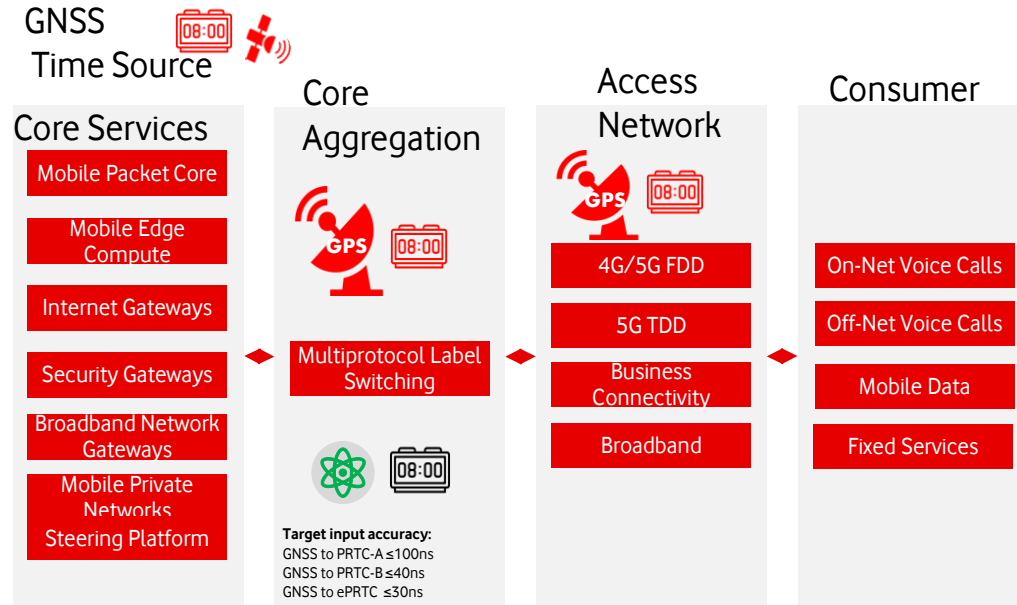


Telecom Dependency in GPS Ispra, Italy

Ettore Genta & Pietro Gastaldo
12 March 2025



From Core to Access network GPS is widely used by Mobile Operators

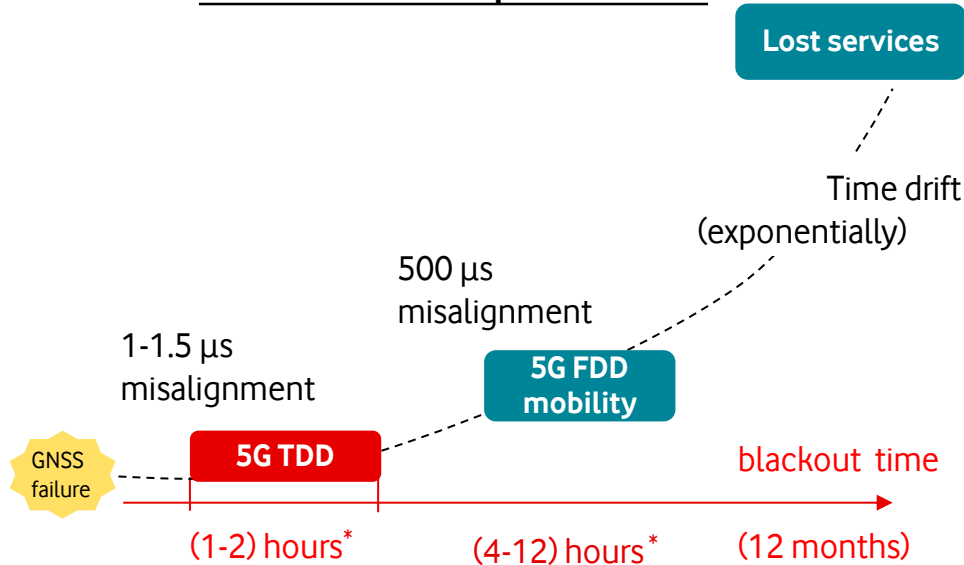


- ✓ **4G/5G FDD** UTC requirements are less demanding up to $\pm 500\mu\text{s}$, MNO's have it **secured with Caesium clocks and holdover up to 10 years**, transported through Fibre.
- ✓ **5G TDD** requires real time $\pm 1.5\mu\text{s}$, and for now it is being served using GNSS.
- ✗ **5G TDD is a capacity layer** holding a considerable amount of data volumes.
- ✗ MNO's will start to **refarm 4G freq. to 5G freq.**

Time is also important on cross Mobile Operators communications.
Hence all mobile operators must use a traceable time source.

