WORKSHOP ON SYNCHRONIZATION AND TIMING SYSTEMS

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5G Synchronization Over Shared and Wholesale Networks

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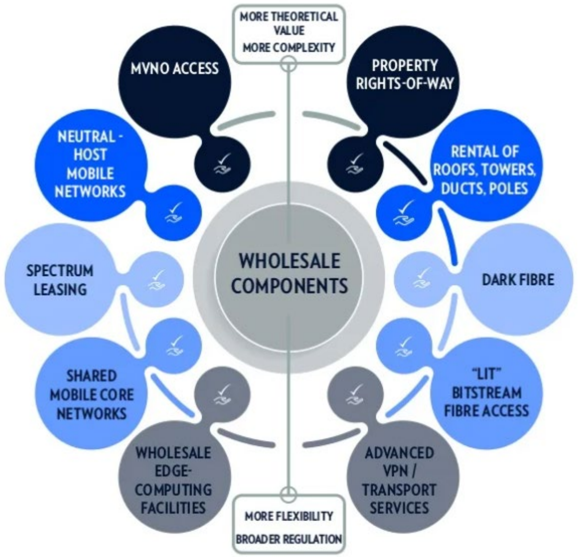
Capacity and Reach

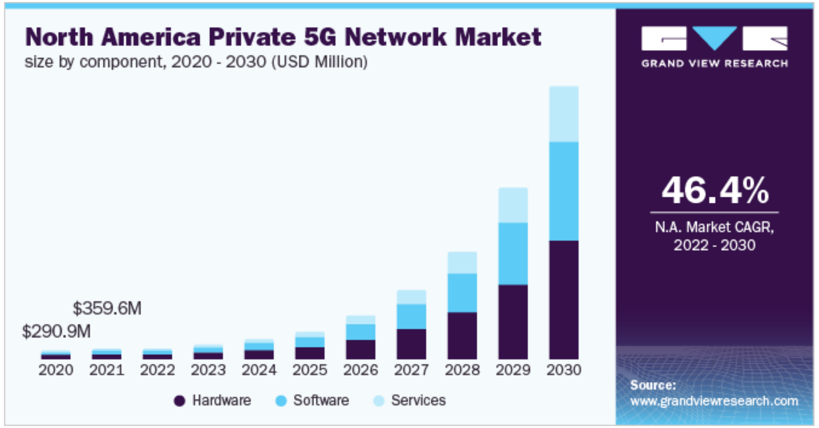


The challenging 5G use cases have made the need for accurate time and phase synchronization critical in 5G networks.

Leased lines are the foundation for most mobile operators to achieve reach and coverage. In most cases, the mobile backhaul transport for Distributed RAN (DRAN) has been a rented packet-forwarding service, Ethernet or IP based. (1)

The global private 5G network market size is expected to expand at a compound annual growth rate (CAGR) of 49.0% (2)

But there is also a demand for new network architectures to allow operators to build scalable networks and to reduce cost and complexity for 5G mobile network rollout.



Virtualization and disaggregation unbundles the network functions and moves functions to the cloud. Synchronization however is still considered a function that is bound to HW.

(1) 5G New Radio RAN and transport choices that minimize TCO, Ericsson 2019
(2) Private 5G Network Market Size, Share & Trends Analysis Report, Grand View Research 2023

