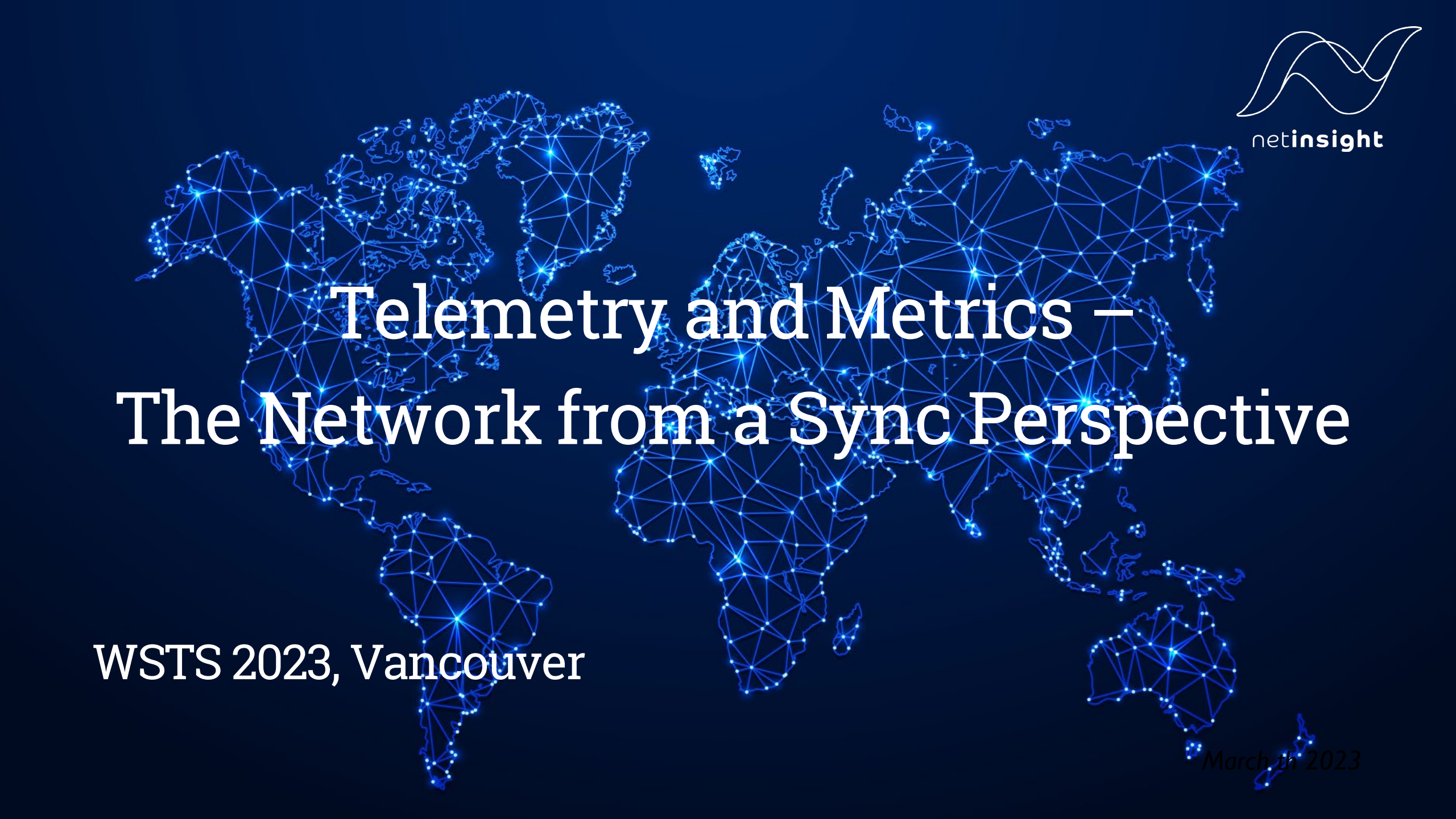


Telemetry and Metrics – The Network from a Sync Perspective

WSTS 2023, Vancouver

March th 2023

Time is fundamental for 5G TDD Networks

5G TDD puts fundamental new requirement on network

➢ **Accurate Time and phase**

New 5G functions require accurate time:

- Massive MIMO
- Carrier Aggregation (CA)
- Coordinated Multi-Point (CoMP)

Existing Time Synchronization solutions have challenges

PTP FTS not possible everywhere

➢ Leased Lines, Costly upgrades

GNSS/GPS vulnerable to jamming/spoofing

➢ Security and availability issue

netinsight

5G synchronization – GNSS independence

The Swedish regulator, Swedish Post and Telecom Authority (PTS) is explicit that a GNSS independent solution to transport synchronization is a mandatory requirement for operating a 5G network in Sweden.

