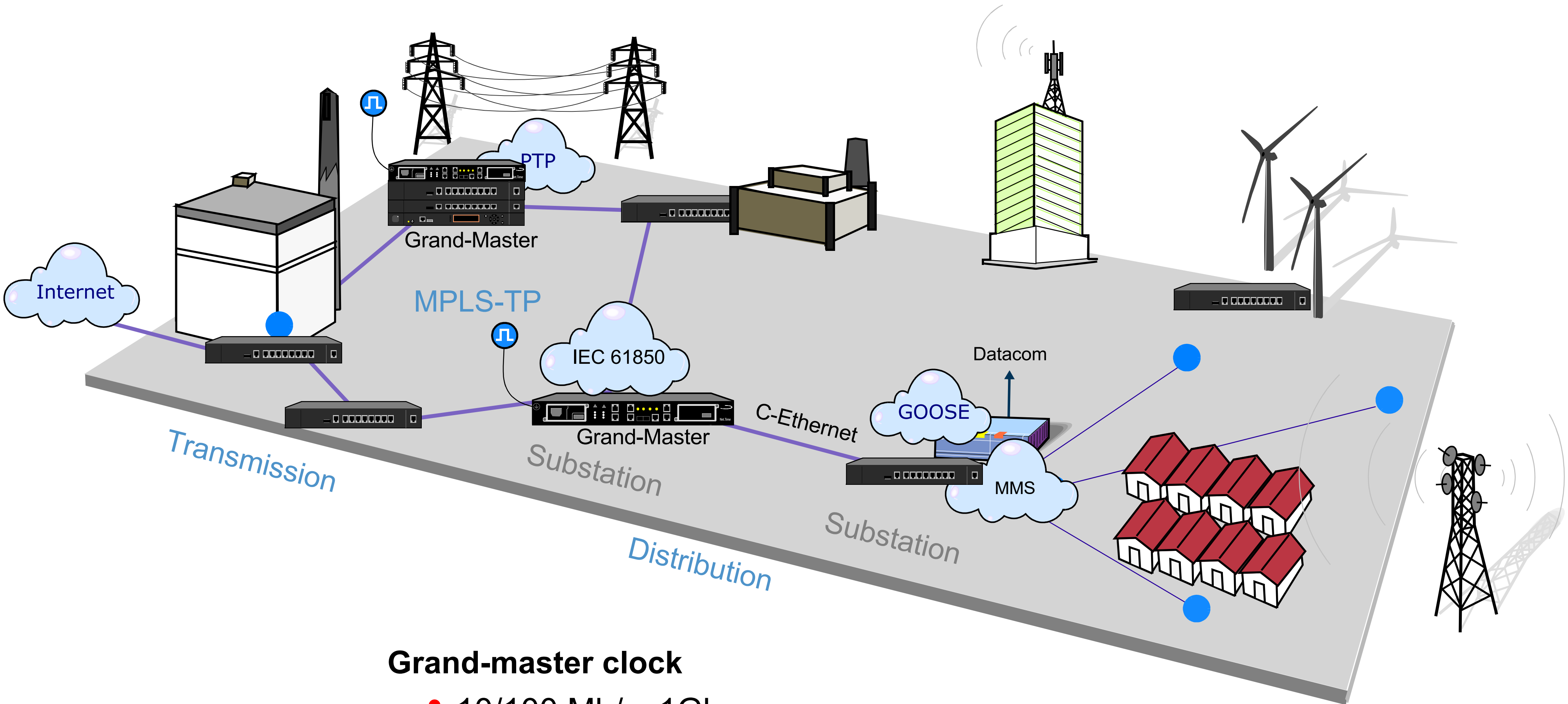
BITS

- E1/T1

MHz

- Several options

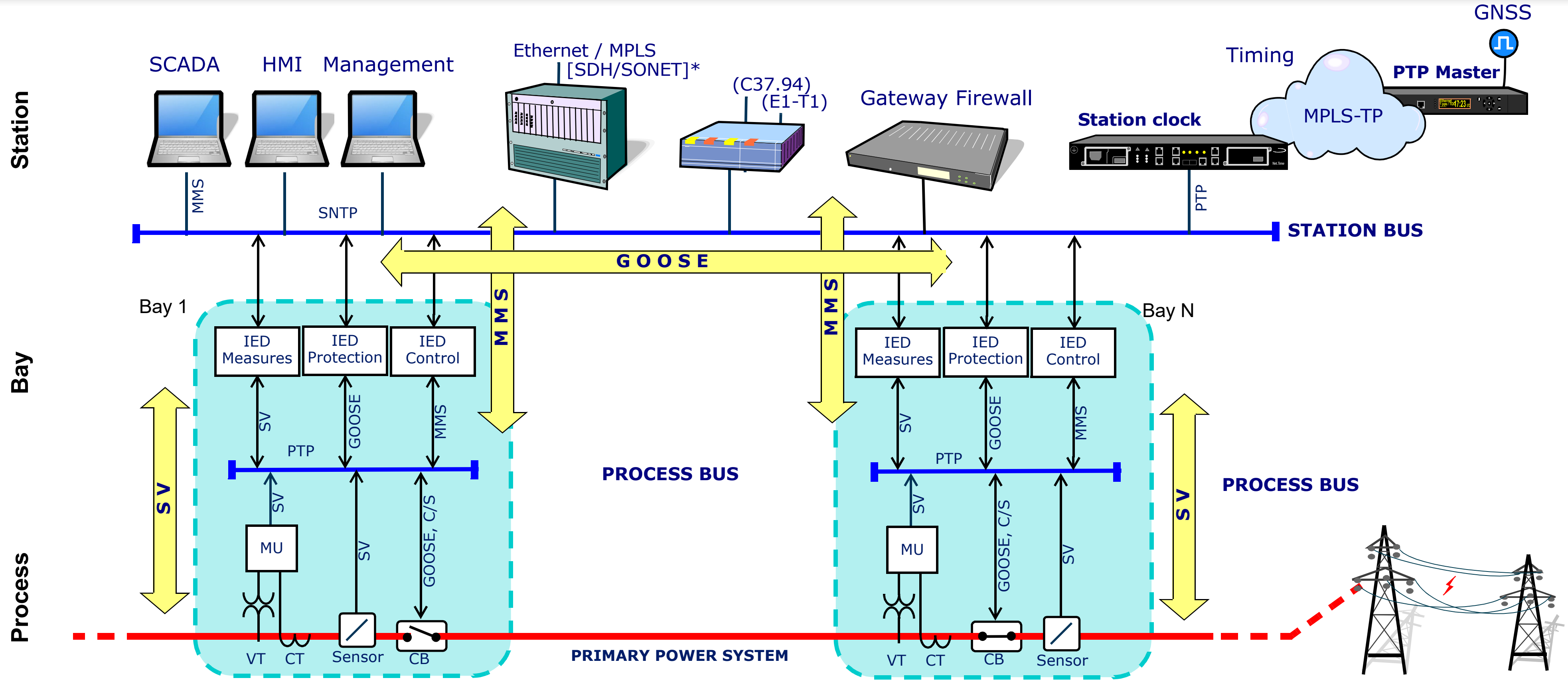
Power Grid synchronization



Grand-master clock

- 10/100 Mb/s, 1Gbs
- Stand-alone GNSS clock
- Boundary clock

Substation synchronization

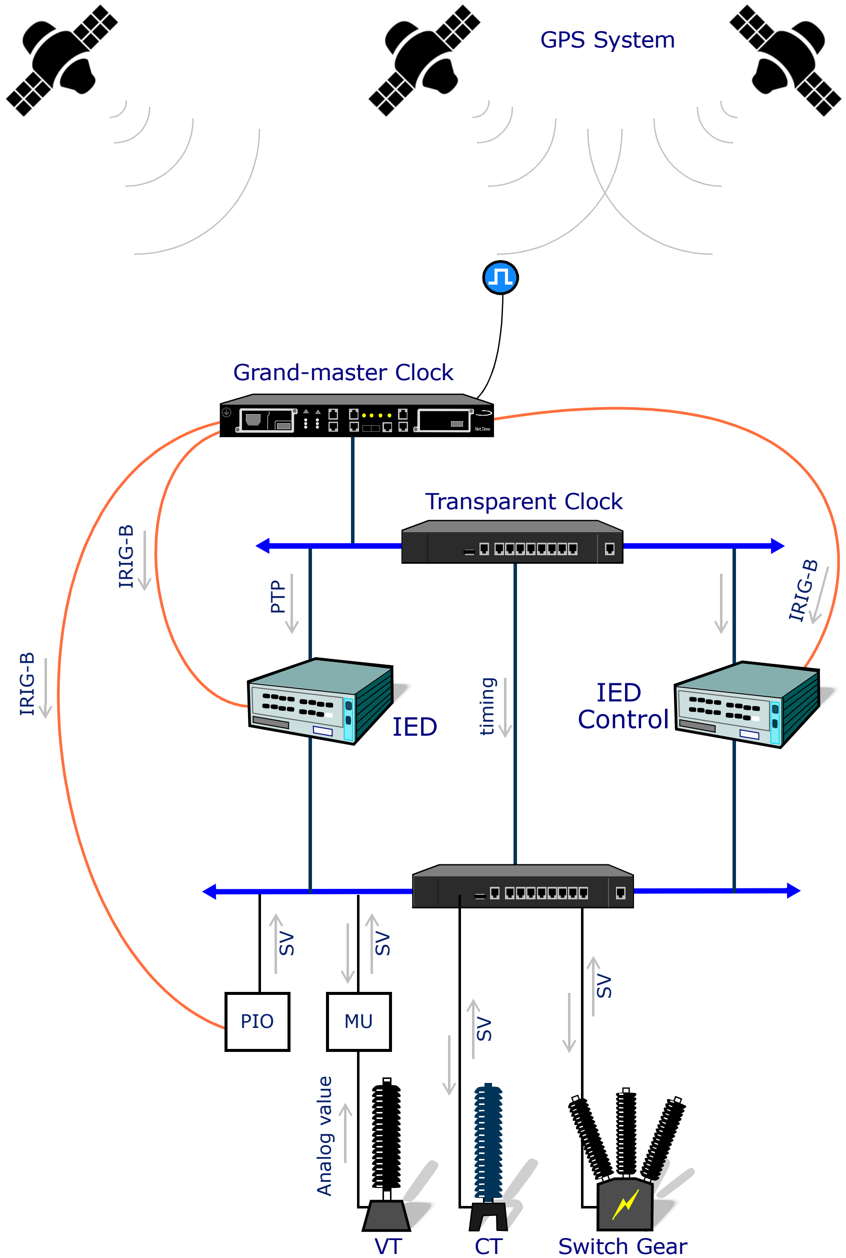


IEDs require accurate synchronization, unfortunately SNTP does not satisfy the needs of all applications.

Precision Time Protocol (IEEE 1588) with **Power Profile** defined in IEEE C37.238 address the requirements of the power industry in terms of accuracy, continuous operation (24/7) and deterministic failure behavior.

