Precise Time as a critical national service

“The Swedish model” featured in 5G magazine

> *Sweden has developed one of the world’s leading national time infrastructures and has pointed the way for how to secure critical national services from an over-dependence on GNSS”*

Karin Ahl
CEO
Netnod

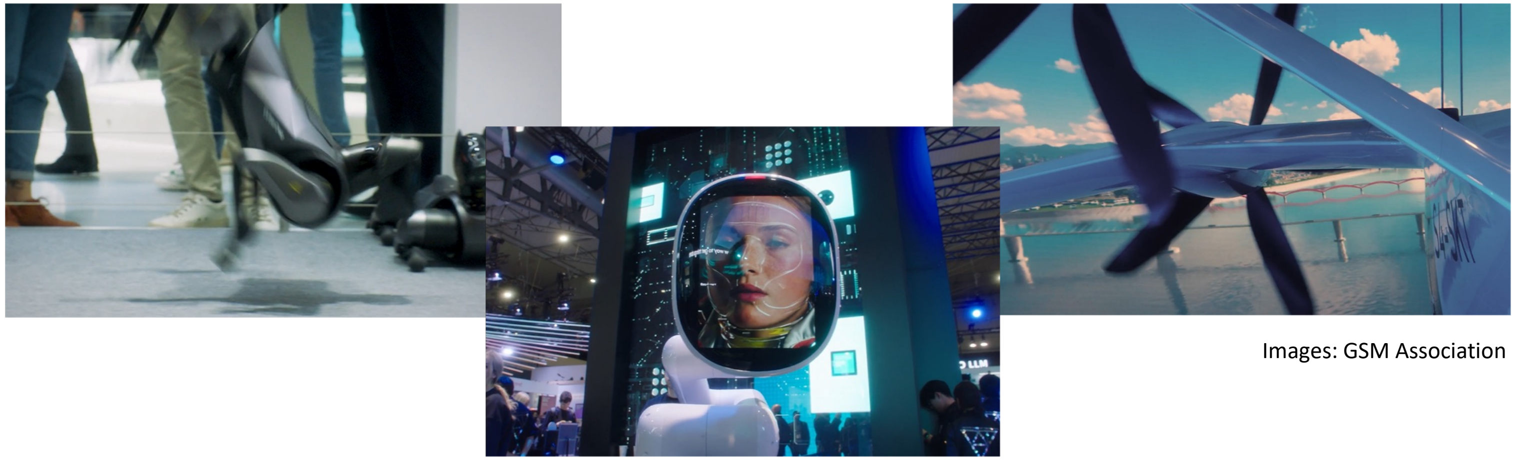
Per Lindgren
CTO and Head of Sync
Net Insight

netinsight

Mobile World Congress 2024

- 101 000 Attendees
- 2 700 Exhibitors, sponsors and partners
- 205 Countries and territories

– "More calm than usual"
– "Sober"
– … the year of the plumber

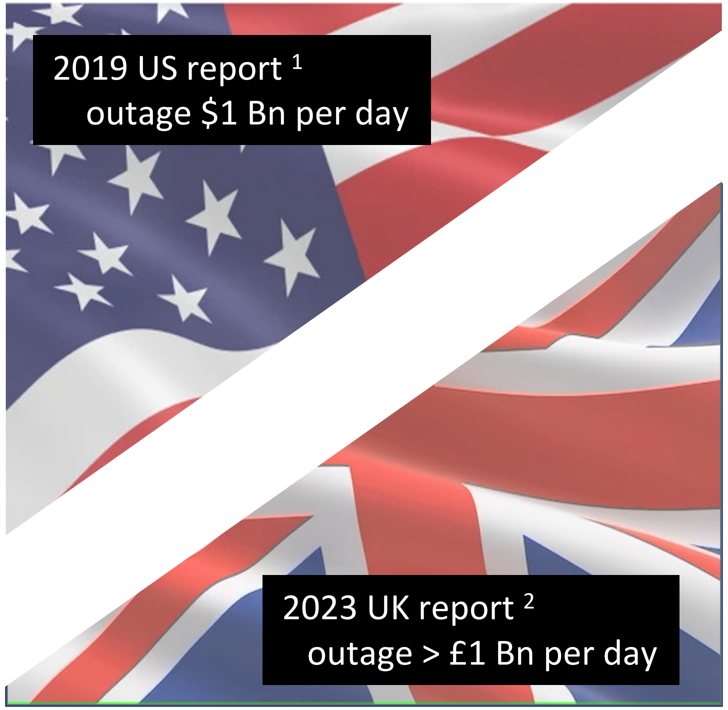


Images: GSM Association

Robotic dogs doing backflips from a skateboard, robots giving life advice or taking a ride in a fullsize drone is fun …

But the groundwork MUST be there. Several other countries are looking on a "National time" from a neutral host.