Conditions for license to use radio transmitters in allocated frequency space within 3400–3720 MHz, Appendix A2

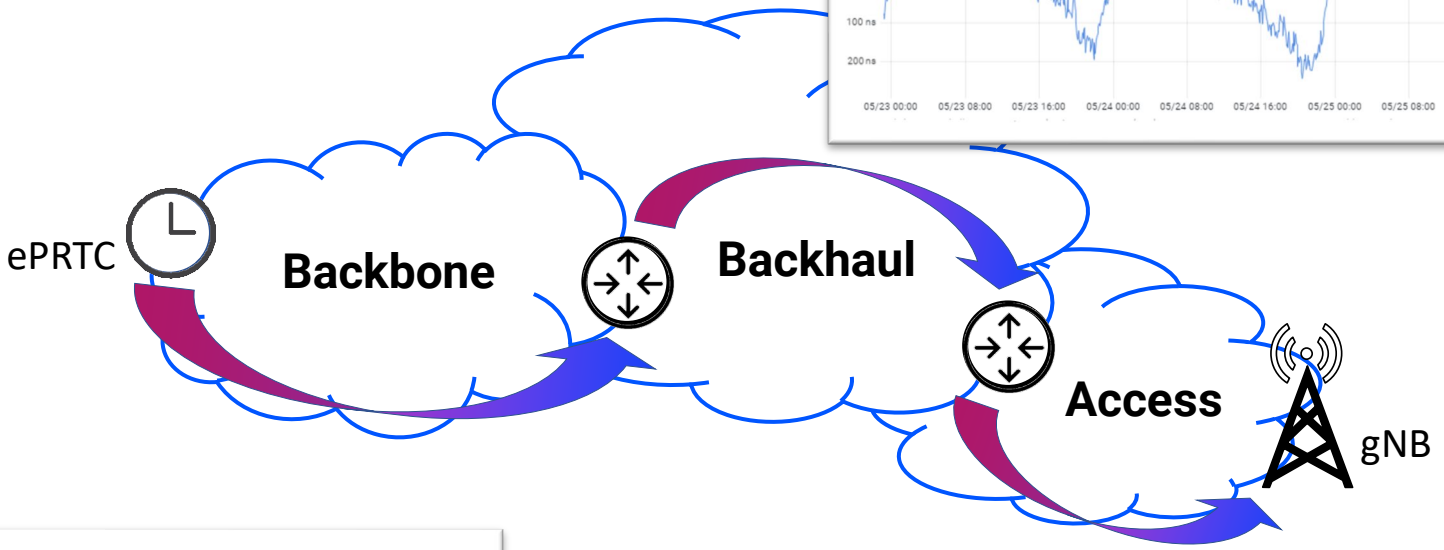
26. If the primary source of common time reference is the reception of signals from satellite (GNSS) or if the source is otherwise located outside Sweden, a redundant source located in Sweden must be functionally tested and ready to put into use when required at latest by January 1st, 2025

Distributing the time from time reference to the NR site over the Mobile transport network can be a challenge!

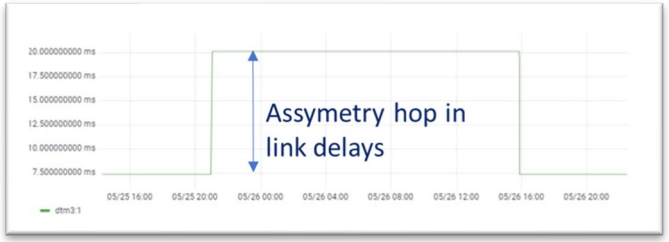
Network Time Error Budget

1500ns

1100ns

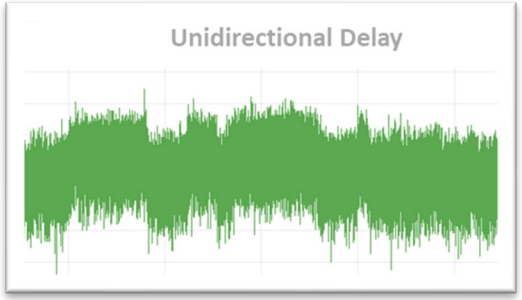


Backhaul:
Wholesale and leased line Service Routers
- Non-PTP supported networks.
- Various **delay variation** patterns – diurnal wander



Backbone:
xWDM systems
- Detect and handle **asymmetry** problems

Core Routers
- cTE and dTE deviations



Access:
Mix of vendors and technologies, Microwave.
Lots of delay variation, including asymmetries.

Measure your network

- Measure to understand sync behaviour and issues
- Measure to understand network behaviour and issues
- Measure and analyze to optimize your synchronization network
- Enables data driven network analysis.

