OSCILLOQUARTZ
A division of Adtran

Data Centers, protecting critical infrastructure from GNSS cyberattacks

Netnod Meeting, 18-19 March 2025 at Forografiska Stockholm.

Jörg Urban, March 2025

Oscilloquartz at a Glance

Focused on offerings solutions & services for communications, government, defense and enterprise applications

Longstanding relationship with customers worldwide since 1949

- About 100 sync focused partners in about 80 countries around the globe
- Driven by customer satisfaction

End-to-end solutions, most comprehensive, scalable and innovativ

Cesium Clock R&D and production in Europe, most comprehensive portfolio

Timing delivery and assurance excellency

An Adtran Company

Innovation leader for timing distribution and assurance

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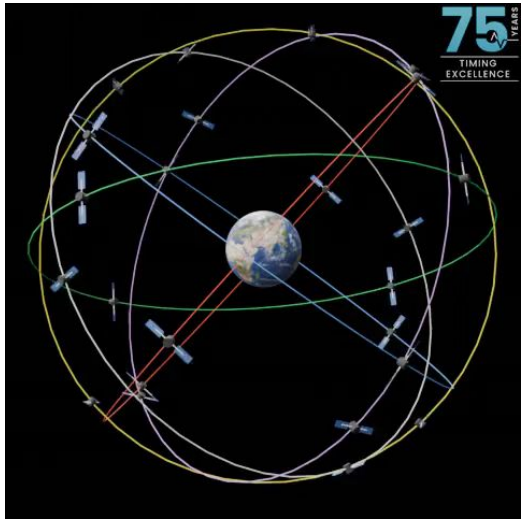
GNSS, Global Navigation Satellite System

