

Telemetry and metrics

A mobile transport network from a Sync perspective

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3 - Sweden

- Commercial launch UMTS (3G) 2100 May 2003
- Since 2008 deploying LTE (4G) 800/2100/2600 FDD and 2600 TDD
- License for NR (5G) 3600 (C-band) was obtained by spectrum auction Q1-2021.
Rollout started April 2021...



5G synchronization – GNSS independency

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

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



Connection to atomic ePRTC clocks

Connection to atomic clocks - a solution financed by Swedish regulator, Swedish Post and Telecom Authority (PTS).



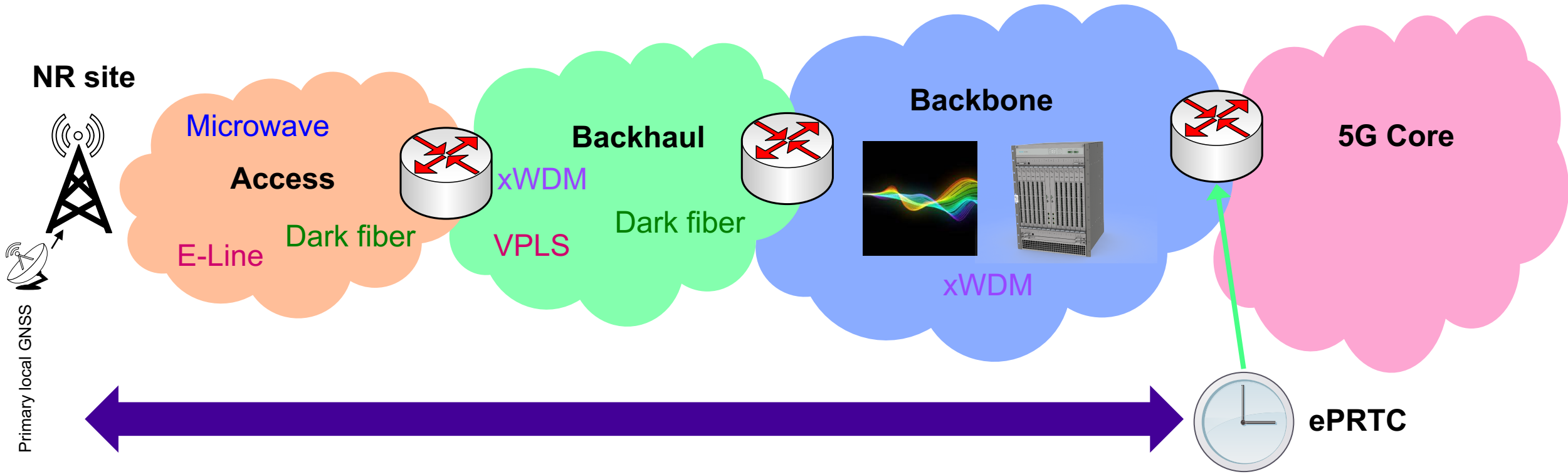
Holdover performance -
Under typical circumstances, the timescales are 100 ns off after about three months of running autonomously / uncorrected, e.g. if the connectivity to the reference is lost entirely.



- Each node has two atomic clocks and can operate autonomously
- Traceable to UTC(SP)
- Supervised by RISE



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



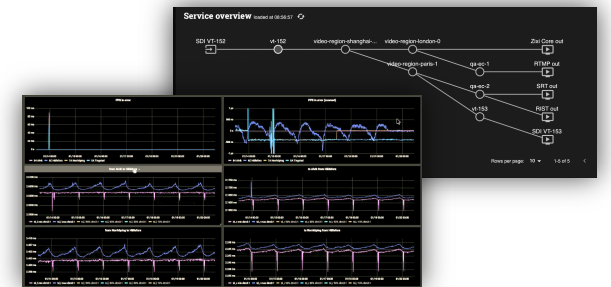
Asymmetry problems, Traffic impairments, cTE and dTE deviations on different HW platforms etc...



