Net.Time Ω Applications

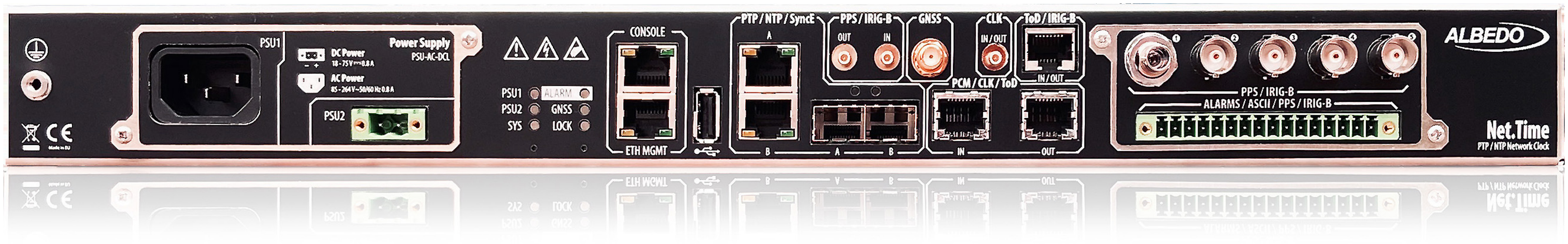
Net.Time Ω has been designed in a modular way to solve any synchronization need of the industry, so that it is possible to integrate under the same architecture any combination of timing protocols including PTP, NTP, PRP, ToD, PPS, IRIG-B, DCF77, SyncE, MHz, T1/E1 and ASCII outputs.

ALBEDO Telecom

ALBEDO a Global manufacturer of Testers & Timing appliances

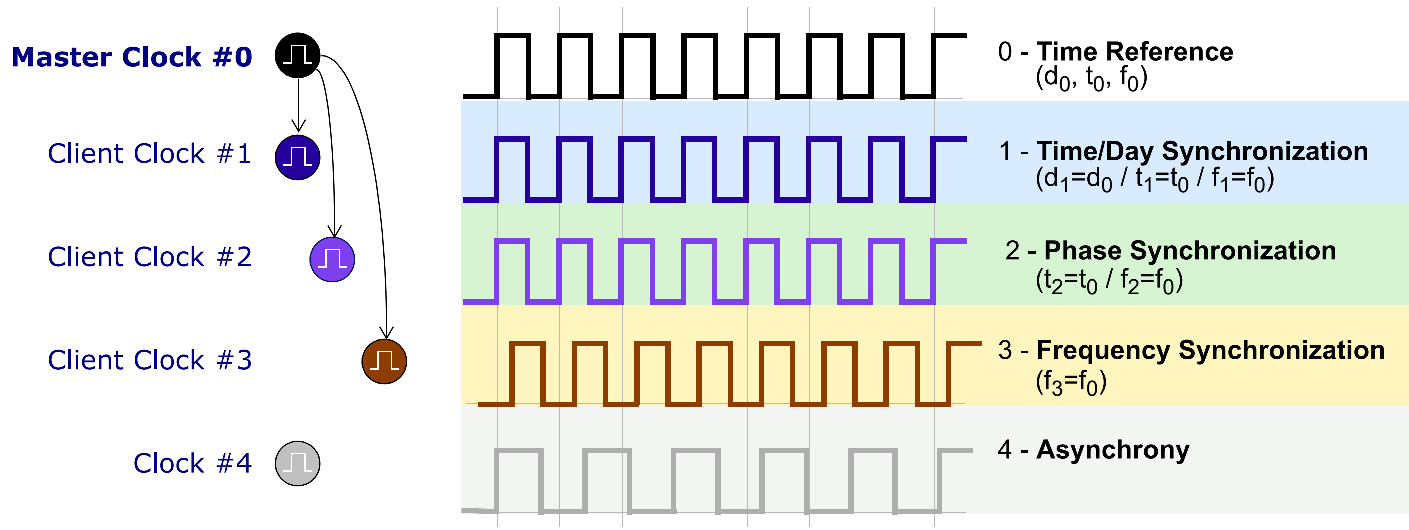
www.albedotelecom.com

Net.Time Ω a flexible clock



Net.Time Ω allows for multiple configurations to meet the timing demands of any industry, including data centres, stock exchange, broadcast, IoT, power utilities, or air traffic control. The result is always a reliable and fault-tolerant solution to loss of reference, network outages and power failures. Simultaneously Net.Time Ω simplifies the migration to PTP without abandoning investments in NTP, IRIG-B or BITS, facilitating on this way the integration, interaction and translation of all types of signals, profiles and protocols.

About **Synchronization**

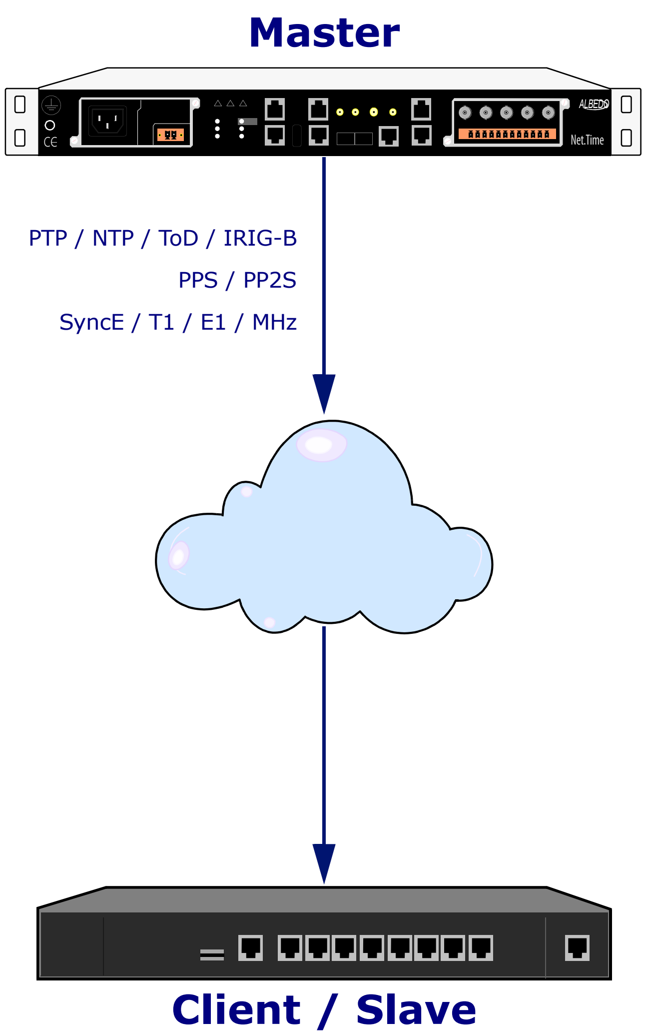


Synchronization aims to discipline clocks in a network to a common time reference.

- **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.

Synchronization **Signals**



Net.Time φ 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
- DCF77

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

- PPS
- PP2S

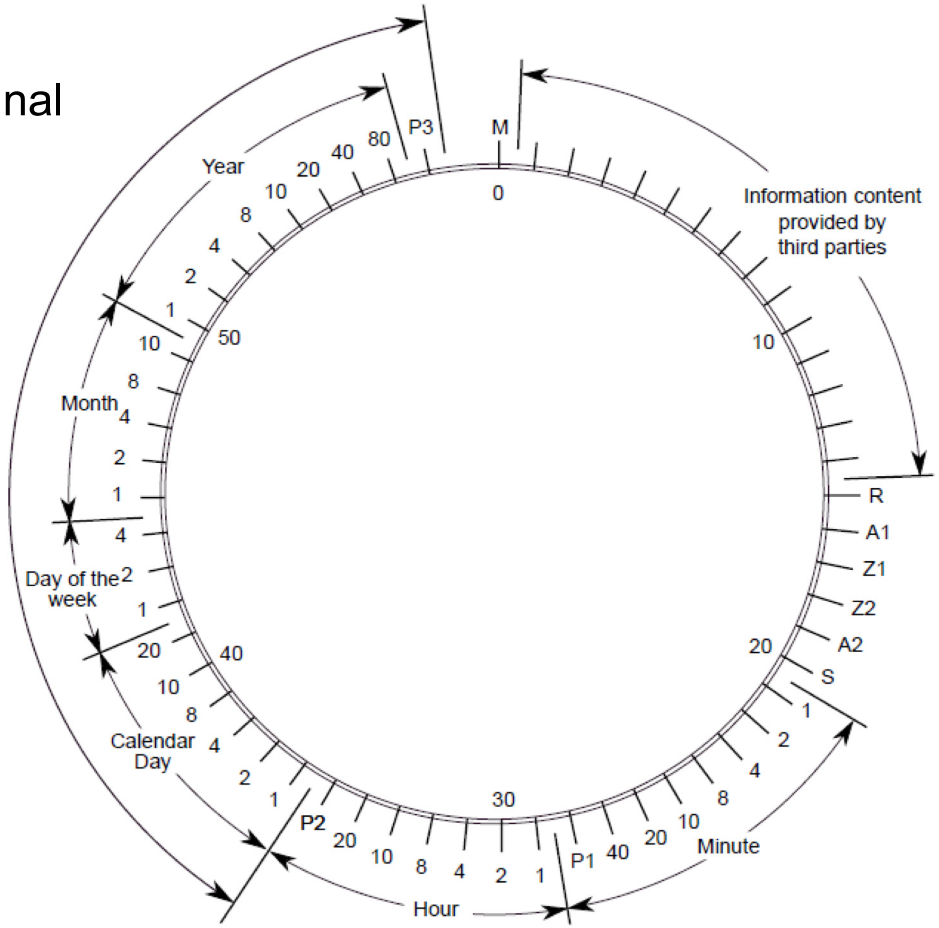
Frequency Synchronization: can only provide frequency:

- T1
- E1
- SyncE
- MHz

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.

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

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

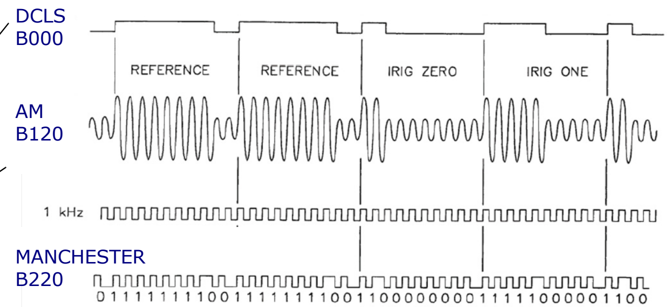
Carrier
- 0: No carrier (DCLS)
- 1: 100 Hz
- 2: 1 kHz
- 3: 10 kHz
- 4: 100 kHz
- 5: 1 MHz

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

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

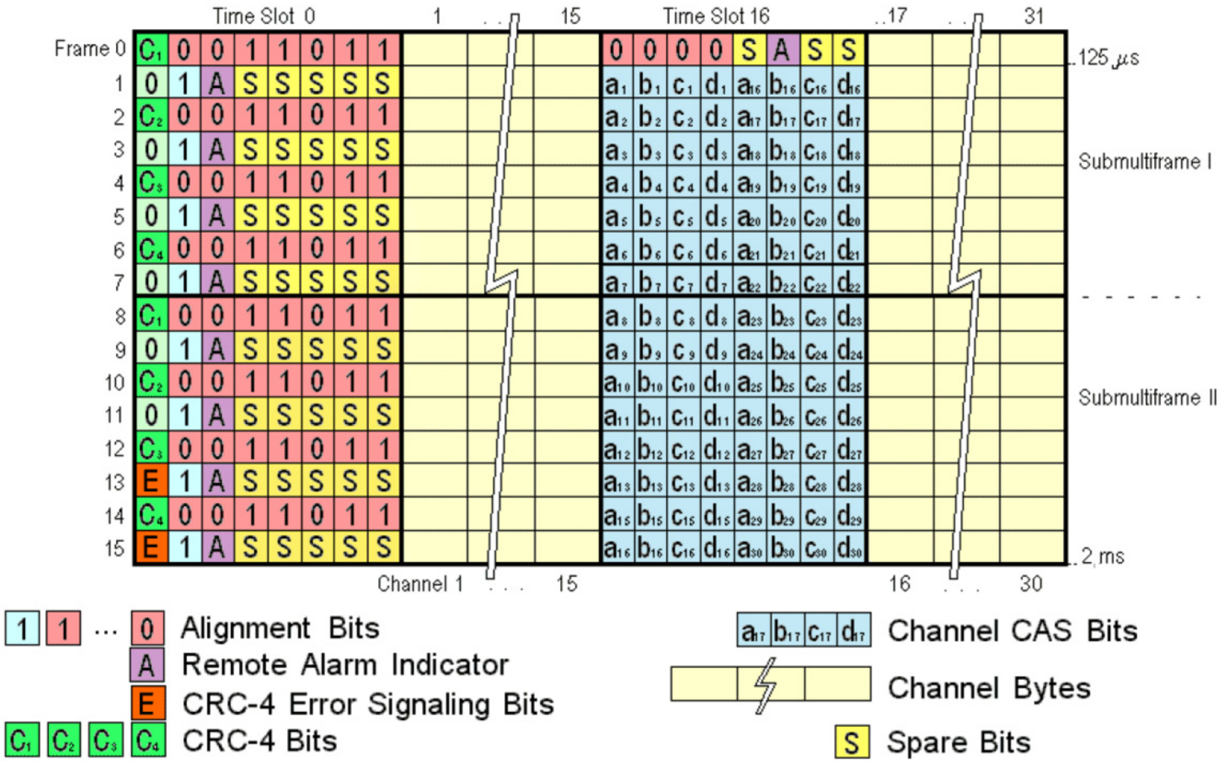


IRIG-B sends a timing signal at 100 pulse/sec rate including Year, Day, Hour, Min, Sec data with an update rate of one second direct or over a Carrier:

Unmodulated DCLS IRIG-B offers several transmission alternatives

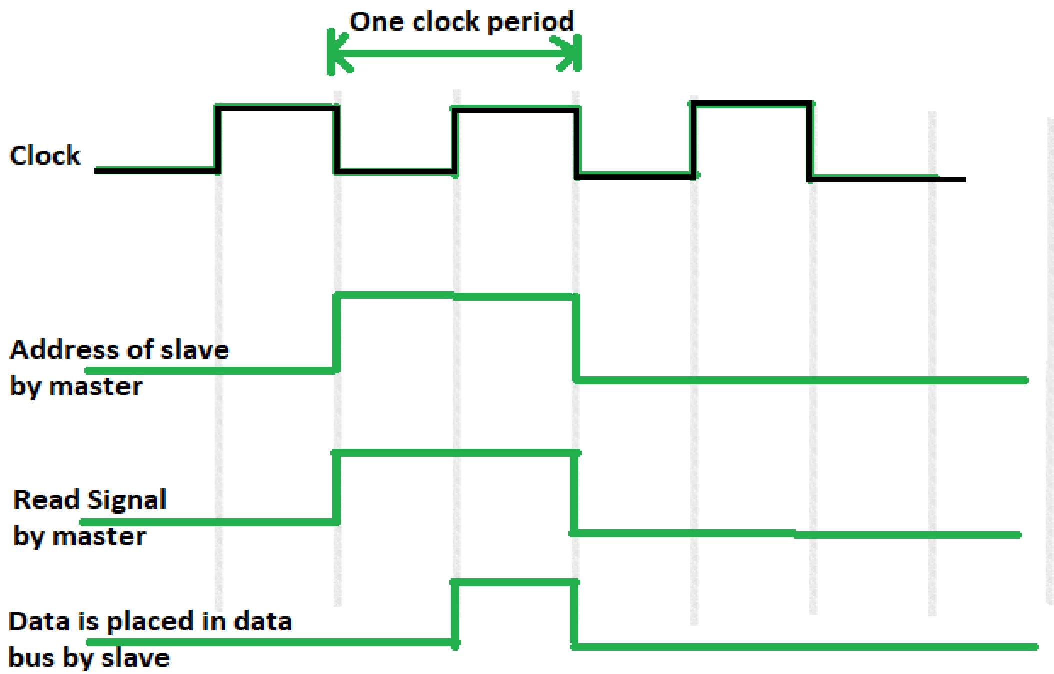
- TTL-level signal over coaxial cable or shielded twisted-pair cable
- Multi-point distribution using 24 Vdc for signal and control power
- RS-485 differential signal over shielded twisted-pair cable
- RS-232 signal over shielded cable (short distances only)
- Optical fiber