Application	Accuracy	Timing
PMU	1 µs	Absolute
Protection	1 µs	Relative
SV	1 µs	Relative
SCADA	1 ms	Absolute

stand-alone **GPS** clock

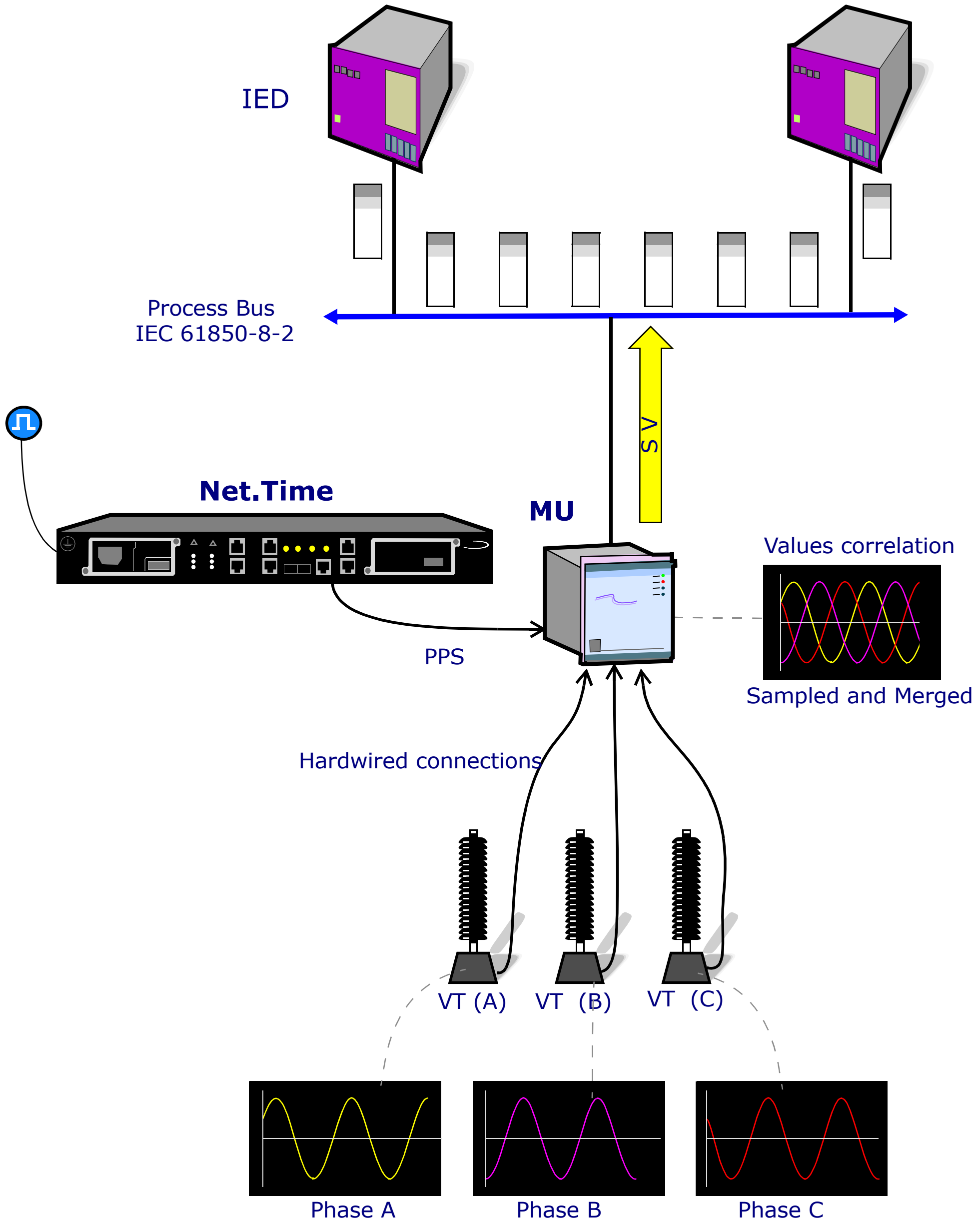


Many Utilities acquire timing from GNSS and the station clock converts signal into a 1-pps or IRIG-B code, which are then distributed by dedicated links to all the IEDs in a substation. However, important to say that this system has some **weaknesses** (*) being **vulnerable** to human and natural disruptions that may perturb normal operations by raising false alarms, delaying actions, and lowering system efficiency.

GPS is a good back-up, nevertheless modern substations should avoid the use of GPS as primary time reference for critical applications because time integrity cannot be assured. The alternative is PTP because it also provides frequency and phase timing and it has the required security to deliver synchronization in a reliable way for applications such as automation, wide-area monitoring, protection, and real-time control.

(*) Problems are produced by interferences and installation faults cause significant concerns about the reliability of satellite timing. Common issues include storms, satellite decommissioning, poor antenna installations, receiver failures, terrestrial or spacial interferences, and malicious spoofing that may send false timing to receivers that in some extreme cases, this could cause operational problems for the electric grid.

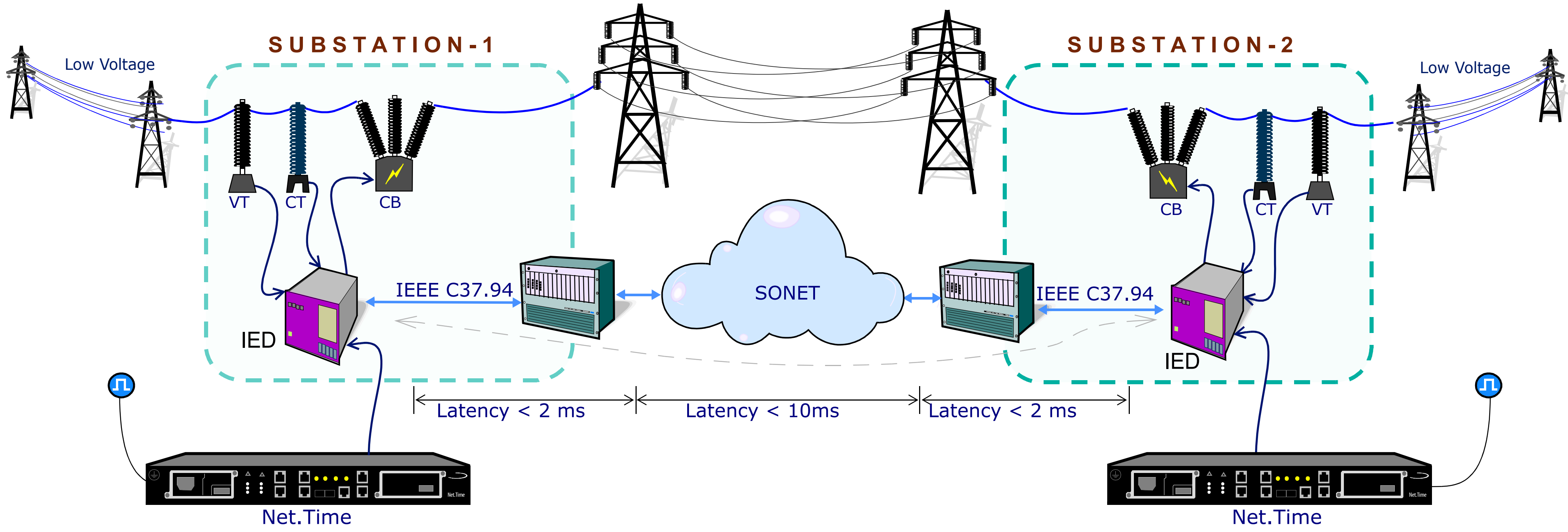
Phase for Merging Units



Merging Units (MU) require **Phase Synchronization**. MU digitize analog measurements of current / voltage.

- MUs combine and perform time correlation of voltages and currents of the three phases of a line.
- Connections from CT / VT to MU are usually hardwired.
- The data is published in the form of sampled values (SV) that can be used directly by bay IEC and controllers and/or protection relays that support this protocol.

Phase for C37.94 teleprotection

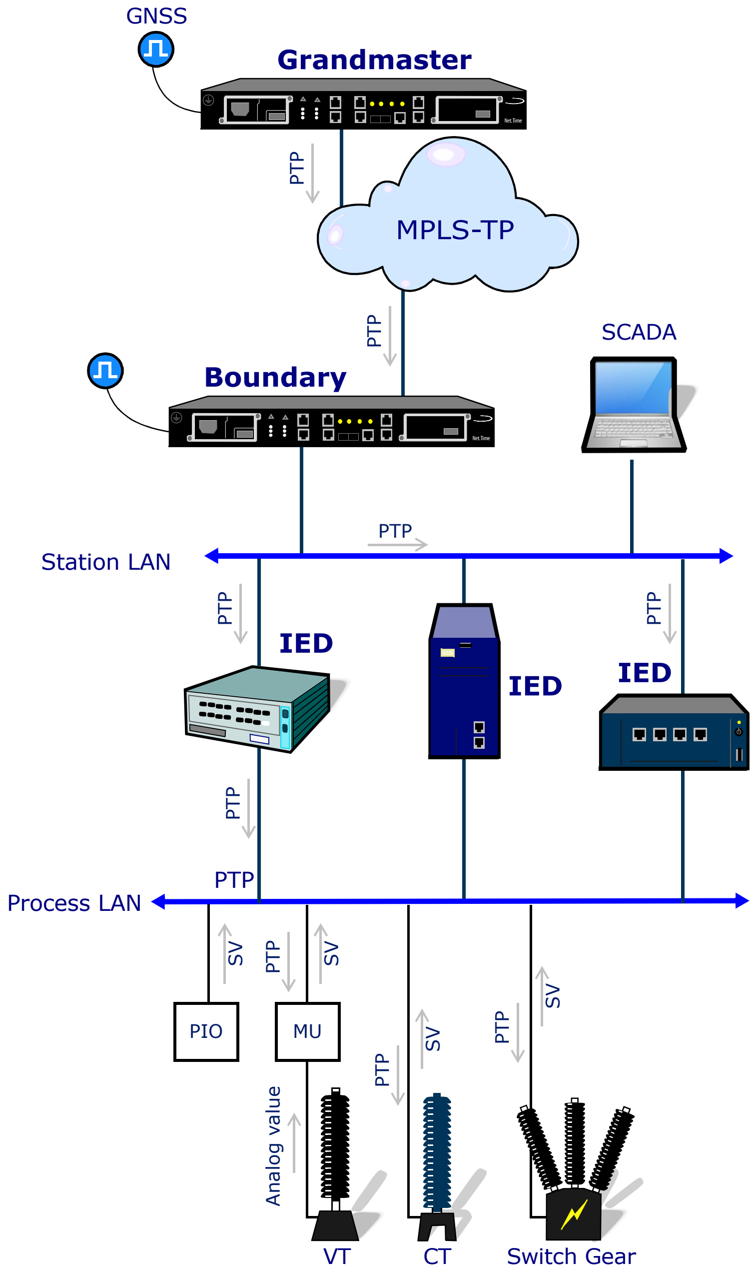


Tele-protection: protection schemes aided by tele-communications

Tele-protection relays on communicate between substations to isolate faults of the electrical plant. The reliability of the links is critical and must be resilient to the effects encountered in high voltage areas such as high frequency induction and ground potential rise.

Phase synchronization is required to prevent overloads and facilitate reconnections.