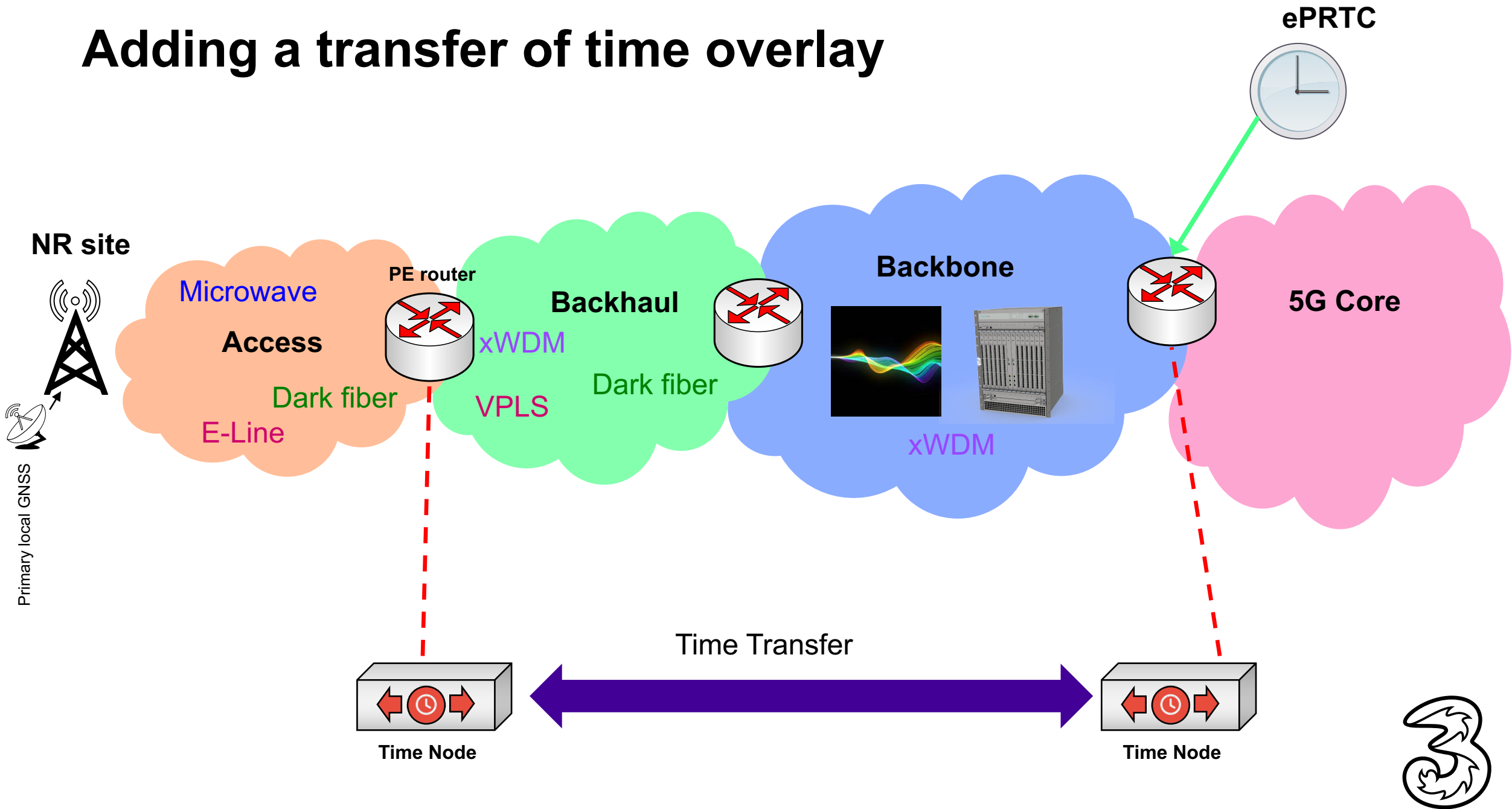
Measure your network

- Constantly improve requires deep knowledge
- Proactive, Everywhere – All the time
- x10 000 accuracy compared software TWAMP
- Enables data driven network analysis.