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



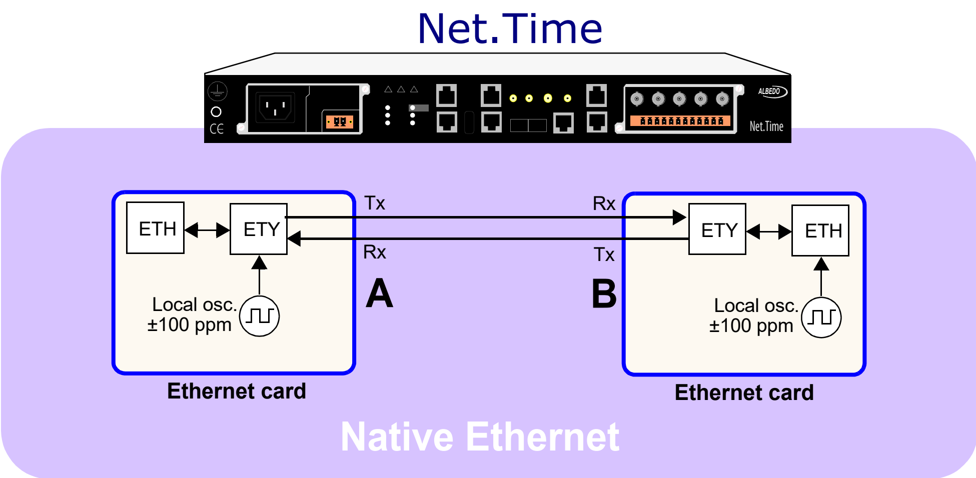
Often known as BITS (Building Integrated Timing Supply) describe a building-centric timing system, the BITS system efficiently manages the number of timing interfaces within a structure providing external timing connections typically deployed as T1 or E1 frequencies but also can refer to MHz and then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

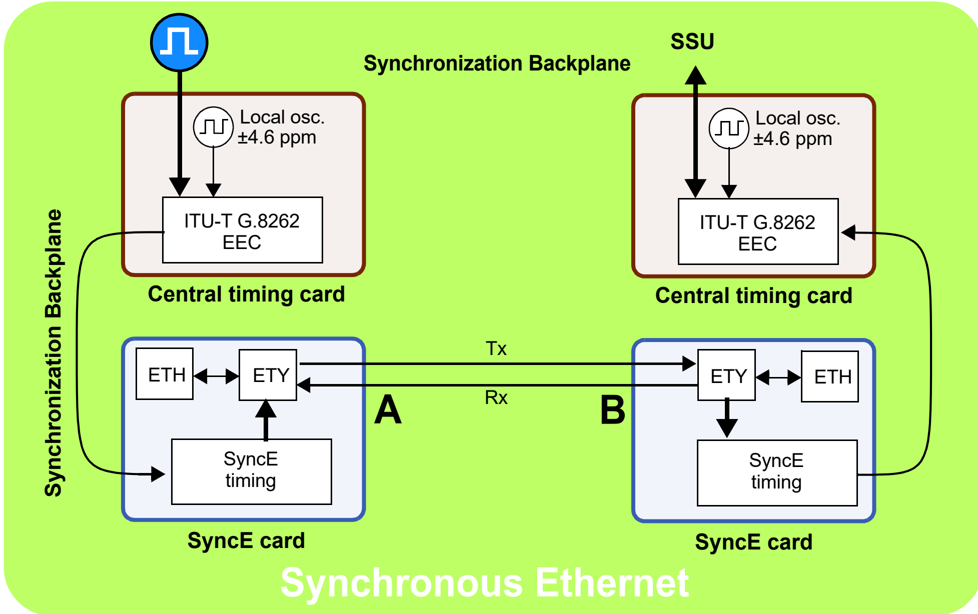
There are several signals suitable for transporting synchronization:

- 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.

SyncE (Synchronous Ethernet)





SyncE is not part of the IEC 61850 but is required in the Power Grid and implemented by Net.Time

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

NTP server

Network Time Protocol support)

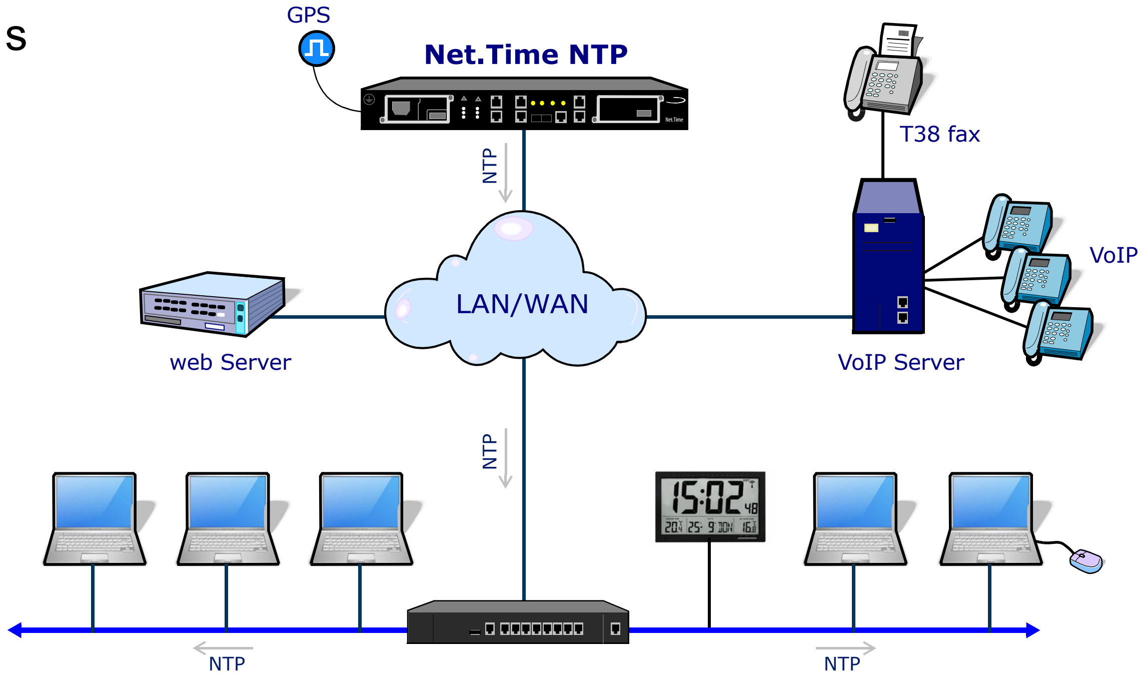
- Port A: NTP server @ 1000 transactions / s
- Port B: NTP client and time ref.

NTP versions

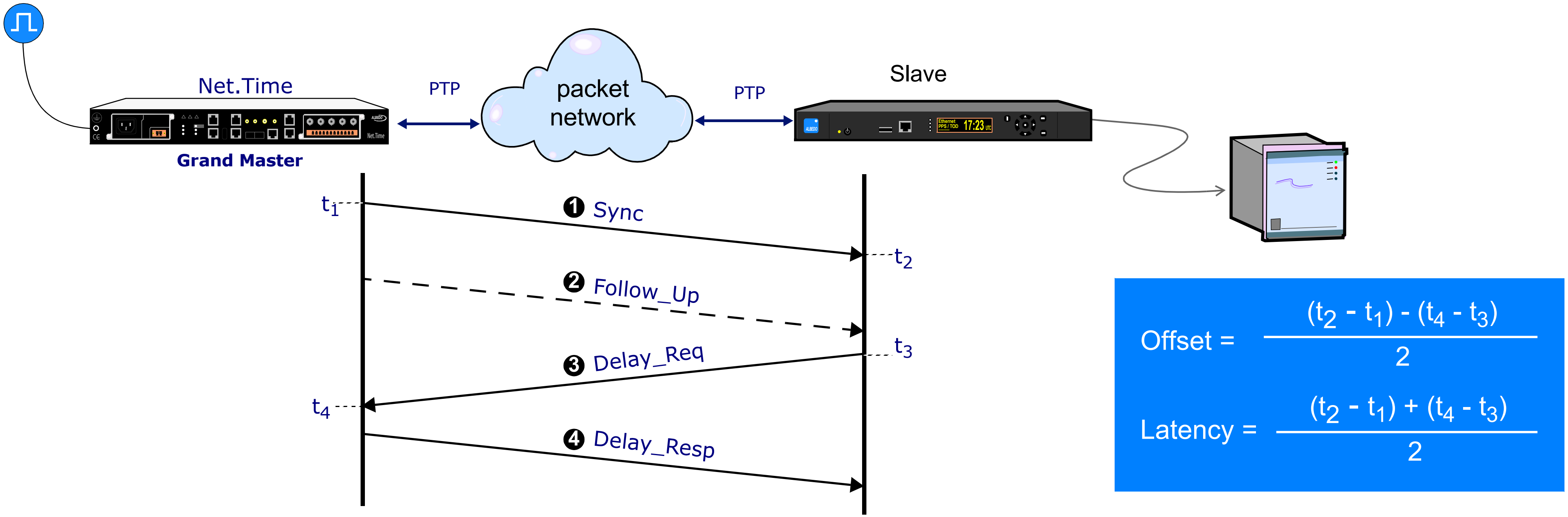
- NTPv3 (RFC 1305) server & client
- NTPv4 (RFC 5905) server & client
- SNTPv3 (RFC 1769) server

Configuration

- Maximum/ Minimum polling interval



PTP - Precision Time Protocol (IEEE 1588)



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.