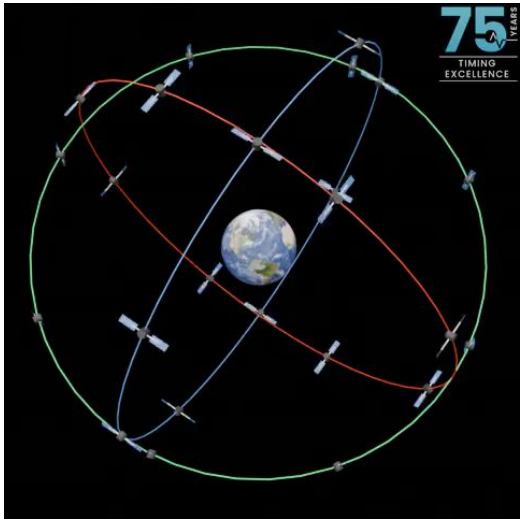
GPS

24+ satellites in 6 orbital planes
Orbiting at 20,200 km altitude



GALILEO

24+ satellites in **3** orbital planes
Orbiting at 20,200 km altitude



Pro's

- Free Service of **PNT**
- Almost everywhere

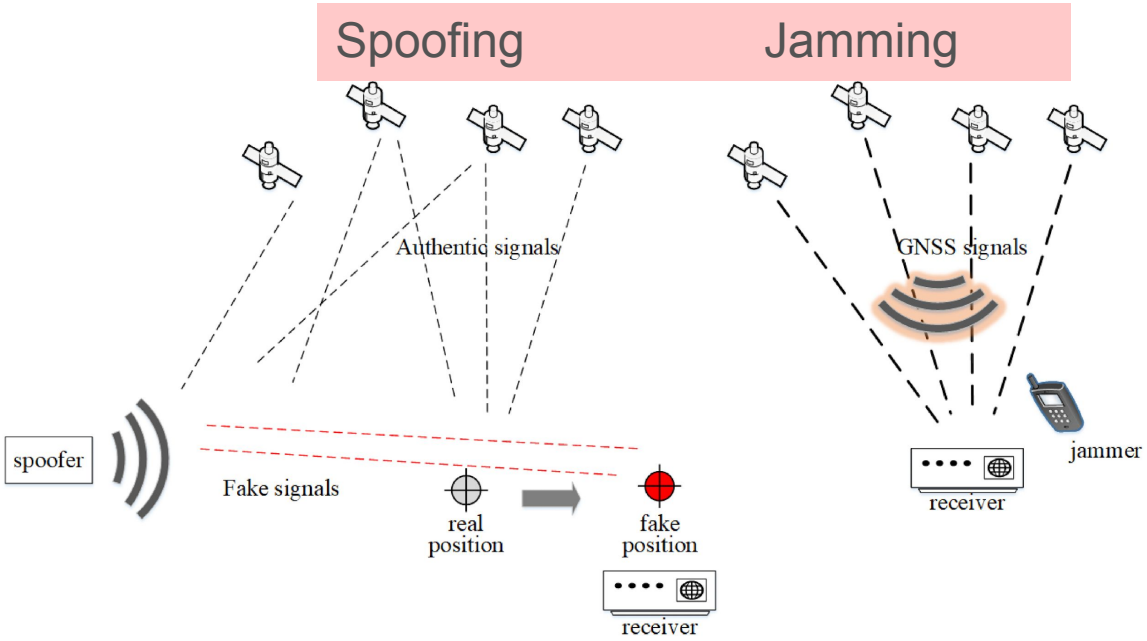
Con's

- Vulnerable source exposed to Cyber Attacks

What are the enemies ?

GNSS a Single Point of Failure!

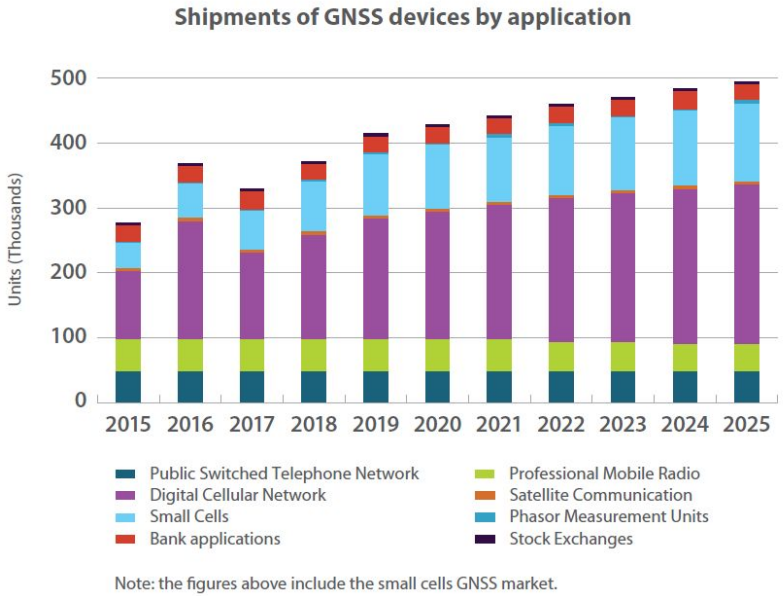
GNSS Cyberattacks



https://gpsjam.org/

TIMING INFORMATION IS ESSENTIAL FOR OUR ECONOMY AND THE MOST COMMON SOURCE IS GNSS

Critical Infrastructure relying on PN(T) availability

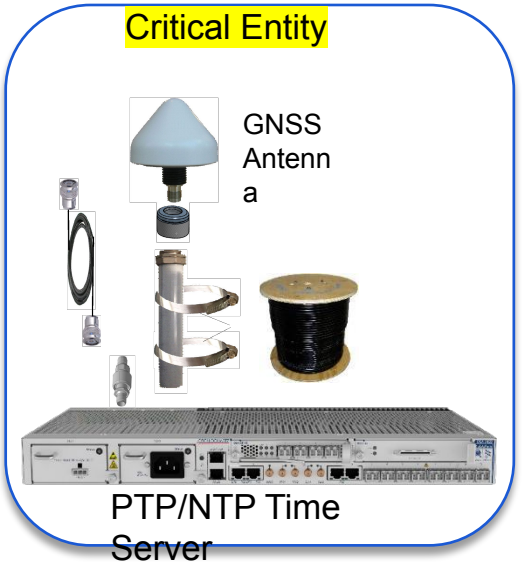


Source: Report on Time & Synchronisation User Needs and Requirements Outcome of the EUSPA User Consultation Platform