Lights up the network from a synchronization perspective.

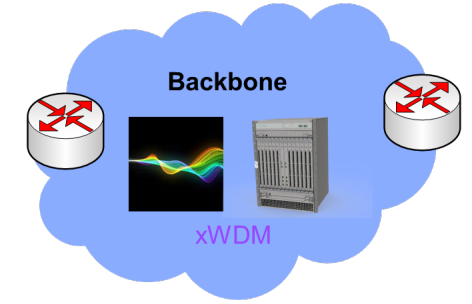


Adding a transfer of time overlay



Example 1

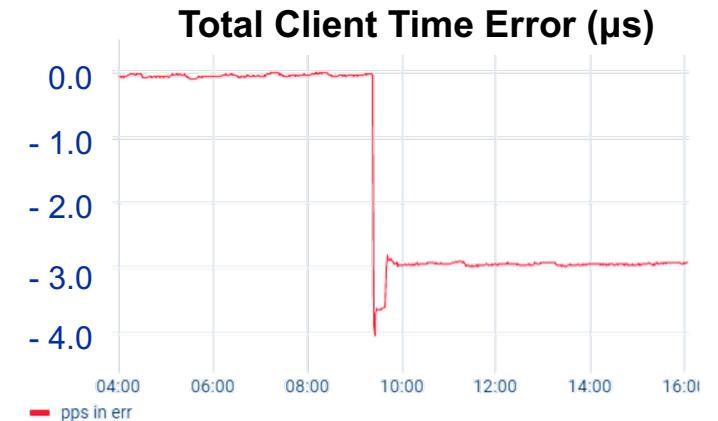
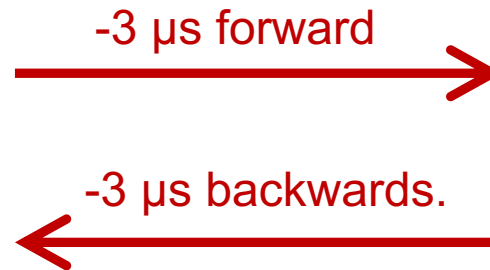
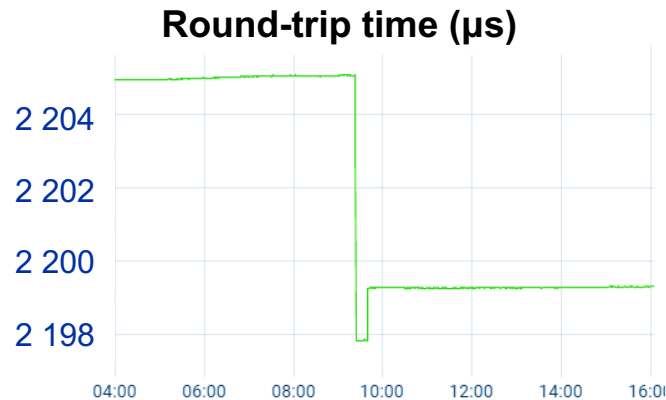
Transfer of time over leased wavelenght (xWDM)



