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The Synchronization Experts.

The Digitalization of Electrical Substations

And why PTP is essential

WORKSHOP ON SYNCHRONIZATION AND TIMING SYSTEMS

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Challenges of todays power grids

- Fluctuation (production AND demand)
- Renewables > 20% in the mix in North America
- Energy production fluctuates in the time domain AND regionally
- Generation amount does not follow the energy demand
- New loads are facing the market

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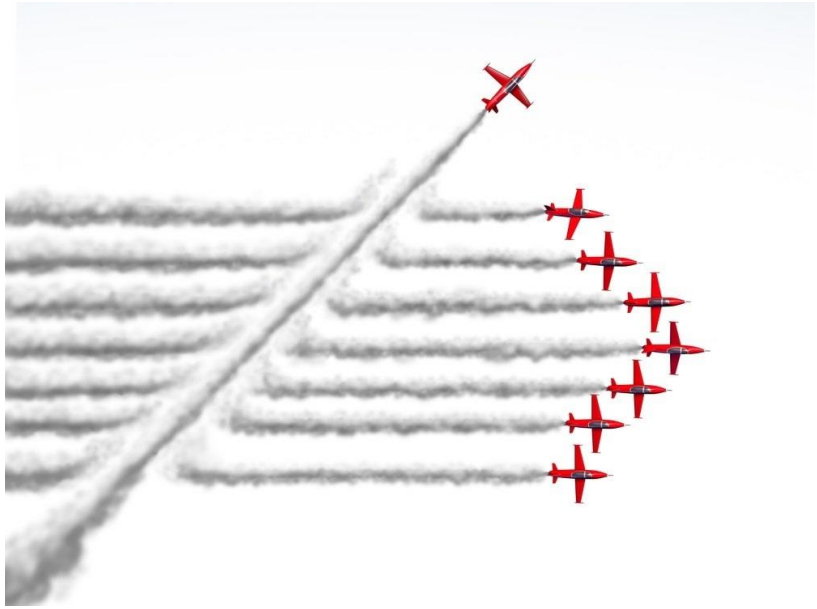
Disruption hits a conservative market/grid



Automotive Disruption

- Its not the first one
- 1908: Model T
- Disruptive Change in Manhattan in 2 years
- Mercedes Benz predicted disruptive point of no return in 2026

US Energy transmission & distribution

- Designed for 50 years
- MarshMcLennan: “Over the next three decades, upward of 140,000 miles of transmission lines will come due for replacement.”
- Replacement alone will not do the job - the grid needs to get ‘smart’

MarshMcLennan:

“Utilities need to consider modernization a golden opportunity to unite public officials, consumers, and the industry to reimagine transmission.”

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Electrical Substations

Substations are the key for the grid modernization

- Strategic nodes of the T&D grid
- Perform switching and routing of AC power
- Are therefore part of the primary process

