



Virtualizing synchronization

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Guten tag.

See you in Dusseldorf!



netinsight

A microsecond (μs)

The network budget



DVB-T-SFN (Single Frequency Network)

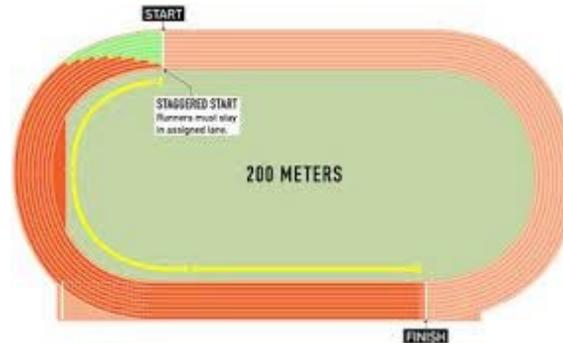
1 μs



5G NR

1 μs

How much is a μs



Speed of light is about 200 m/ μs in a fiber.

The time it takes for light to travel around half a football pitch



Phasor Measurement Units (PMUs)

1 μs

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



GNSS outages rose massively between 2017 and 2018 by well over 2,000% and remain high 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)

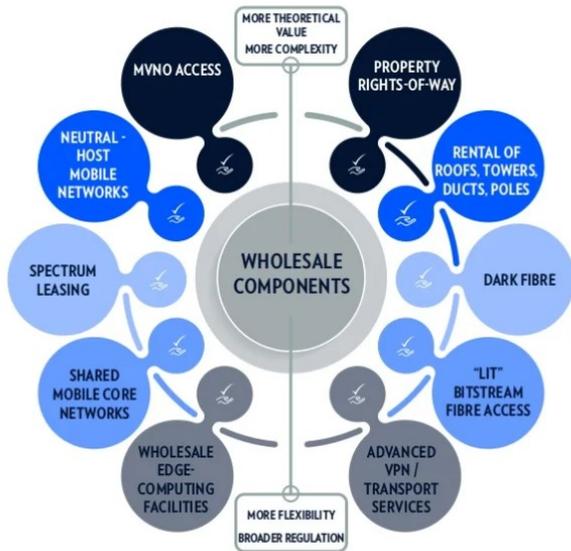
2. US Executive Order 13905 of February 12, 2020

3. Eurocontrol Think Paper, 2021

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

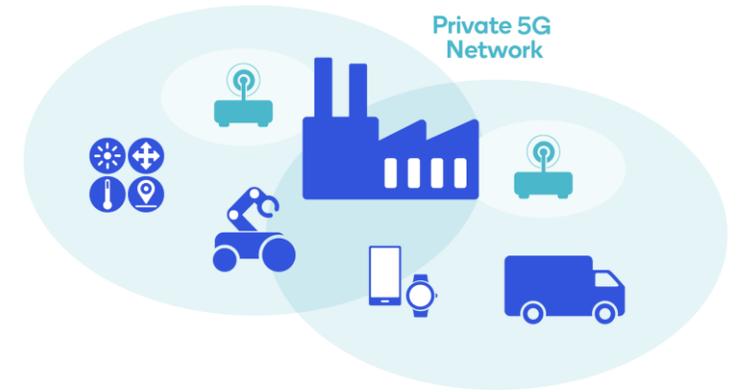
Virtualization and disaggregation



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

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.



TELECOM INFRA
PROJECT

OOPT is a project group within TIP that works on the definition of open technologies, architectures and interfaces in Optical and IP Networking.