Timing **Evolution**

(1960)
IRIG-B
- Bulk metering
- Simple
- Robust

10 us

(1990)
NTP
- Internet
- Even recorder
- Security
- Personal Data

1 ms

(2020)
PTP
- Airports
- Broadcast
- Telecom
- Utilities
- Navigation

100 ns

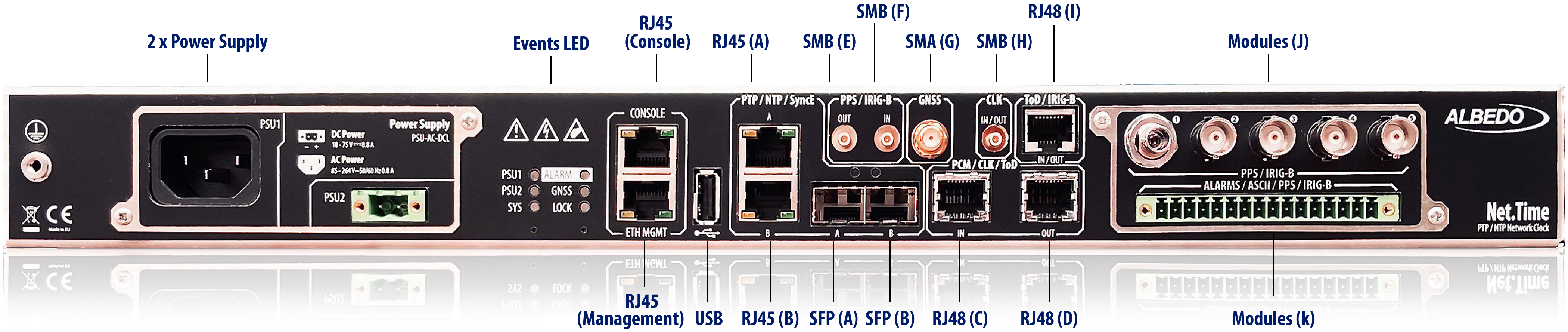
(1980)
BITS
- SONET
- SDH
- GSM
- Military

1 ms

(1960)
DCF77
- Railways
- Stations

10 us

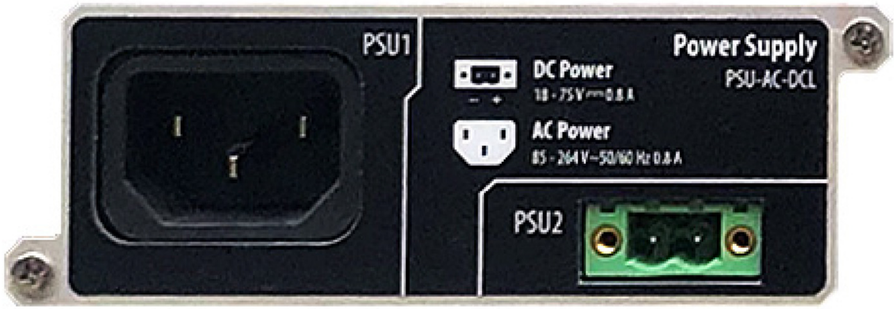
Some industries have a combination of **all them**



from **10Mb/s** up to **1Gb/s**

- 19” / ETSI/1U/201 mm rack mount
- Fanless operation
- Weight: 1.9 kg / 4.2 lb
- Redundant power supply
- 6 x LEDs
- USB: Software and firmware upgrade
- Storage temperature: -40 ~ +85ºC
- Operating: -25 ~ +75ºC (10 ~ 95% RH non condensing)
- Slot for 5 x Optional Modules

Power Supply redundancy



Multiple combinations

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

Options

- AC: 100 ~ 240 VAC, 50- 60 Hz (IEC 60320 C13/C14)
- DC: 18 ~ 75 VDC or 43 ~160 VDC (2-pin 5.1 mm)
- AC/DC: 85 - 264 VAC and 100 - 370 VDC (2-pin 5.1 mm)
- Rubidium better than ±5.0 e-11
- • OCXO better than ±0.1 ppm
- • Internal time reference better than ±2.0 ppm
- Hold-over

Rubidium or OCXO Oscillator

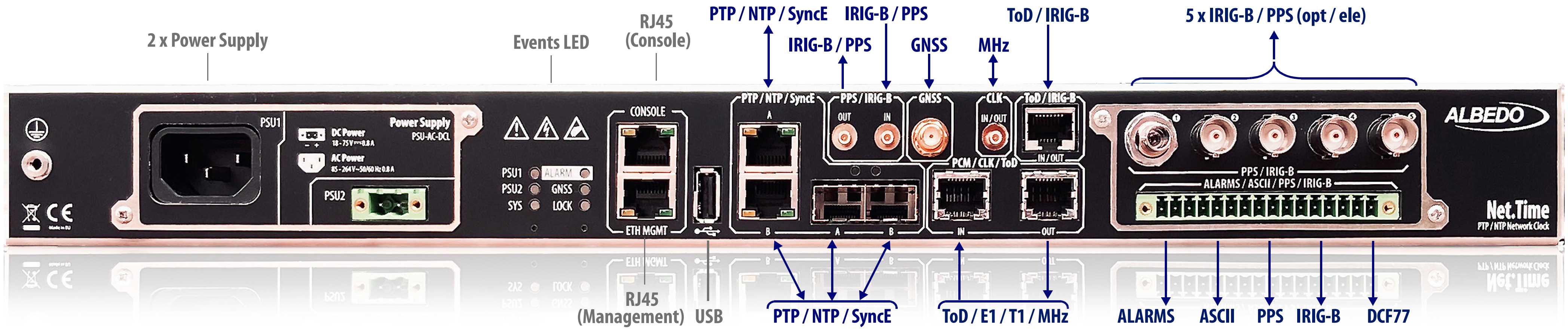
Performance

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

Hold-over

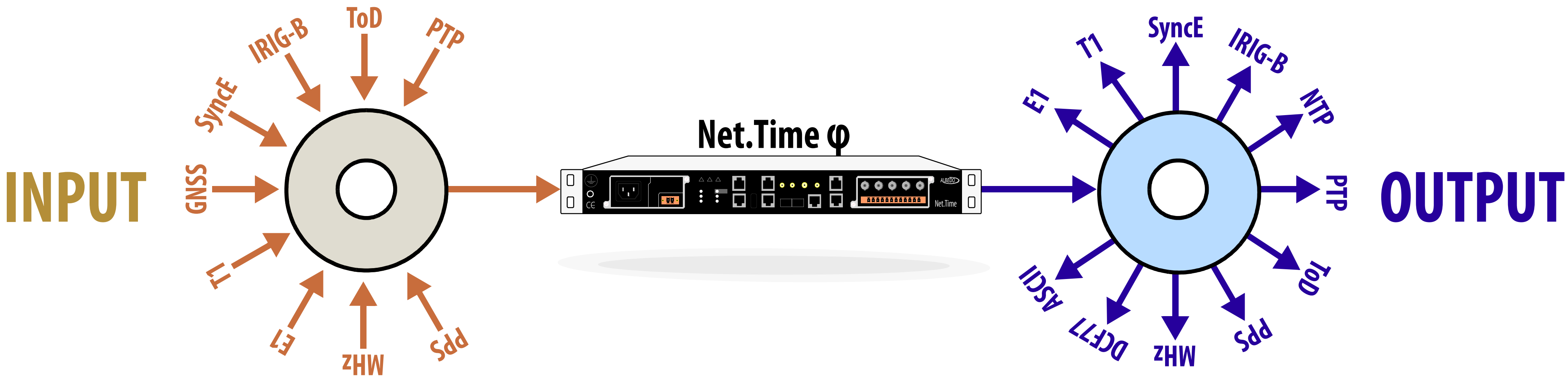
- Rubidium: 100 ns @ 10h, 500 ns @ 24h, 1µs @ 48 hours
- OCXO: 500 ns @ 2h, 1µs @ 4 h, 10µs @ 24 hours