In case of prolonged GPS outage this is how any Mobile Network would be impacted.

Mobile Network Impact Timeline

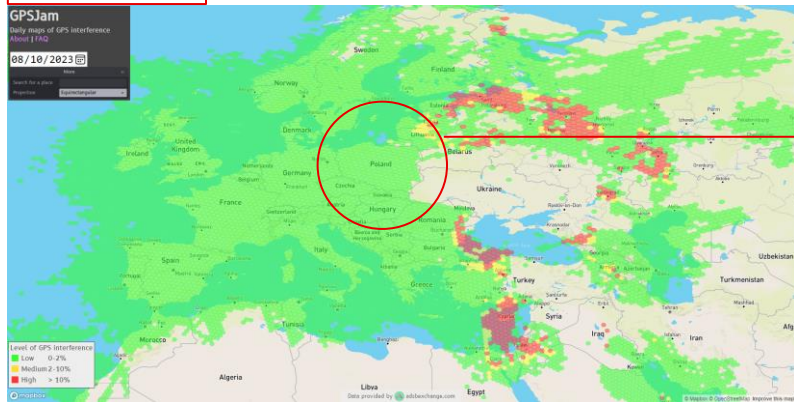


- In 1-2 hours, misalignment starts and the **5G TDD sites would be shutdown**, not to impact the service performance.
- 4-12 hours, 5G FDD mobility would be impacted, expected **degradation on voice services**.
- 12 months, **blackout**.

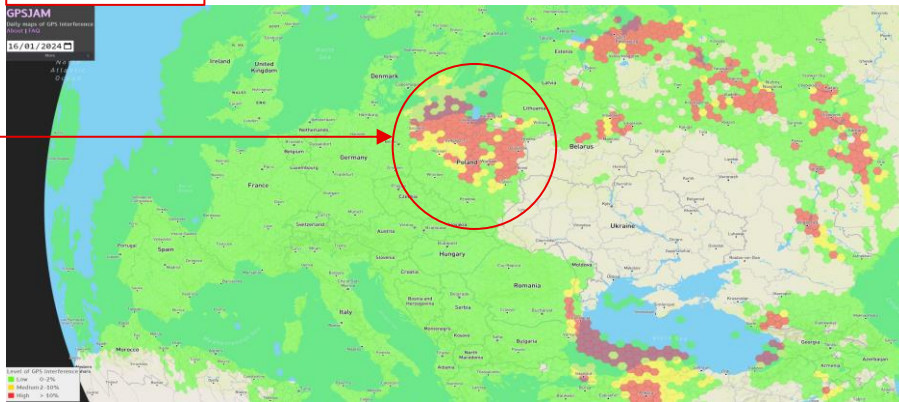
Mobile Network Operators invested on Atomic clocks for Time keeping with holdovers up to 10 years.

News report of GPS being impacted by the geopolitical conflicts in the Baltic and Middle east regions..

08/10/2023

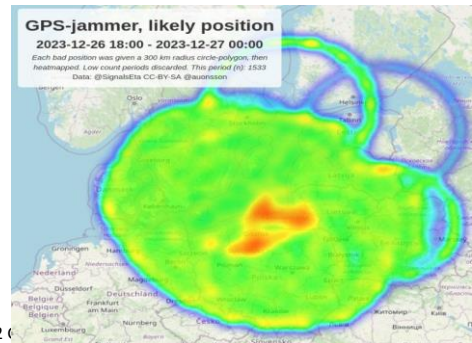


16/01/2024



Source <https://gpsjam.org>

Electronic Warfare likely position



Electronic Warfare eq. connected to the Kaliningrad radar station - Source ISW



Vodafone is active with industry and regulatory bodies to define a reliable time reference alternative to GPS

Achievements



10 points PNT Resilience plan

- DCMS calculated the impact of GNSS loss: £1.4bn a day to £7bn a week
- 10 points plan was created to build the UK PNT backup solution
- Vodafone UK PoC with NPL achieved <100ns PRTC-A accuracy through fibre
- Commercial agreement to source time from NPL reached with VF.