PTP in the Substation



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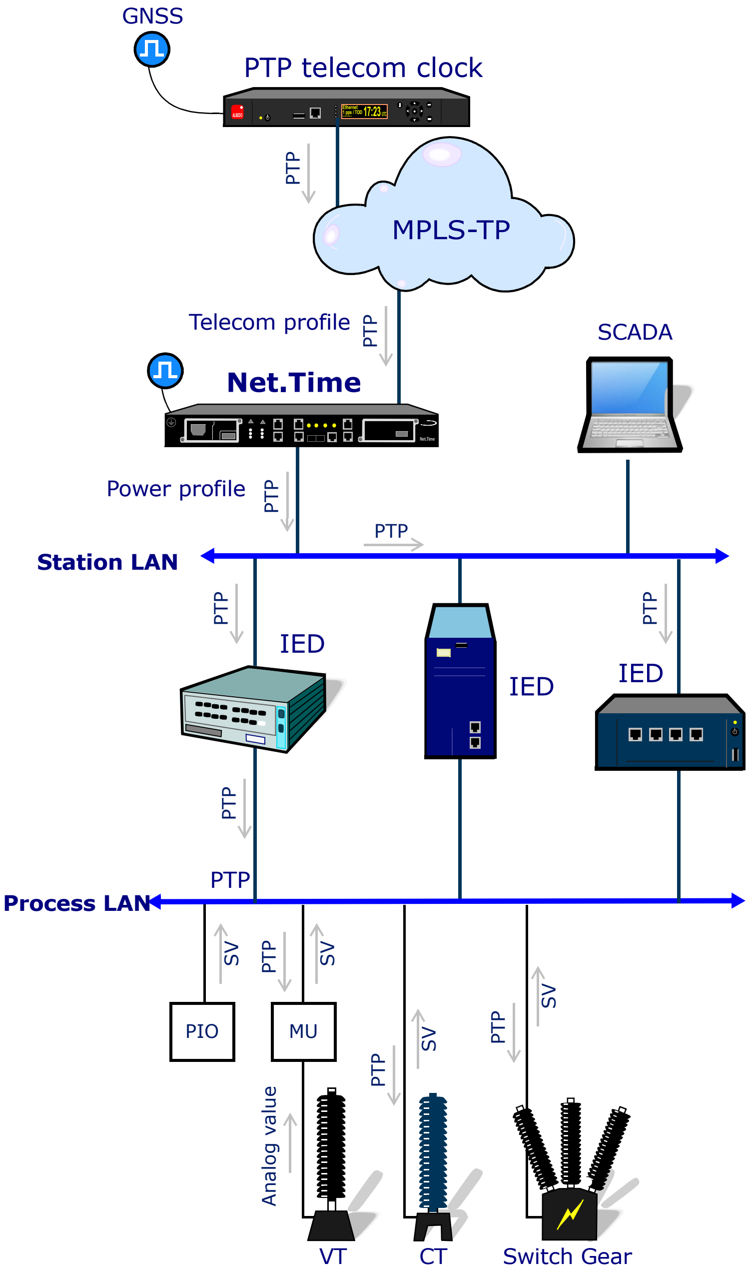
Application	Accuracy	Timing
PMU	1 μs	Absolute
Protection	1 μs	Relative
SV	1 μs	Relative
SCADA	1 ms	Absolute

Phasor Measurement Units (PMU) are not part of the IEC 61580 but the C37.1188 standard. PMUs are deployed across the grid for analyzing the quality of the power service by measuring magnitudes such as phase angle, line voltage and current waveforms in real-time. Values are collected at 30 to 120 samples/s, time-stamped with UTC and sent to data servers. Information is processed comparing many different points to know the situation, to load balance and to prevent faults. Synchrophasors have indeed timing needs due to high-frequency reporting, the wide geographic distribution and the large number of PMUs.

PTP Profile translator



Net.Time supports the following PTP profiles

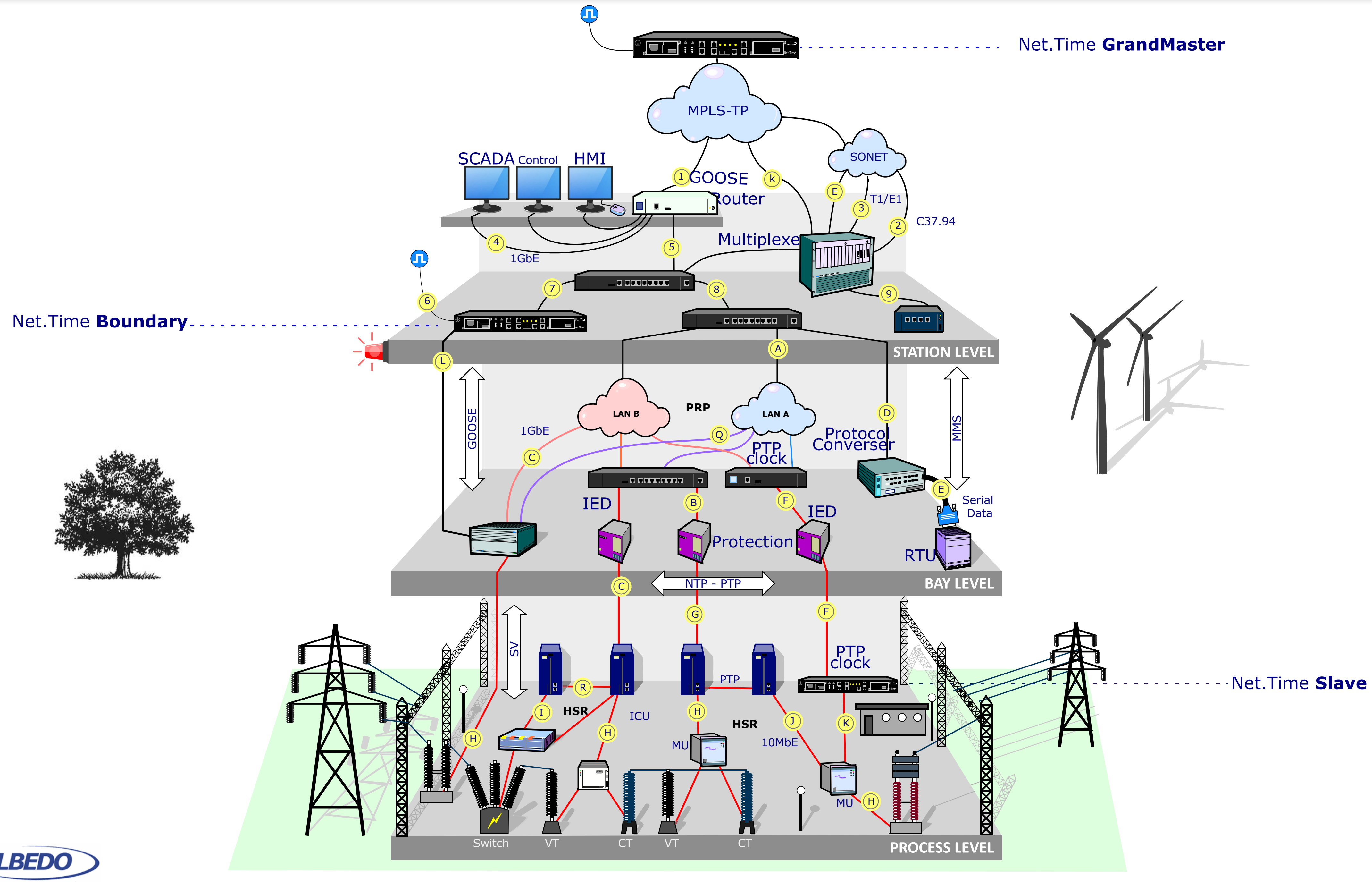
- Default
- Telecom
- Power
- Utility

Then it is possible to interconnect networks using differents synchronization profiles:

- Telecom to Power
- Telecom to Utility
- Power to Telecom
- Power to Utility
- Utility to Telecom

ADVANTAGE: no need for protocol translator

Grandmaster / Boundary / Slave



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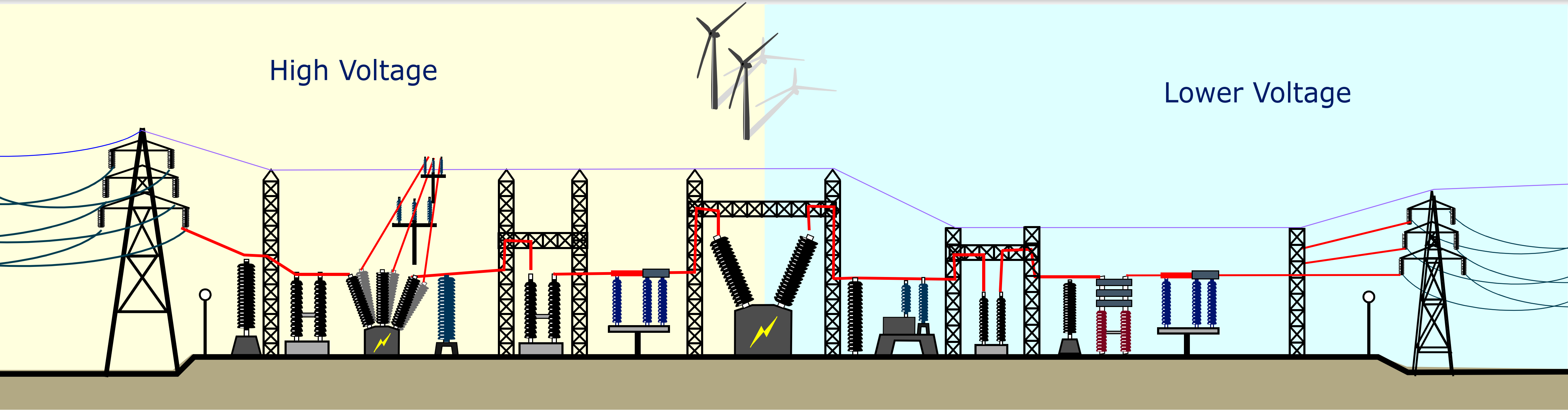
Substation **Grandmaster**



The Primary Power manages the high voltages lines coming from Generation while the secondary the lower voltages distributed to Industrial and residential consumers. In this scenario phase and frequency synchronization is a basic requirement for normal operation.

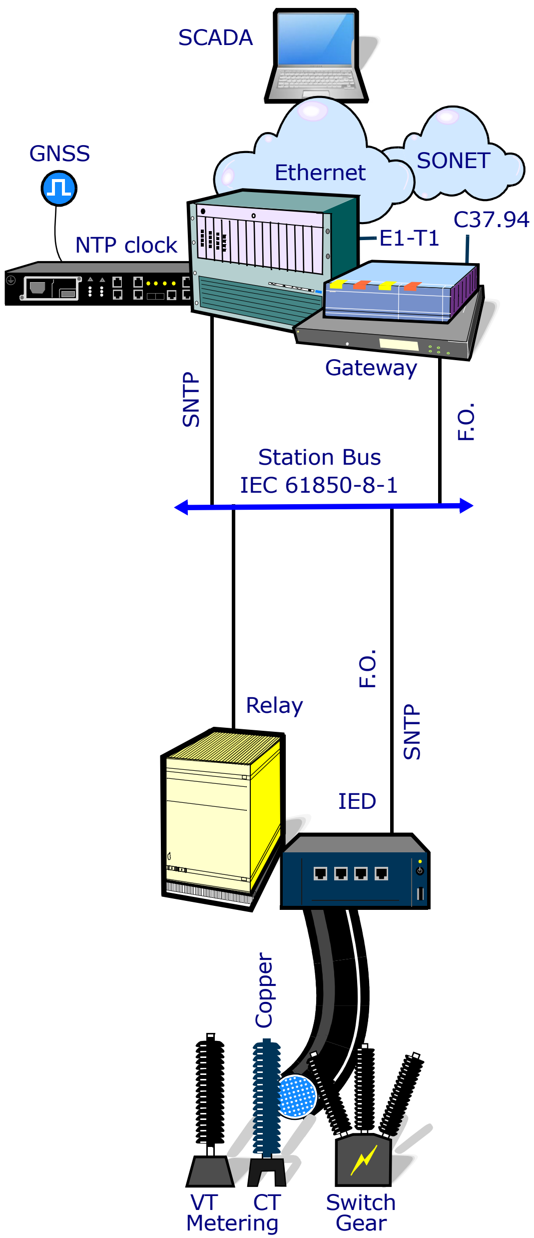
Conventional clock

- Opt/elec Ethernet 10/100 Mb/s
- Stand-alone GNSS clock
- PPS, NTP, IRIG interfaces