Acc. NIS2 directive

- Mobile communication
- Defense & Public: Professional Mobile Radio (PMR), Satcom, Satellite Ground Stations
- Air Traffic Control
- Utilities: Electricity / Smart Grid, Water and Wastewater Systems, Gas/Oil transportation
- Finance: Banks, Stock Exchanges
- Data Centers
- Transportation Systems: Railways, Toll Systems
- Broadcast: DVB-T, DAB

Data Centers – the heart of the digital economy



Data Centers:

Complex Infrastructure, highly secured, resilient, energy efficient, high bandwidth connectivity

Thousands of independent machines running concurrently across multiple data centers / time zones

- Time will make them work as one machine!
- While computers get faster and faster – need for Time accuracy across the System increases
  - PTP (accuracy & scalability) will replace NTP
  - Better DCI bandwidth utilization while retransmits are reduced
  - Energy supply optimization

The Cloud virtualizes the Data Centers while moving to the edge of the (mobile) network

HTTPS://DIGITAL-STRATEGY.EC.EUROPA.EU/EN/LIBRARY/DIRECTIVE-MEASURES-HIGH-COMMON-LEVEL-CYBERSECURITY-ACROSS-UNION-0

Resilience of European Critical Infrastructures

Network **I**nformation **S**ecurity (NIS) #2 Directive

- Successor of NIS from 2016
- enforcing a stronger Cybersecurity across the EU
- Accountability of company management for compliance with cybersecurity risk-management measures
- Strengthened security requirements with a list of focused measures

Critical Entities Resilience Directive (CER Directive)

- strengthen the resilience to a range of threats ensuring that critical entities can prevent, resist, absorb and recover from disruptive incidents

Ensuring the resilience of entities that use critical infrastructure to deliver essential services remains high on the agenda of the European Union and its Member States

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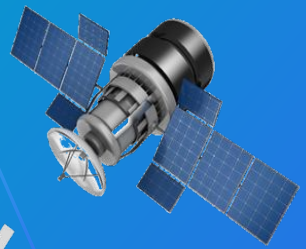
How to make Critical Infrastructure resilient to GNSS (Galileo, GPS) outages and cyber attacks?

TIME MATTERS



Proposed EU PNT ecosystem consisting of space and terrestrial assets

important to consider backup solutions (C-PNT and A-PNT)