Overreliance on GNSS



(1) Economic Benefits of the Global Positioning System (GPS)
https://www.nist.gov/system/files/documents/2020/02/06/gps_finalreport618.pdf
(2) The economic impact on the UK of a disruption to GNSS
https://www.gov.uk/government/publications/report-the-economic-impact-on-the-uk-of-a-disruption-to-gnss

People and businesses across the entire economy rely on the availability of mobile communications. Today, many critical systems and functions rely on accurate time for synchronization and coordination.

A recent report from the UK government estimates the economic impact in UK from a large-scale GNSS would be about 7,5 Billion GBP in a seven-day outage. A similar US government report estimated the cost in the US to over 1 billion USD per day where half of the impact is telecom related.

As an example: during the Christmas period 2023, parts of Poland, Lithuania, and southern Sweden experienced significant GNSS signal disruptions, affecting aviation and navigation systems.

Such incidents not only pose immediate operational challenges but also raise long-term security concerns for all industries relying on GNSS for critical operations.

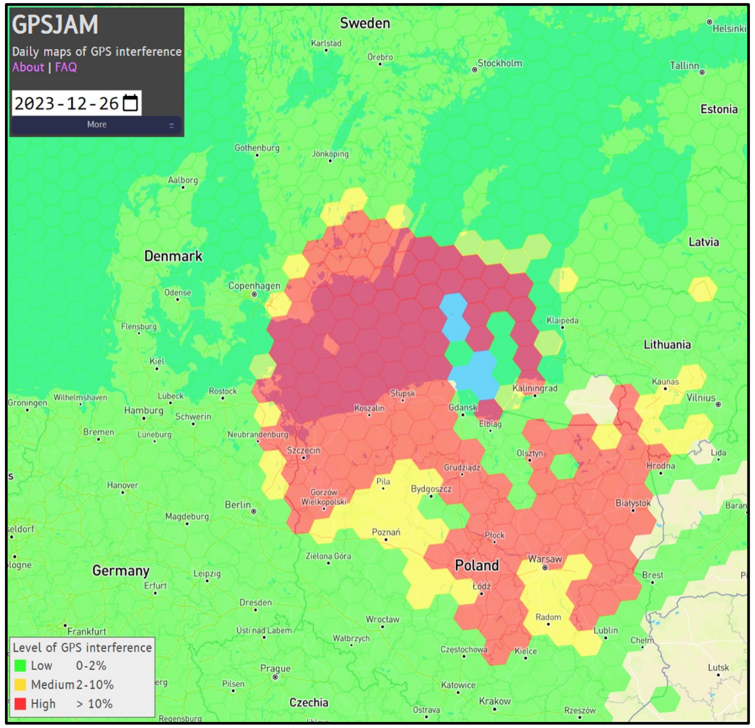


Image: https://gpsjam.org

Ubiquitous but vulnerable

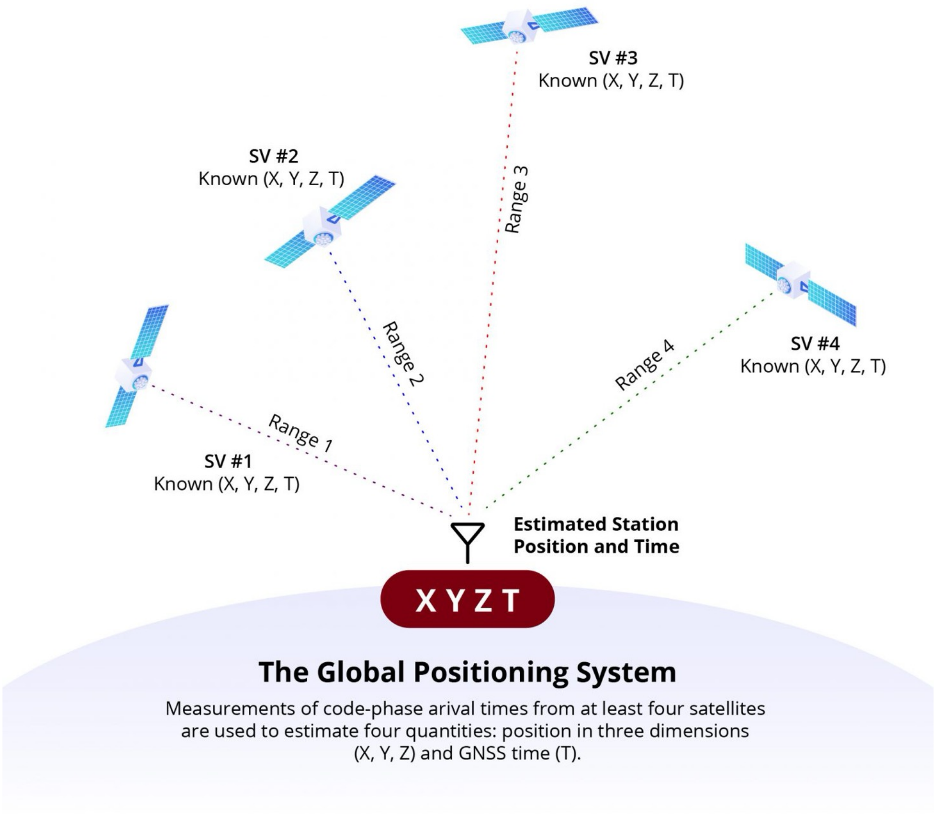


Image: GNSS Trilateration from Tallysman Wireless Inc

- GPS transmits its L1 signal with 14.4 dBW. However, by the time you get it is -157 dBW, as the satellites are 20200 km away

