Time Synchronization in broadcast

Experiences From 20 Digital TV Networks

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WORKSHOP ON SYNCHRONIZATION AND TIMING SYSTEMS

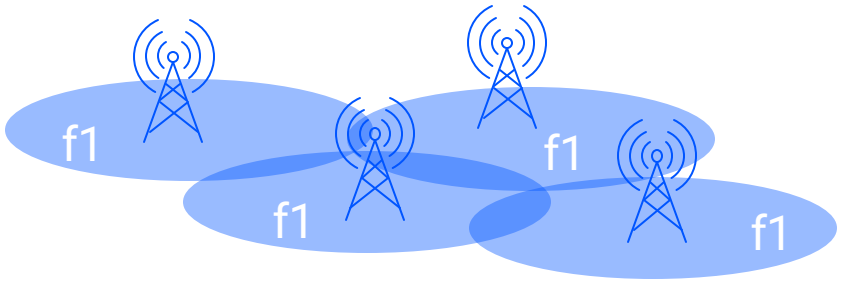
Different tracks in media where synchronization is important

Production
(ST2110, AES67)

Terrestrial broadcast
(ATSC3.0, DVB-T2)

Broadcast and the use of SFN (Single Frequency Network)

Single Frequency Network:



Multi Frequency Network:

Digital Terrestrial TV SFN networks

Requires accurate Time Synchronization

Time synchronisation is a critical component of any SFN network

DVB-T/T2 and ATSC 3.0 allows for SFN operations. For efficient SFN operation all transmitters need to be time synchronized within **±1,5 µs** time error

Synchronisation in ATSC 3.0 is based on the IEEE1588v2 format, but transmitters can still use 1 PPS/10MHz signals

The time synchronization can be provided to the transmitters via GPS satellites or terrestrially over the network or both for resiliency

For SFN (as in 5G TDD), stable and accurate **phase** is most important - **±1,5 µs**

Three ways to do time synchronization

GNSS/GPS

- Most common sync solution
- Very accurate timing <100 ns
- Vulnerable to jamming and spoofing

- National TV often considered critical infrastructure
  - **18 countries** mandated GPS-independent backup for SFN sync

IEEE1588/PTP

- Part of the ATSC3.0 standard
- To meet DVB-T2 and ATSC3.0 SFN timing requirements, FTS is typically required

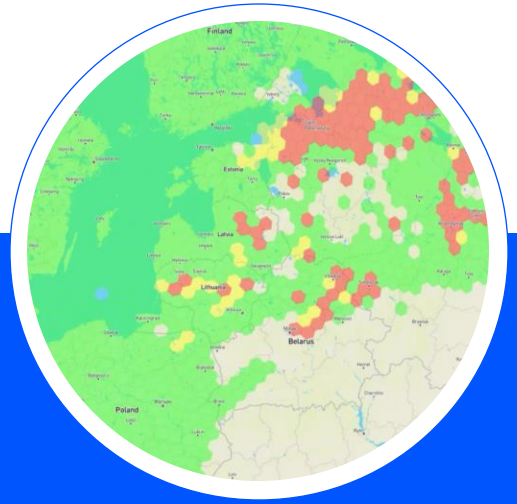
- TV operators often lease capacity making PTP FTS sync complex
- Often older microwave in last mile with combination (not always IP) – not always PTP capable

Precision TimeNet

- Does not require PTP HW support in intermediate nodes
- Works over leased lines and heterogenous networks

- Suited for TV operator with heterogenous networks with a lot of leased capacity
- Interoperable with PTP and being standardized as ePTS in ITU.