GNSS independence is mandatory

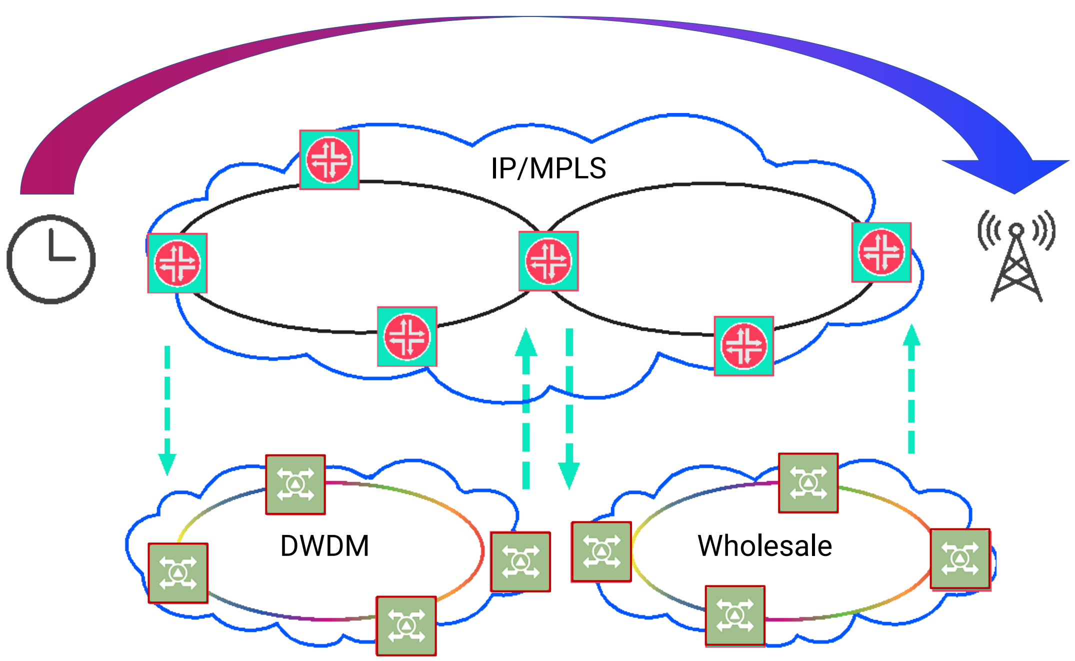
Service providers
Investing to introduce GNSS independent timing in the networks.

Regulators
Several regulators mandate critical infrastructure are GNSS independent in a few years time.

- GPS outage could cause a loss in US economy of more than 1 Billion USD per day. Up to half of that in the telecom sector [1]
- US Executive Order on Strengthening National Resilience with guidance for GNSS independent timing. [2]
- All Program Offices and system/service/application owners shall migrate away from GPS, GNSS and WAAS as soon as feasible, but no later than FY 2025 [3]
- European Commission has issued a call for tenders for GNSS independent timing [4]
- Swedish regulator PTS mandate GNSS independent solution for operating the 5G network [5]

1. 2019 Report sponsored by National Institute of Standards and Technology (NIST)
2. US Executive Order 13905 of February 12, 2020
3. FAA Order 1770.68 "Selection and Use of Time and Frequency Sources for all Systems, Services, and Applications Supporting NAS Operations, 2020
4. European Commission, Alternative Position, Navigation and Timing (PNT) Services
5. The Swedish Post and Telecom Authority Dnr: 18-8496 "Additional terms in the auction of frequency bands 3.5 GHz and 2.3 GHz": 2020-10-20

Open and Disaggregated Synchronization



PTP w. Full Timing Support (FTS) means that *every* network element needs to be PTP enabled and interworking

Open

- Open networking and open APIs prevents vendor locking and enables innovation
- Telecom Infra Project (TIP) accelerate the development and deployment of open, disaggregated, and standards-based technology solutions

Disaggregated

- Timing is independent of network capacity and network layers
- Timing could grow and develop independent from other network components, allowing for Virtualization and cloud solutions

End-to-End

- Guiding principle for the Internet
- The only way to build scalable network solution.