Sudden change of round-trip time on WDM

Client Clocks always distributes change evenly

Wrong assumption Only backwards direction changed this time



RTT drops 6 µs

Result: cTE -3 µs



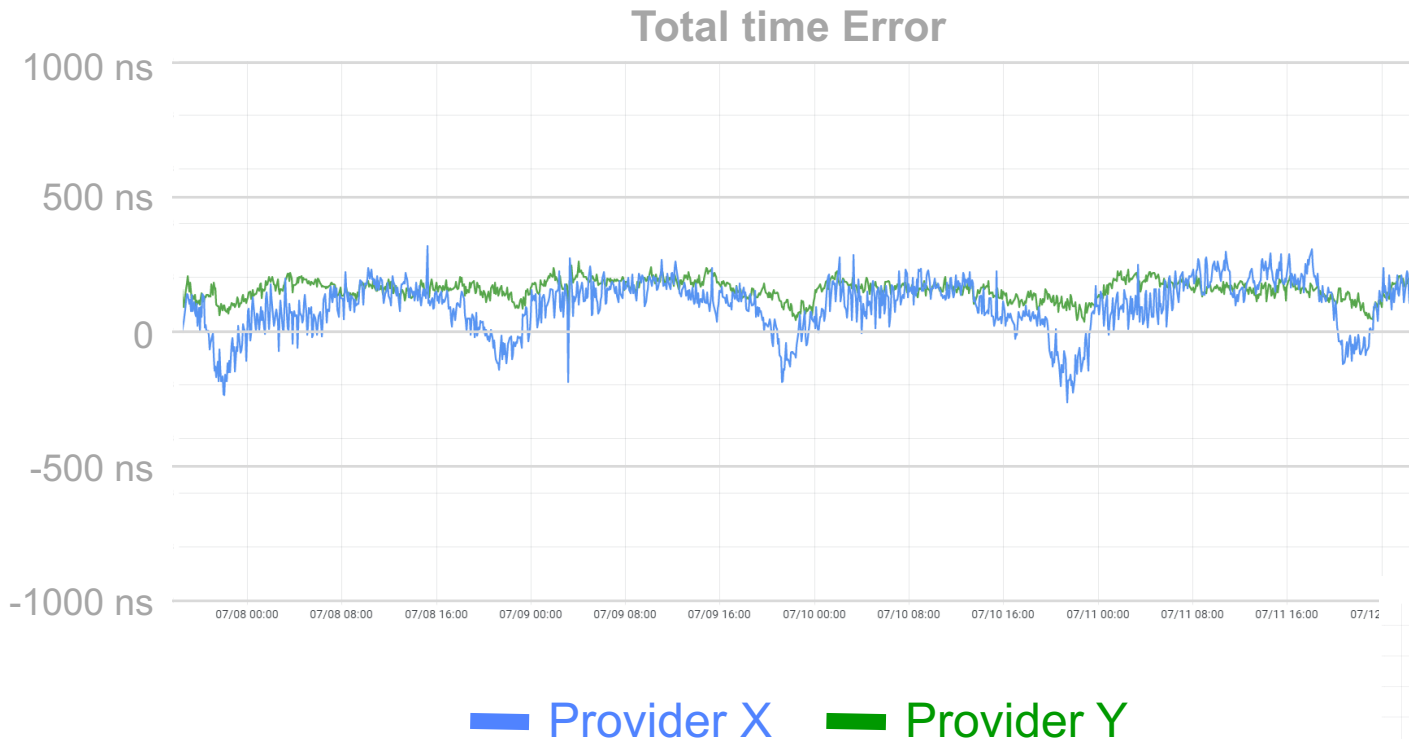
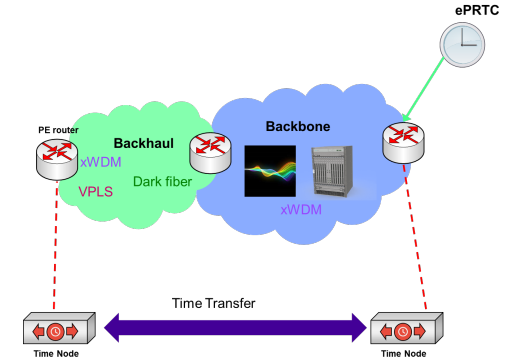
Example 2

Transfer of time over VPLS capacity service

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

Provider X handles timetransfer traffic as "Business Critical" (Prioritized data).

Provider Y handles all traffic (no Qos differentiation) as one "pipe"



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.