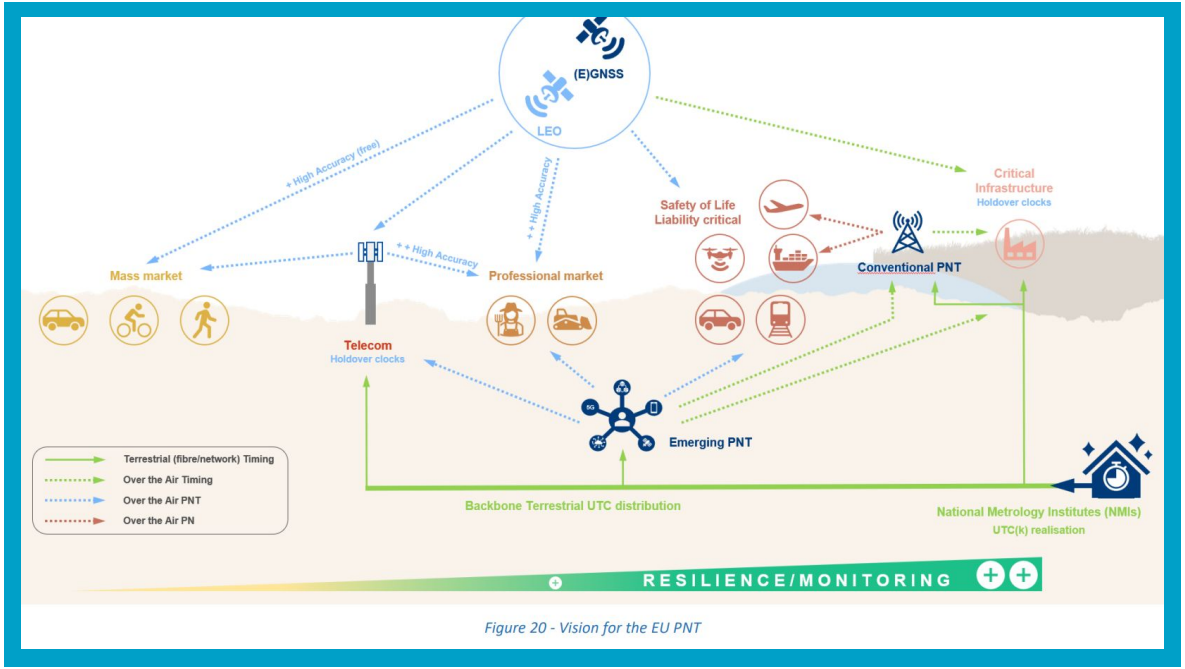


Figure 20 - Vision for the EU PNT

https://joint-research-centre.ec.europa.eu/scientific-activities-z/complementary-and-alternative-pnt_en

Scope of the ERNP

- Space based and terrestrial PNT
- Current and expected future-use of the PNT system / services
- Emerging PNT systems and services (5G, next gen DVB-T, LEO, …)

- Reference to CER (Critical Entities Resilience Directive (EU) 2022/2557) and NIS2 (Directive (EU) 2022/2555)

enhances services, resilience, availability, and continuity

Satellite-based alternatives for resilient PNT

Galileo PNT service options, 2nd Gen is being prepared

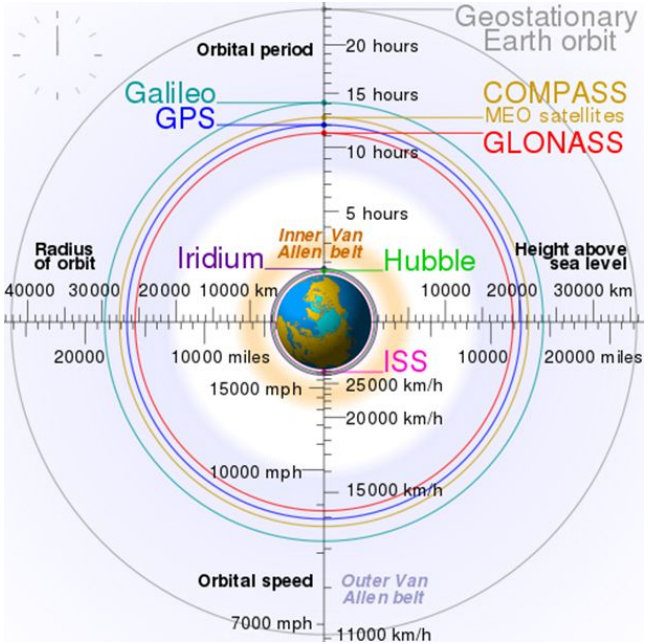
- Open service for public use
- Open service enhanced by navigation message authentication (OSNMA) protects integrity of GNSS information
- Galileo Public Regulated Service (PRS) provides an encrypted service to authorized users
  - Galileo System Build 2.0 deployment successfully completed on 12 April 2024 leading to new PRS Signal in Space

European Geostationary Navigation Overlay Service (EGNOS) is a regional satellite-based augmentation system

- Protects integrity of GNSS information

Low Earth orbit (LEO) satellites

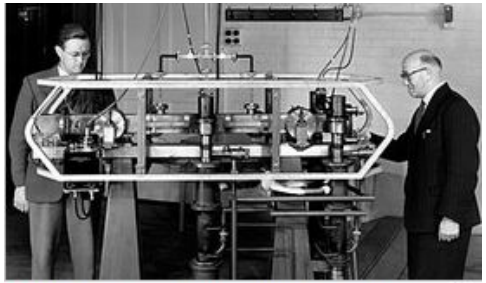
- Satellite time and location (STL), e.g., Satelles (iridium owned)
- ESA design architect for Galileo is preparing for a PoC



