ITSF 2022

Time Synchronisation in TV Networks – Experiences From 20 Digital TV Networks

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This is netinsight

Global presence with customers in over 70 countries

25+ years experience serving the largest live events

Listed on Nasdaq Stockholm

- 500+ high-end customers in media –combination of large broadcasters and service providers
- Presence in >70 countries
- GPS-independent time synchronization solution implemented in 20+ national digital TV networks

Strong global customer base

Synchronization in Media

Production and Contribution

- Frequency Synchronization
  - Avoid frame “slip”
  - Ensure frame alignment in production
  - Black Burst or PTP
- Frame (phase) Synchronization
  - Video frame Aligment
    - In studio
    - Over WAN (Wide Area Networks)
    - Remote Production and VAR
  - Lip sync and sync audio/video/data

Digital Terrestrial TV distribution

- SFN (Single Frequency Networks) networks in DVT-T/T2 and ATSC3.0 requires both frequency and phase synchronization
  - DVB-T2 SFN requirements: **1,5 µs**

DVB T2

ATSC 3.0

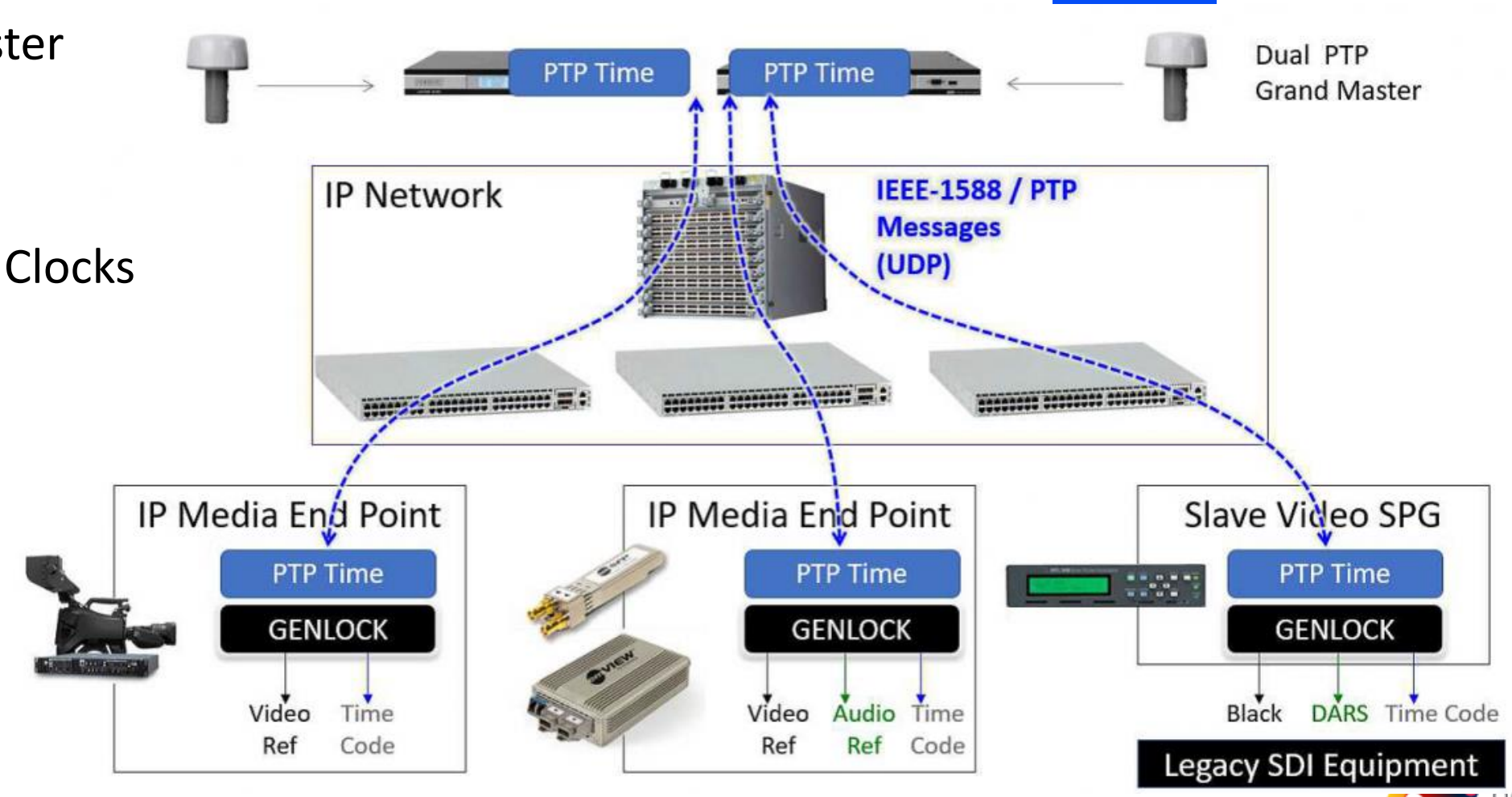
dab+

Time sync (PTP) critical for all IP Media

PTP Grandmaster

PTP Boundary Clocks

PTP Slaves



Redo Picture

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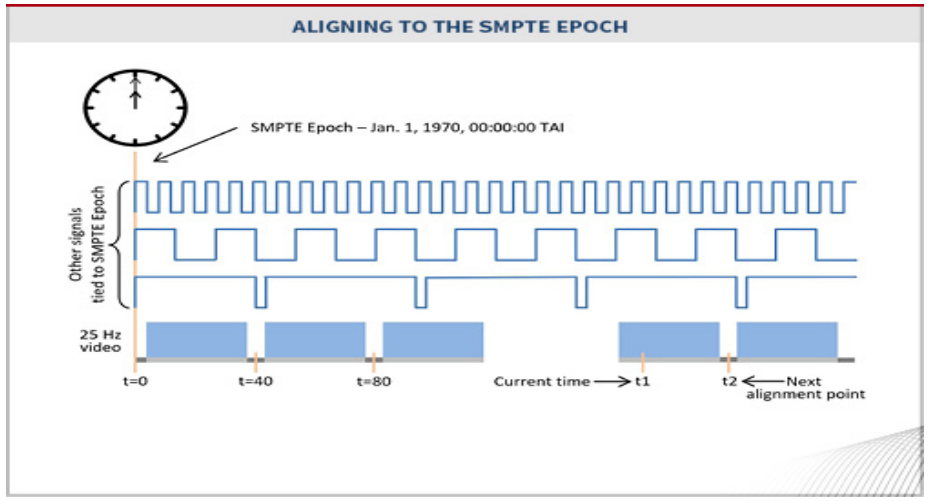
SMPTE **ST 2110** System Timing and Definitions

- System time via PTP with profile defined in SMPTE ST 2059-2
  - Timing requirement of 1 µs (±500ns) across the network
  - Allows arbitrary (ARB) timescale, signalled in profile (others use PTP timescale).
- Media clocks shall comply with SMPTE ST 2059-1 (SMPTE Epoch alignment)
- Real Time Transport Protocol (RTP) shall be used for all media essences
- RTP clock used for Time Stamps is locked to the Media clock for the specific essence type