Only relying on GNSS comes with challenges for resilience



Sensitive to jamming and spoofing*

Limited to deploy at certain sites

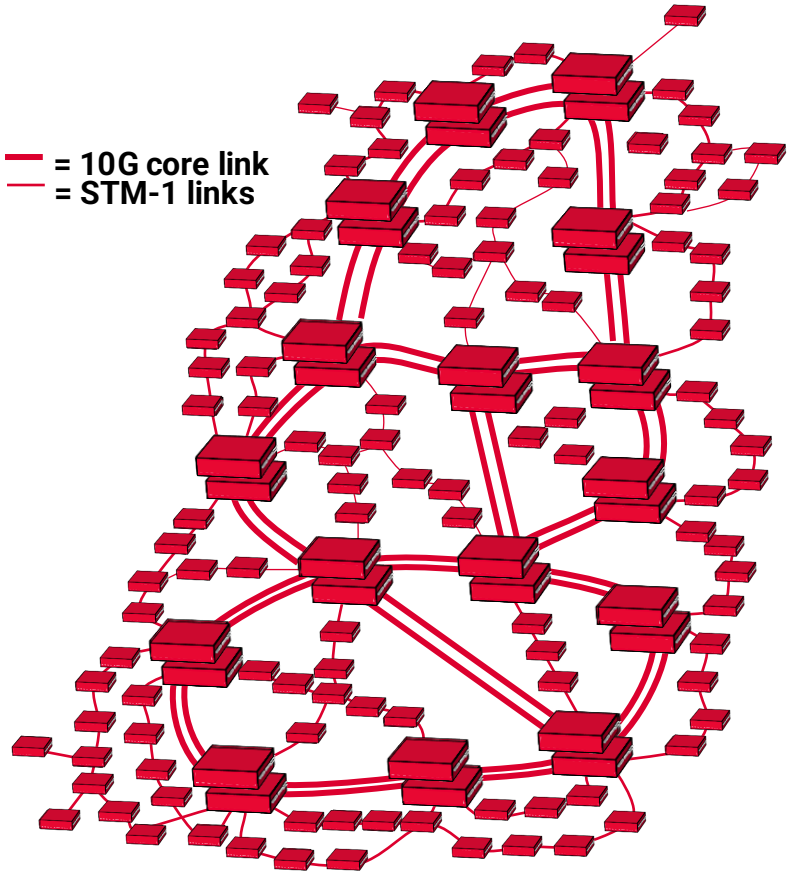
Raised as global concern also for commercial usage**

GPS outage could cause a US telecom sector loss of up to 500M USD per day***

* GPS disruptions across the Baltics during Christmas, gpsjam.org 2023
** The New York Times, 2024
*** Report sponsored by NIST