Future GNSS will be multilayer constellations with LEO, MEO and GEO

Terrestrial-based alternatives for resilient PNT

- The first clock was built by L.Essen and J. Parry in 1955



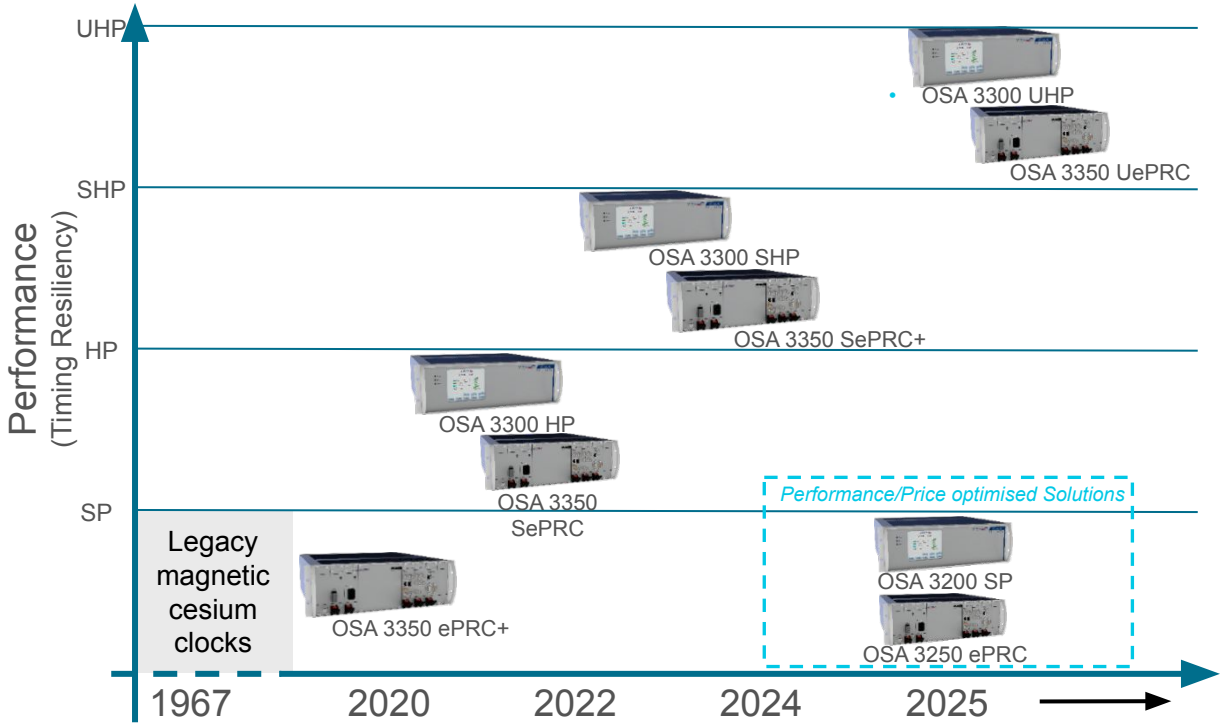
Louis Essen (right) and Jack Parry (left) standing next to the world's first caesium-133 atomic clock.

- OSA was founded in 1949 and was a laboratory
- OSA was well know as very stable quartz and oscillator manufacturer
- In the 1960's, OSA developed its first own Cs tube
- First Oscilloquartz Cs clock was delivered in 1967 to Norway

"OSCILLATOM" was shown at Expo 1967 in Montreal

OSA optical cesium development started in 1984-89, then 2008-12 and since 2014

Evolution of cesium atomic clock technology



OSA optical cesium clock

- innovation will replace legacy technology
- Major performance improvements
- Designed for GBaas/TaaS** and more