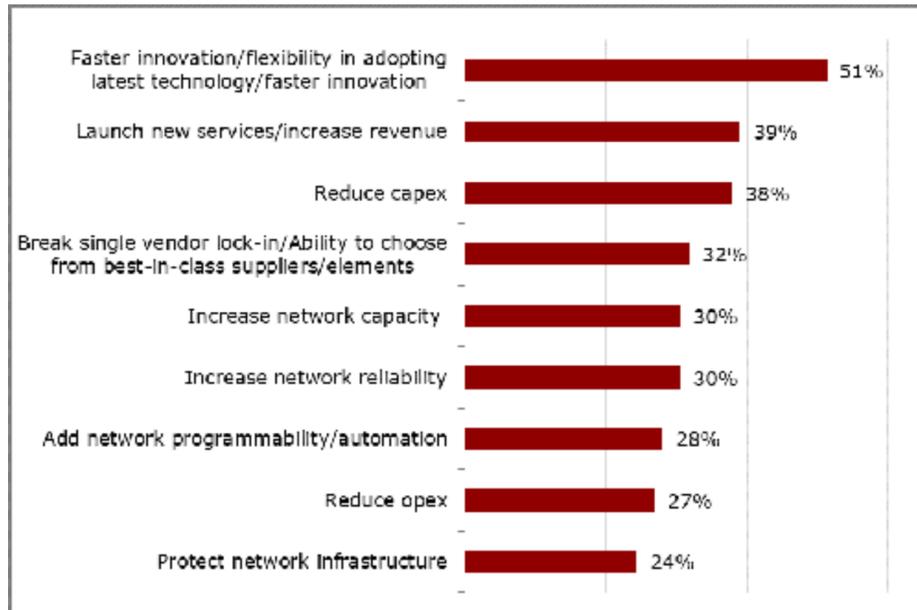
ONF is accelerating the state-of-the-art in open networking and catalyzing creation and adoption of open disaggregated solutions



Transforming Radio Access Networks Towards
Open, Intelligent, Virtualized and Fully
Interoperable RAN

Disaggregated - Drivers and experience

What are the top factors motivating your organization to adopt disaggregated networking solutions?



Source: Heavy Reading 3/3/2021

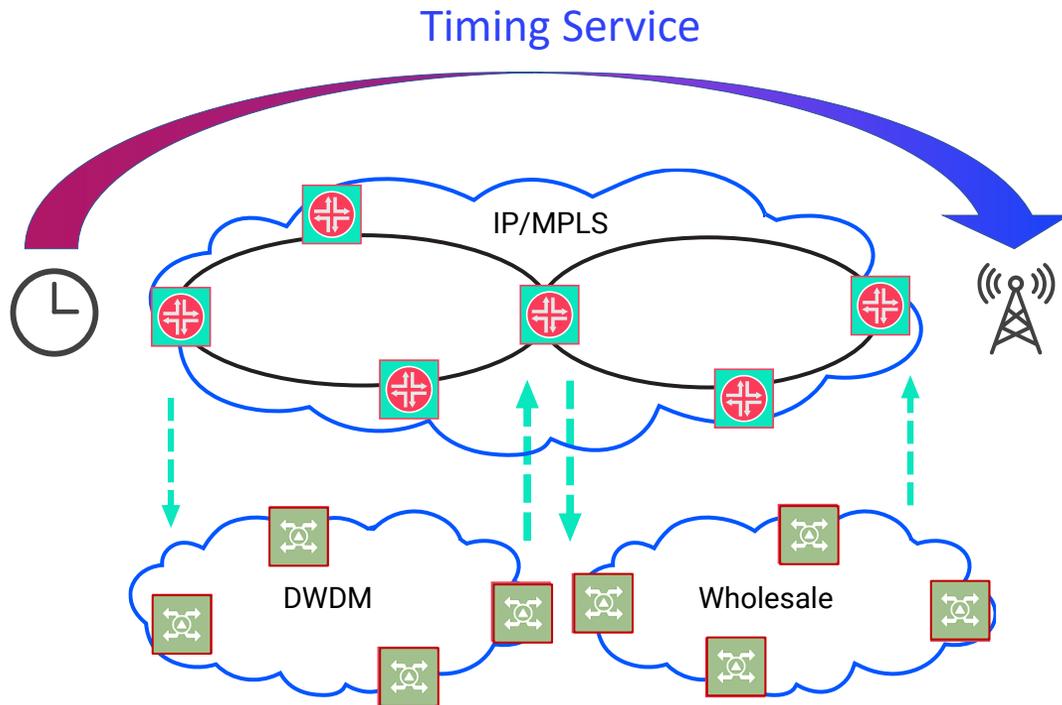
Top Drivers

- Faster innovation and flexibility in adopting the latest technology
- Ability to launch new services and increase revenue

Experience

- In the early days of white box and virtualization, capex reduction typically scored at the top of the list in terms of drivers.
- However, as time has progressed, operators have increasingly focused on services and revenue benefits.