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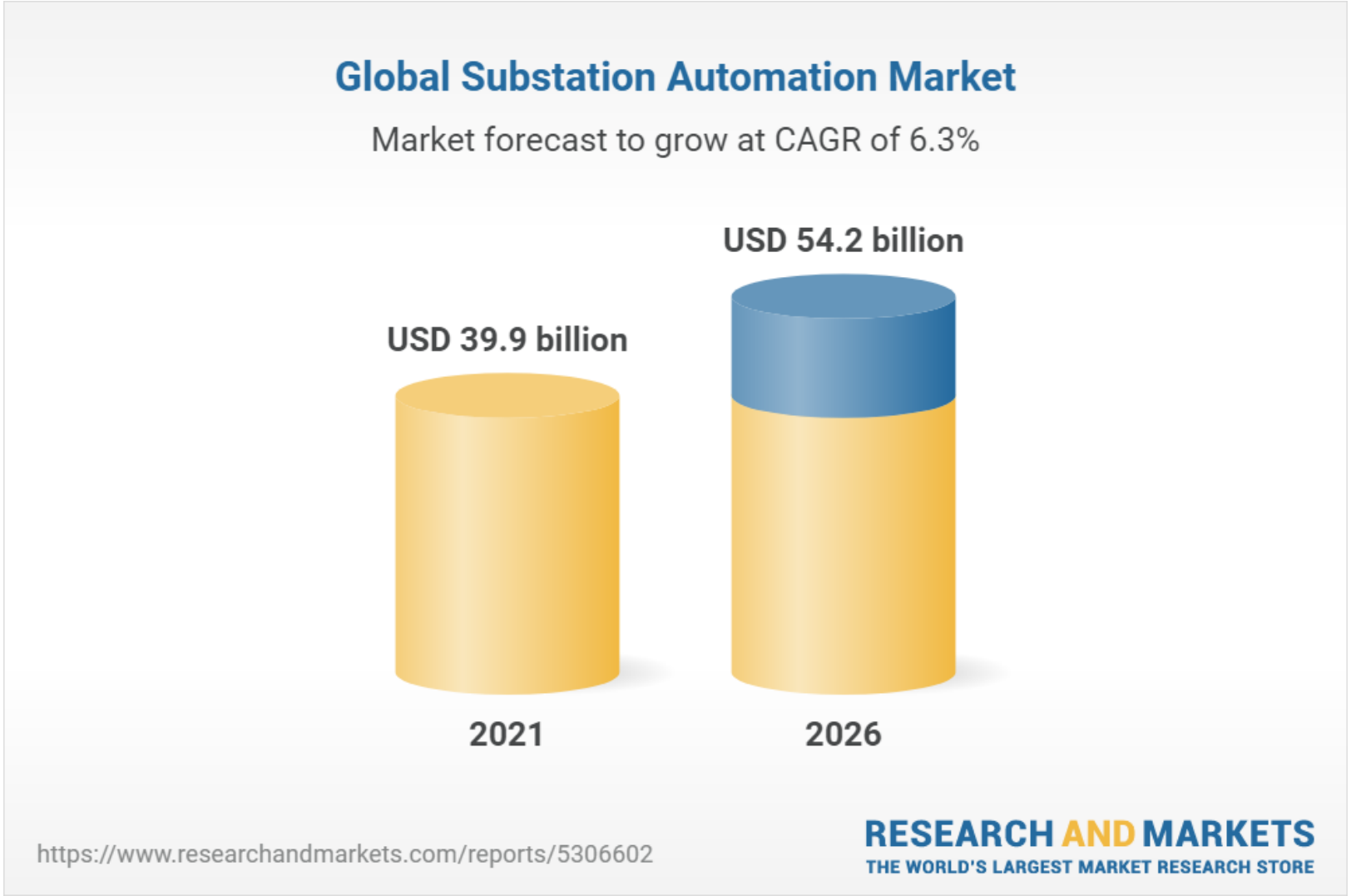
Source: Entsoe

Substation market



Traditional Substations

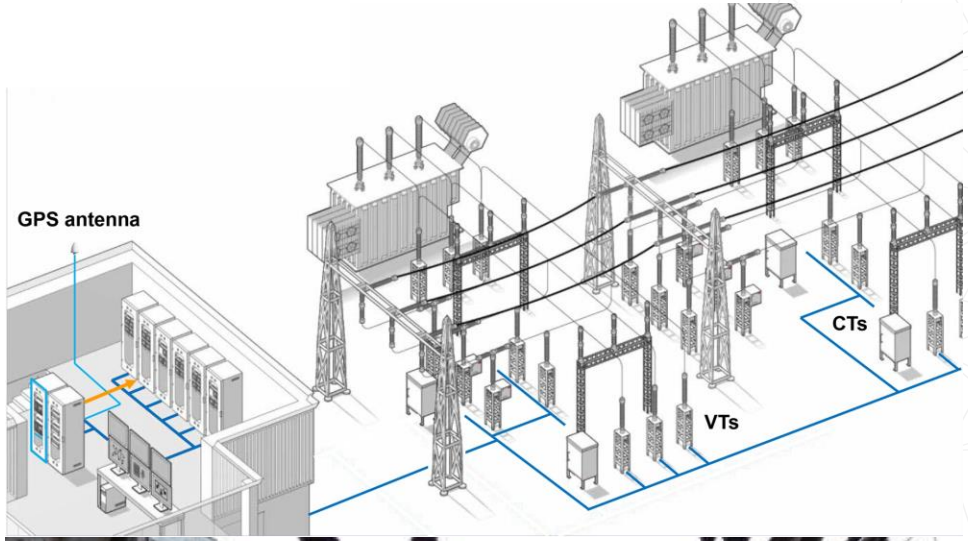
- Logic resides in bay station
- Logic hardwired with VTs and CTs on the process level