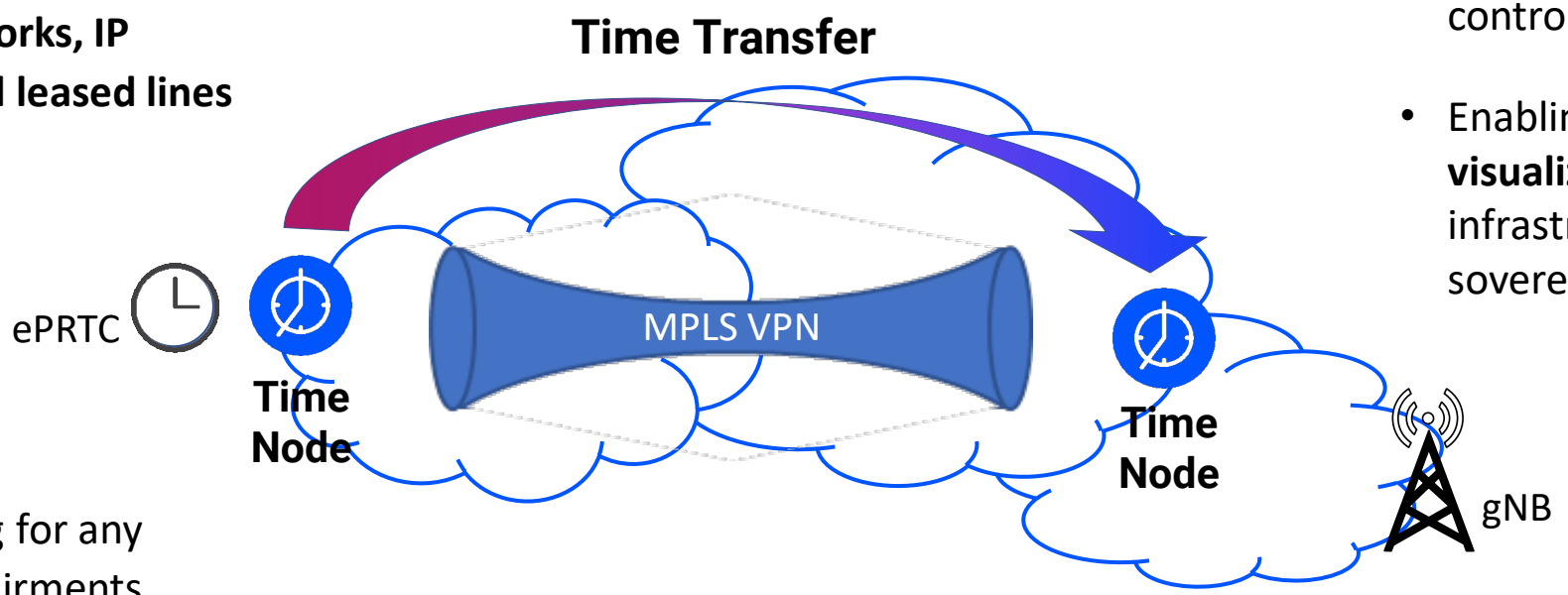
Light up the network from a synchronization perspective.

netinsight

Customer Case from 3 Sweden: Adding a time transfer overlay to handle non-PTP enabled links and leased lines

- Adding TimeNode with reliable distribution of high accuracy PTP over **existing DWDM networks, IP networks and leased lines**

- Handling and compensating for any network impairments



Backbone:
xWDM systems
Core Routers

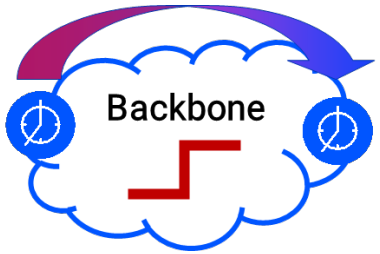
Backhaul:
Wholesale and leased line
Service Routers

- **Extensive sync telemetries** per sync link and sync node are key to maintaining synchronization control.

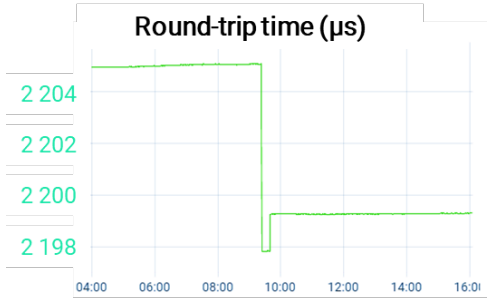
- Enabling **full end-to-end sync visualization** over any network infrastructure providing sovereign control

Example 1

Transfer of time over leased wavelenght (xWDM)