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
- Lifecycle Service Orchestration (LSO) enables automation and orchestration of timing

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

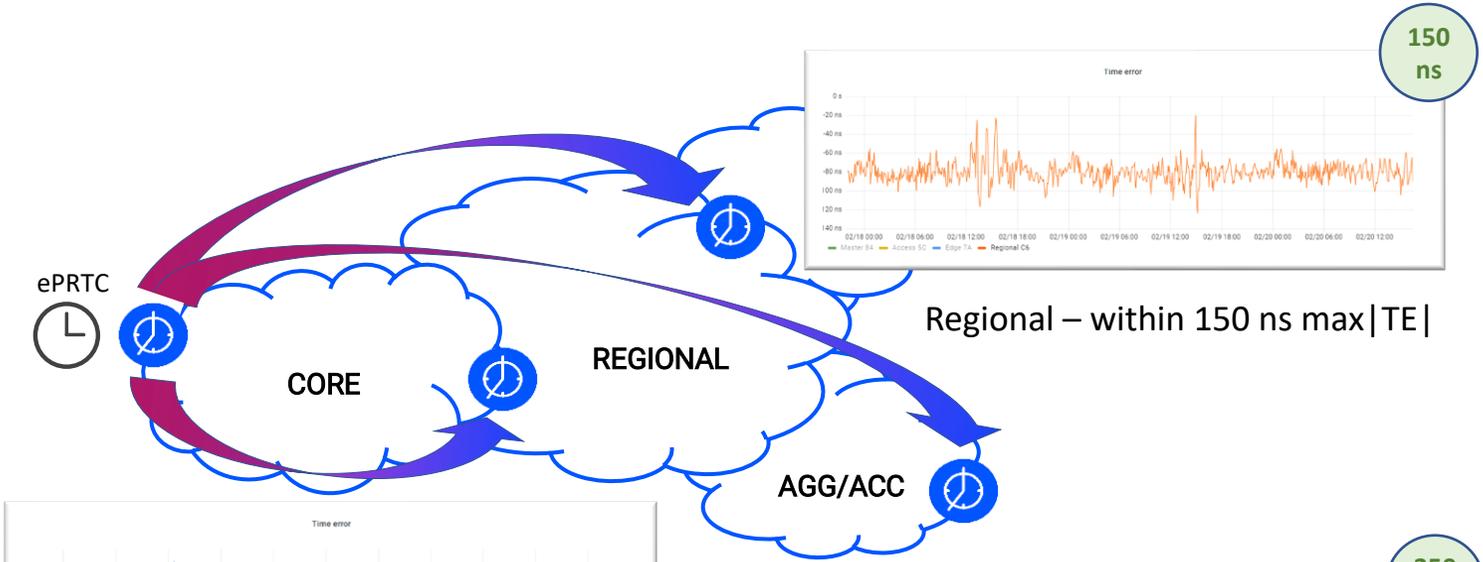
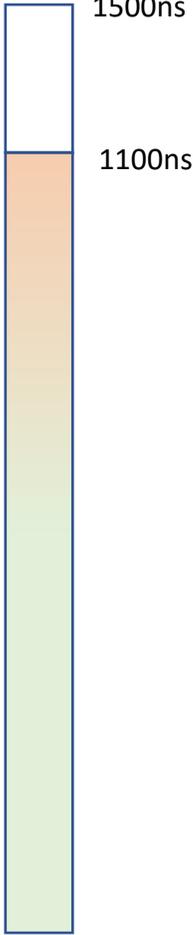
- Guiding principle for the Internet
- The only way to build scalable network solution.

What can be expected

Without ANY timing support from the network. End-to-End overlay what can be expected.

- Core Asymmetries are the challenge. Can those be handled
- Regional Mix of transport vendors and transport technologies. The classic example.
- Aggregation/Access Mix of fiber metro networks, Microwave links and Leased Lines over wholesale capacity services.