14.4 dBW ~27 W
-157 dBW ~ 0,000 000 000 000 0002 W

- *Yes, our plan is to have a single point of failure*

“The Swedish Model” - GNSS independent time synchronization for 5G

PTS Requirement:
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.

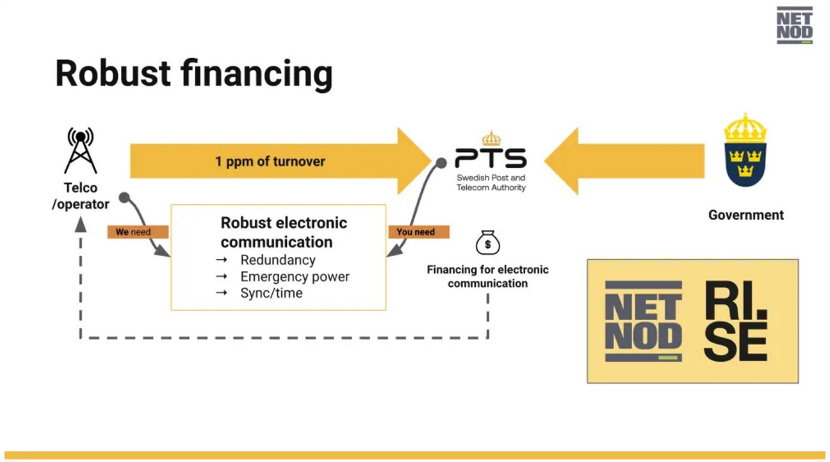
Swedish Telecoms Regulator PTS is mandating GNSS independent synchronization back-up for all Swedish 5G networks

Netnod provides time traceable to Swedish national time and offers free and commercial services with different SLAs and accuracy on 6 locations

5G Mobile operators need to distribute time (Time Transfer) from the national clock sources of Netnod, to their 5G radio access networks

Image: Netnod

A robust, secure, and neutral national time service that all 5G operators could use



In 2014, the government commissioned Netnod to develop a national time distribution network without GNSS dependency. The first question was that of funding. Netnod were commissioned to develop a system that would be robust and available throughout the country; but which also had to be affordable for all operators. The costs here are significant, beyond what can be covered by the market alone.

The funding model is therefore based on a public/private cooperation which works very well. This model enables Netnod to develop long term plans for the time distribution service and ensures state-of-the art time nodes in all parts of the country.