Timing **interfaces**



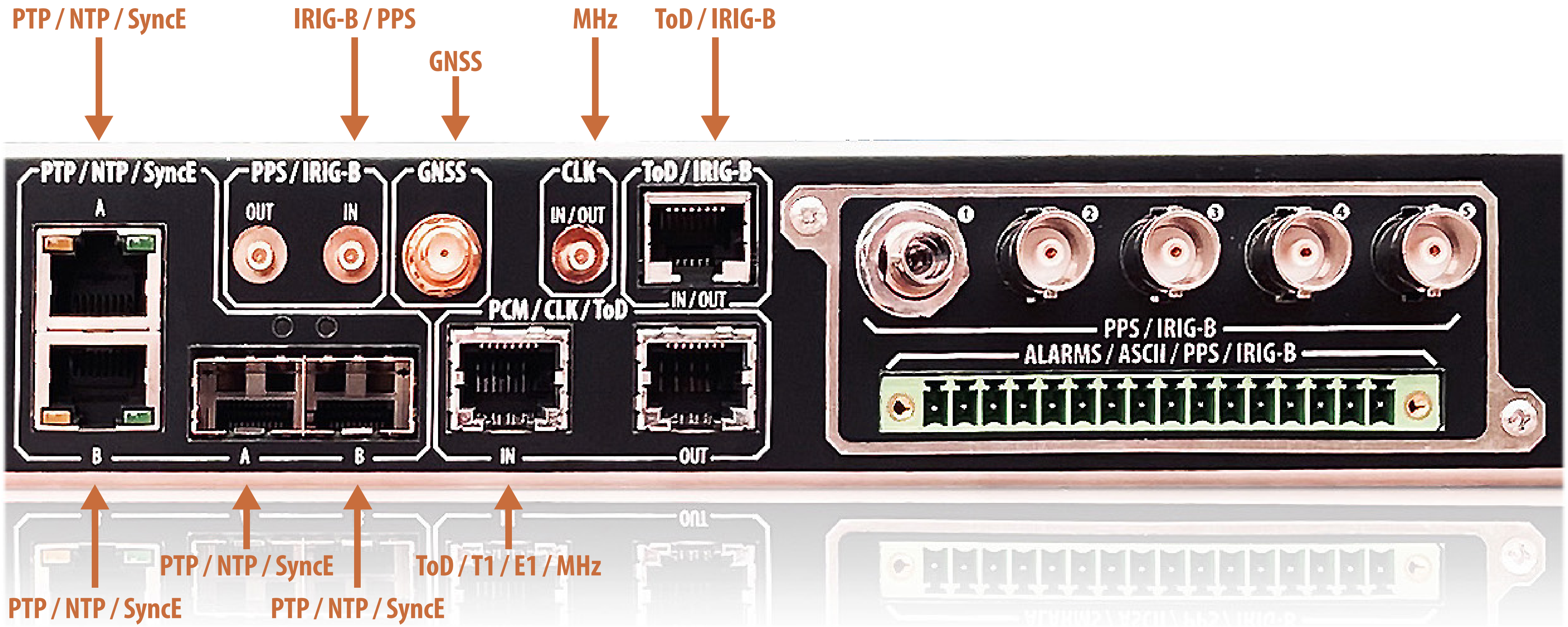
	GNSS	PTP	NTP	ToD	IRIGB	PPS	PP2S	SyncE	T1/E1	MHz	ASCII	DCF77	Alarm
RJ45 (A)		out	out					in/out					
RJ45 (B)		in	in					in/out					
SPF (A)		out	out					in/out					
SPF (B)		in	in					in/out					
SMB (E)					out	out	out						
SMB (F)					in	in	in						
SMB (H)										in/out	in/out		in/out
SMA (G)	in												
RJ48 (I)				in/out	in/out								
RJ48 (C)				in					in	in	in		in
RJ48 (D)				out					out	out	out	out	out
BNC/ST (J)					out	out	out				out		out
Socket (K)					out	out	out				out		out

Universal Time Protocol **Translator**



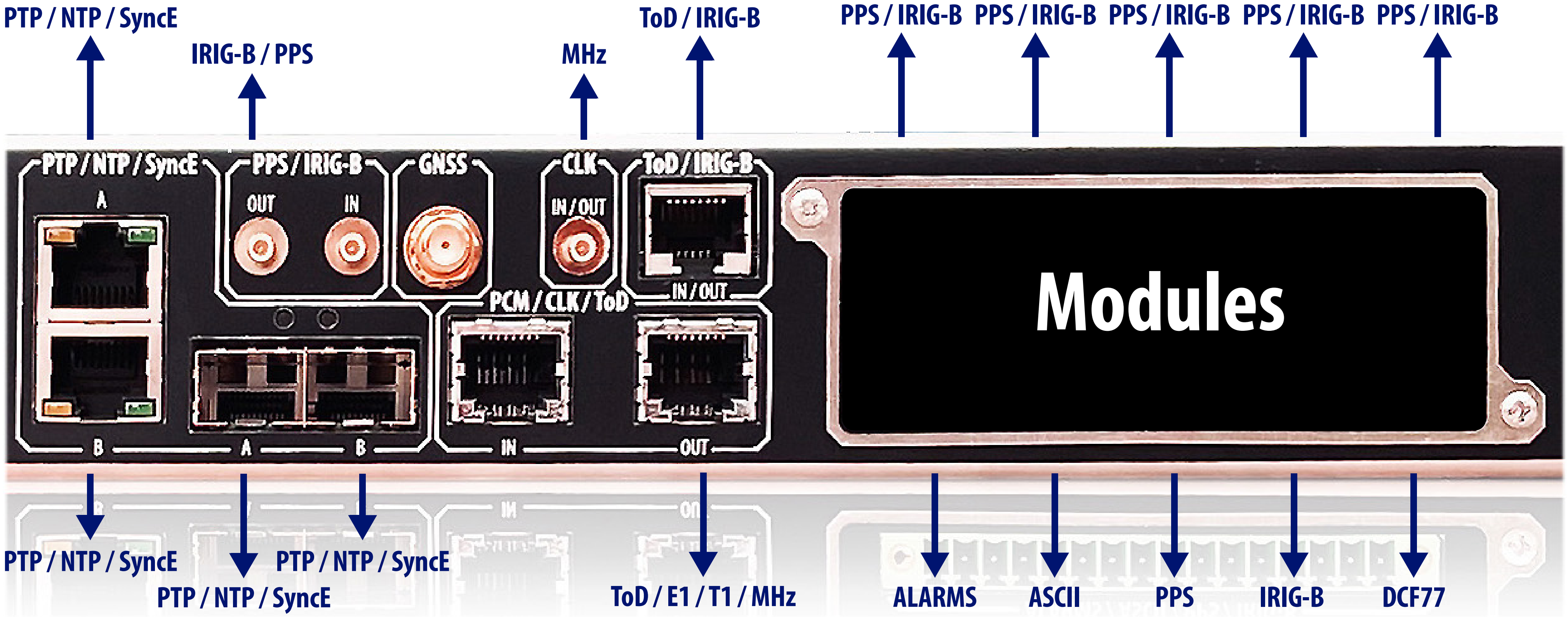
Output Signals	Input Signals: GNSS	PTP	ToD	IRIG-B	PPS	SyncE	T1/E1	MHz
PTP	yes	yes	yes	yes	yes	yes	yes	yes
NTP	yes	yes	yes	yes	yes	yes	yes	yes
ToD	yes	yes	yes	yes	yes	yes	yes	yes
IRIG-B	yes	yes	yes	yes	yes	yes	yes	yes
PPS	yes	yes	yes	yes	yes	yes	yes	yes
SyncE	yes	yes	yes	yes	yes	yes	yes	yes
E1/T1	yes	yes	yes	yes	yes	yes	yes	yes
DCF77	yes	yes	yes	yes	yes	yes	yes	yes
MHz	yes	yes	yes	yes	yes	yes	yes	yes