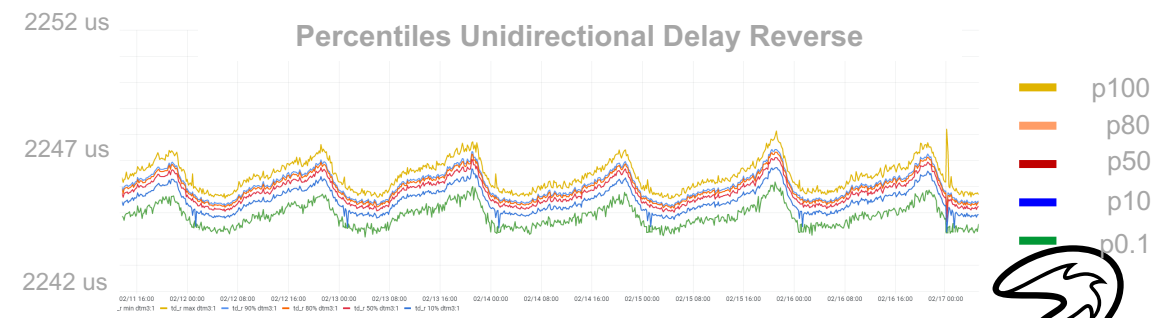
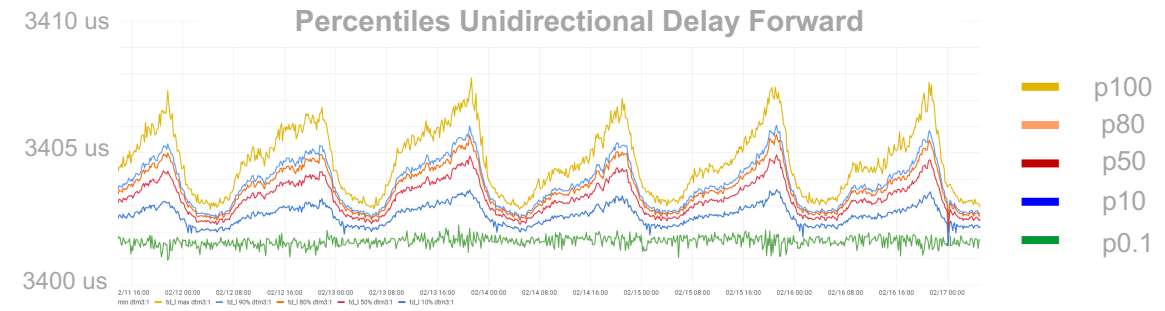
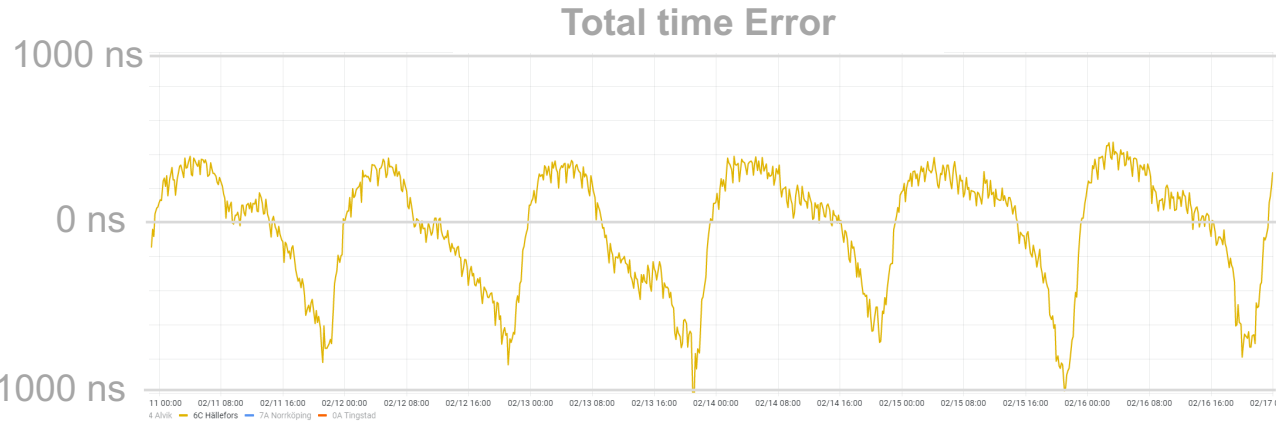
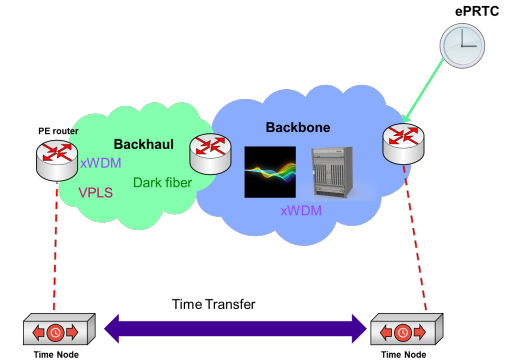
- Round-trip time day variation
- Unidirectional delay variation
- Standard deviation in unidirectional delays over peak busy hour
- AI analysis.