Each of these nodes is redundant from the others and has all critical equipment doubled in a dual node setup to ensure local redundancy. The time nodes are housed in secure bunkers in 6 locations throughout Sweden.

Netnod provides time traceable to Swedish national time, and offers free and commercial services with different SLAs and accuracy. This includes Netnod Time Direct, delivering time to a customer at a Netnod Internet Exchange to within 30 microseconds; and a PTP service which delivers time over dedicated fiber to within 30 nanoseconds of Swedish national time.

Image: Netnod

National distribution of time from Netnod to RAN

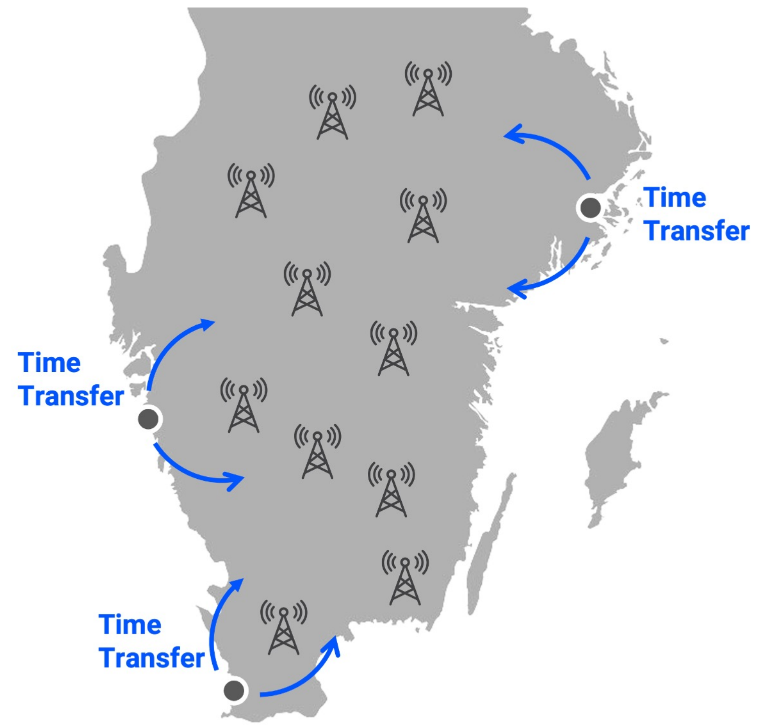
For 5G mobile operators, the PTS mandate presents both a challenge and an opportunity

Approach must be cost-effective and agile,

- To ensure swift deployment of 5G services

Traditional network-based synchronization solutions require extensive infrastructure upgrades

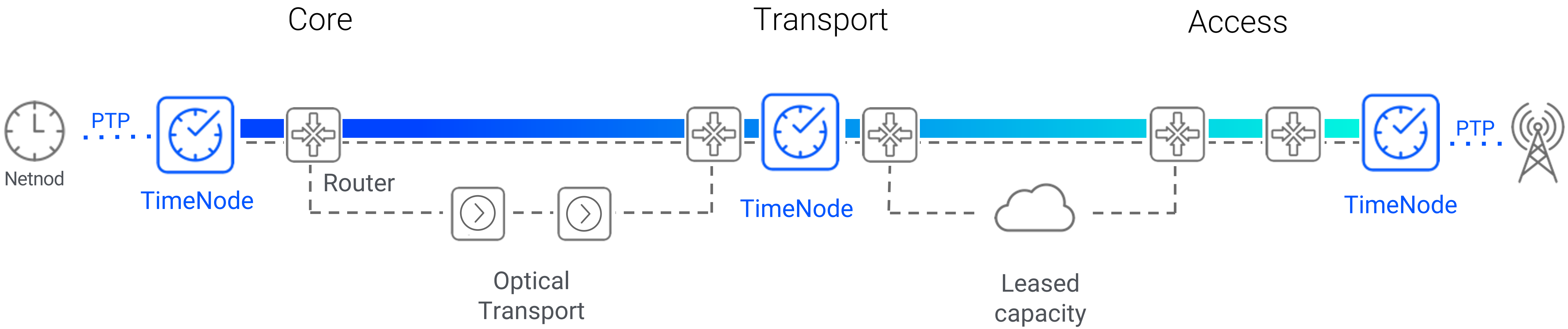
- Which results in increased costs and complexity