Network Time Error Budget



Regional – within 150 ns max|TE|



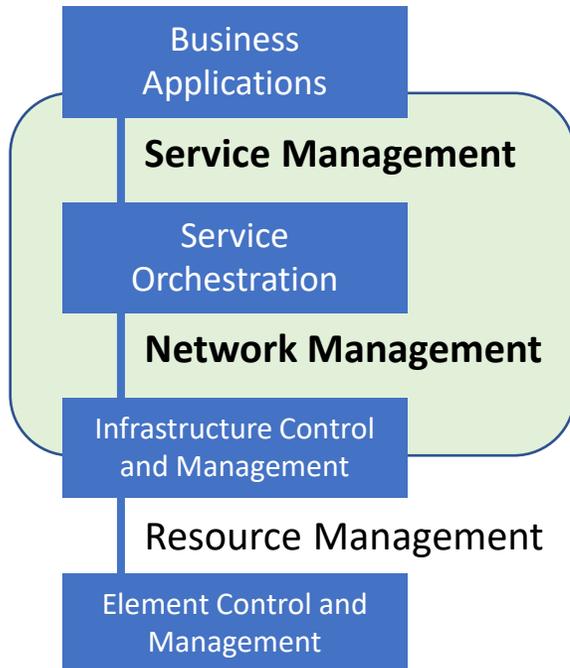
Over the core network – within 100 ns max|TE|



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

Open Networking

Transport

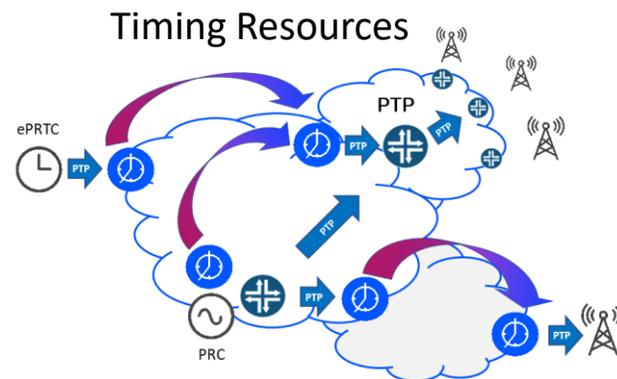


Timing

Timing Services



Timing Network



- **Timing Controllers**
Focus on domain controllers to allow for integration, e.g. vendor domains
Element view management functions (MIBs and YANGs) not important.
- **Common and agreed definition of a Timing services**
And the management properties thereof to allow business applications and service orchestration.
- **Open and interoperable UNI/NNIs**
But allows for innovation on the internal interfaces.
 - Merging of clocks (a'la gPTP) for example collaborative clocks
 - More efficient timestamp transport and signaling
 - Encryption and security

Telemetry enables network control

Software-defined networking centralizes network control and enables data-driven architectures.

Synchronization metrics is key to network control

- Link and Node metrics.

Absolute Time Errors, RTT. Unidirectional delays, Delay percentiles, Delay and time error, variations, control state, temperature etc.

- Controller and network Metrics
Spread, Hotspots, Families etc.

- Proactive, everywhere – all the time

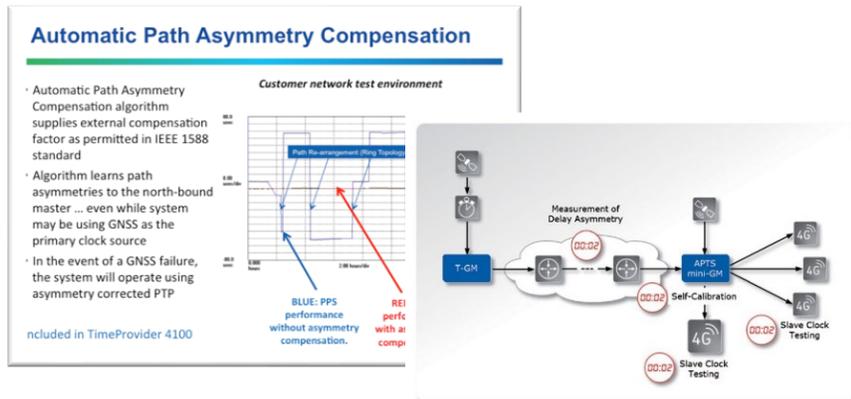
Enables AI/ML - Artificial Intelligence (AI) and Machine Learning (ML) for efficient network operation and enhanced network optimization.