Time synchronization used:

- IRIG-B
- PPS

Time sync usage in bay station

- Sequence of event recording
- Fault recording
- Synchrophasor measurements



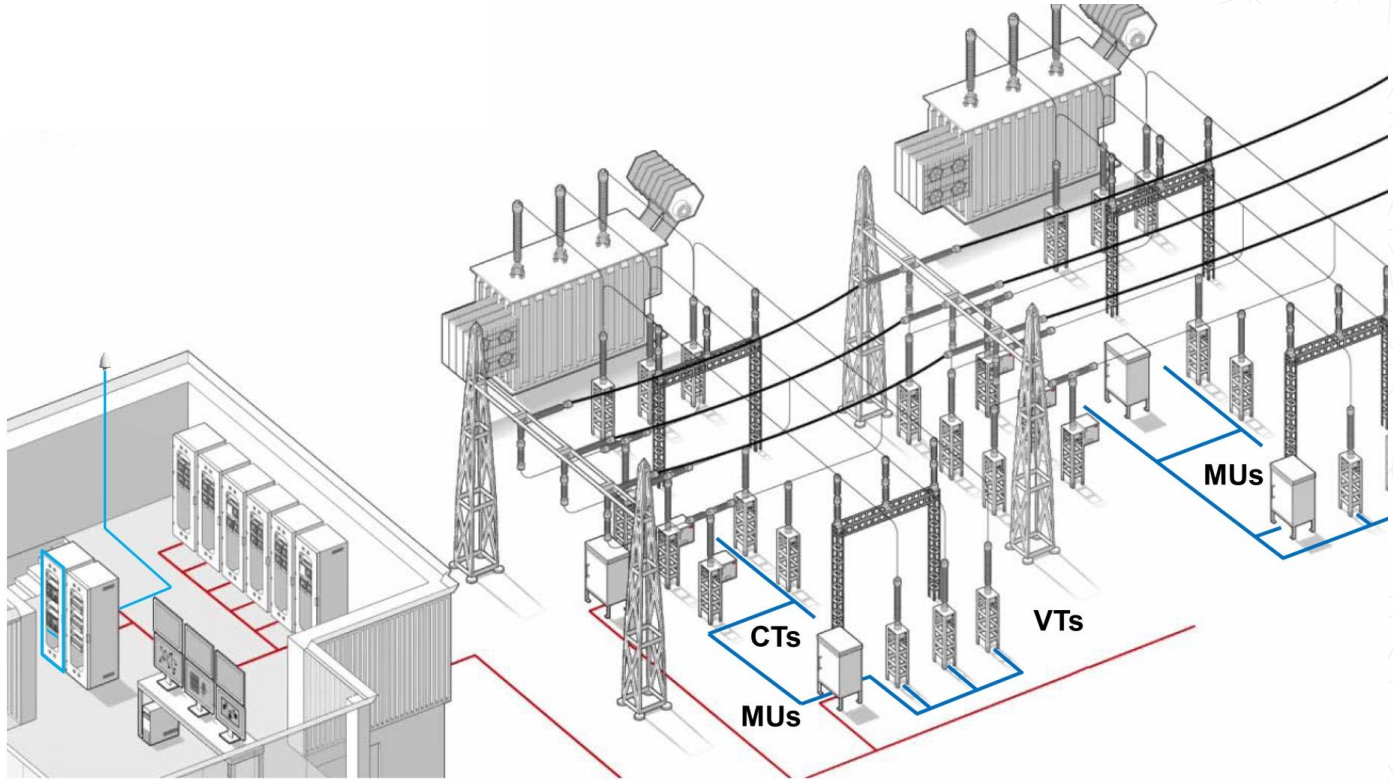
The digital Substation

- Logic goes down to process level
- Logic distributes over IEDs and Merging Units
- Growing complexity