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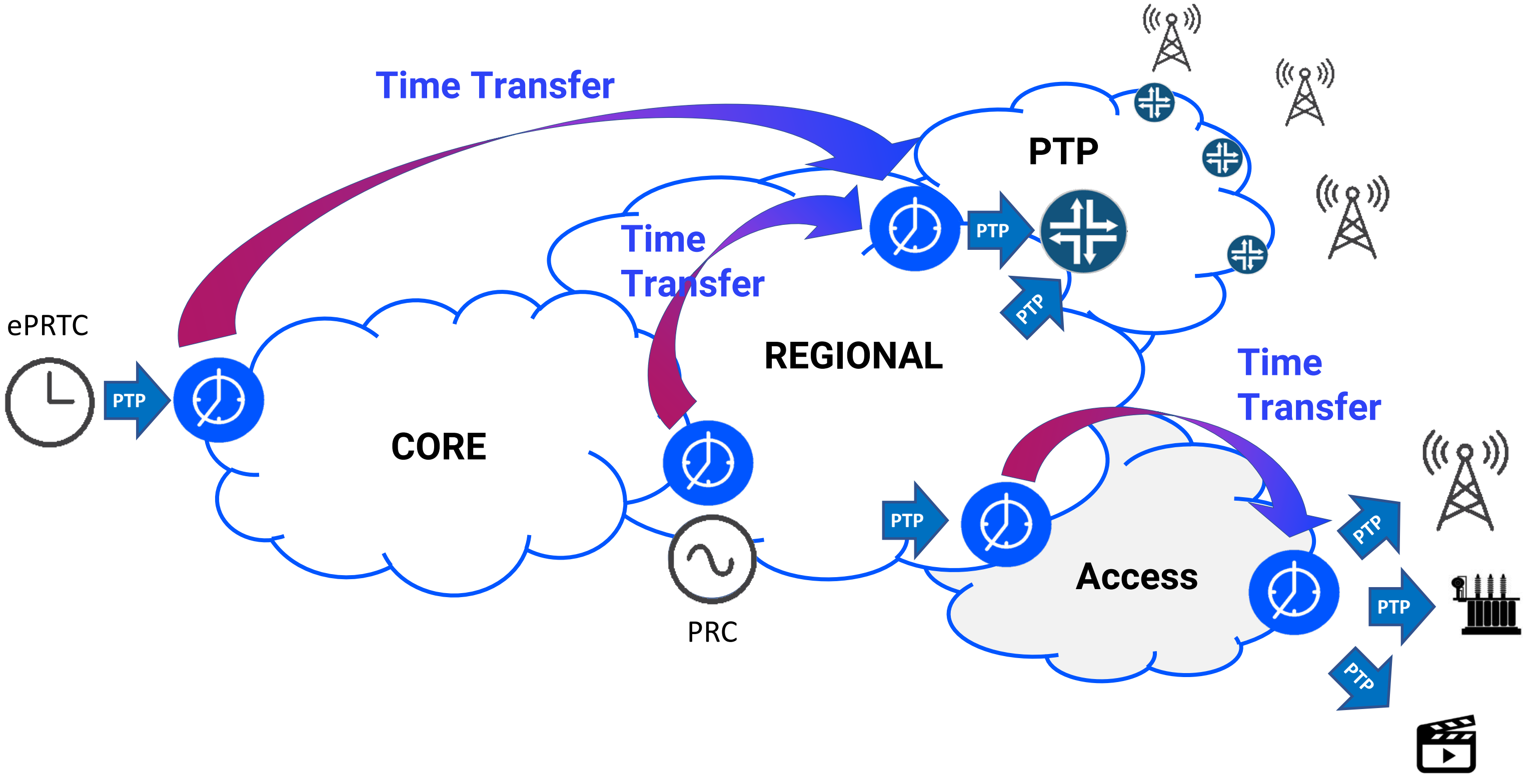
Extending PTP over shared networks



Extending PTP over non-compliant networks

- GNSS backup
- Leased lines or wholesale
- Non-PTP enabled network segments
- Enabling network wide Cesium Assisted holdover

PTP Network Interoperability

- ITU-T G.8275.1 Telecom Profile (full timing support). Is very interoperable
- Clock source traceability and resilience
- Clock Class, Priority and phase traceability features

PTP is the API

- ITU-T G.8275.2 and G.8265.1 Telecom Profiles for Partial Timing and Frequency
- IEC 61850-9-3 and IEEE C.37.238 Power and Utility Profiles
- SMPTE ST 2059-2 and AES67 Broadcast and Media Profiles

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Supporting OpenRAN with T-plane

This configuration of Config LLS-C2 Option A requires Full Timing Support in the entire timing chain towards all O-DU which is difficult in a open virtualized network.

To fully support OpenRAN in wholesale and leased line environments, transport independent timing is required.