Sudden change of round-trip time on WDM



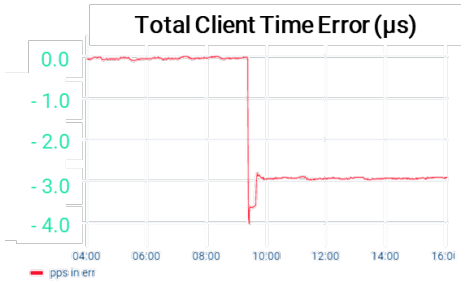
RTT drops 6 µs

Client Clocks normally distribute change evenly

-3 µs forward

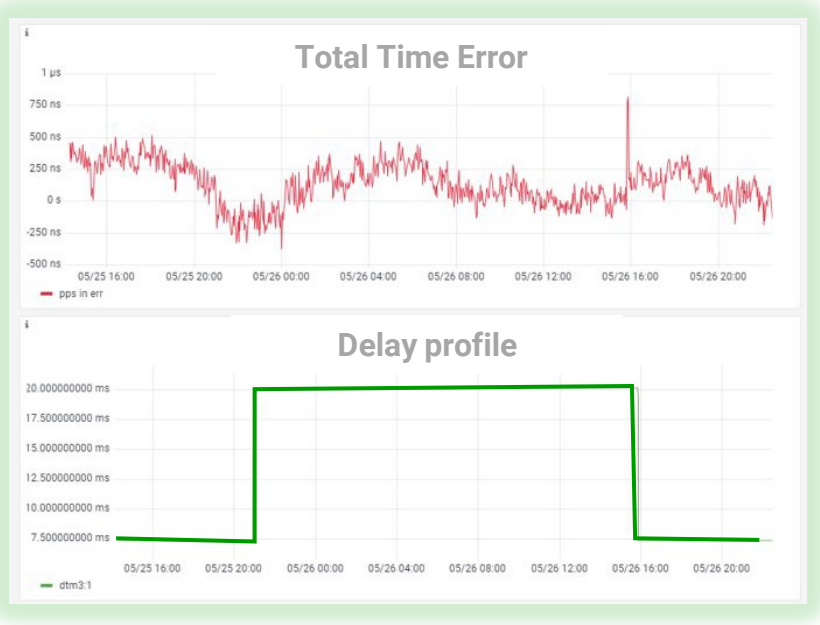
-3 µs backwards.