Limitations with traditional IEEE1588 PTP

- Hardware **support required** in every node
- **No support** over leased capacity
- **Performance issues** after multiple hops

Disaggregated hardware-independent solution distributes time synchronization over any IP network



In-network sync
Overlay distribution on top of any IP network

Advanced real-time control nodes
Edge compute to optimize sync performance

Centralized intelligence
End-to-end observability and orchestration

netinsight

ITU-T G Suppl.ePTS "Enhanced Partial Timing Support"

ITU-T Study Group 15 / Question 13
Network synchronization and time distribution performance

Question:	13/15	**Proposed new ITU-T Supplement**	Geneva, 20 November-01 December 2023	
Reference and title:	ITU-T G Suppl.ePTS "Enhanced Partial Timing Support"			
Base text:	-		**Timing:**	2025
Editor(s):	Mikael Johansson (Telefon AB LM Ericsson)		**Approval process:**	Agreement

Summary (provides a brief overview of the proposal):

This Supplement provides a framework for enhancement to partial timing support, i.e., timing carried over an overlay time transport technology without timing support from the network nodes (e.g., T-BCs supporting G.8275.1 PTP profile) as an extension to G.8275.2, G.8273.4 and G.8271.2 recommendations.

The solution is optimized for the wide area network. This may allow to carry accurate timing from network segment having access to PRTC / ePRTC references, towards a remote network segment not having access to a local PRTC/ePRTC reference, or to provide a back-up timing reference to the remote segment.

Relations to ITU-T Recommendations or other documents (approved or under development):
G.826x series, G.827x series, G.810, G.781.1

Liaisons with other study groups or with other standards bodies:
IEEE1588, IEEE 802.1, 3GPP, O-RAN

Supporting members that are committing to contributing actively to the work item:

Net Insight, Türk Telekom A.Ş, Huawei, Calnex, Keysight, ZTE

netinsight

Precision TimeNet Technology

Improving Time Accuracy over Congested Networks

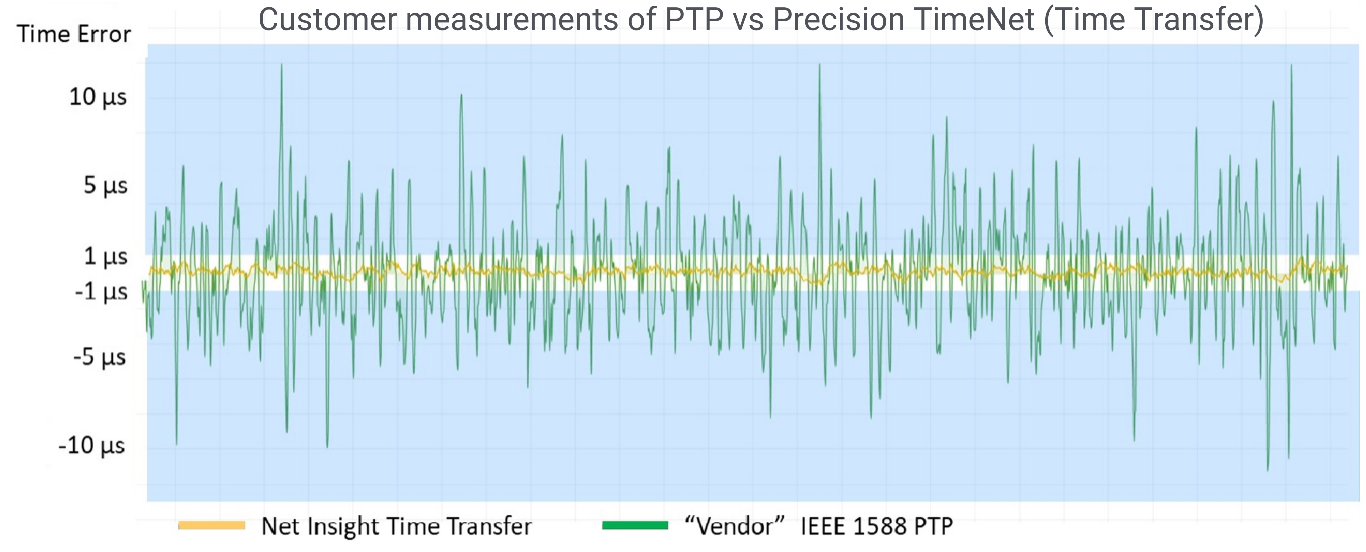
Adjustable sync packet rate to handle network jitter (suppress noise)