ITU-T Q13/15

OpenRAN TELECOM INFRA PROJECT

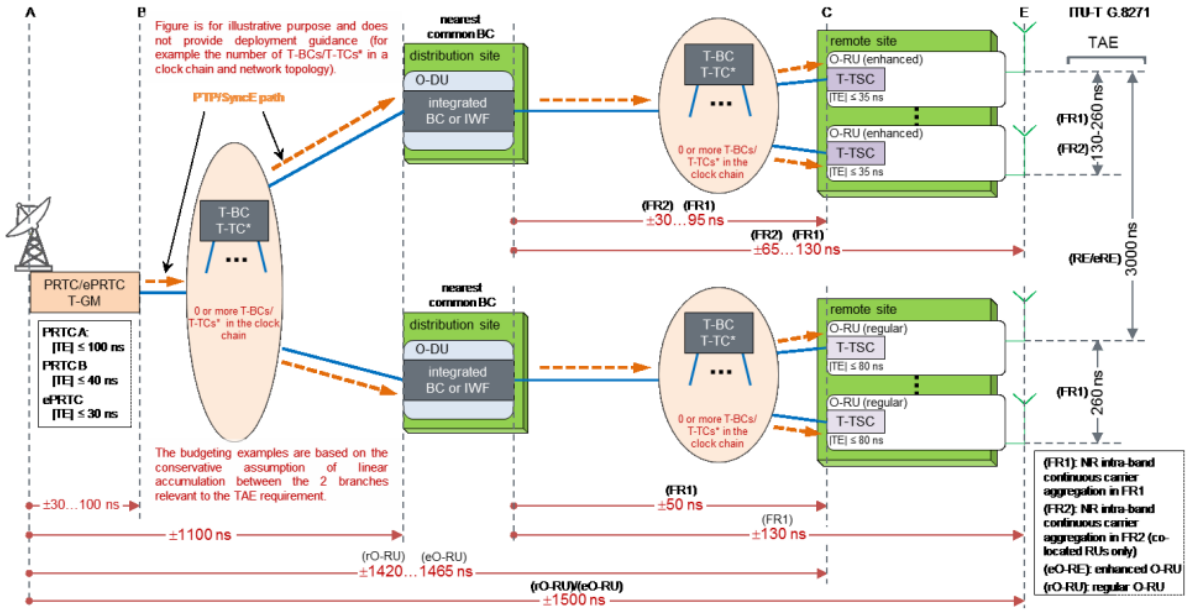