IEC 61850 clock

- Optical Ethernet 100/1000 Mb/s
- Boundary clock
- PTP, PPS, NTP, IRIG interfaces

Evolution to **IEC 61850**

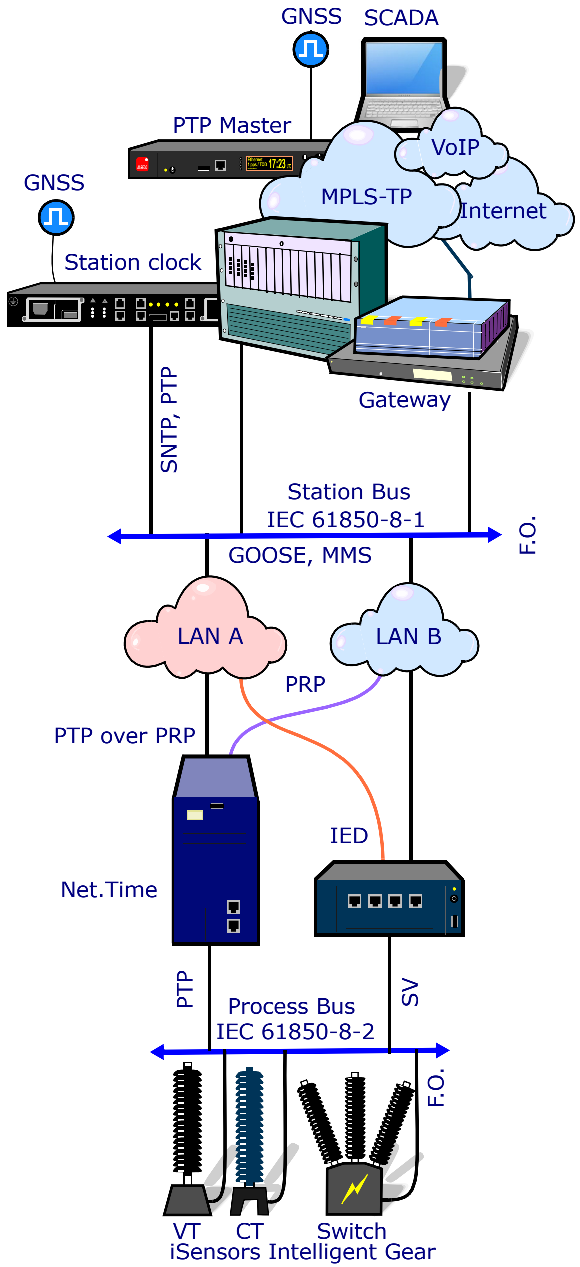


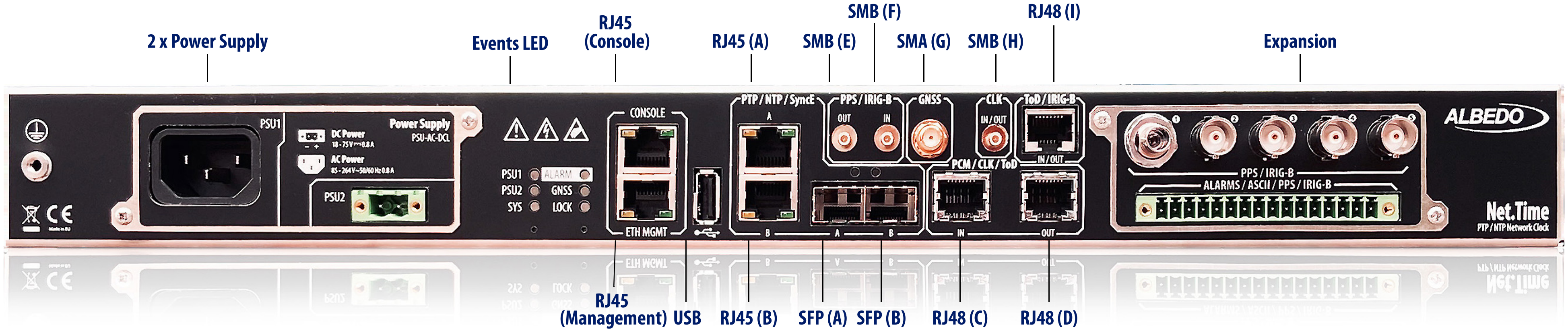
Conventional Substation

- IRIG-B
- PPS
- T1/E1

IEC 61850 substation

- PTP
- PRP
- SyncE
- NTP
- IRIG-B
- PPS
- T1/E1





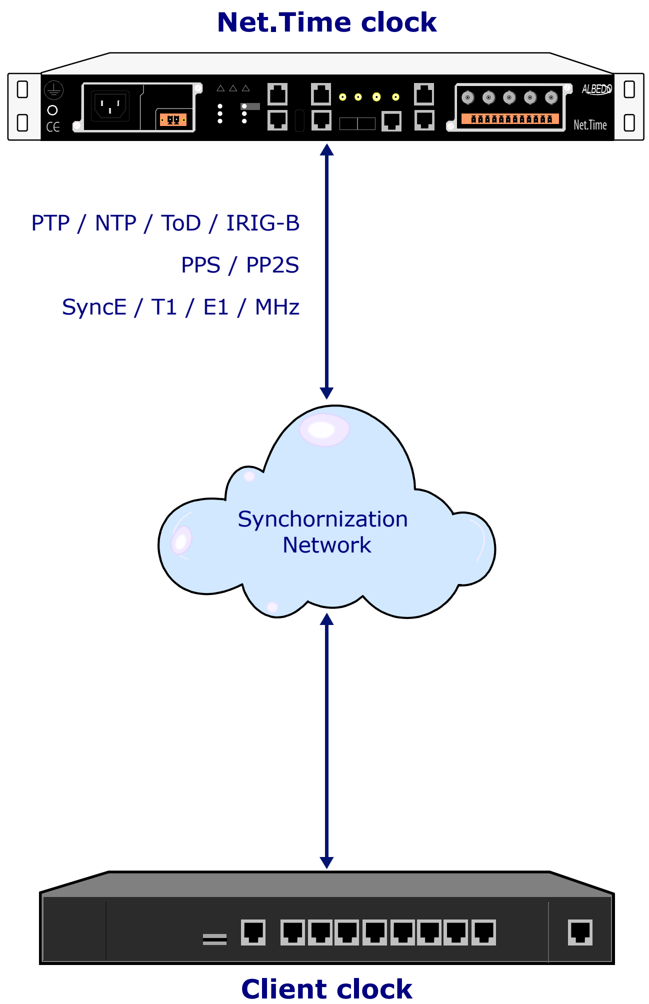
Net.Time is the state-of-art clock designed to deploy enhanced synchronization networks that are providing more precise and secure signals required by mission critical services like electricity and broadband wireless applications.

Net.Time has a built-in GNSS receiver, atomic Rubidium oscillator, redundant power supply and accepts a large variety of time references (GNSS, PTP, NTP, ToD, IRIGB, PPS, SyncE, T1/E1, MHz) that can be used as primary or backup references. Exactly the same time protocols are possible as output signal for distribution, moreover, protocol translation is possible in all directions.

Net.Time can be configured as Grandmaster, Edge, Boundary and Slave clock. Several PTP profiles are supported including Telecom, Power and Default, that can work simultaneously when the set up is Boundary facilitating the profiles translation and inter-operation.

As result of the above mentioned features Net.Time simplifies the migration to most advanced synchronization based on time, phase and frequency protocols offering seamless integration between different architectures and time technologies.

Net.Time Synchronization signals



Net.Time can synchronize by means of several signals that can be grouped according the following hierarchy.

Time/Day Synchronization which is the most comprehensive as provide day, phase & frequency:

- PTP
- NTP
- ToD
- IRIG-B

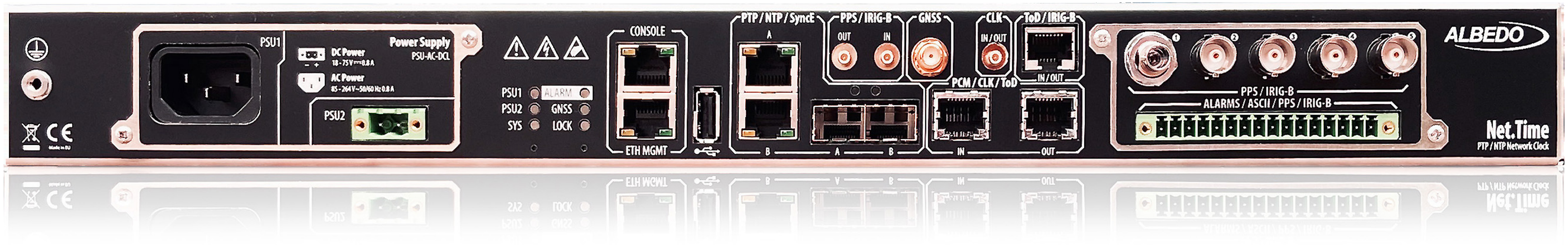
Phase or Time Synchronization: can only provide phase and frequency:

- PPS
- PP2S

Frequency Synchronization: can only provide frequency:

- T1
- E1
- SyncE
- MHz

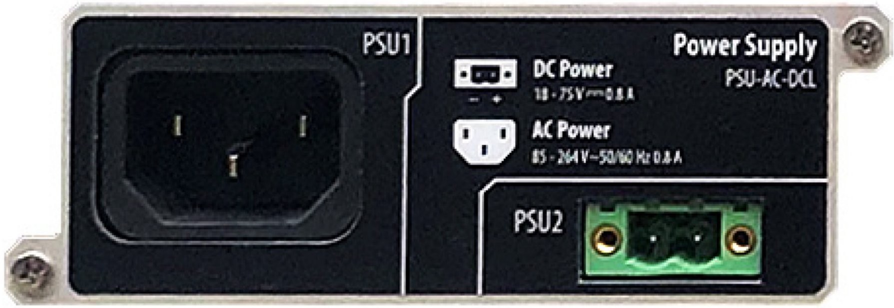
Net.Time **ergonomics**



Platform

- 19” / ETSI/1U/201 mm rack mount
- Fanless operation
- Weight: 3.4 kg / 8.7 lb
- Redundant power supply
- 6 x LEDs
- USB: Software and firmware upgrade
- Storage: -20 ~ +85ºC
- Operating temp.: -10 ~ +65ºC
- Operating humidity: 10 ~ 90%

Power Supply redundancy



Multiple combinations

- Single: AC / DC / DCAC
- Double: AC+AC, AC+DC, DC+DC, AC+DCAC, AC+DCAC, DCAC+DCAC

Options

- AC: 85 ~ 264 VAC (IEC 60320 C13/C14)
- DC: 18 ~ 75 VDC (2-pin 5.1 mm)
- DCAC: 85 ~ 264 VAC (2-pin 5.1 mm)
- DCAC: 100 ~ 370 VDC (2-pin 5.1 mm)

