The proposed EU C-PNT ecosystem and terrestrial time transfer

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WSTS , 12-15 May 2025

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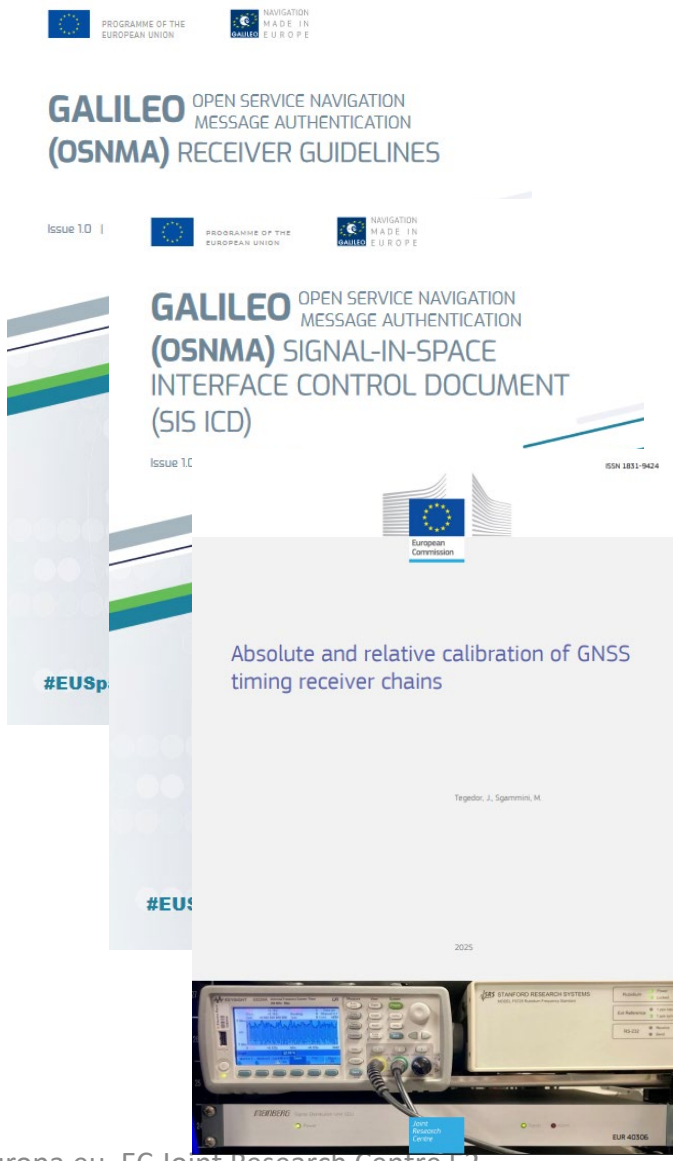

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GIANO ARGOS ASGARD GEARS FANTASTIC BARSHEE

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PNT and definition of time

PNT (Position, Navigation and Time) is combination of three distinct yet integral capabilities:

- **Positioning**, the ability to determine one's location and orientation in two or three dimensions, in reference to local or global reference.
- **Navigation**, which is the ability to determine a path between current and desired position (relative or absolute), as well as to navigate this path.
- **Timing**, which is the ability to acquire and maintain time either locally or globally. This also includes time transfer service.