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

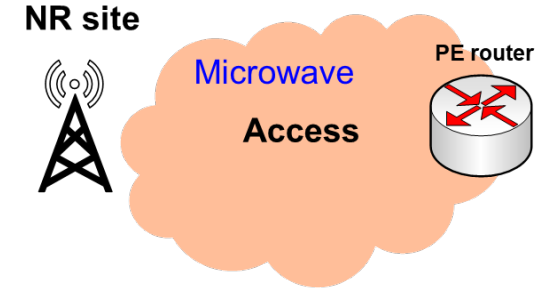
Problem are now found and could be addressed



Example 4

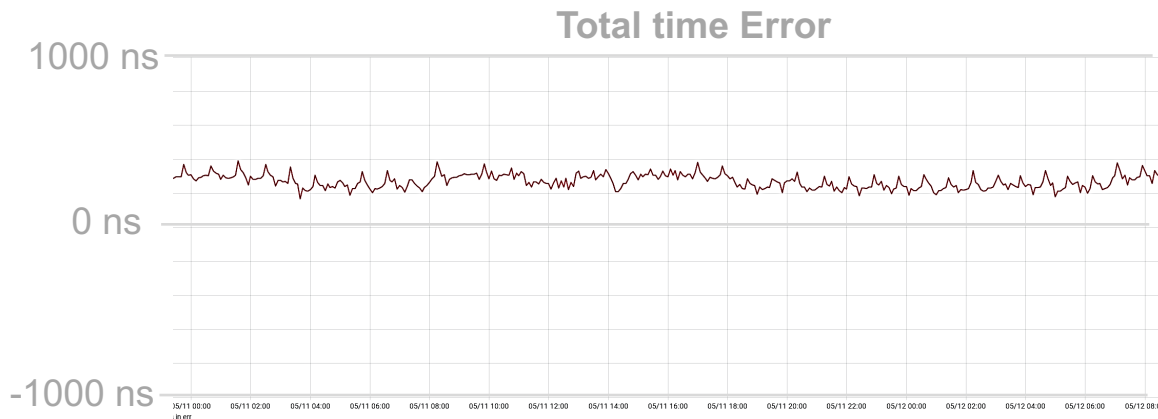
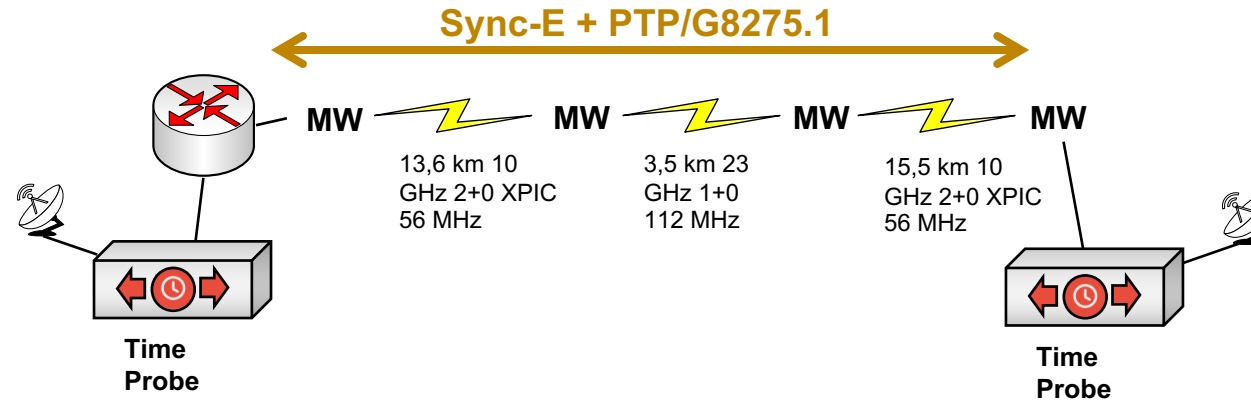
What is the TE budget for the Access network?