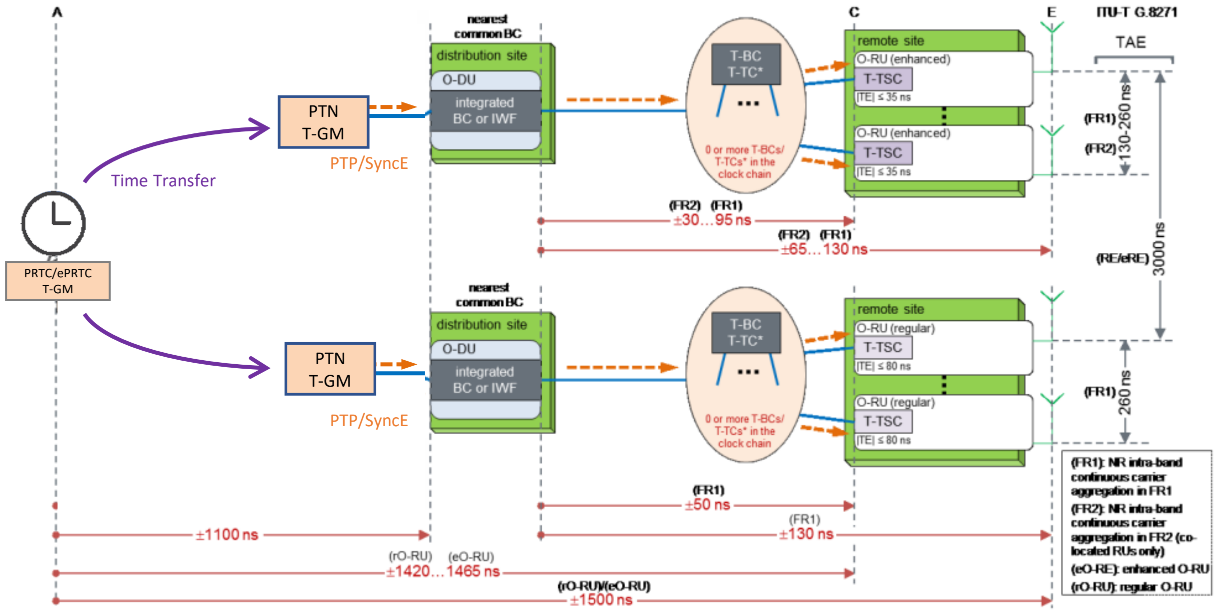
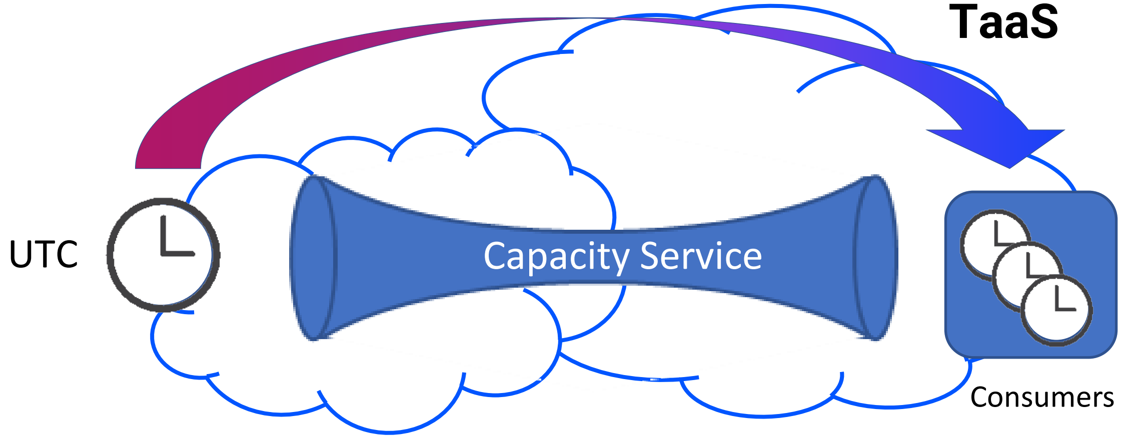