➔ Hard wiring is replaced by redundant LAN connectivity between the IEDs, Merging Units and the station bus

Problem:

- The logic is decentralized
- LAN communication is NOT deterministic
- Synchronicity is lost



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The digital Substation

Solution:

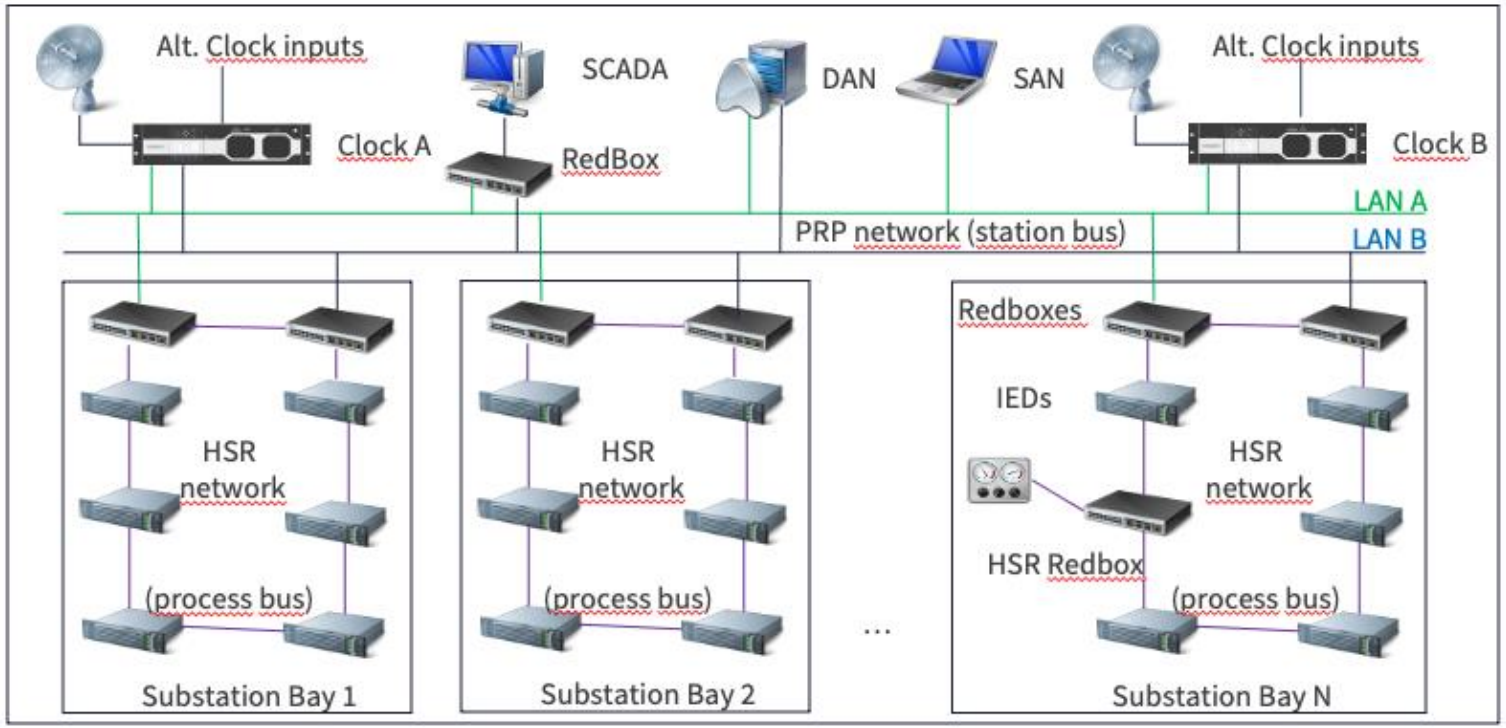
- Time synchronization over LAN – time & data share the same path
- IEEE1588-2008 PTP is the best fit to reach < 1 usec over LAN technology
- Utility profile IEC61850-9-3 is used

➔ PTP time synchronization is one of the key technologies for digital substation automation