*Super enhanced Primary Reference Clock

**GNSS-Backup-as-a-Service/Time-as-a-Service)

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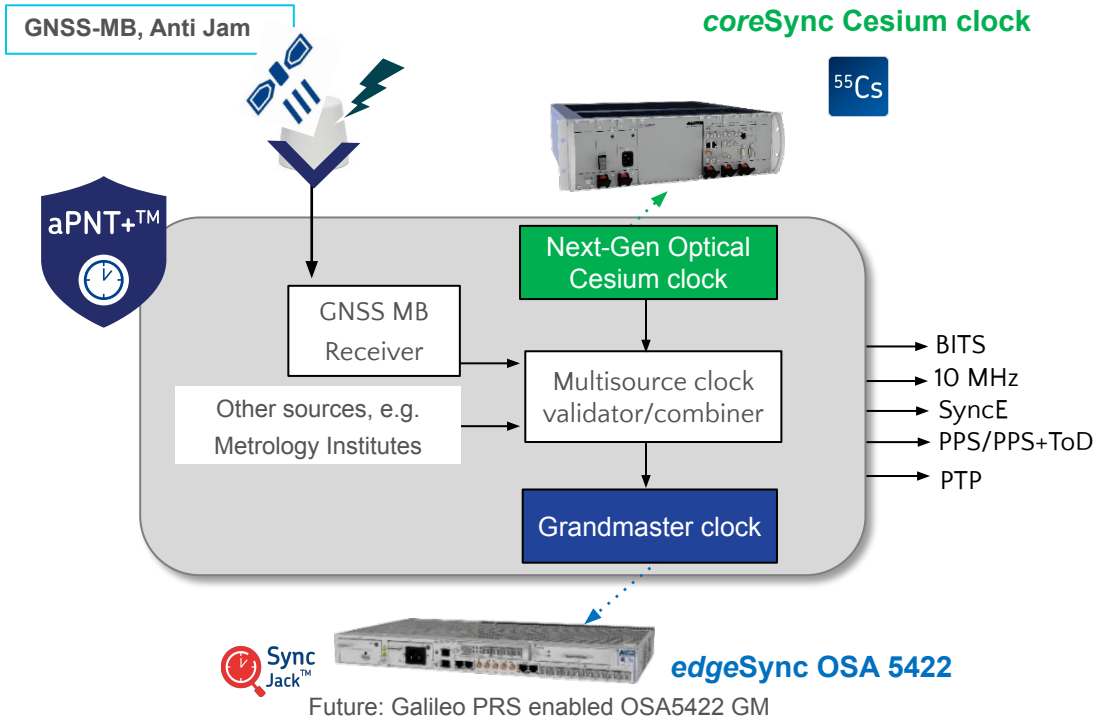
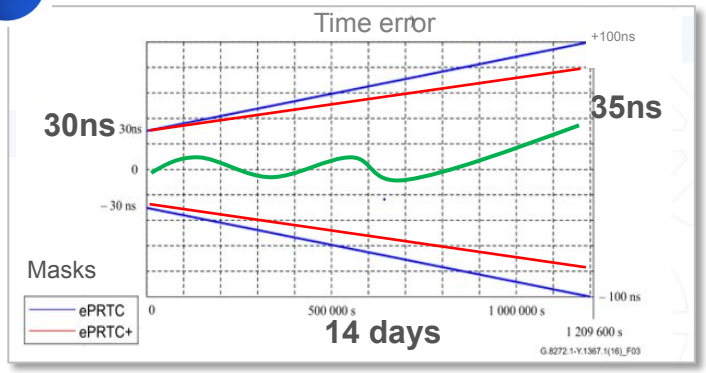
EPRTC+ TECHNOLOGY STANDARDIZED BY ITU-T

GNSS agnostic Core TimeClock



Short-term GNSS backup holdover performance



Long-term GNSS backup holdover performance

Time/Phase holdover if GPS/GNSS goes down

ePRTC+ solution	100ns over 30 days	(3350 ePRC+)
	100ns over 55 days	(3350 SePRC)
	100ns over 100 days	(3350 SePRC+)