Figure 16: Example of Absolute vs Relative Requirements (Config LLS-C2 Option A, where O-DU is nearest common T-BC)



Example of Absolute vs Relative Requirements (Config LLS-C2 Option A, where Time transfer are connected to O-DU)

Time as a Service



DVB-T 5G SMPTE 2110

Direct wavelength asymmetries

OTN Mapping
- Deep service FIFOs
- Different delay each time they start
- Large and random asymmetry

Coherent transmission
- Service FIFOs in DSPs
- Different delay each time they start
- Varying and random asymmetry

cTE up to several µs

Varying cTE

Fiber
- 1m fiber about 2.5ns cTE (5ns latency)
- Leased fiber, patch panels, splicing, re-routing.
- Large but static asymmetry

Optical Components
- DCF are cut according to dispersion, DCMs are OK
- OAs and ROADMs have manufacture tolerances due to internal fiber splicing
- Large but static asymmetry

cTE up to 10s of µs

Static cTE

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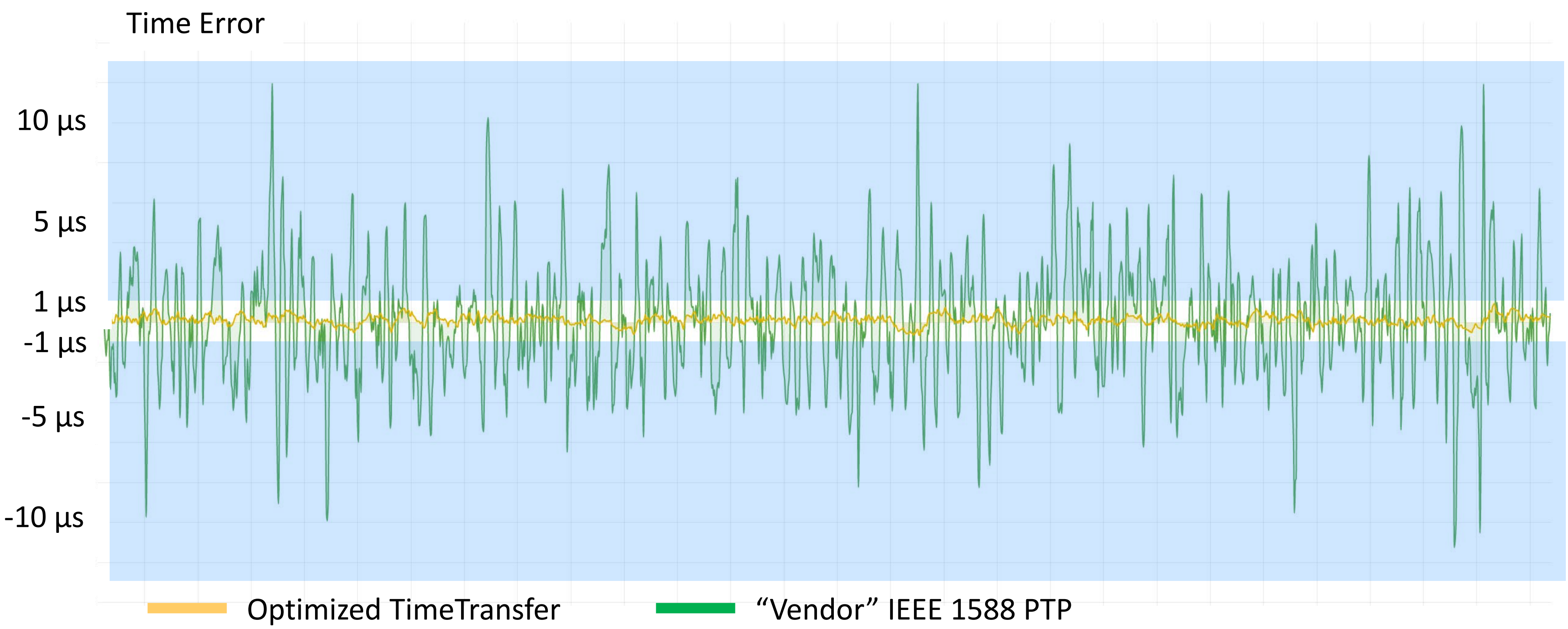
Network Impairments in connectivity

A comparison that one of our customers carried out between optimized time transfer and stock standard PTP in a VERY tricky network usecase