Robustness and Resilience of time :

Redundancies on all levels

- Time source
- GNSS systems
- Antenna
- Clock
- Communication path



Core technology IEC61850

Timing industry: IEC61850-9-3 (Utility profile)

➔ BUT it is much more:

- A set of specifications used by the utility and energy industry for IED communication
- Main focus is on substation automation
- Has an abstract data model that comes with semantics

By CubeBubi (talk) (Uploads) - self-made, CC BY-SA 3.0, https://en.wikipedia.org/w/index.php?curid=17225936

- The data of the data model can be mapped to different communication protocols
- Has inherit methods to engineer, provision and configure the plant in a whole
- Meant to provide homogeneity in order to enable easy integration and interoperation between IEDs of diff. manufacturers
- Defines all aspects of communication including time synchronization

➔ It is the swiss army knife for digital substation automation

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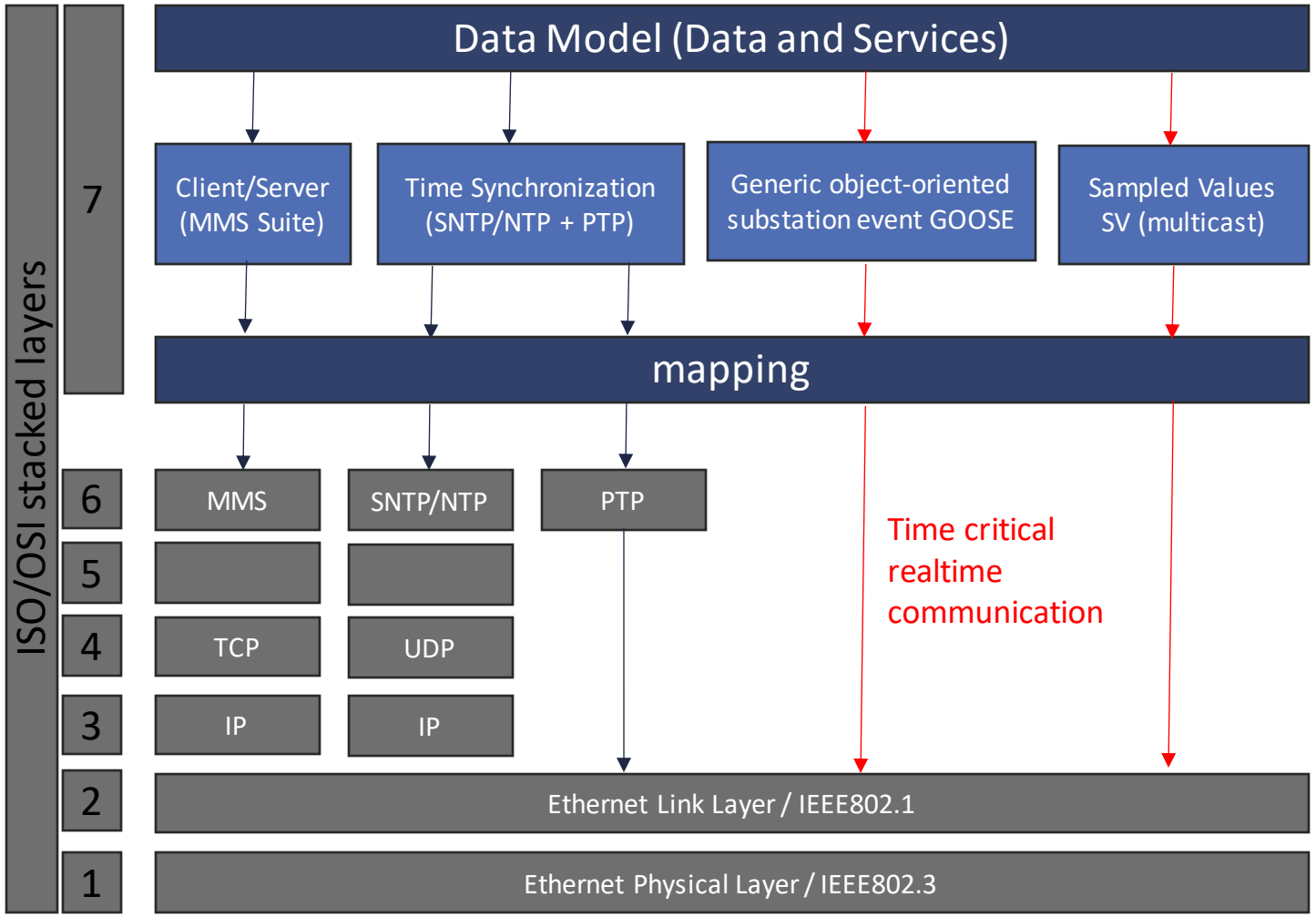
IEC61850 communication