Wrong assumption Only backwards direction changed this time



Result: cTE -3 µs

Detect, analyze and compensate for asymmetries

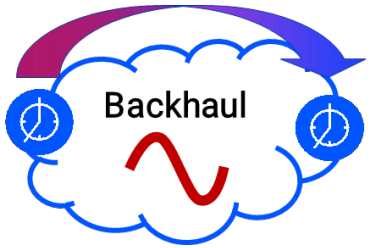


Sudden changes in unidirectional delay results in asymmetry profile change

netinsight

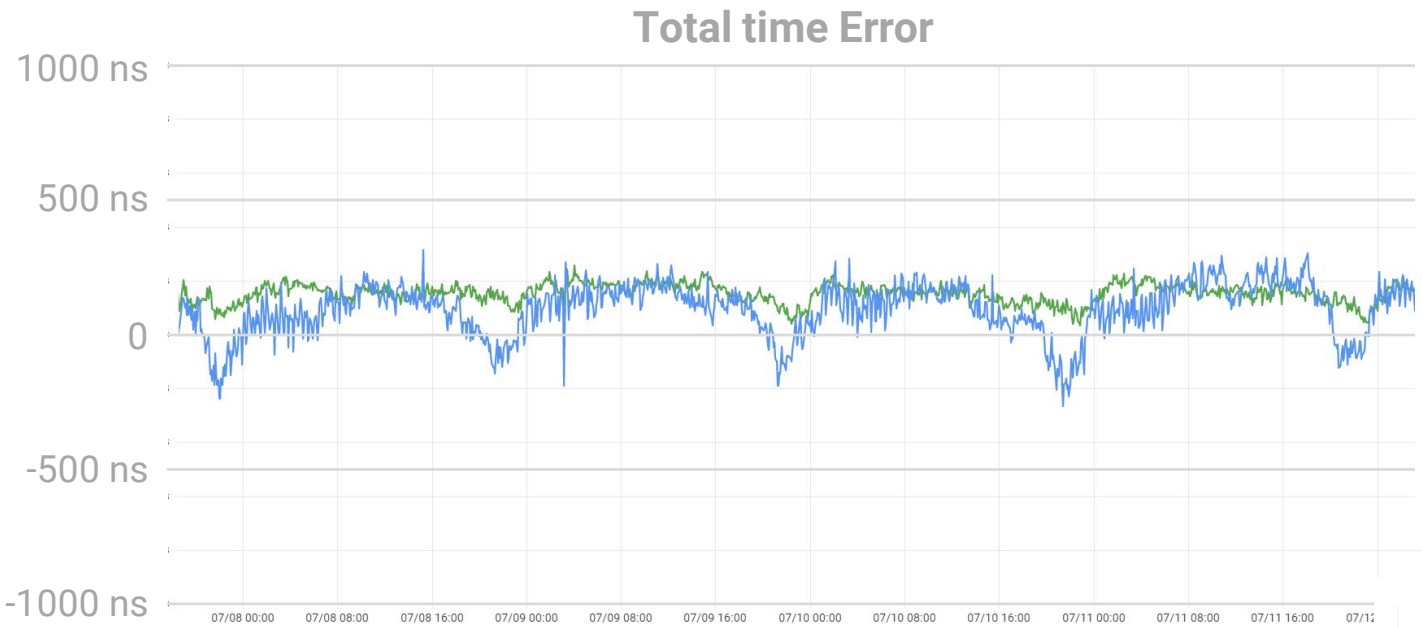
Example 2

Transfer of time over VPLS capacity service



VPLS Capacity provider X and Y towards PE router on site A and B

Provider X handles time transfer/PTP traffic as ”Business Critical” (Prioritized data).
Provider Y handles all traffic (no Qos differentation) as one ”pipe”



Provider X Provider Y

Not all Capacity Services are created equally.

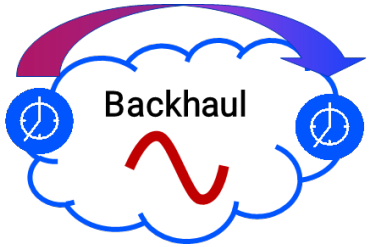
Even small changes in service characteristics can have large synchronization impact

Detailed metrics are required to understand impact to Synchronization.

- Round-trip time day variation
- Unidirectional delay variation
- Standard deviation in unidirectional delays over peak busy hour
- AI analysis.