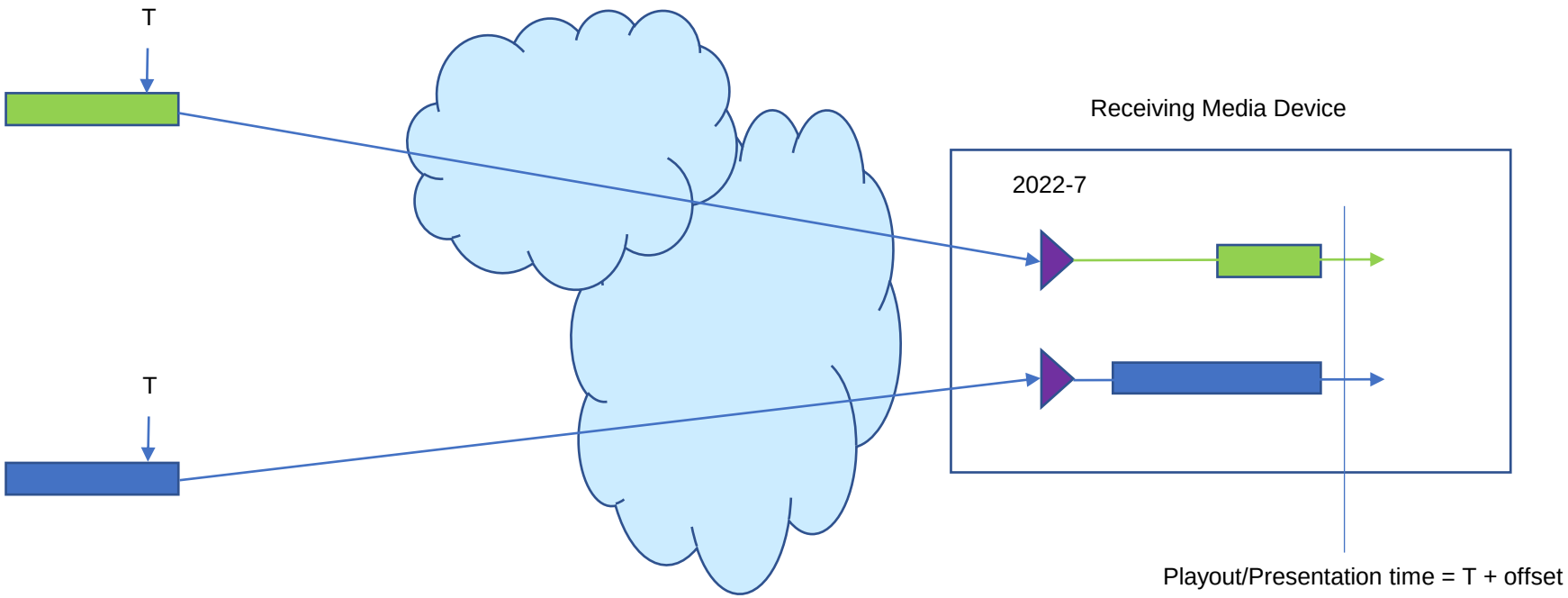


RTP packet header

Offsets	Octet	0								1								2								3							
Octet	Bit [a]	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	0	Version			P	X	CC			M	PT							Sequence number															
4	32	Timestamp																															
8	64	SSRC identifier																															
12	96	CSRC identifiers …																															
12+4xCC	96+32xCC	Profile-specific extension header ID																Extension header length															
16+4xCC	128+32xCC	Extension header …																															

- All 2110-20 packets containing data for one specific video frame has the same timestamp
- The timestamp for a 2110-30 audio packets is the sample time for first audio sample in the packet

Essence alignment and playout



- Requires same clock everywhere
- Aligns any essences produced anywhere if they were timestamped with an UTC locked, SMPTE epoch aligned, media clock
- Offset must be larger than longest essence delay (network transit + 2022-7 latency + …)

Transition from Legacy Media Timing

SDI IP

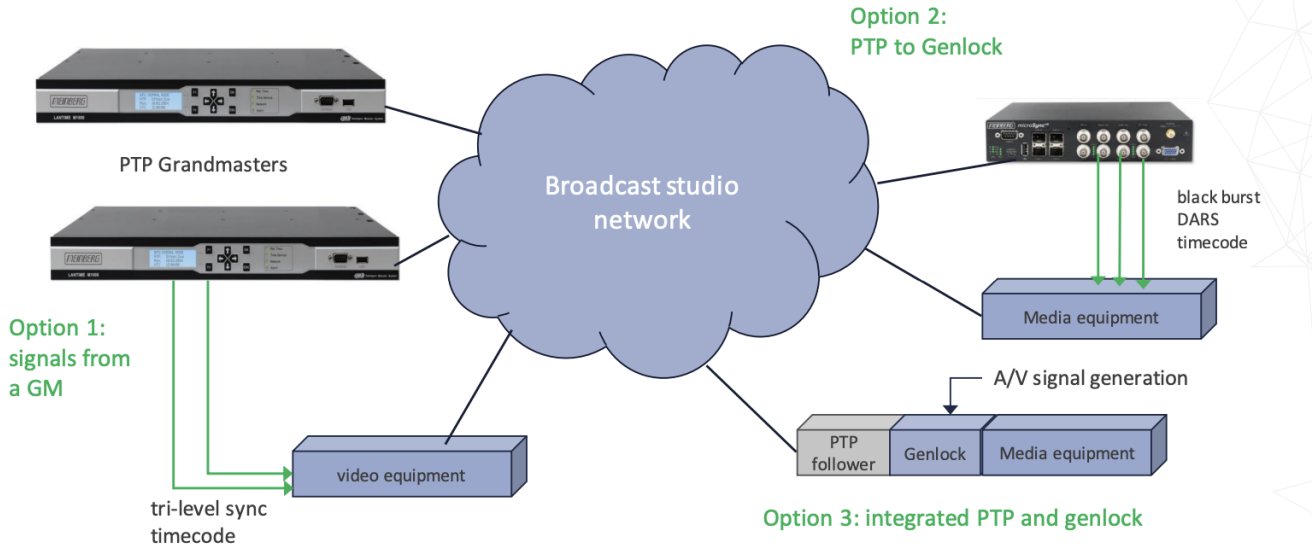
Legacy Media Sync Formats:

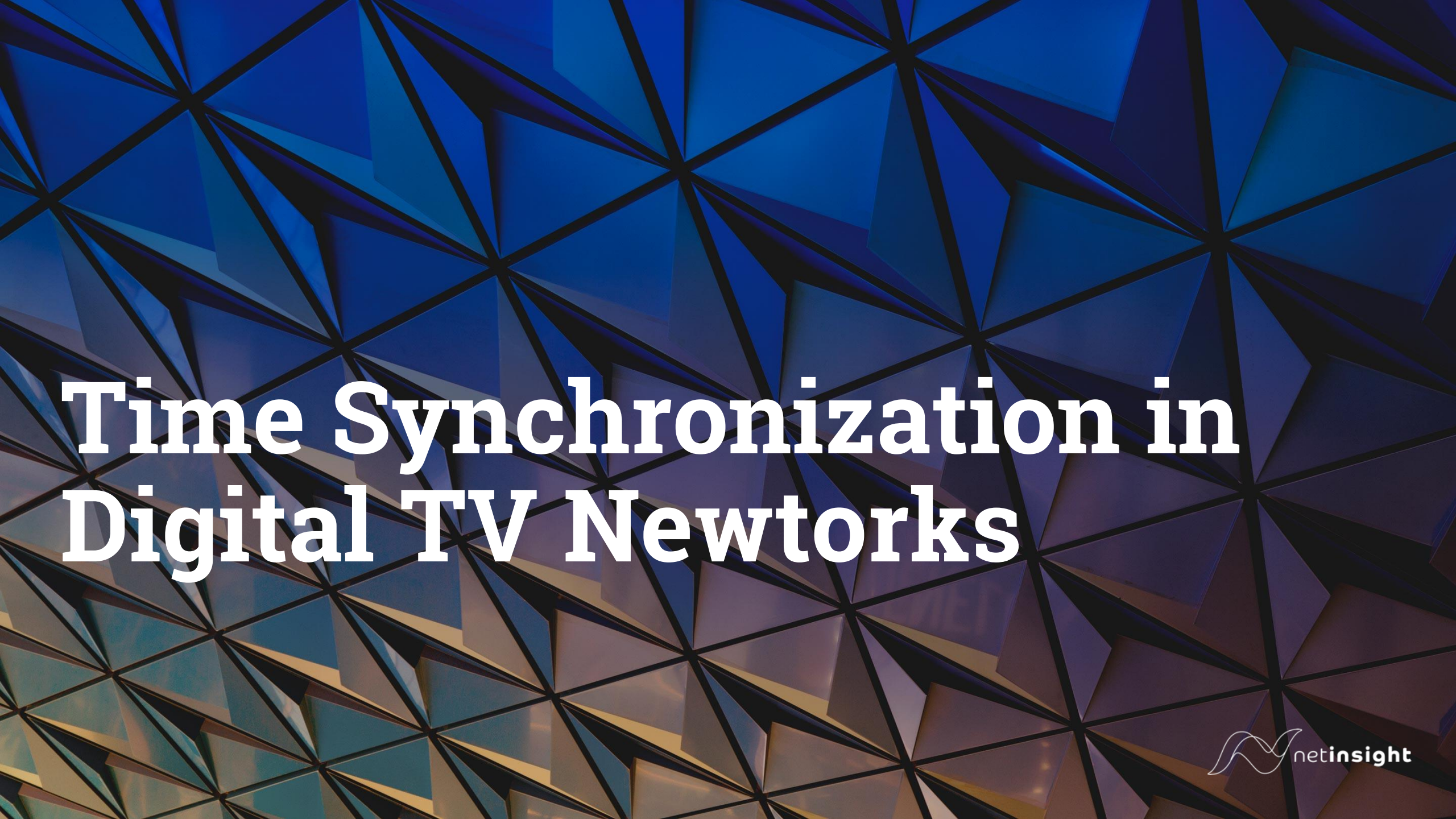
Video Timing Signals
- Black Burst
- Tri-Level Sync