Realtime communication

- Control functions on bay- and process level
- IED 2 IED communcation
- GOOSE (Generic Object Oriented System Event) for event communication
- SV (Sampled Values) for continuous communication

MMS communication

- Client/Server communcation
- Between IEDs and control room
- Station level communication
  - SCADA
  - Time Server
  - other IT
- MMS (Manufacturing Message Specification for non-time-critical communication

Time Synchronization

- (S)NTP
- PTP IEEE1588-2008 & IEC61850-9-3

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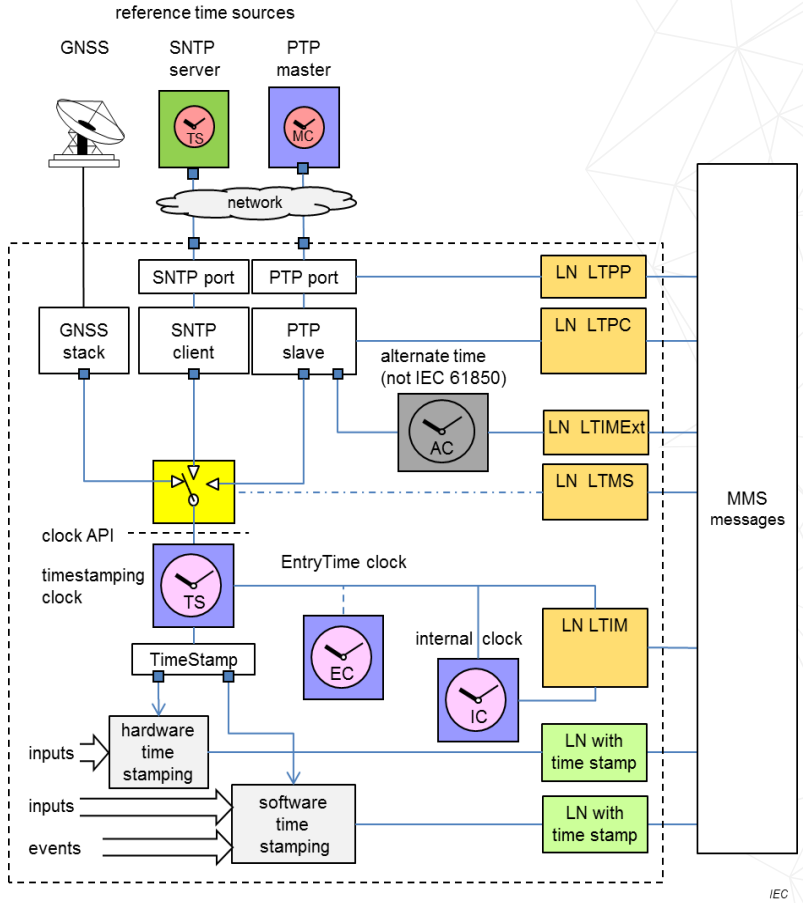
Conclusion

- Digitalization is the next and ongoing step in substation automation
- IEC61850 is a collection & umbrella of specifications
- It is all about Homogenization & Interoperability
- Big vendors are adapting IEC61850 (GE, ABB, ALSTOM, SE …)
- Robust, Precise and resilient time synchronization is crucial for IEC61850

BUT: Time servers do not fully integrate into the IEC61850 world
IEC61850-90-4 defines the basic clock model for Time servers

MEINBERG IS THE FIRST TO WORK ON THE IEC61850/MMS INTEGRATION FOR TIME SERVERS



Thank you!

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