- **500-40,000+** (vs 16-128 in PTP)

Adjustable sync packet sizes

Intelligent filtering algorithms with adjustable filter bands

Multi-link routing – combine multiple paths into a TimeNode to further improve accuracy



PTN Time Transfer: within ± 500ns

PTP (G.8275.2, PTS): ~ 10-100 µs

netinsight

Asymmetry detection and calibration

DETECT

1. Detect sudden change in Round-Trip Times (RTT) and/or unidirectional latency i.e. change between local clock (slow) and link clock (fast)
2. Detect interruption of packets
3. Detect sudden change in link characteristics – Jitter, packet loss
4. Detect difference in Spread (Calculations from different incoming sync links)
5. Detect change in TE (if GNSS input)

MANAGE

1. In case of 2 or more valid incoming sync links, disable changed sync link. Otherwise enter short Holdover
2. Recalculate new TE offset for affected Link and store new Link Profile
3. Activate sync link and continue two-way time transfer calculations with new sync link parameters

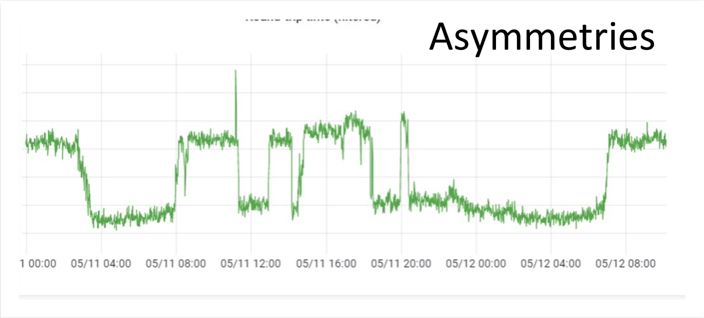
Wide Area Network Synchronization

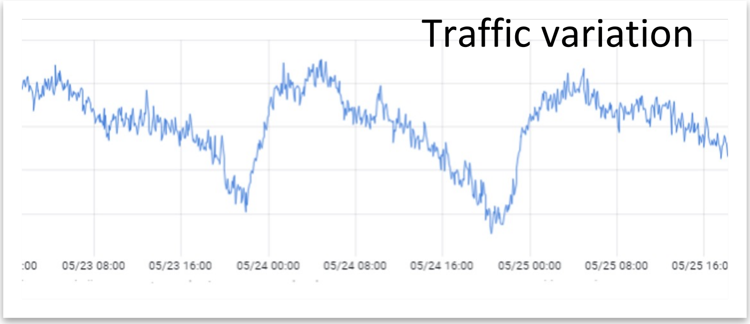
Synchronization Orchestration

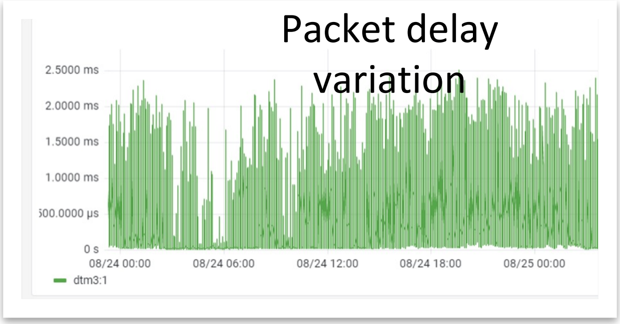
Asymmetry analysis
Recalibration

Observing characteristics

Route and link optimizations







Change detection algorithm.
Profile management.
True mesh 2-way metrics

Advanced predictive algorithms

Hardware assisted filtering.
Timestamp selection

Realtime Control System

The Swedish model, presented in 5G magazine

Sweden has developed one of the world's leading national time infrastructures and has pointed the way for how to secure critical national services from an over-dependence on GNSS.

https://tecknexus.com/5g-network/5g-and-beyond-5g-magazine-feb-2024-edition/precise-time-as-a-critical-national-service-netinsight-2/