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

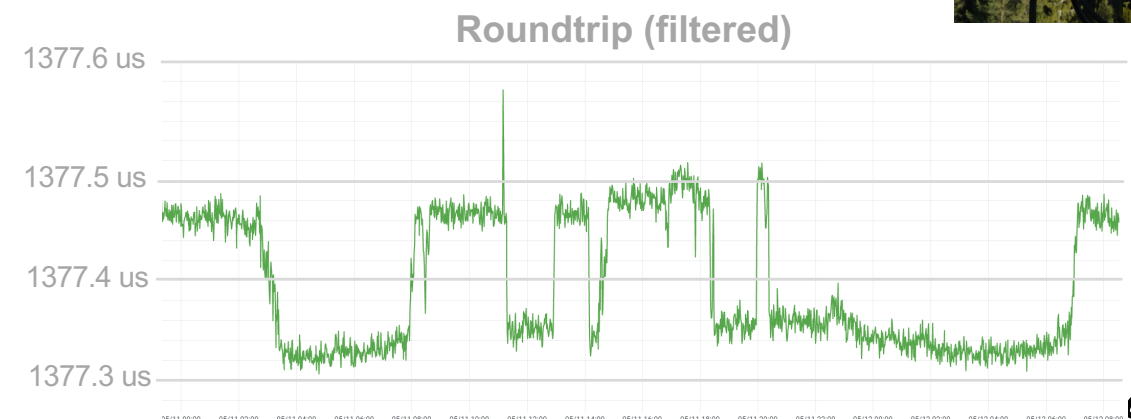


Only one way to know for sure ...

Measure the Metrics !