Rubidium or OCXO

Internal Oscillator

- Rubidium better than ±5.0 e-11
- OCXO better than ±0.1 ppm
- Internal time reference better than ±2.0 ppm

Rubidium features

- GNSS Locked
- Time/Phase Accuracy to UTC: ±20 ns at 1σ after 24 hours lock
- Frequency Accuracy: 1 e-11 (averaged over one week)

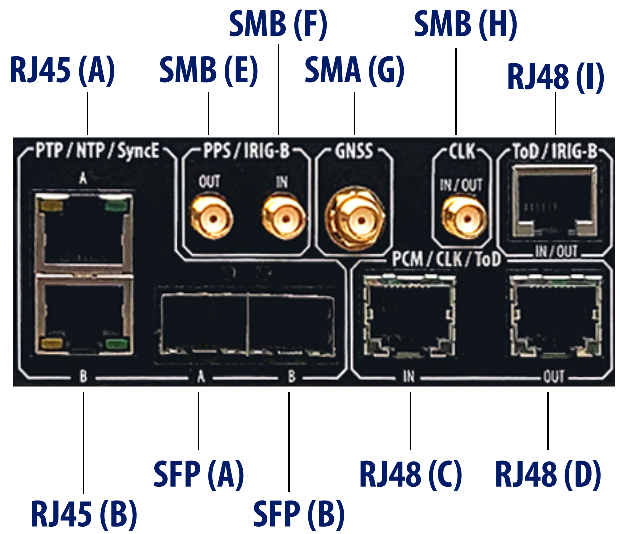
Hold-over

- Output freq. accuracy (after 24 h. locked): 1.5 e-11 / 24h
- Output time accuracy (after 24 h. locked): ±100 ns / 2h ±1.0µs / 24h

Free-run

- Output freq. accuracy (7.5 minutes warm up): ±1 e-9
- Output freq. accuracy on shipment (24 h warm up): ±5.0 e-11
- Aging (1 day, 24 hours warm up): ±0.5 e-11
- Aging (1 year): ±1 e-9

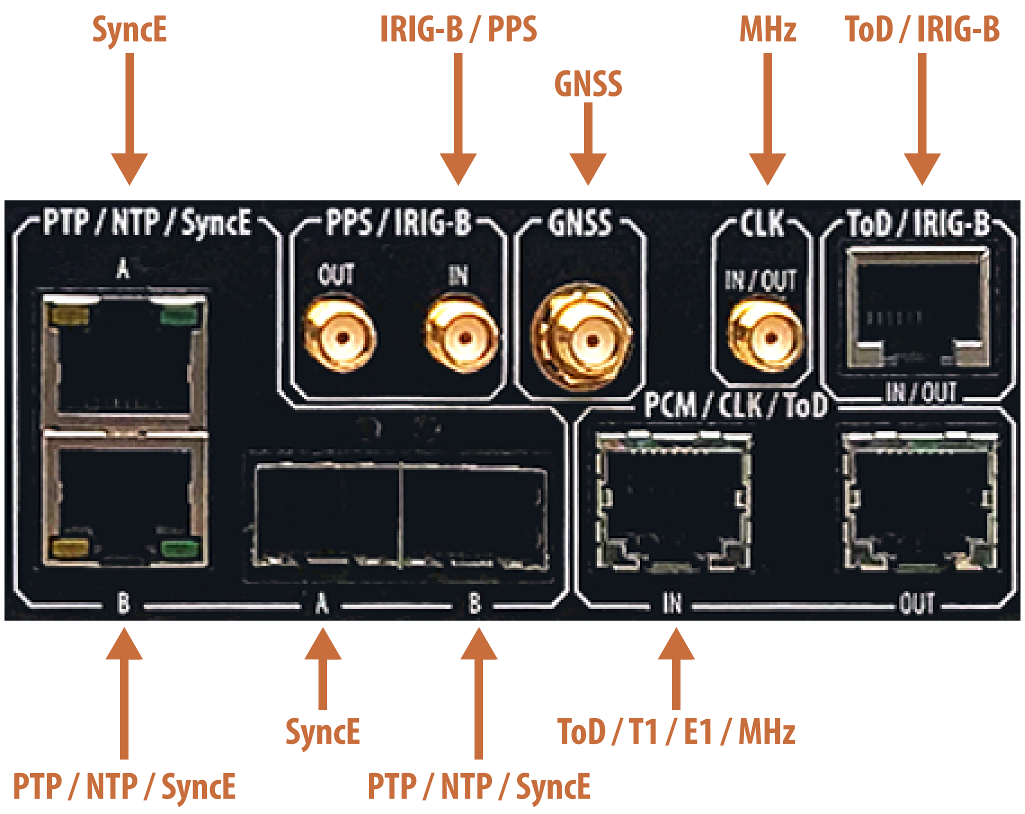
Time **interfaces**



Multiple time references are possible in Net.Time from GPS to IRIG-B

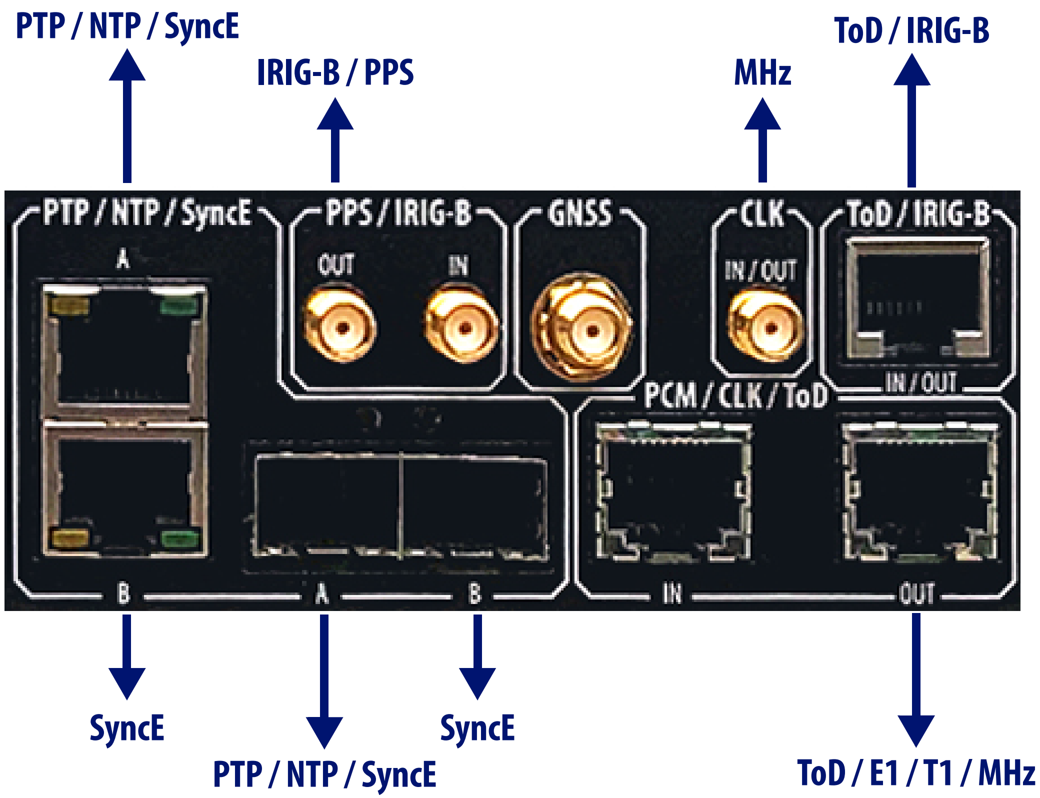
	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out

Input references



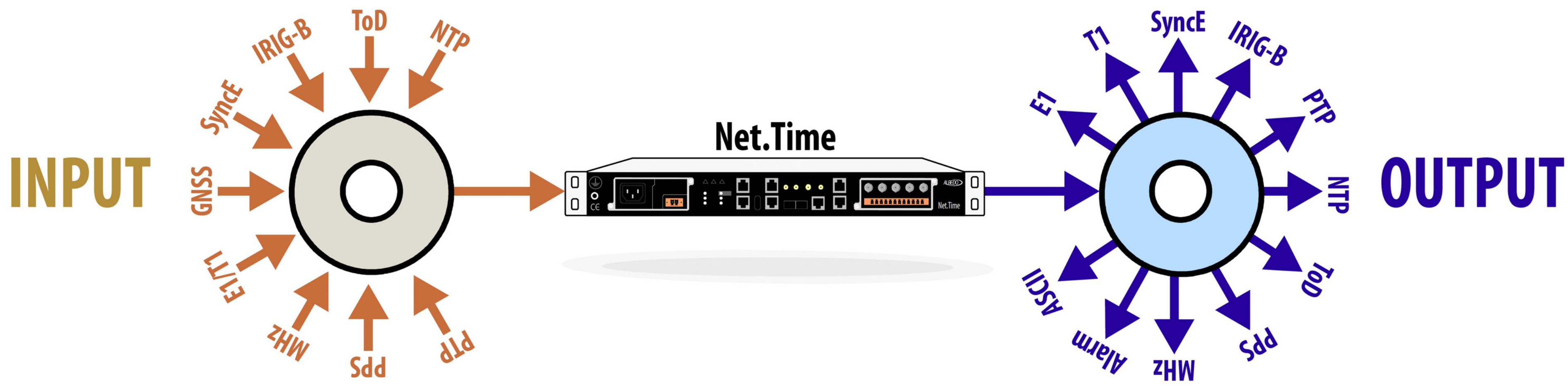
Can be defined the sequence of alternatives in case of the main time reference failure.

Output references



Can be defined the sequence of alternatives in case of the main time reference failure.

Universal Protocol **Translator**

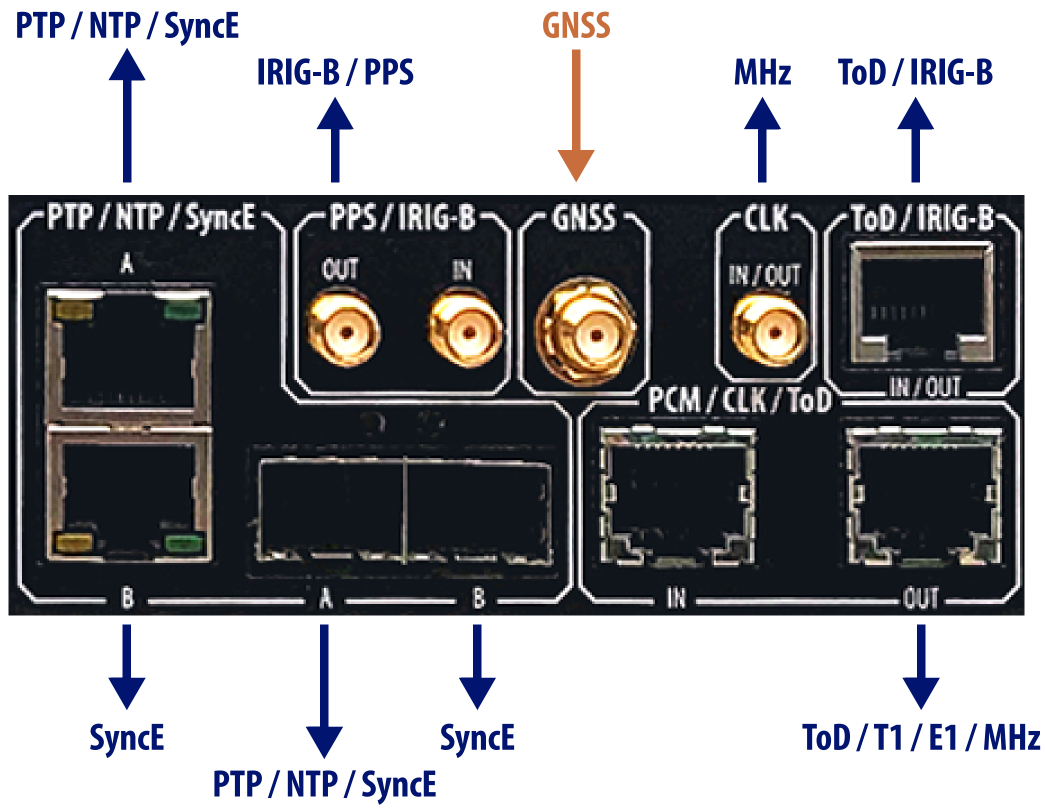


		Input Signals								
		GNSS	PTP	NTP	ToD	IRIG-B	PPS	SyncE	T1/E1	MHz
Output Signals	PTP	yes	yes	yes	yes	yes	yes	yes	yes	yes
	NTP	yes	yes	yes	yes	yes	yes	yes	yes	yes
	ToD	yes	yes	yes	yes	yes	yes	--	--	--
	IRIG-B	yes	yes	yes	yes	yes	yes	--	--	--
	PPS	yes	yes	yes	yes	yes	yes	freq	freq	freq
	SyncE	yes	yes	yes	yes	yes	yes	yes	yes	yes
	E1/T1	yes	yes	yes	yes	yes	yes	yes	yes	yes
	MHz	yes	yes	yes	yes	yes	yes	yes	yes	yes