Input references



up to **10 different** time **references**

Output signals



up to **22 simultaneous** Outputs

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

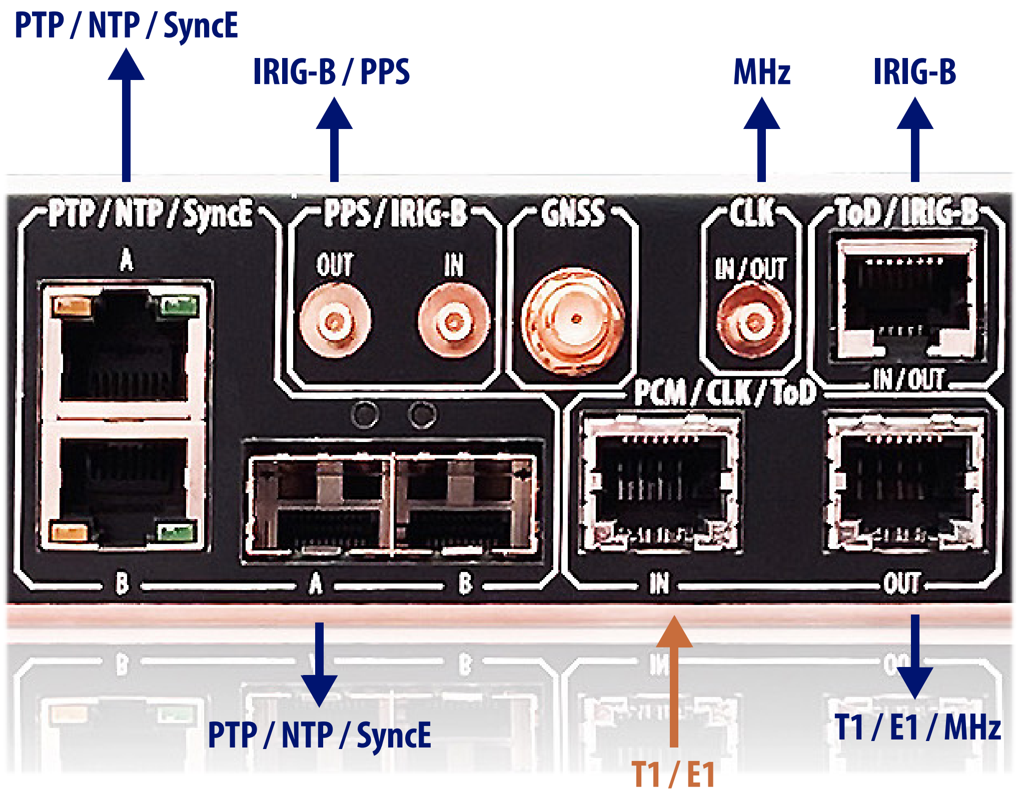
E1/T1 are only a Frequency references therefore can only discipline Frequency signals.

Rates

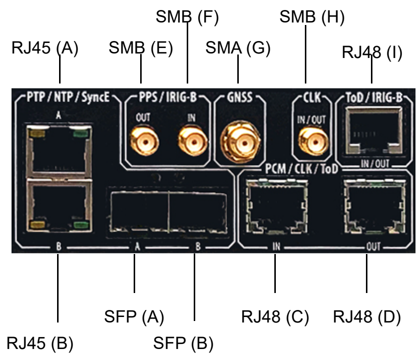
- 1544 Mb/s
- 2048 Mb/s

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

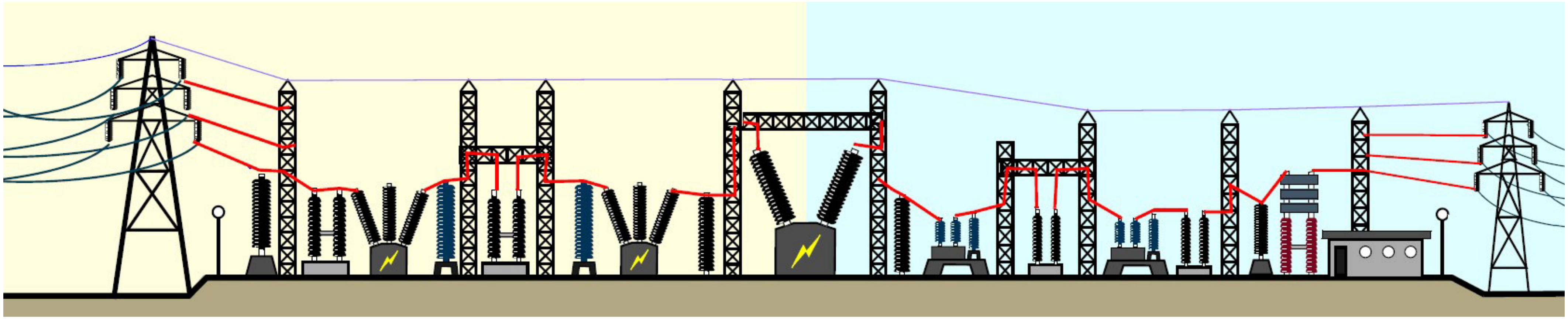


any **input** to **output**

5 x Modules


Modules
RIC-50
IRIG-B / PPS
RIC-50
PPS / IRIG-B
IRIG / DCF
PPS / IRIG-B
IRIG-B / DCF
RIC-52
IRIG-B / PPS
RIC-52
ToD / ASCII / IRIG-B
PPS
IRIG-B
IRIG / DCF
PPS / IRIG-B
IRIG-B / DCF
RIC-54
IRIG-B / PPS
RIC-54
PS / IRIG-B
ALARMS / ASCII / PPS / IRIG-B
IRIG / DCF
ALARMS / ASCII / PPS / IRIG-B
RIC-82
IRIG-B / PPS
RIC-82
PPS / IRIG-B
ALARMS / ASCII / PPS / IRIG-B
ALARMS / ASCII / PPS / IRIG-B
RIC-84
IRIG-B / PPS
RIC-84
PPS / IRIG-B
ALARMS / ASCII / PPS / IRIG-B
ALARMS / ASCII / PPS / IRIG-B

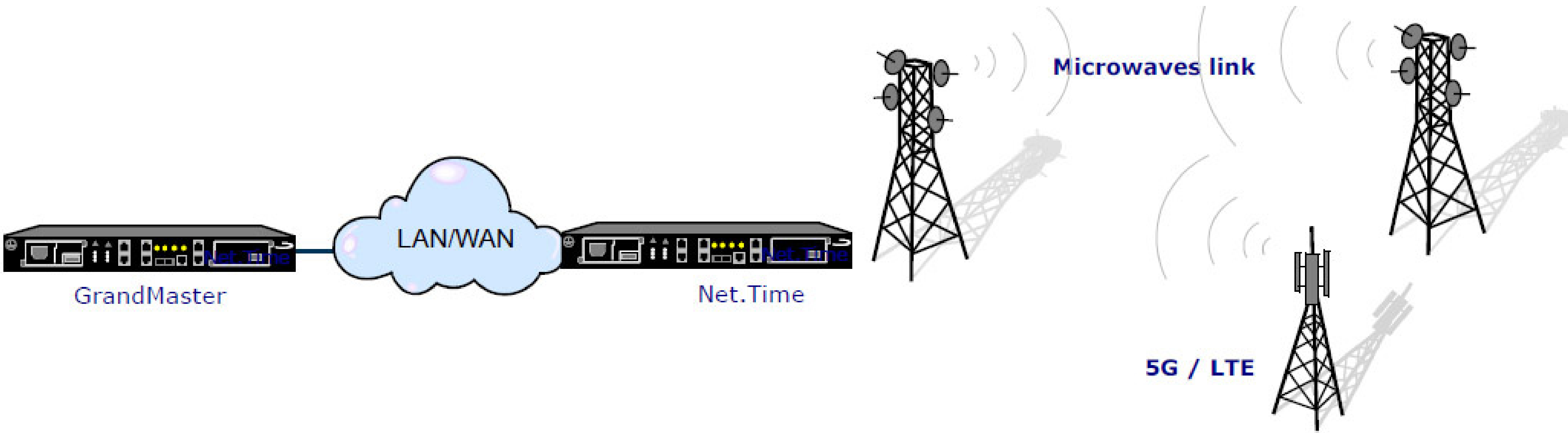
Power Substations



Smart grid automation requires extremely precise time accuracy --and stability as well-- for tasks such as peak-hour billing, virtual power generators, or outage management. It is also necessary for the automatic protection of high voltage lines that are permanently supervised, when a substations detects an event, it is timestamped and transmitted to ensure correct operation.

The support of Power profile, PRP and IRIG-B make Net.Time ideal for the new digital substations willing to secure the investment and the support of both, legacy and new interfaces. In substation many resources require accurate synchronization ranging from microseconds to milliseconds.