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

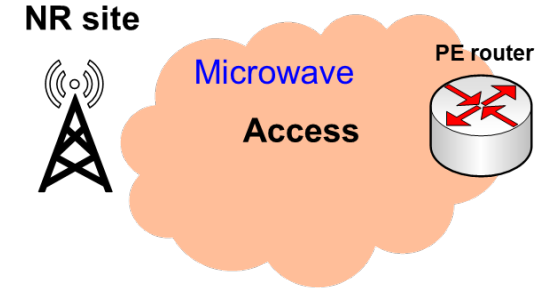


Microwave delay changes are not visible in the timing domain



Example 4

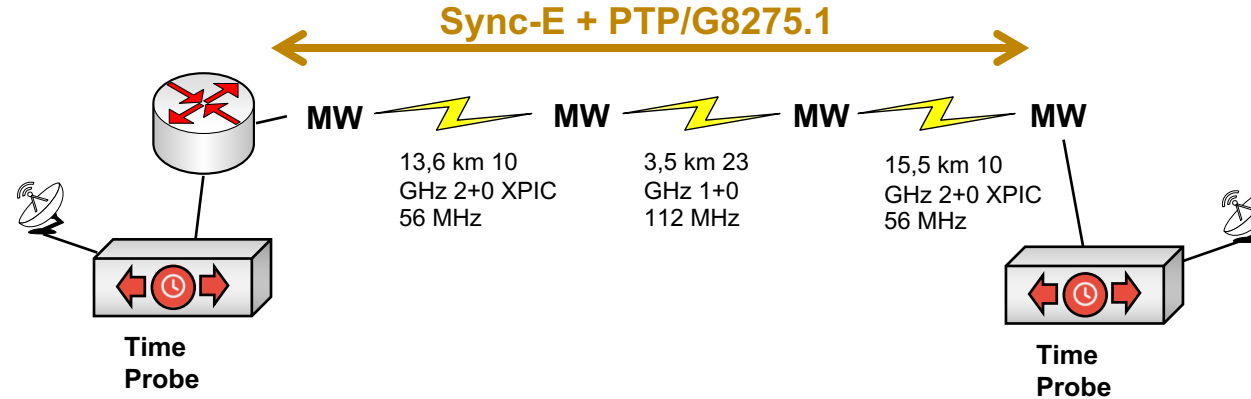
What is the contribution from the Access network?



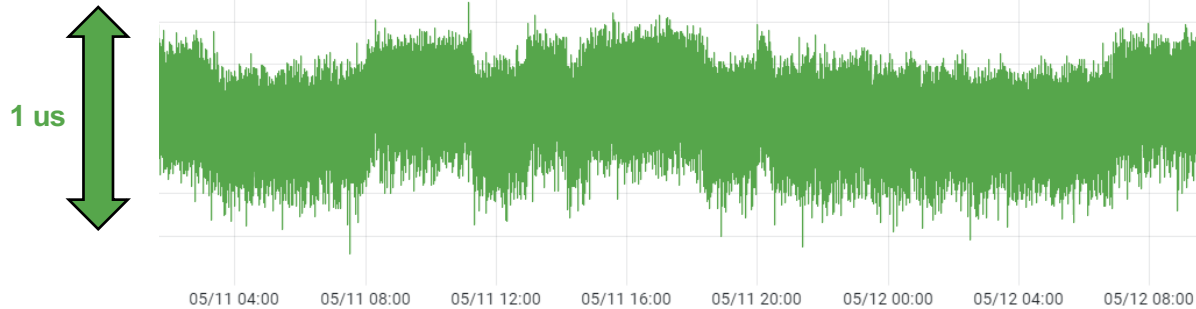
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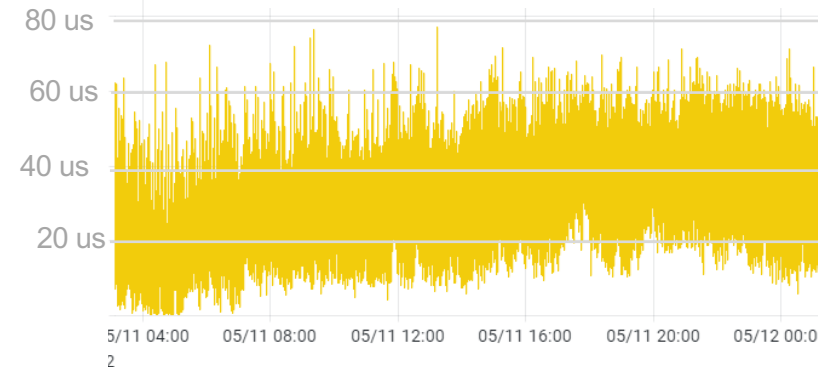


Unidirectional Delay

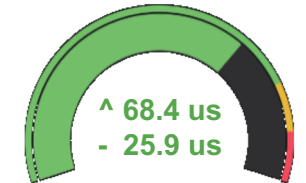


Noise (delay variation) are about 5x asymmetries. But 1 μ s filtered delay variation is easily handled and within scope

Standard Deviation Unidir Delay



Microwave noise is significant but easily handled



Know your network

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

to operate 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