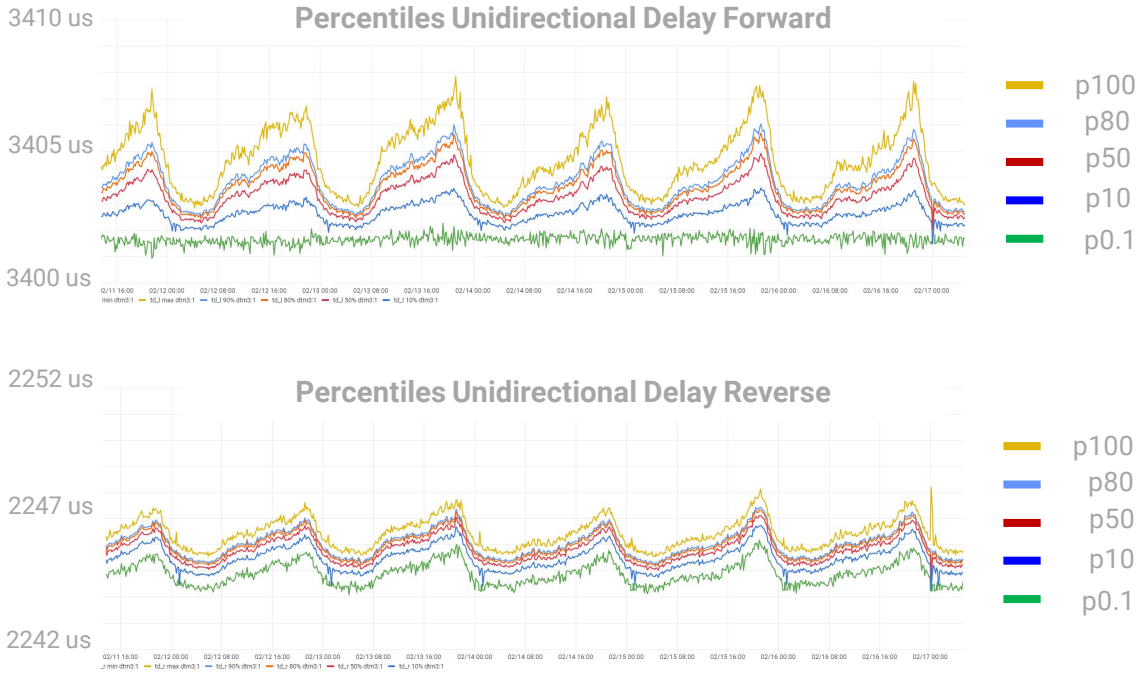
Example 3

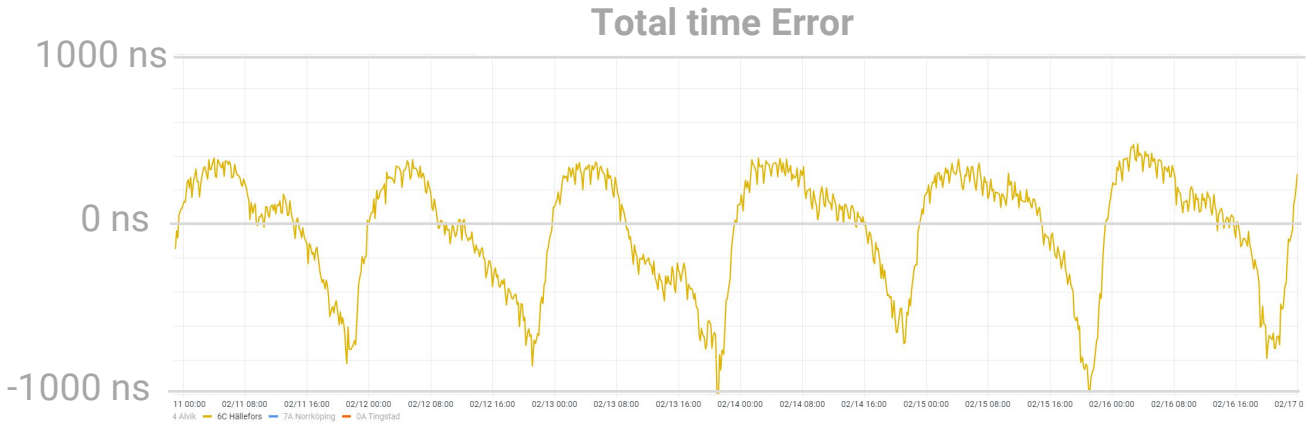
Transfer of time over VPLS Capacity service



VPLS Capacity provider X towards PE router on site C

Vendor X handles timetransfer traffic as ”Business Critical” (Prioritized data).





Site C is known to be particularly troublesome
Earlier troubleshooting, e.g. using TWAMP have not resolved it

Detailed Telemetry showed probable causes

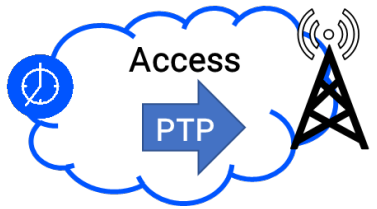
- Very different unidirectional delays in the two directions
  VPLS capacity service is probably NOT co-routed
- Very different Floor Packet Percentile (0.1%) behavior in the two directions.
  Service has a heavy traffic induced asymmetries of several us

Problem is now found and could be addressed

netinsight

Example 4

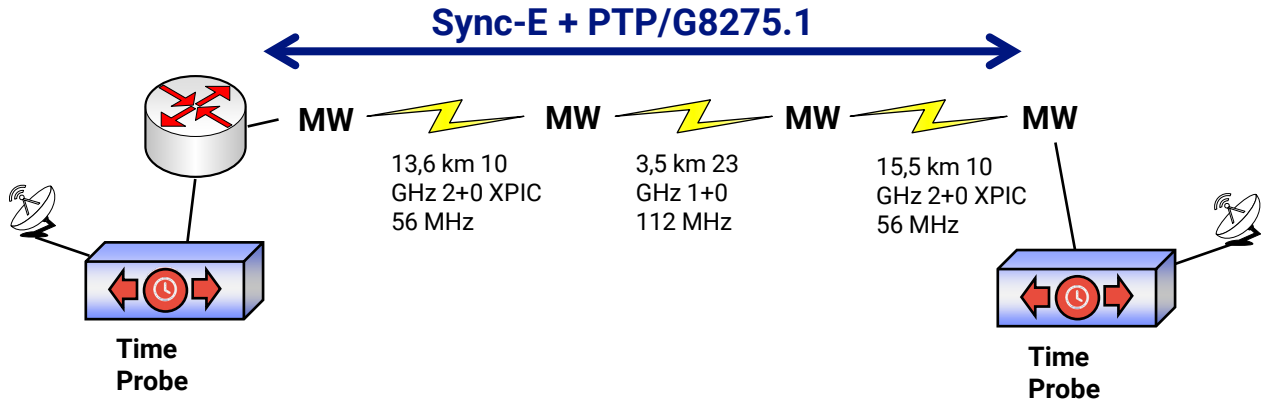
What is the TE budget for the Access network?