Audio Timing Signals
- Word Clock
- Digital Audio Reference Signal (DARS)

Linear Time Code
- Used to insert timestamps in captured media

IEEE1588v2 with ST 2059-2 Profile




Time Synchronization in Digital TV Newtorks
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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 most transmitters 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 (and 5G TDD), stable and accurate **phase** is most important - **±1,5 µs**

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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 infrastrcucture
  - 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 of IP and SDH – not always PTP capable

Overlay Sync (PTN)

- 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

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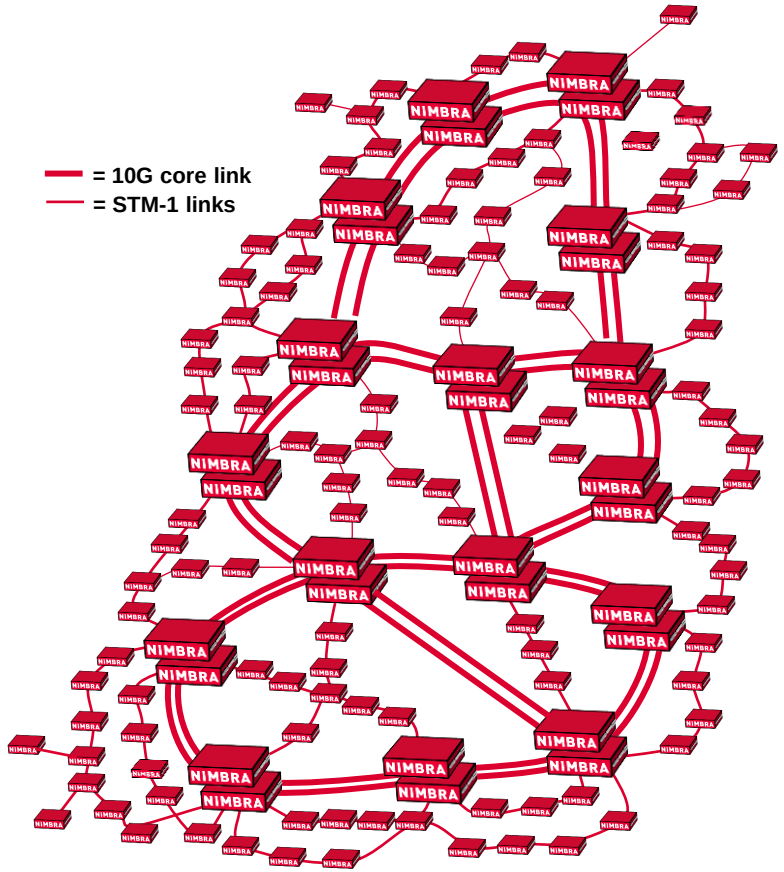
Telenor (Norkring) Broadcast first TV operator to mandate GPS/GNSS independent TV distribution

- 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
  - Over 900 Net Insight Nimbra nodes