Disaggregation – what about asymmetries

- Sudden changes in unidirectional delay results in asymmetry profile change
- But is it really cause for solving this by throwing hardware at it
- Peeking at other sync vendors shows that everyone is working on this.

An obvious asymmetry change in an otherwise troublesome network.



- "the requirement for full PTP on-path support across the mobile backhaul network is relaxed to partial or even no support."

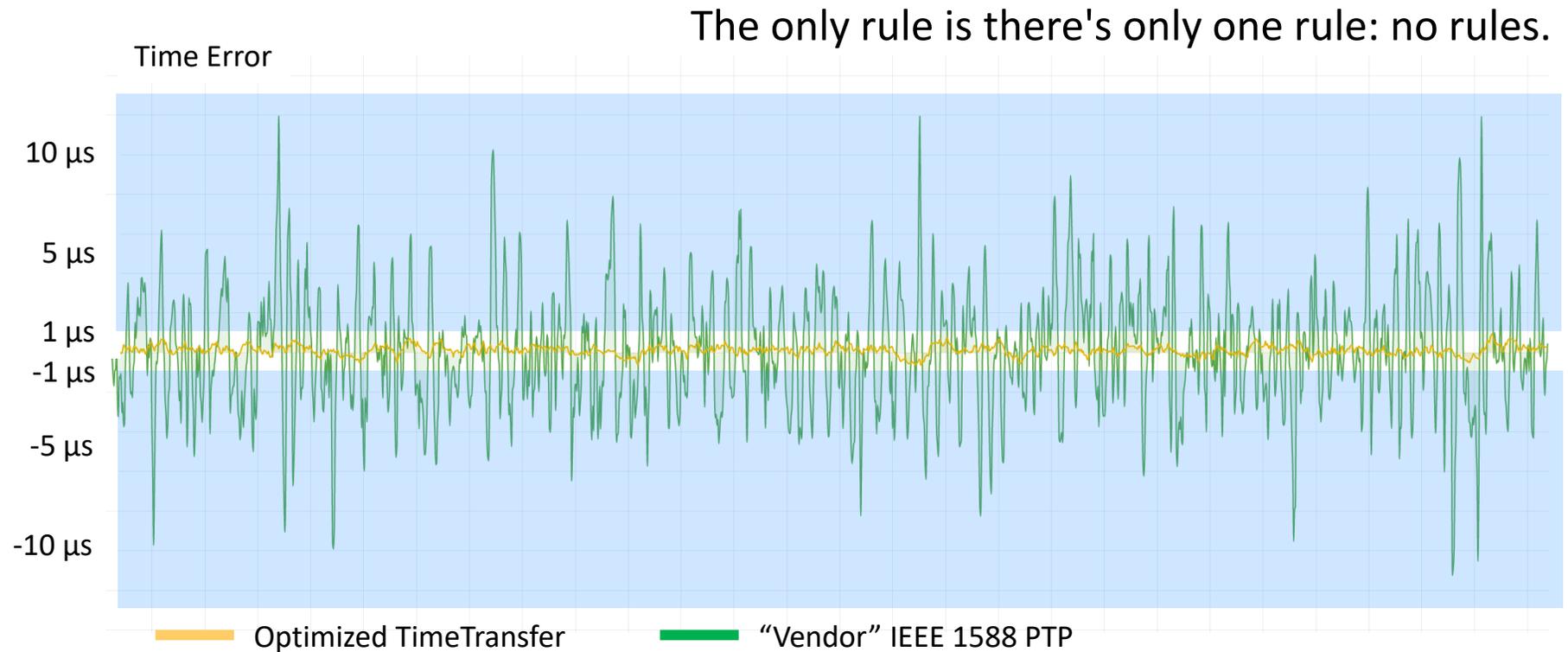


End-to-end – Network Impairments

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

Conclusion

Open

- The entire telecom industry head towards open and disaggregated network architecture
- Lifecycle Service Orchestration (LSO) enables automation and orchestration of timing

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's now proven that end-to-end does deliver the timing performance and resiliency required by applications.

Where do we go next ?