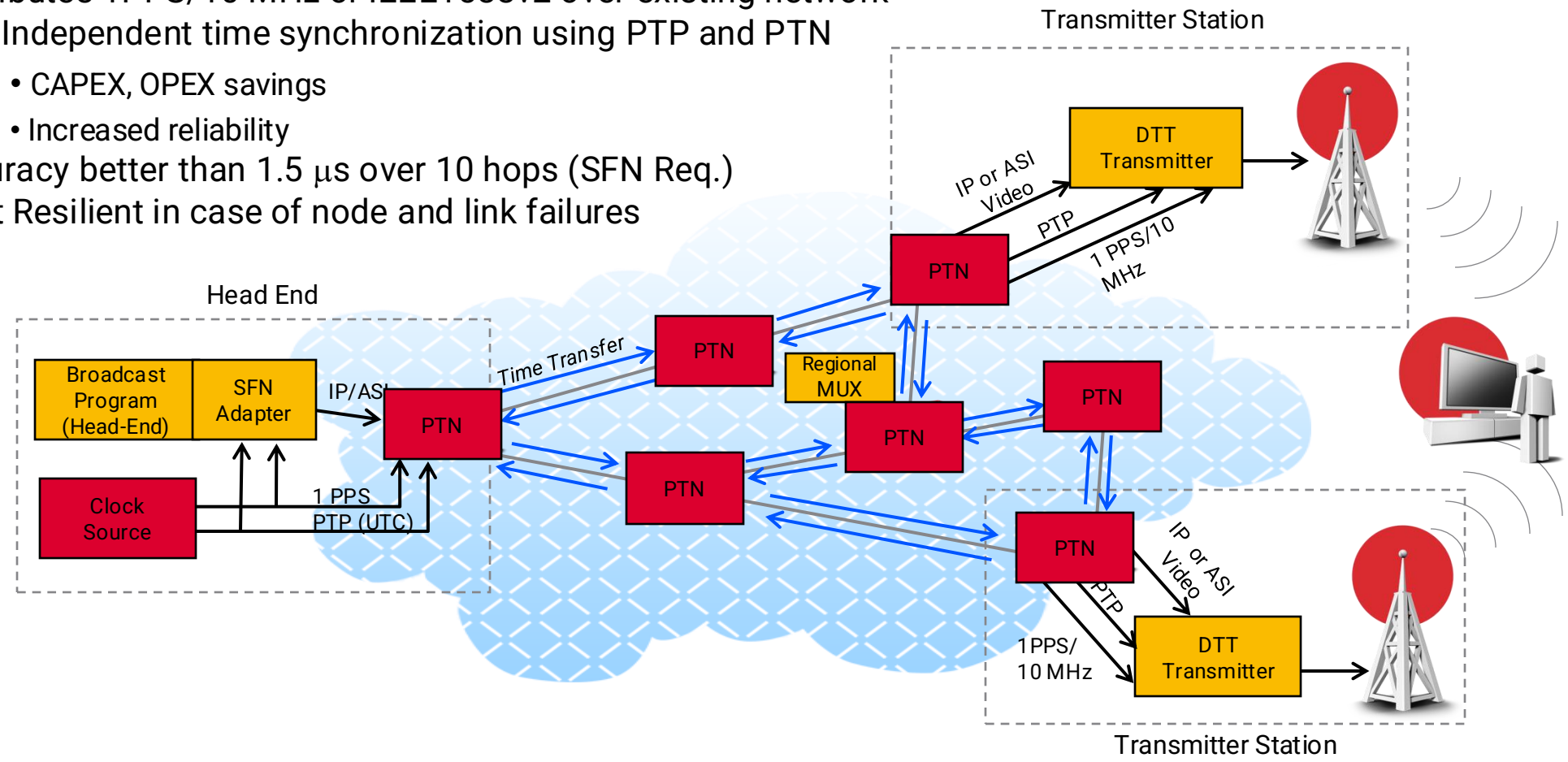
GPS independent DTT SFN Networks

- Norway first country mandating GPS-independent digital terrestrial TV distribution already 2005
- 1200+ digital TV and DAB Transmitters in Norway
- Fully meshed redundant network with 10 Gbps IP core links, but also hundreds of STM-1 microwave links
- Same equipment used for distributing video and data to transmitters used to distribute time as an overlay service

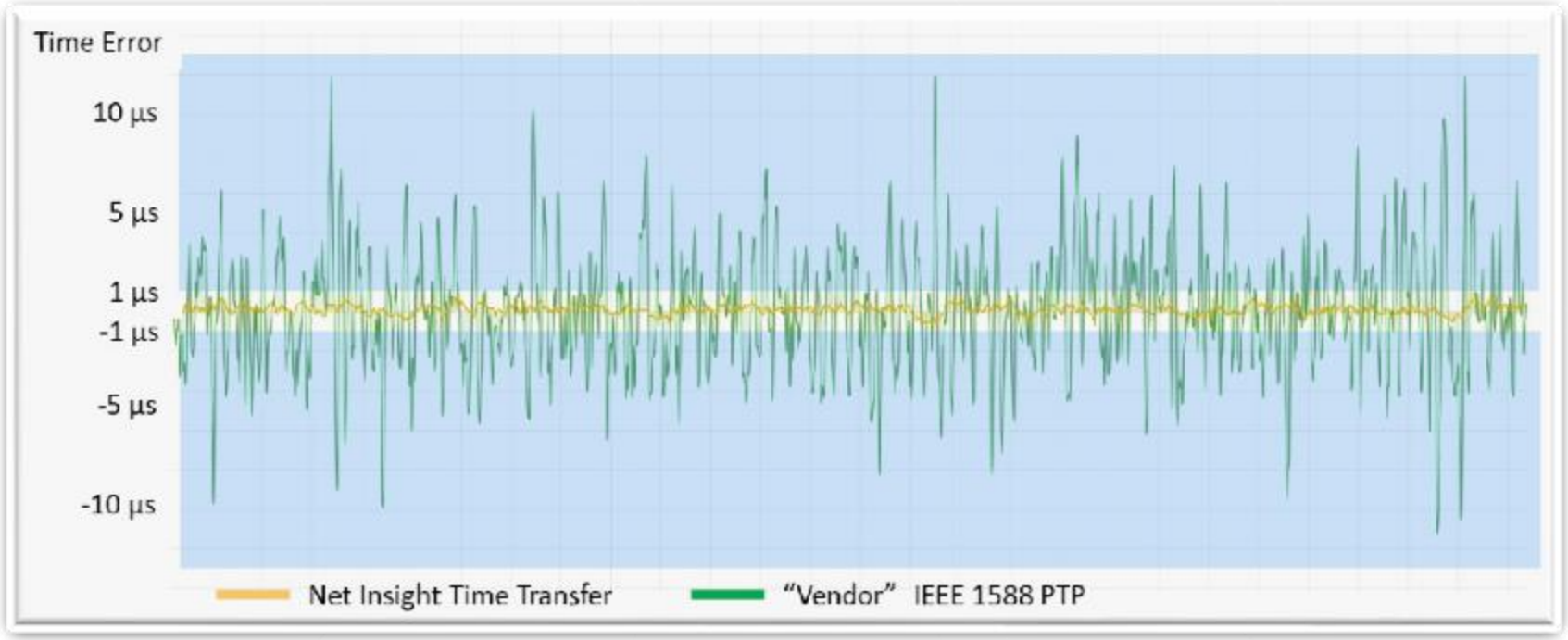


GPS independent DTT SFN Networks

- Distributes 1PPS/10 MHz or IEEE1588v2 over existing network
- GPS Independent time synchronization using PTP and PTN
  - CAPEX, OPEX savings
  - Increased reliability
- Accuracy better than 1.5 μs over 10 hops (SFN Req.)
- Fault Resilient in case of node and link failures