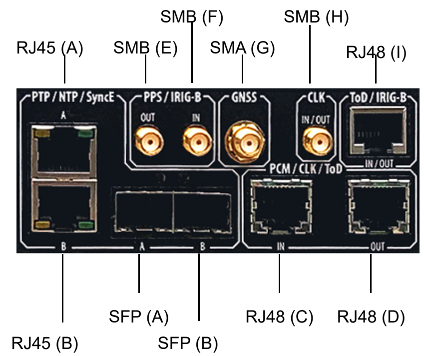
GNSS disciplines ALL protocols

Features

- Built-in GNSS receiver
- Single and Multiple constellation
- Fixed position mode for GNSS references
- Automatic setting of UTC-to-TAI offset
- 4 ~ 5 VDC output
- Cable delay compensation
- Automatic antenna detection



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



ALBEDO Telecom

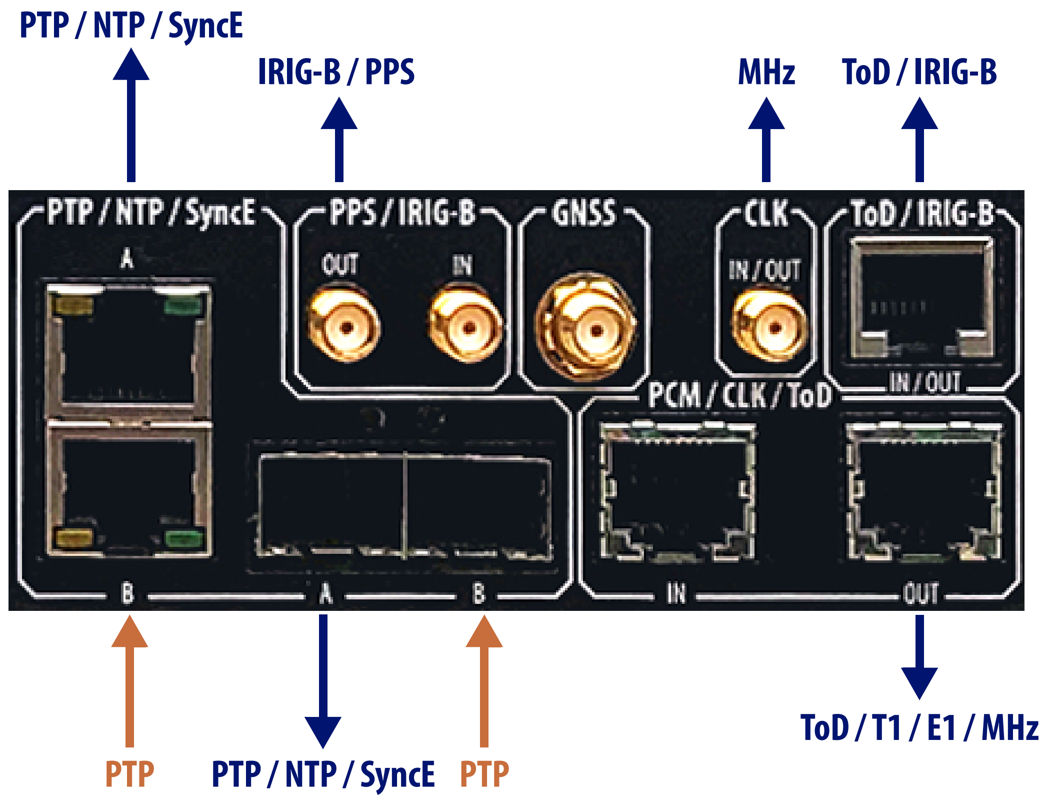
PTP to ALL protocols

Ports

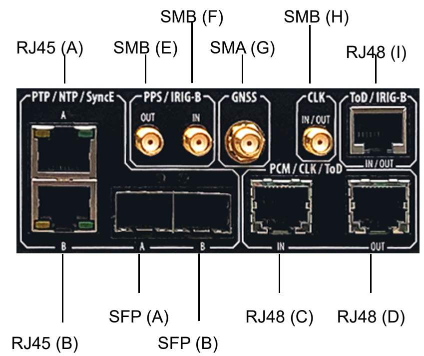
- Port A: PTP master
- Port B: PTP slave
- 256 clients @ 128 packets/sec

Profiles

- Default profiles
- Telecom frequency profile
- Telecom phase and time profile
- PTS / APTS profile
- Utility Profile



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



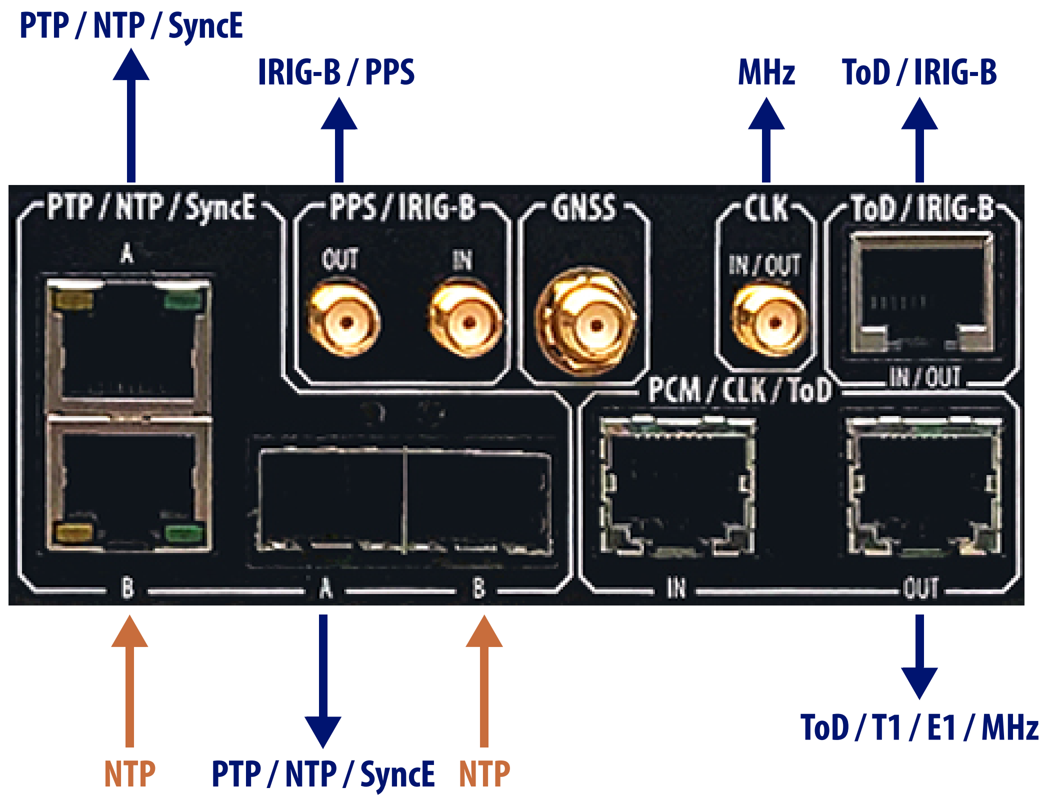
NTP to ALL protocols

Ports

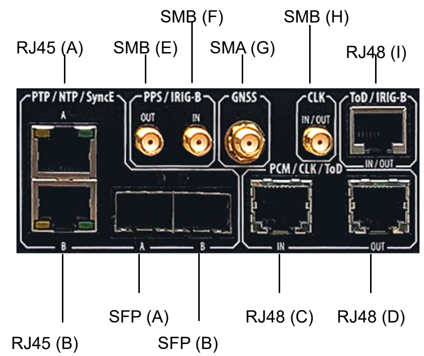
- Port A: NTP master
- Port B: 1000 transactions per second

NTP versions

- NTPv3 (RFC 1305) master and slave
- NTPv4 (RFC 5905) master and slave
- SNTPv3 (RFC 1769) master



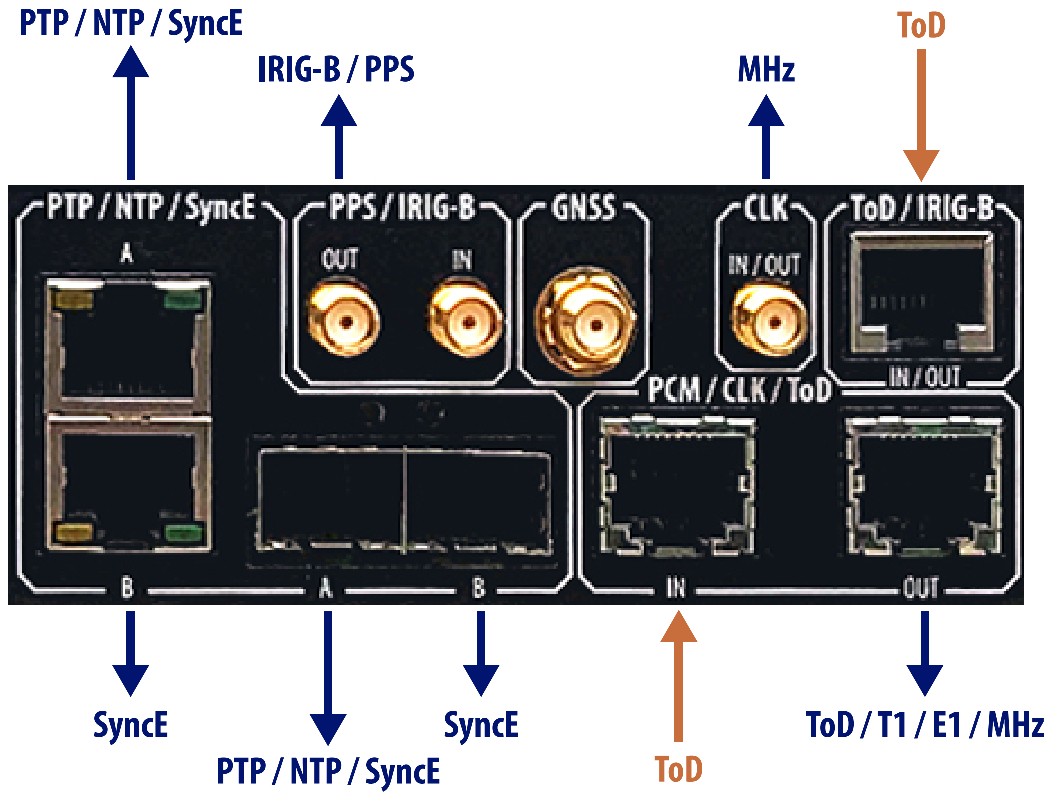
	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