PTP ~ 10-100 µs off

TimeTransfer within +/- 500ns

- Several parallel flows
- Different characteristics
- 4000 samples per second



Algorithms possible to virtualize / containerize
FPGA / SW combination

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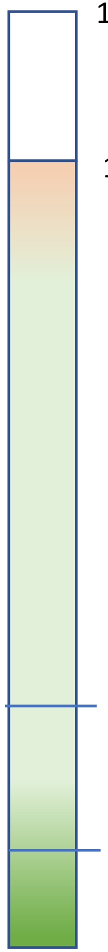
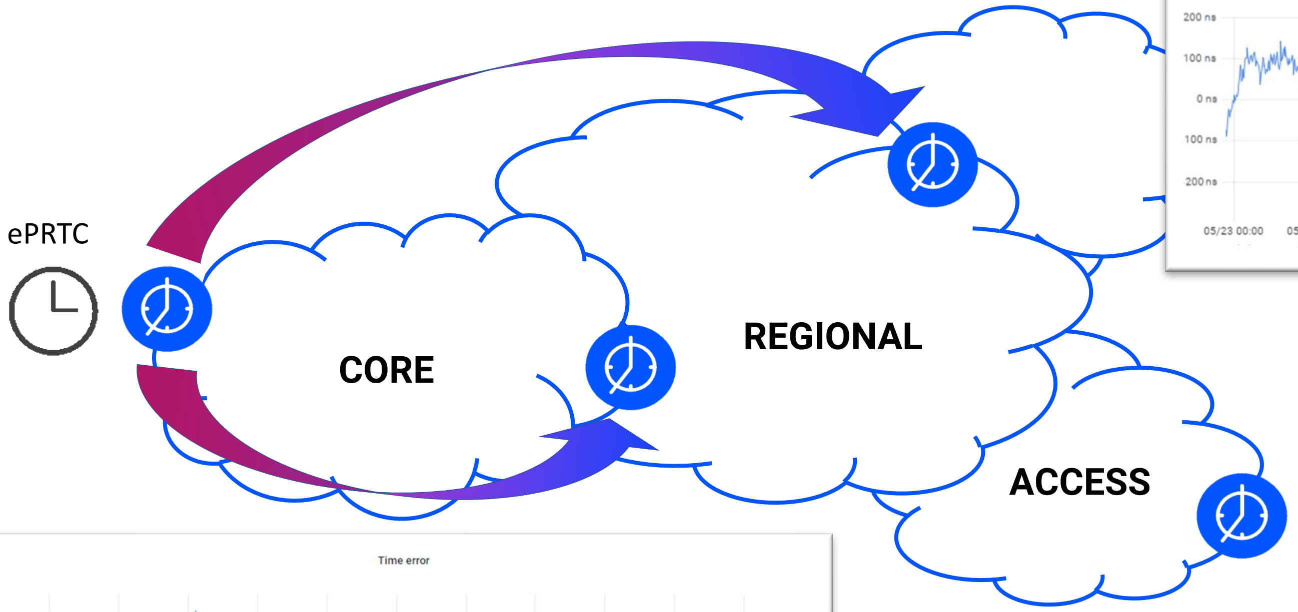
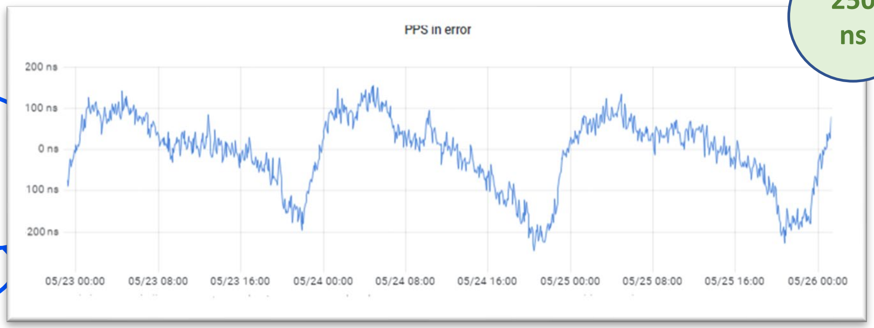
Time as a Service accuracy

Network Time Error Budget



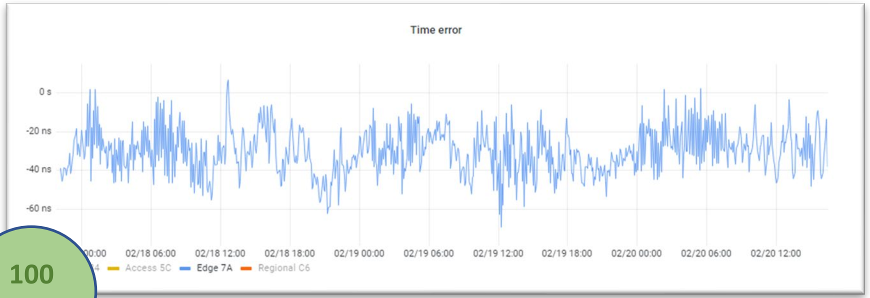
100 ns





250 ns

Regional / Leased Line
– on 250 ns max|TE|
(with more daily impact from traffic)



Over the core network
– within 100 ns max|TE|

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Conclusion

Open

- The entire telecom industry head towards open and disaggregated network architecture
- Transport must be open (not restricted to Full Timing Support). Shared and Wholesale Networks are natural network building blocks.

Disaggregated

- Timing must become independent of network capacity and network layers to avoid being the bottleneck for innovations and new architectures
- Timing could grow and develop independent from other network components, allowing for Virtualization and cloud solutions

End-to-End

- It is proven that end-to-end does deliver the timing performance and resiliency required by applications.

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