Time accuracy is challenging for PTP Partial Timing Support



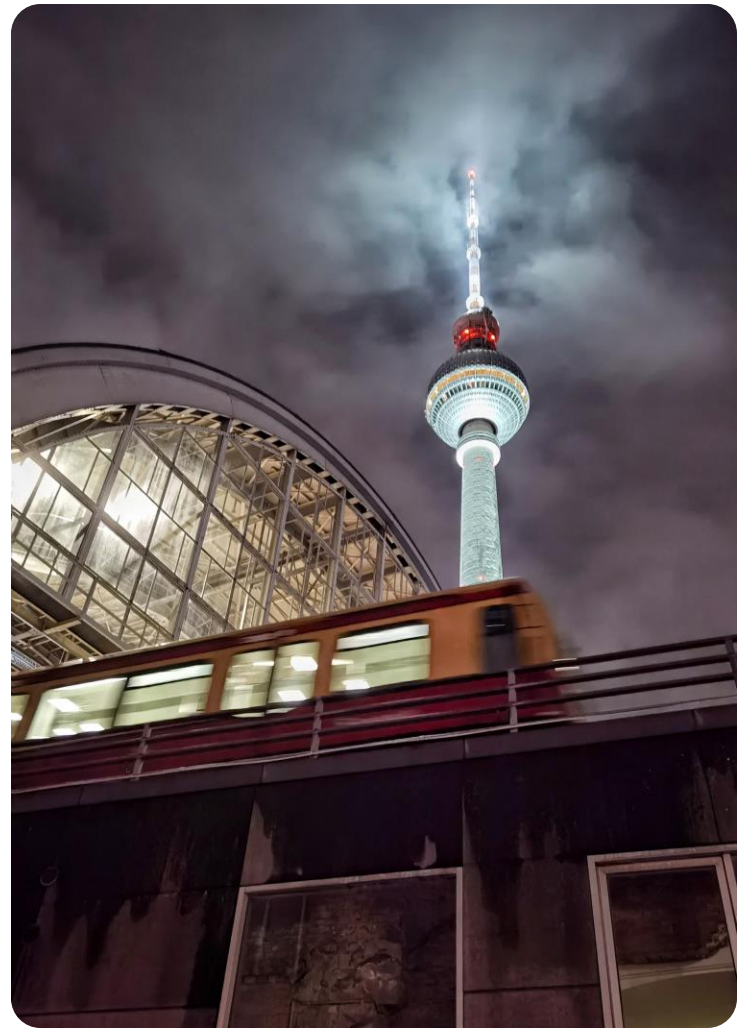
Field measurements of PTP vs Precision TimeNet

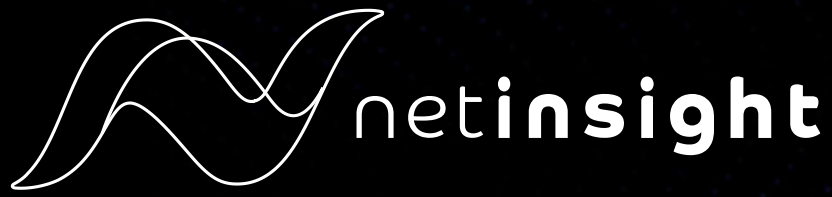
- **PTN Time Transfer within ± 500ns**
- **PTP PTS ~ 10-100 µs**

- Adjustable sync packet rate to handle network jitter (suppress noise)
  - **500-20,000+** (vs 16-128 in PTP)
- Adjustable sync packet sizes (MTU)
- Intelligent lucky packet filtering algorithms with adjustable filter bands
- Multi-link routing – combine multiple paths into a TimeNode to further improve accuracy

Summary – implementing GPS independent synchronization for broadcast

- Challenge that digital TV networks are often a combination of leased line and microwaves making PTP a challenge – Overlay Synchronization helps
- Redundancy is key. National TV considered a mission-critical service
- Older TV transmitters requires 1PPS/10 MHz. New transmitters handles PTP IEEE1588v2





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