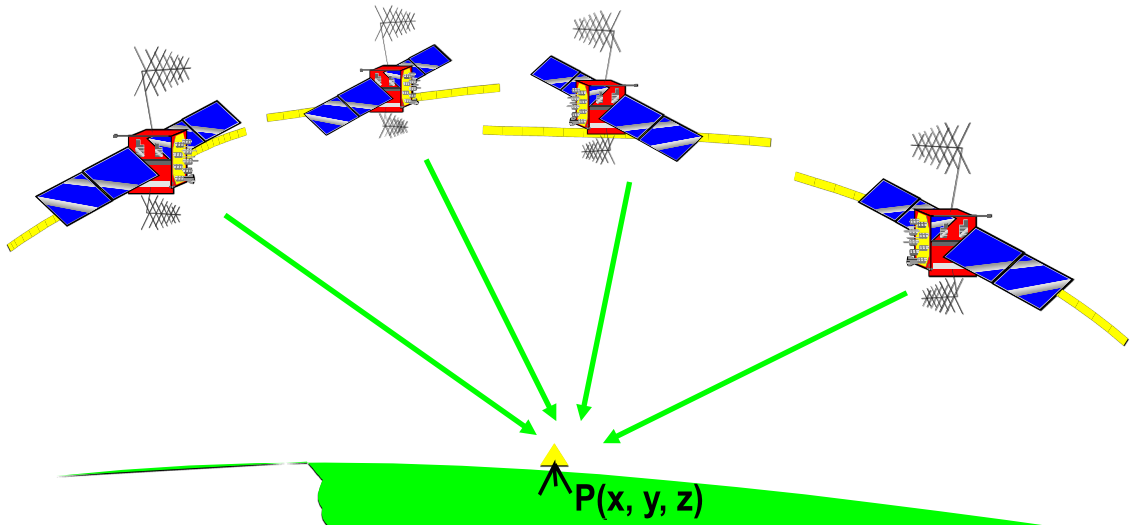

Figure courtesy of Professor T Moore, NGI, University of Nottingham

Risks to **PNT**

The GNSS (Galileo) is the backbone of modern PNT, and given its importance there is a strong rationale for additional resilience:

- €1.4 trillion (10% of European GDP, Gross Domestic Product) is enabled by GNSS.
  - Essential to transport (air, sea, and road), industry (telecommunication, energy, and finance), agriculture, fisheries, security and defense;
- Evolving international context increasing probability of PNT disruptions
- The economical benefits of development and implementation of PNT ecosystem in EU.

Way to address:

- Adequate information about the risks and its mitigation;
- Practical implementation of Continuous PNT (CPNT);
- Mitigation of reported issues.

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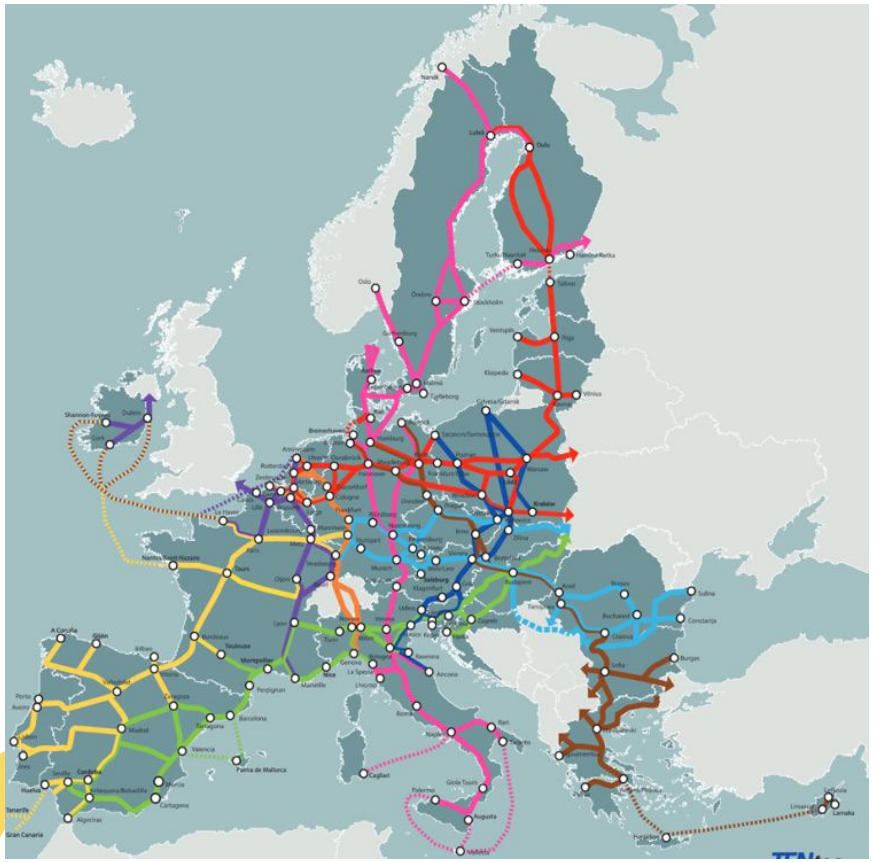
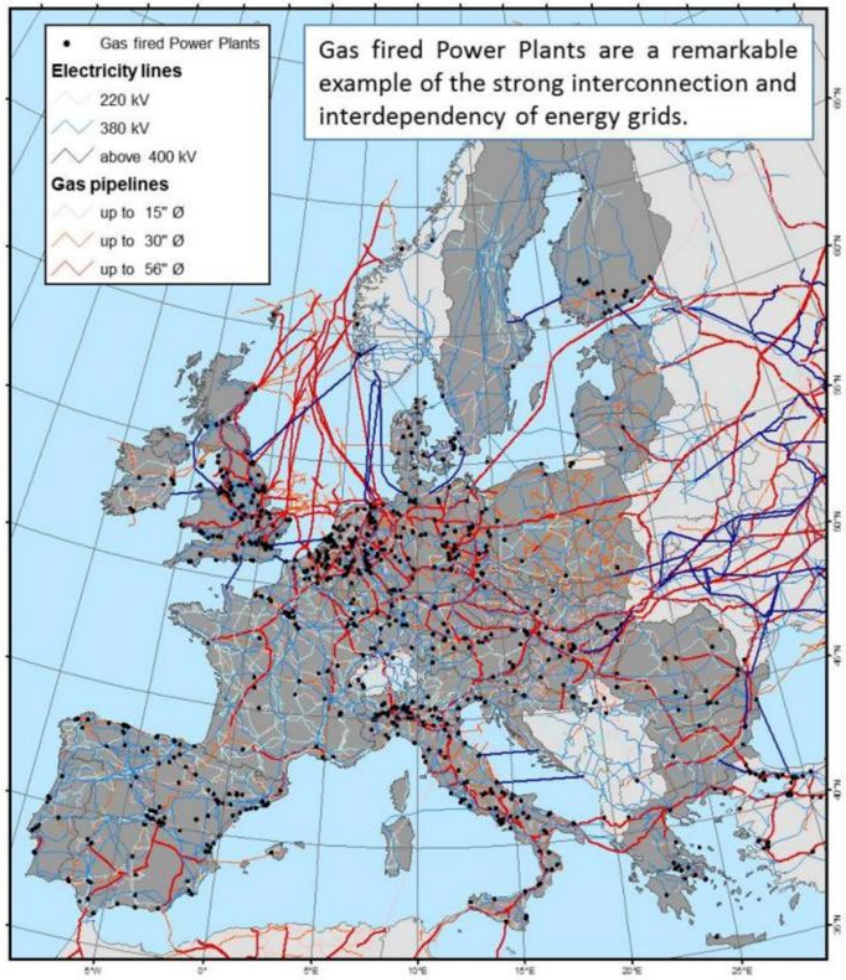
Critical Entities Resilience Directive