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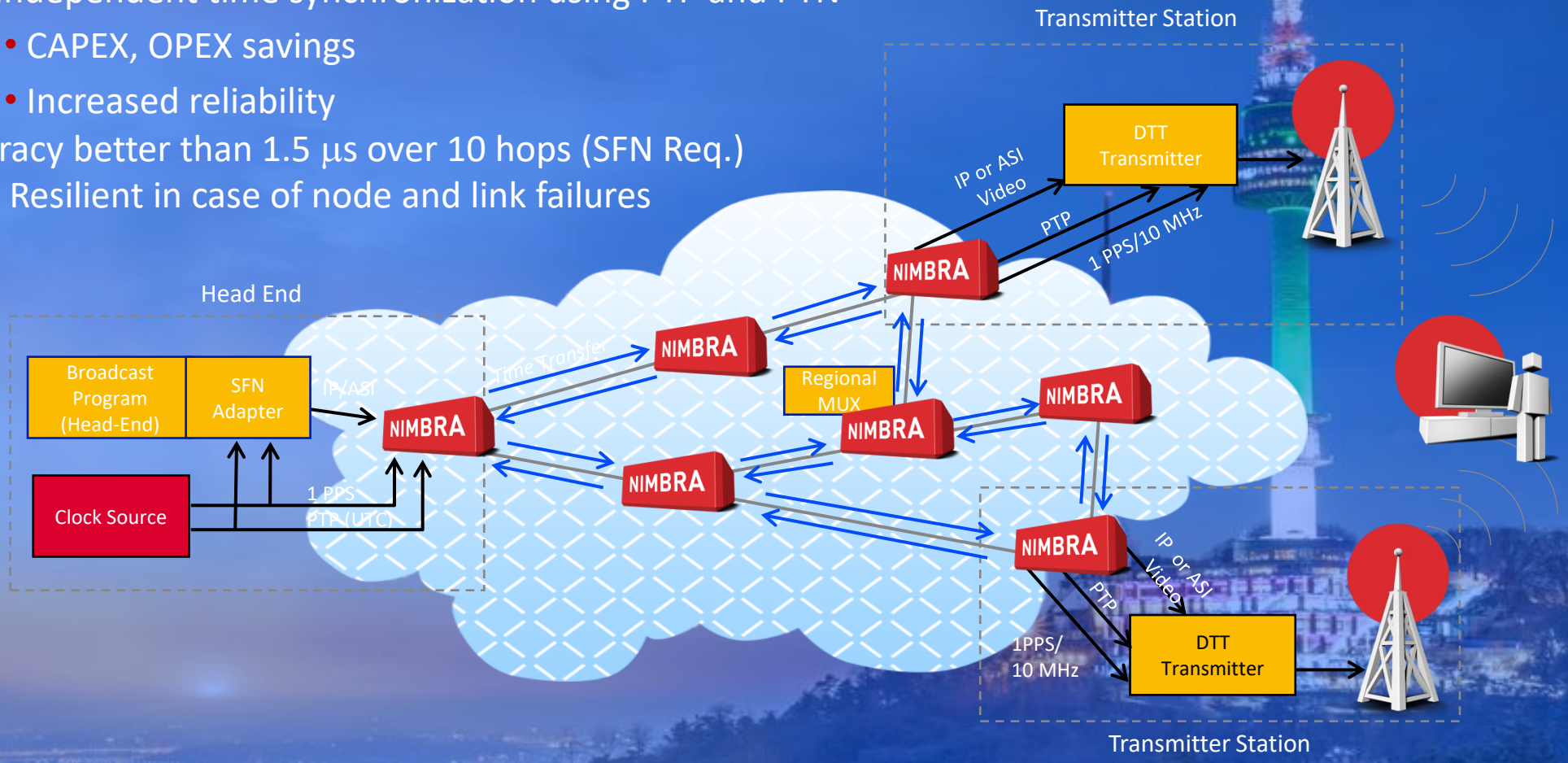
GPS Independent DTT SFN Networks

- Disitributes 1PPS/10 MHz or IEEE1588 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



Summary - Synchonization in Media networks

- Synchronization is key in all media networks
- New ST2110 Media standards mandate PTP as synchronization interface following the SMPTE broadcast profile ST 2059-2
  - But…, need to handle legacy equipment using legacy broadcast sync formats
- PTP increasingly used to synchronize remote sites, But… Broadcasters and TV operators often use leased IP capacity making FTS PTP sometimes challenging
- Media is moving to remote and distributed production workflows
  - Frame Stores and/or link offset buffers may add significant delay for delay sensitive solutions
- Digital TV networks first critical infrastructure mandating GPS-independent time synchronization

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