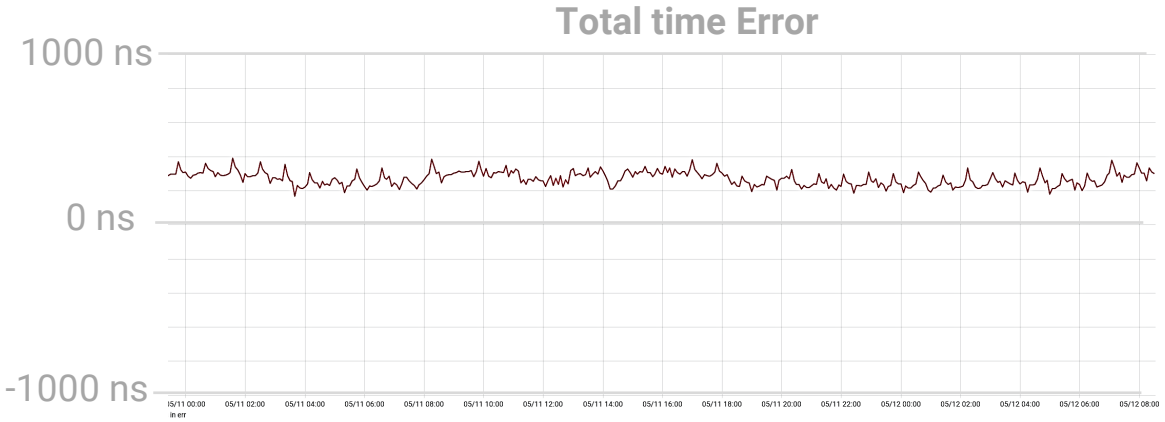


From PE router - Sync-E + PTP/G8275.1 over 3 x Microwave segments

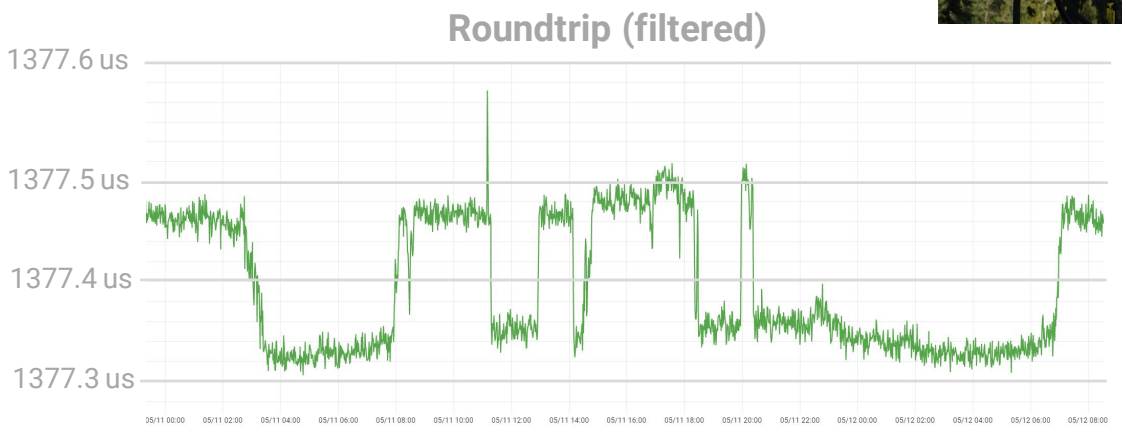
Only one way to know for sure …

Measure the Metrics !





Well performing MW are within 200 ns Total TE in 3 hops

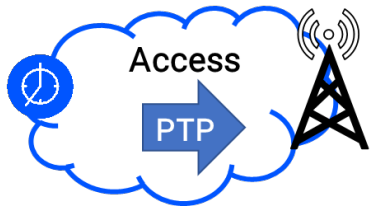


Microwave delay changes are not visible in the timing domain

netinsight

Example 4

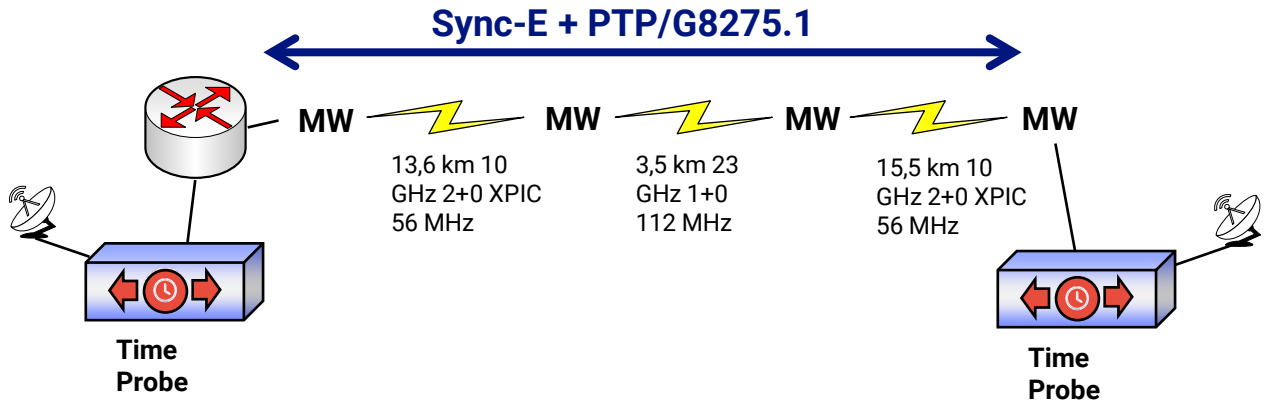
What is the contribution from the Access network?