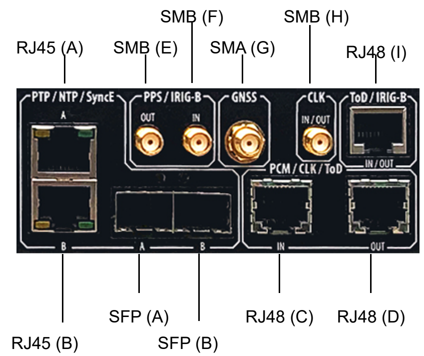
ToD to ALL protocols

ToD formats supported

- ITU-T G.8271
- China Mobile
- NMEA



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



ALBEDO Telecom

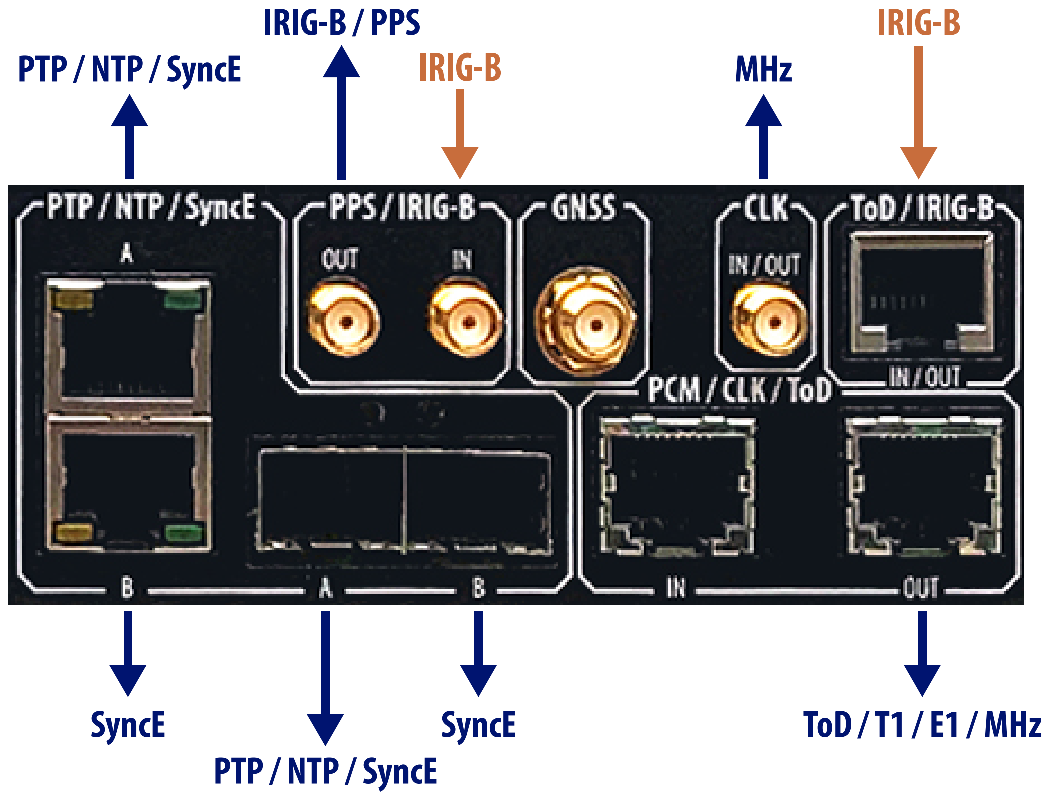
IRIG-B to ALL protocols

IRIG-B formats supported

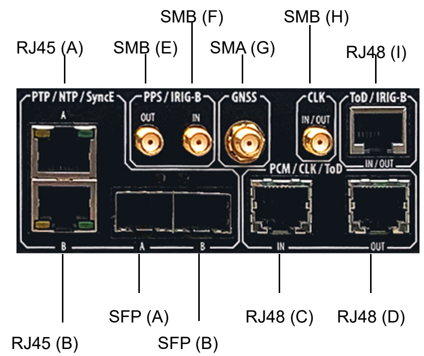
- B00X
- B12X
- B13X
- B14X
- B15X
- B22X

IRIG-B at the interface

- 5 ~ 10 Vpp
- AC/DC coupling
- Termination 50 W / 600 W / High Z



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



MHz to SyncE, T1/E1 & MHz

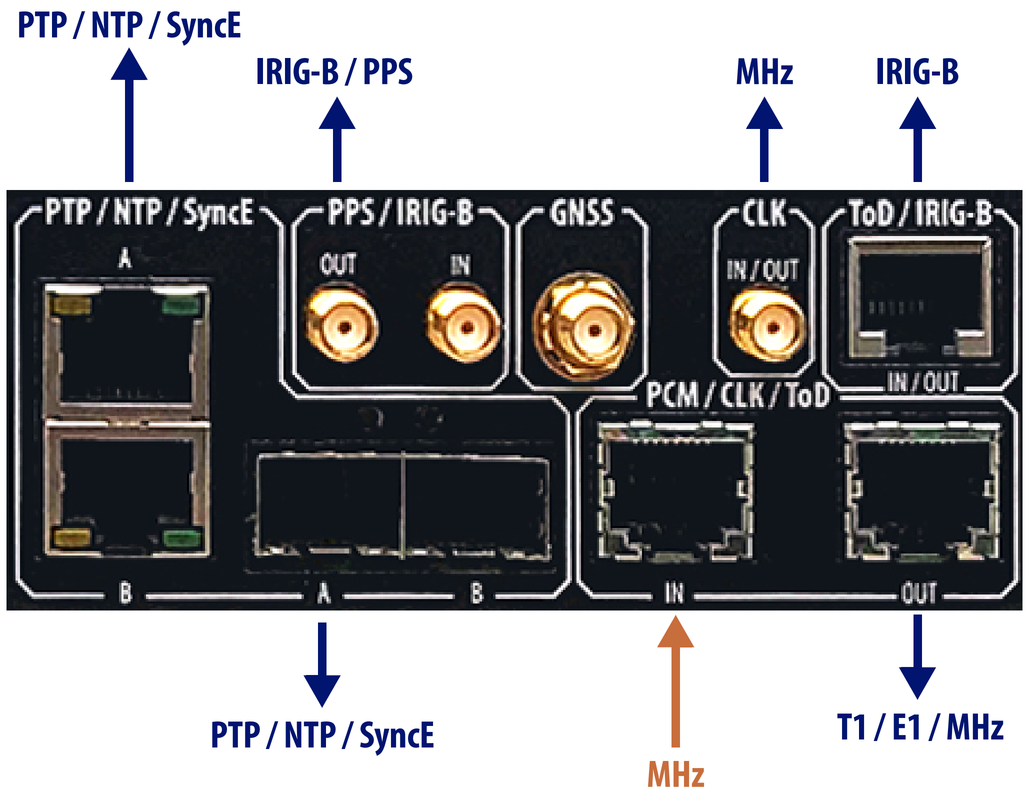
E1/T1 are only a Frequence references therefore can only discipline Frequence signals.

Rates

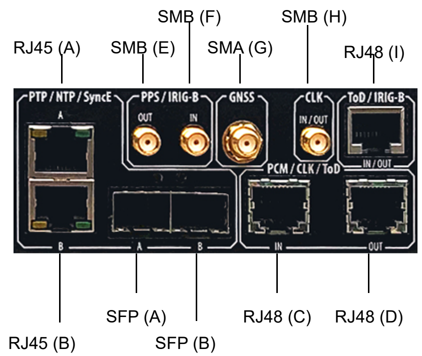
- 1544 kHz
- 2048 kHz
- 5 MHz
- 10 MHz

Can discipline

- SyncE
- T1/E1
- MHz: 10, 5, 2.048 and 1.544 MHz



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



MHz to SyncE, T1/E1 & MHz

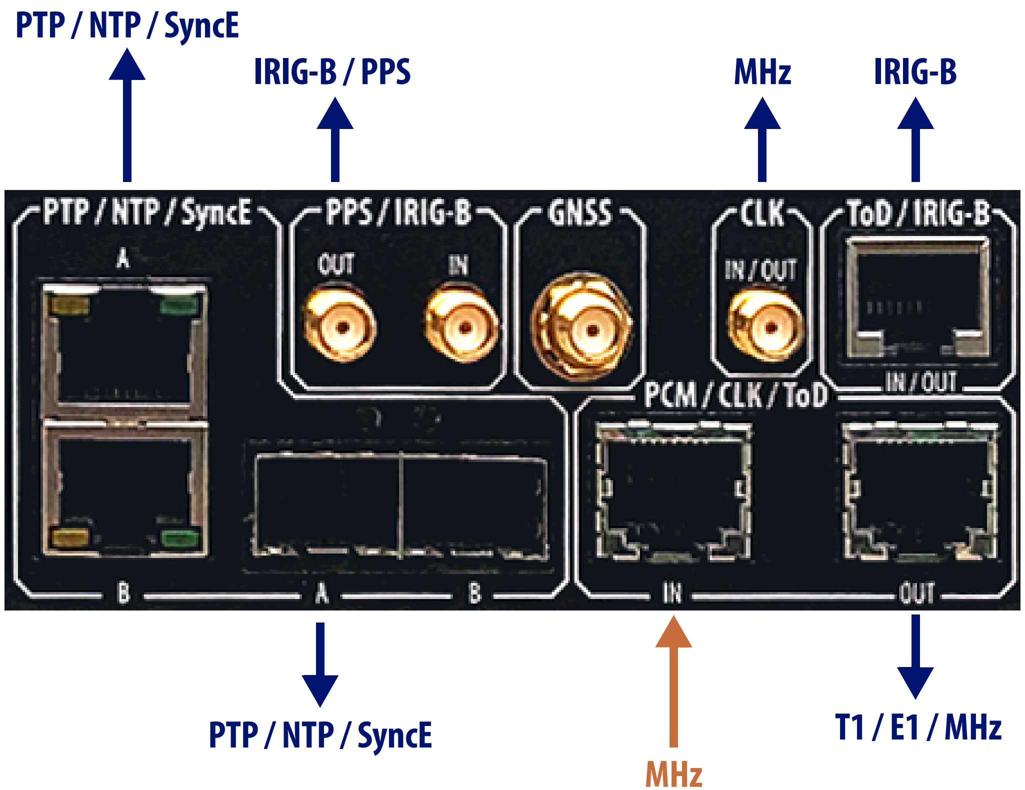
E1/T1 are only a Frequence references therefore can only discipline Frequence signals.