Building Block for Terrestrial aPNT Solution

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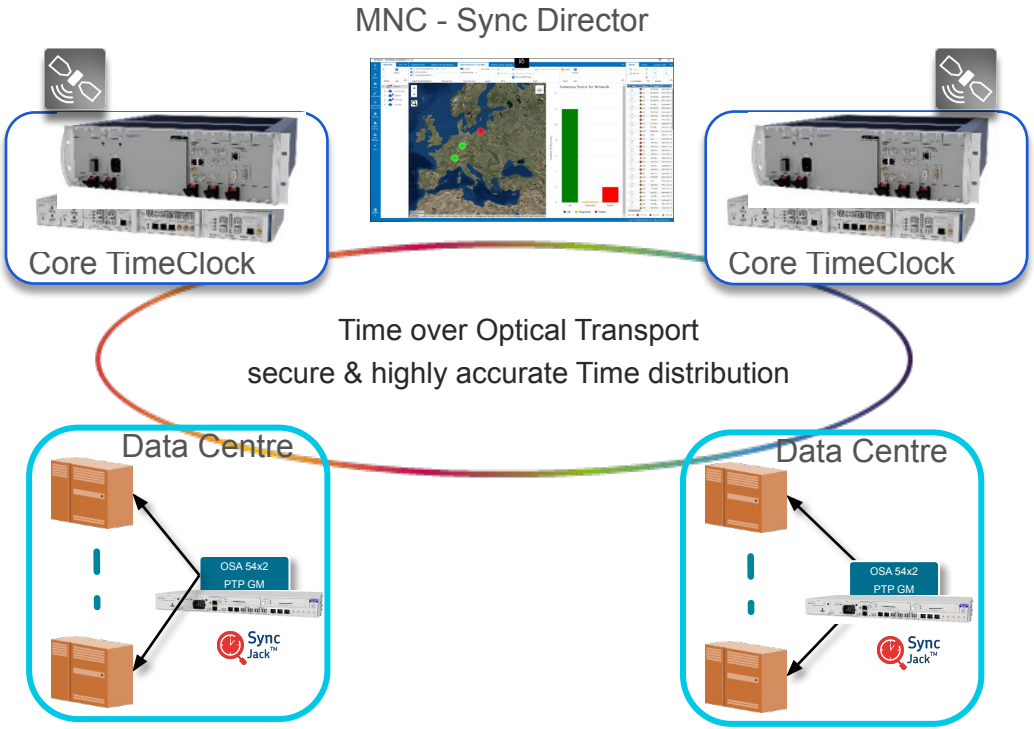
FOLLOWING REGULATIONS AND RECOMMENDATIONS

Summarizing, Resilient Timing Solution for DC



- Terrestrial based alternative for resilient PN**(T)**
- Key Building Blocks
  - Core TimeClock to mitigate GNSS vulnerabilities / dependency
  - WR PTP - Optical Layer Transport
    - Security & resiliency
  - Sync Management for easy FCAPS
    - E2E Mgt of Timing network
    - GNSS Assurance for proactive jamming & spoofing detection & reporting

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Thank you

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The new timing and sync solution –
Highly accurate and redundant timekeeping, distribution and assurance