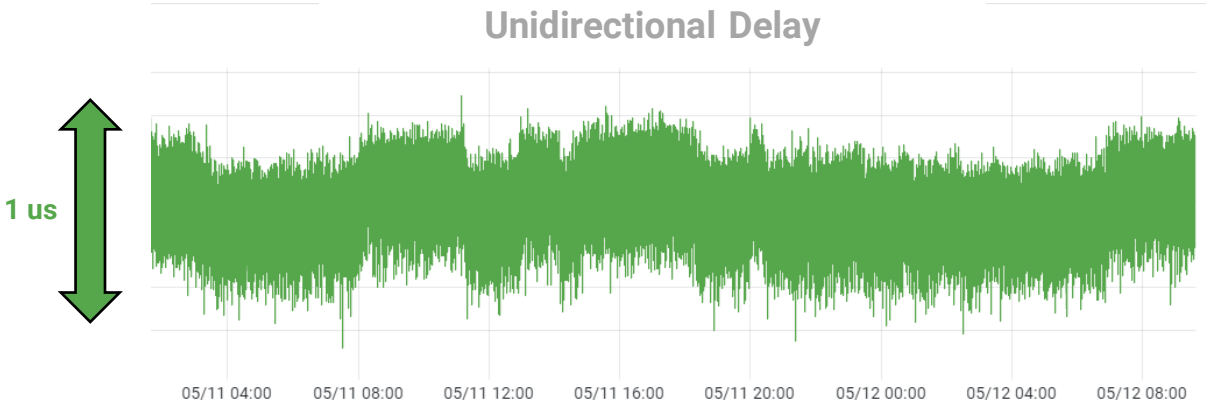


From PE router - Sync-E + PTP/G8275.1 over 3 x Microwave segments

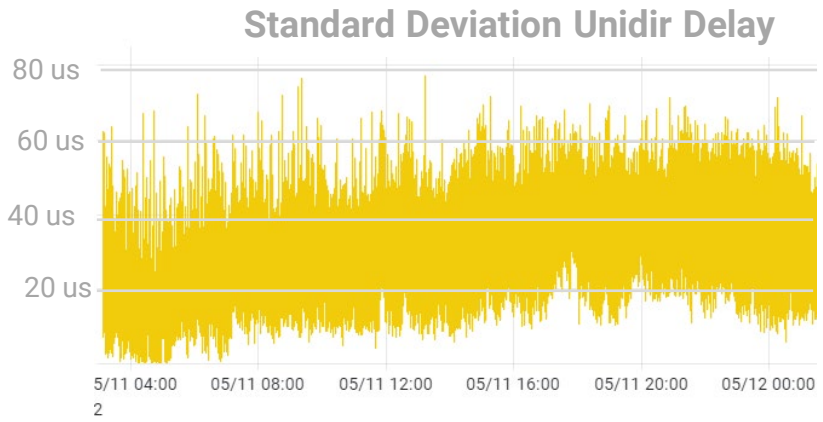
Only one way to know for sure …

Measure the Metrics





Noice (delay variation) are about 5x asymmetries. But 1 µs filtered delay variation is easily handled and within scope



Microwave noise is significant, but can be easily handled

netinsight

Telemetry analysis

- ~ 100 synchronization metrics
  - Absolute Time Errors, total time errors, RTT. Unidirectional delays, Delay percentiles, Delay and time error, variations, control state, temperature etc.
- Measure, Analyze, Optimize
  - Resolution down to nanosecond, every second, enables datadriven network analysis.
- Realtime network probing
  - For optimized sync service
  - For optimized network service

Grafana

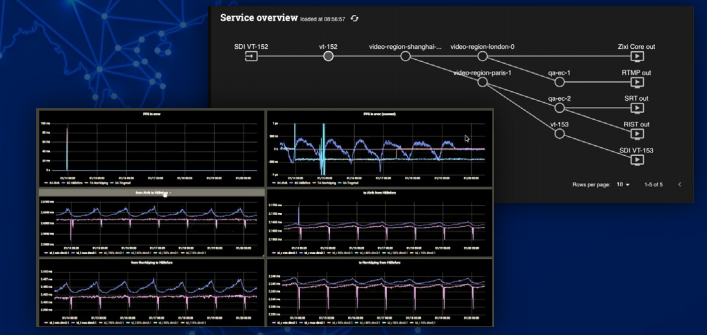
netinsight

Know your network

Knowing your network from a phase synchronization perspective has become key.

to operate and optimize your network

To troubleshoot, identify root causes and constantly improve a phase/time synchronized network that are in operation requires a deep knowledge of how the network performs.



Thank You

Thanks to 3 Sweden for sharing network data