European Union



Europe Time distribution

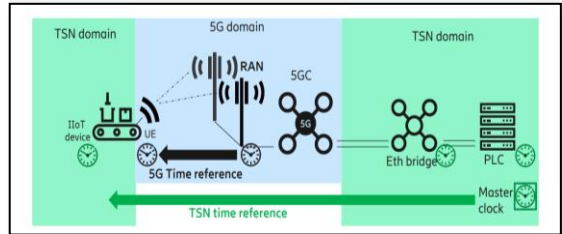
- Vodafone provided recommendations for Time resilience into EU PNT strategy
- The EU PNT strategy is aligned with Vodafone Strategy and UK Gov strategy
- ITSF European Forum (PoC results of Telco time profile with NPL)



A GLOBAL INITIATIVE

Time as a Service (TimeaS)

- Vodafone Standards team working with GSMA to introduce Time as a Service



- Rel. 18 is out June/2024 for 5G and for 4G.
- Precise Time on the masts will enable also Positioning.
- In the end mobile Operators will be able to provide alternative PNT services.

Targets/ Next Steps

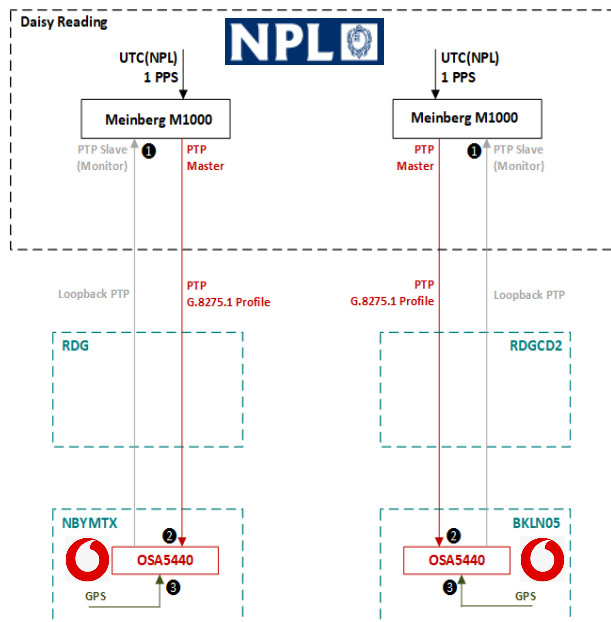
- Work closely with NPL and regulators.
- PoC to achieve PRTC-B <40ns with promising initial results.
- PoC for submarine Time transport between IE and UK.

- Continue working with the EU and the NMI's to achieve GPS resilience for Telco networks and associated infrastructures.
 - Commercial agreements.
 - Telco profile Time delivery.
 - Telco Standards.



Vodafone is looking into terrestrial alternative source of Time and distribution, hence the collaboration with NPL UK and the NTC program.

Test 1 config. Fibre (M1000)



PoC test results using different configurations and oscillators

	Test 1	Test 2	Test 3	Test 4
Start Date	16/08/2023	01/09/2023	30/09/2023	14/10/2023
Device	Test Time server	Production Timeserver	Production Timeserver	Production Timeserver
PTP Profile	Telecom Profile	Default Profile	Default Profile	Telecom Profile
Message rate	<ul style="list-style-type: none"> • 8 announce every 1s • 128 sync per 1s • 128 request every 1s 	<ul style="list-style-type: none"> • 1 announce every 2s • 1 sync per 1s • 1 request every 1s 	<ul style="list-style-type: none"> • 8 announce every 1s • 64 sync per 1s • 64 request every 1s 	<ul style="list-style-type: none"> • 8 announce every 1s • 128 sync per 1s • 128 request every 1s
Sync E	Yes	No	No	Yes
Switch	No	Yes	Yes	No
Offset (GNSS vs NPL)	Bracknell: 30 ns	Bracknell: 14 ns	Bracknell: 20 ns	Bracknell: 14
Stability	54 ns	82 ns	76 ns	74 ns

Ideally achieve ePRTC equivalence, e.g. multiband GNSS clock input with Caesium, so VF can declare NPL UTC the primary UK sovereign reference and GNSS as secondary.



What is the Vodafone vision regarding Time...

Vodafone aims to continue collaborating with the EU , the NMIs, and GEANT to create the European Resilient Time Network, which will be crucial for stability during these uncertain times.

Vodafone have introduced Caesium clocks with 8-10 years life span across all its EU operations securing the legacy systems (4G and 5G FDD) and is also working to secure the new 5G-NR and upcoming 6G networks.

As of today, primary reference for time is still GPS but we aim to secure it via an **EU resilient terrestrial time source distributed via fibre**.

Vodafone encourages the NMIs across Europe to adopt the same operational method used by the National Physics Laboratory in UK:

- **Commercial**; reshape org. to be able to commercialise time, setup contracts as a Time supplier for the MNO's and CNI's.
- **Telco profile (<40ns)**; in-country time network with redundancy with multiple distributions points, where MNO's and CNI's like can tap in.
- **Telco standards**; secured facilities with Telco SLA's.