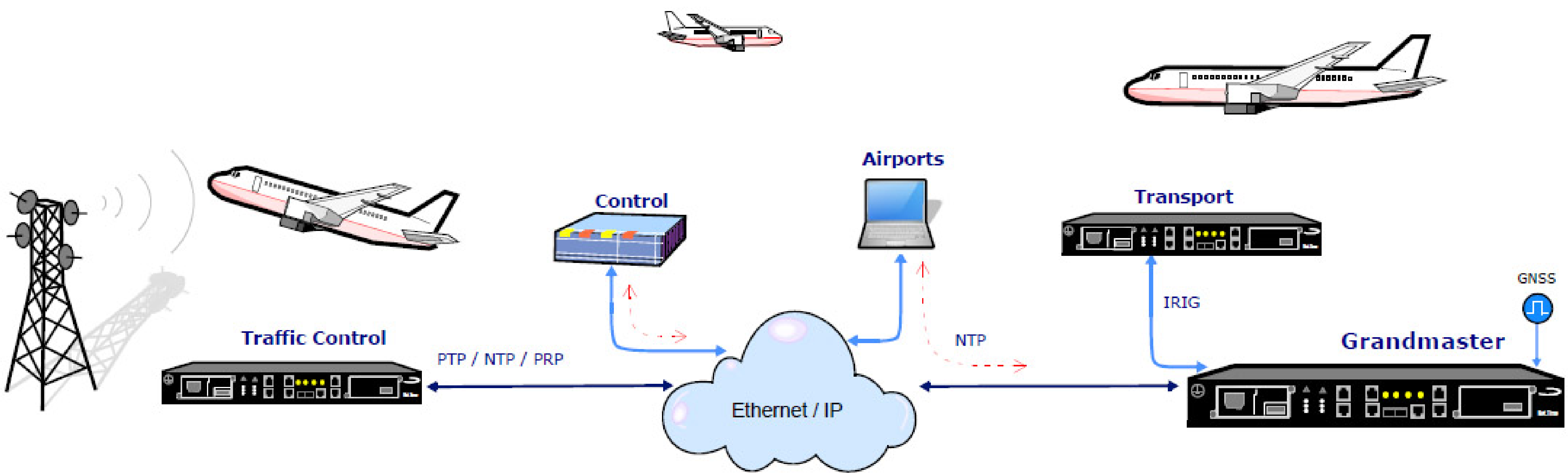
Wireless WAN



Wireless operators require accurate phase and time alignment at the backhaul of the wireless in order to increase the density of terminals reducing cells size. Timing is also necessary for reusing the frequencies, to control the hand-over, logging the events and many more new services that are boosting the mobile business. Net.Time in telecom networks is deployed at the edges and generally configured as a boundary clock to provide a high level of accuracy and protection with signals such as PTP, SyncE, PPS, T1/E1 and MHz.

New wireless deployments have stronger requirements at synchronization plane in order to reduce the size of the cells reusing more often available frequencies and, very important, wireless terminals have to share up/downstream channels to improve the efficiency by using phase information.

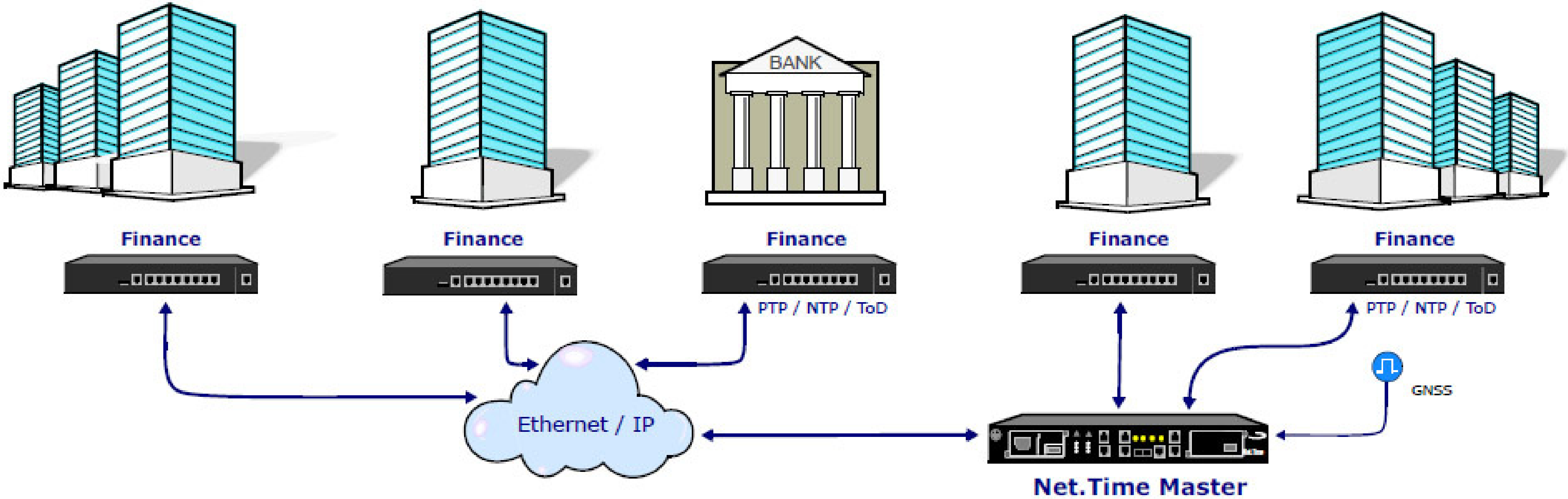
Air Traffic Control



Time is a key resource in Navigation Systems to ensure the proper functioning. Inherited signals such as IRIG-B, NTP and TDM are still in use but progressively are being replaced by PTP time-stamping systems to provide a unique, accurate and consistent synchronization based on Net.Time equipped with atomic oscillators disciplined by GNSS and distributed throughout the territory, air traffic control centres and airports.

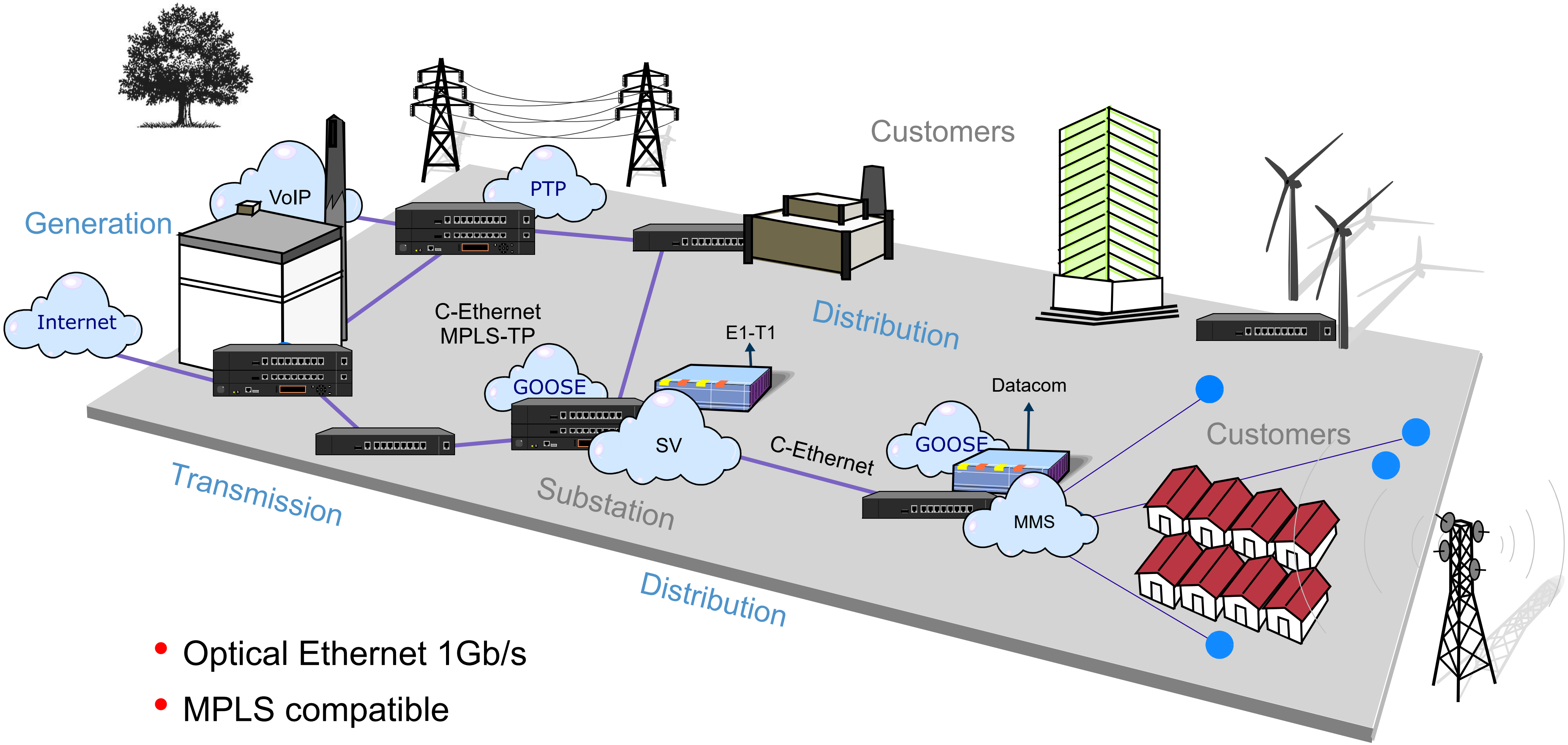
Timing is a key resource to ensure the correct operation of the Air Navigation Systems. Legacy signal --such as IRIG B, NTP and TDM-- are still on use but are being progressively substituted by PTP time stamping to provide a unique, accurate and coherent synchronization signals based on atomic clocks disciplined by GNSS and distributed across the IP network to the whole territory.