CEs are vital for economic growth and societal well-being, and need to be protected. Example include transport (core terrestrial corridors in the left picture) or energy grids (right).





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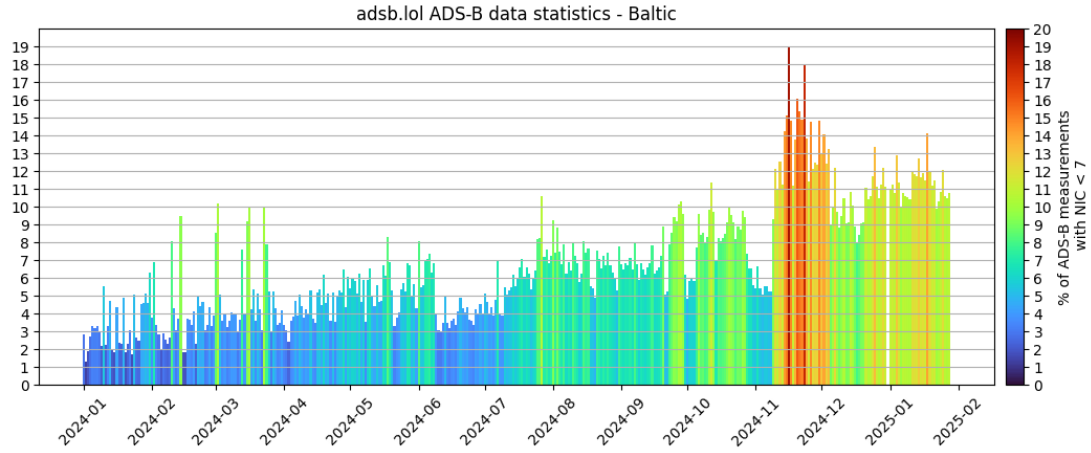
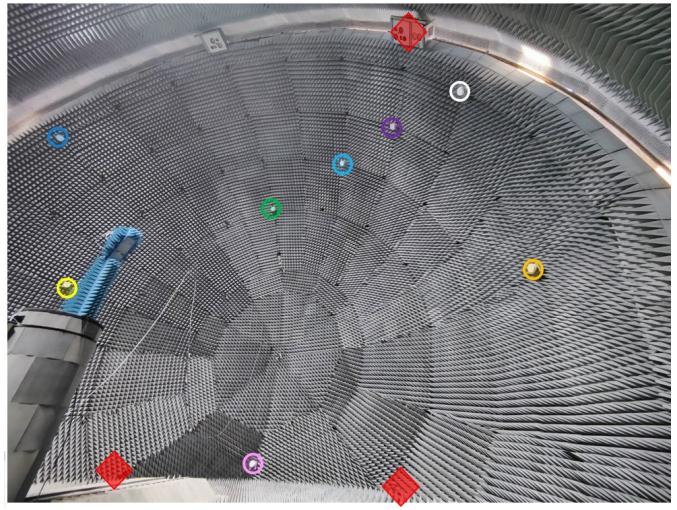
PNT Baltic area interference