Rates

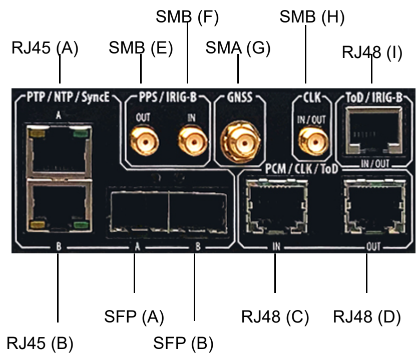
- 1544 kHz
- 2048 kHz
- 5 MHz
- 10 MHz

Can discipline

- SyncE
- T1/E1
- MHz: 10, 5, 2.048 and 1.544 MHz



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



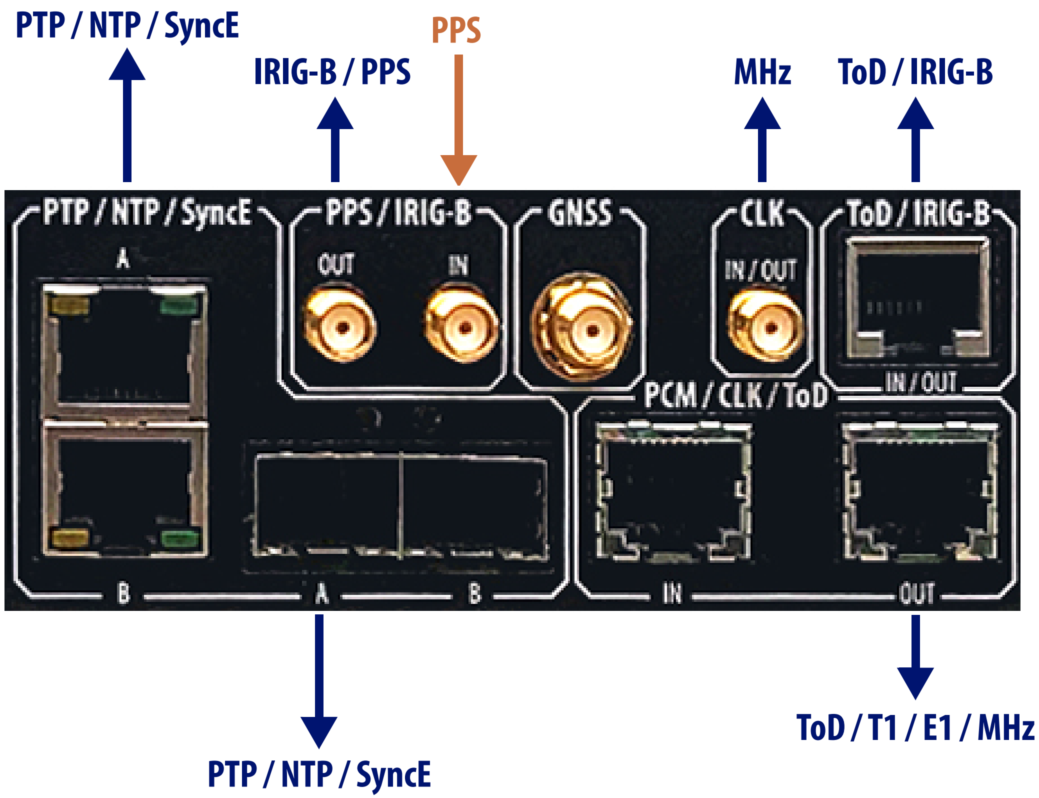
PPS to ALL protocols

PPS does not have Day information then it can only be reference for Phase and Frequence signals.

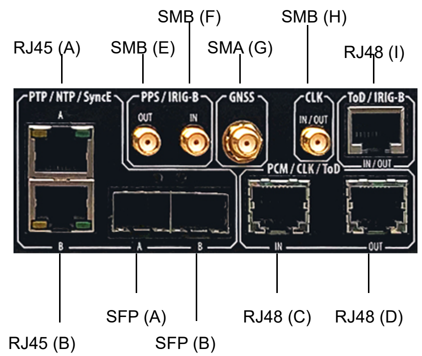
- 1 PPS and 1 PP2S
- Unbalanced SMB 50 W ITU-T G.8271

Can discipline

- 1 PPS and 1 PP2S
- T1/E1
- MHz: 10, 5, 2.048 and 1.544



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



SyncE to PTP, NTP, SyncE, T1/E1 & MHz

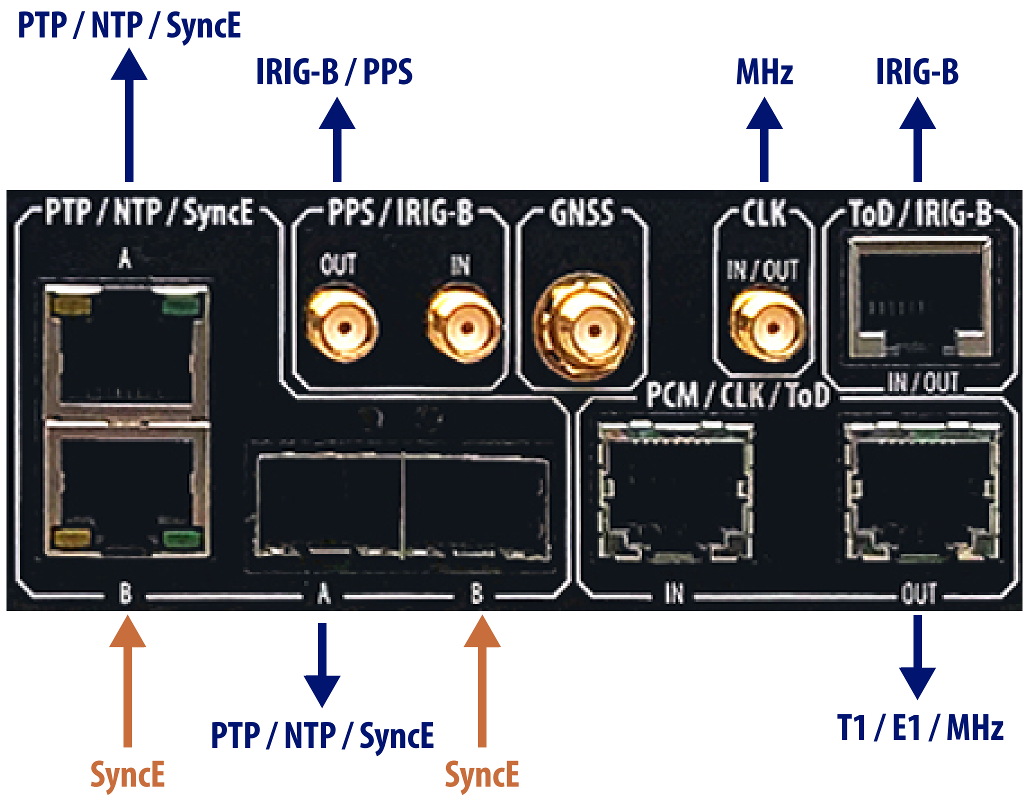
SyncE is only a Frequence reference therefore can only discipline Frequence signals.

SyncE features

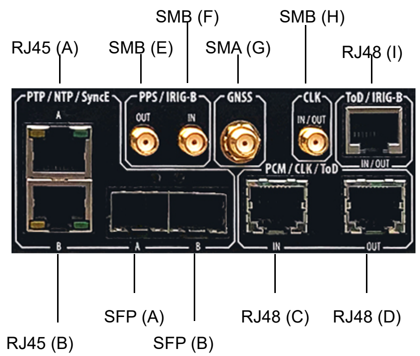
- Built-in GNSS receiver
- Single and Multiple constellation
- Fixed position mode for GNSS references
- Automatic setting of UTC-to-TAI offset
- 4 ~ 5 VDC output
- Cable delay compensation
- Automatic antenna detection

Can discipline

- SyncE
- T1/E1
- MHz: 10, 5, 2.048 and 1.544 MHz



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



T1/E1 to PTP, NTP, SyncE, T1/E1 & MHz

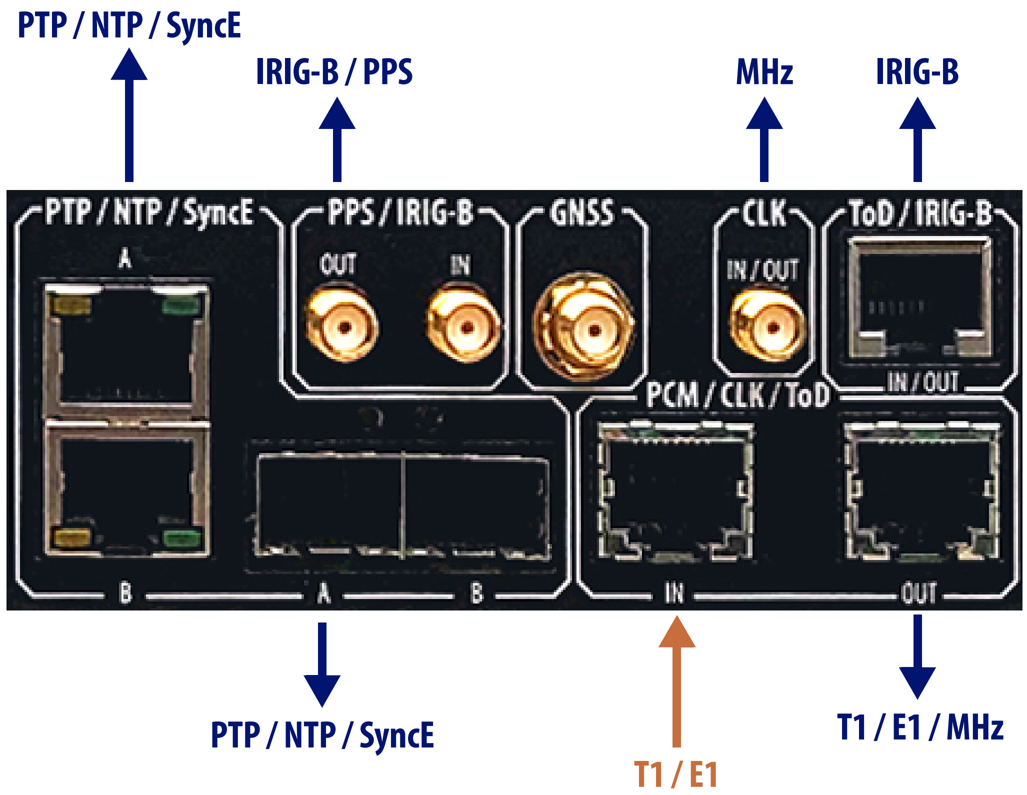
E1/T1 are only a Frequence references therefore can only discipline Frequence signals.

Rates

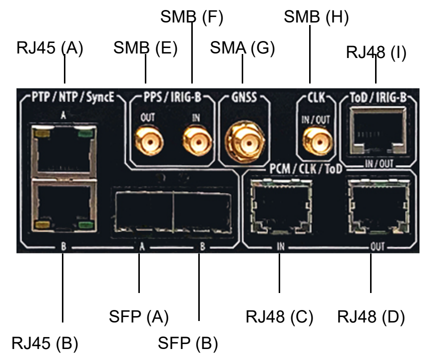
- 1544 Mb/s
- 2048 Mb/s

Can discipline

- SyncE
- T1/E1
- MHz: 10, 5, 2.048 and 1.544 MHz



	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz
RJ45 (A)		out	out					in/out		
RJ45 (B)		in	in					in/out		
SPF (A)		out	out					in/out		
SPF (B)		in	in					in/out		
SMB (E)					out	out	out			
SMB (F)					in	in	in			
SMB (H)										in/out
SMA (G)	in									
RJ48 (I)				in/out	in/out					
RJ48 (C)				in					in	in
RJ48 (D)				out					out	out



That's all

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the Path to Excellence