Finance Institutions



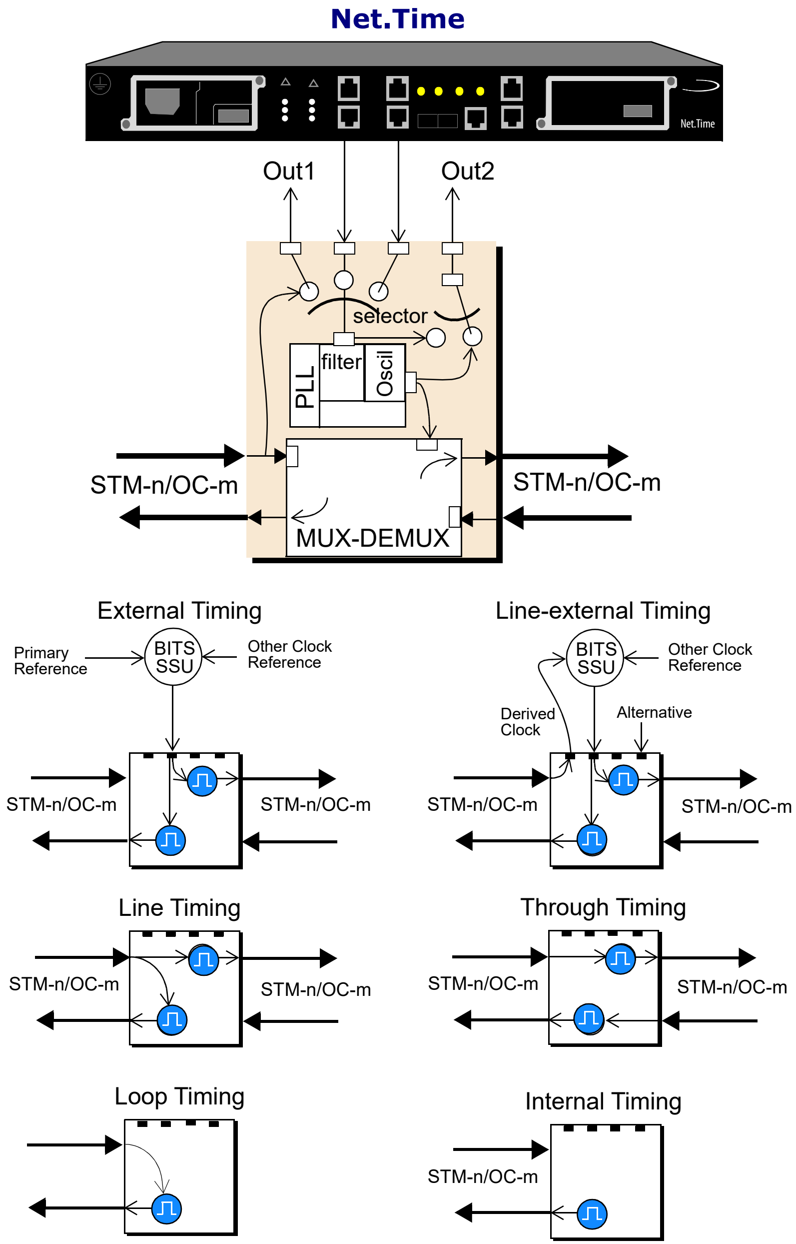
Financial services rely on powerful transport layer capable to provide high speed, availability, security and reliability. At the timing side, NTP and GNSS has been la widely used to synchronize nodes, transactions, and to log time-stamped events in a chronological sequence. Nevertheless today are in the migration pace to PTP that will improve the quality and functionalities of this service.

Power Grid



- Optical Ethernet 1Gb/s
- MPLS compatible
- PTP Telecom / Power profiles

Frequency for SONET/SDH



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

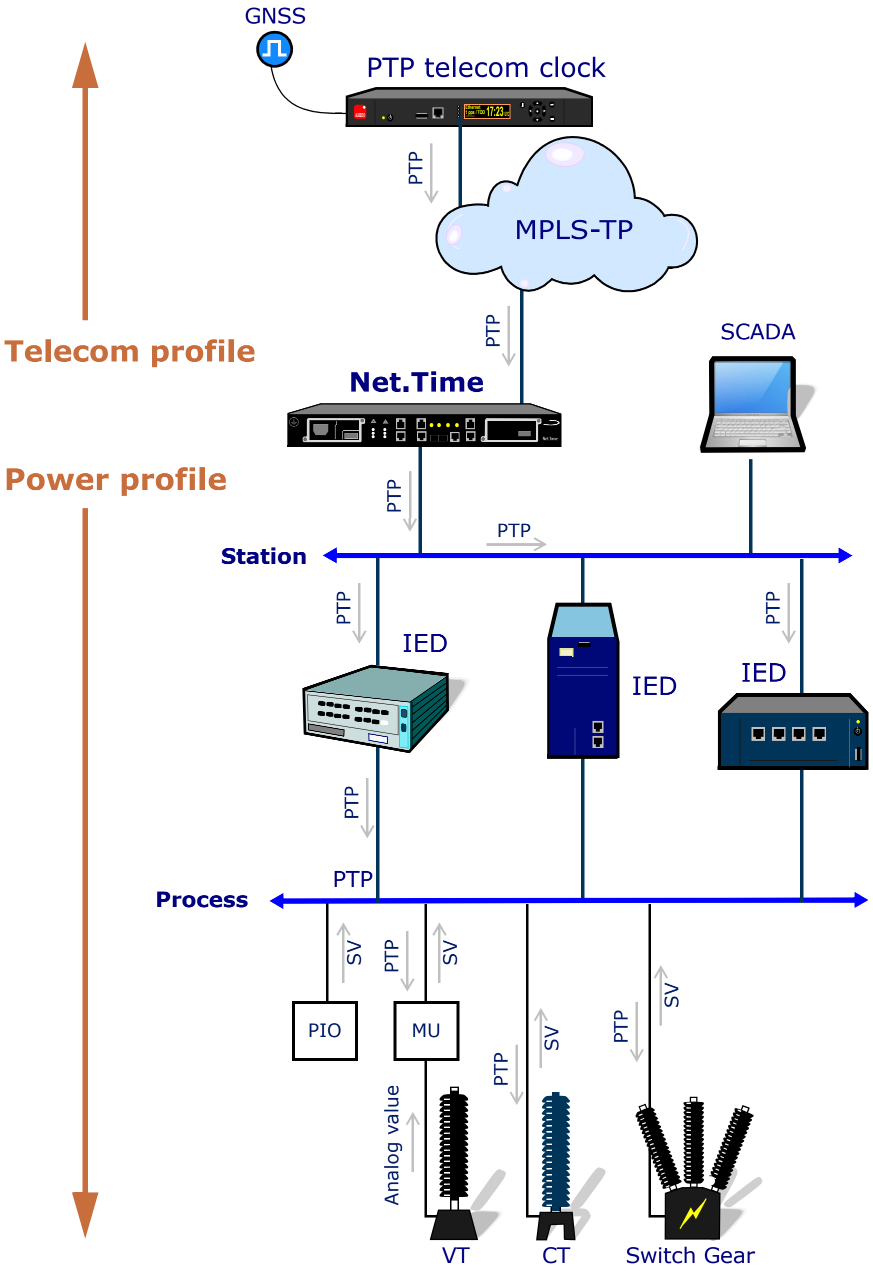
1 - External timing: The NE obtains its signal from a BITS or stand-alone synchronization equipment (SASE). This is a typical way to synchronize, and the NE usually also has an extra reference signal for emergency situations.

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.

PTP Profiles translation



Net.Time supports the following PTP profiles

- Default
- Telecom
- Power
- Utility

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

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

No need for PTP profile translator

Net.Time is a Profile translator

That's all

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