Core network

Ensemble of highly precise and

accurate ePRTCs

< +/-30ns to UTC

Aggregation/access Network

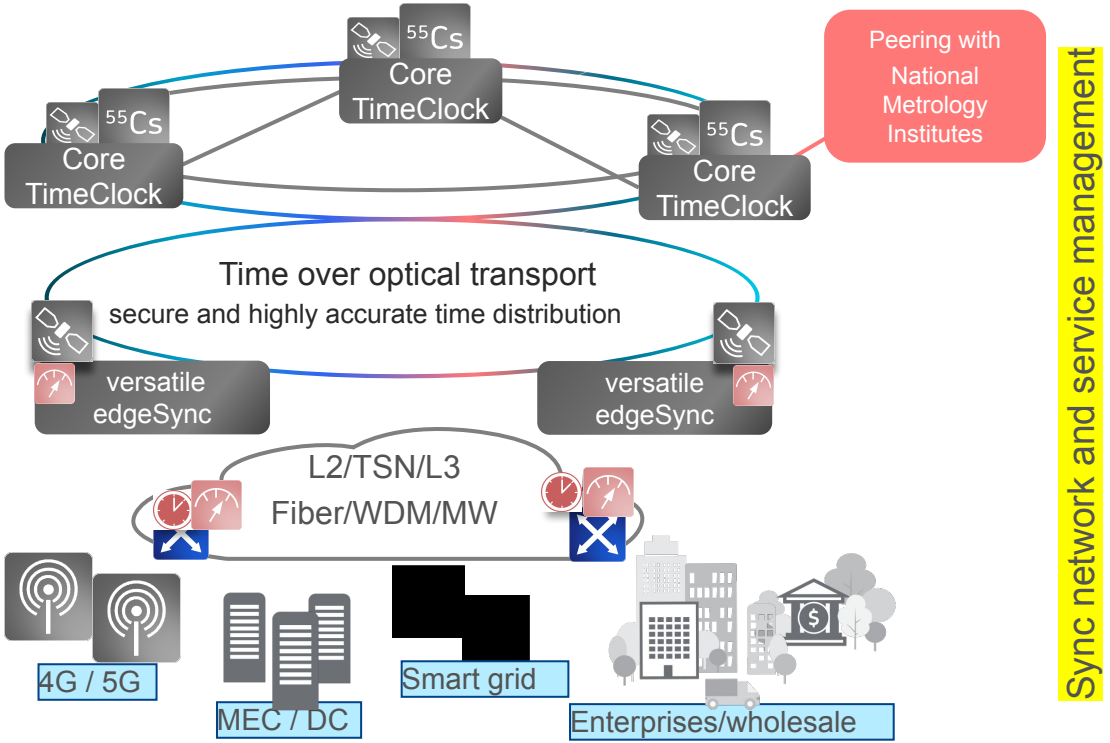
COs enabled to provide time information to variety of consumers

Better +/- 100ns (PRTC-A), 40ns (PRTC-B)

Access Network

Applications

Better +/- 1000ns to UTC



SLA enabling sync architecture for mission-critical communication networks

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OSA Product Line Overview

Mosaic *sync*Director™

Sync Jack™ aPNT+™

accessSync™

OSA 540

SFP SyncPlug

OSA 5405-I/O/M

edgeSync™

OSA 5410 XG

OSA 5412

edgeSync+™

OSA 5422

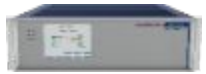
coreSync™

OSA 5430 NG GM/SSU

OSA 5440 NG GM/SSU

coreSync™

OSA 3300/50 Optical Cs



OSA 323X Magnetic Cs

OSAinside™*

OSA 5400

TimeCard

SyncModule

OSA SoftSync

TimeScale

PNT cyber threats

5G O-RAN/edge DC

Data center

911 center

front/backhaul

Core network

Smart power grids

Aviation radars

Defense comm

TV studio

Financial trading

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ASKING AI

why do we need nano second time sync in data centers?

Copilot

Nanosecond time synchronization in data centers is essential for several reasons:

1. **High-Frequency Trading**: In financial markets, transactions occur in fractions of a second. Nanosecond precision ensures that trades are accurately timestamped, preventing discrepancies and potential losses [1].
2. **Network Coordination**: In optical data center networks, nanosecond synchronization is crucial for the correct functioning of routing and switching processes [2]. It helps minimize sync errors and ensures efficient data flow.
3. **Latency-Sensitive Applications**: Applications like virtual reality, augmented reality, and real-time analytics require extremely low latency. Nanosecond synchronization helps achieve the necessary precision for these applications to function smoothly [3].
4. **Distributed Systems**: In distributed computing environments, precise time synchronization ensures that processes across different servers are coordinated accurately, preventing data inconsistencies and improving overall system performance [2].
5. **Emerging Technologies**: Technologies such as 5G, AI, and machine learning rely on precise timing for optimal performance. Nanosecond synchronization supports the high-speed data processing required by these technologies [1].

Overall, nanosecond time synchronization enhances the efficiency, accuracy, and reliability of data center operations, supporting a wide range of critical applications and technologies.