Since 2024 aviation in Baltic area is affected by interference and spoofing. To address this, JRC:

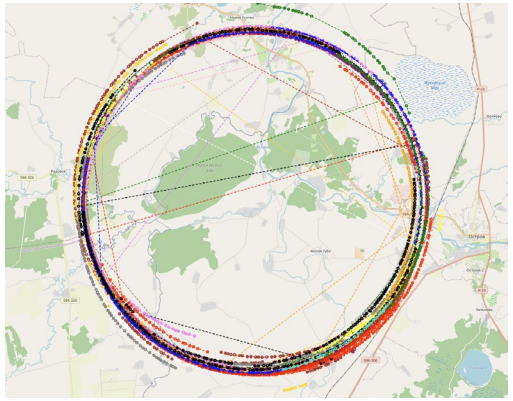
- Continuously monitor ground and space based ADS-B monitoring and collection of recorded events
- Verify the receivers/antennas including avionic receivers
- Calibrated of anechoic chamber for CRPA antenna testing
- Conduct testing using live & simulated GNSS signals + synthetic interference



Percent of all flights affected in Baltic area.



Anechoic chamber antenna testing



Example of reported anomalies

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ERNP and
EU C-PNT ecosystem

The European **Radio Navigation Plan**

ERNP was mandated in 2016 Space Strategy for Europe. The 2023 edition is the EC staff working document, written by DG DEFIS and DG JRC. The document aims to:

1. Provide information on **conventional and emerging PNT** systems and services;
2. Facilitate the uptake of the European GNSS (Galileo and EGNOS) services by
   - providing **detailed information on European GNSS** current and future services and their **added value**;
   - Recommending **EU level actions for the uptake of EGNSS** in across market domain/sector, including legislation and standards.
3. Recommend actions to **increase the resilience of PNT** services in the EU and explains the **EU PNT policies** while summarizing international ones.
4. Outline **the medium-term vision of EU PNT evolution** based on the COM exercise (2022-2023) and inputs from stakeholders, clarifying that **this is not yet an agreed policy**.

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Results of the **JRC** Alternative PNT Test Campaign

2D Positioning Performance	Static Outdoors [m]	Static Indoor [m]	Kinematic Outdoors [m]	Kinematic Indoors [m]
Satelles Inc	17.0	15.0	N.A.	N.A.
Locata Corp	< 0.01	< 0.01	< 0.02	< 0.02
NextNav LLC	9.0	14.0	11.0	N.A.

Summary of the position performance at 95 percentile

Timing Performance	Time Generation [days]	MTIE [ns]	Time Transfer Fibre [ns]	Time Transfer Networks [ns]	Time Transfer OTA Outdoors [ns]	Time Transfer OTA Indoors [ns]
OPNT BV	N.A.	N.A.	0.057	N.A.	< 200 (±100)	N.A.
7 Solutions SL	80	280	0.089	N.A.	N.A.	N.A.
SCPTime	1	< 1000	N.A.	35	N.A.	N.A.
GMV AD SAU	100	57	1	500	N.A.	N.A.
Satelles Inc	110	364	N.A.	N.A.	145	< 340
Locata Corp	1	< 1000	0.4 (4.9)	0.4 (6.1)	0.7 (6.1)	0.2 (5.2)
NextNav LLC	11.6	40	N.A.	N.A.	N.A.	< 39

Summary of the time performance at 99.7 percentile

Given the objective, **this is not qualitative but <u>quantitate assessment</u>** of the tested technologies.

Position accuracy is directly related to complexity of solution used.

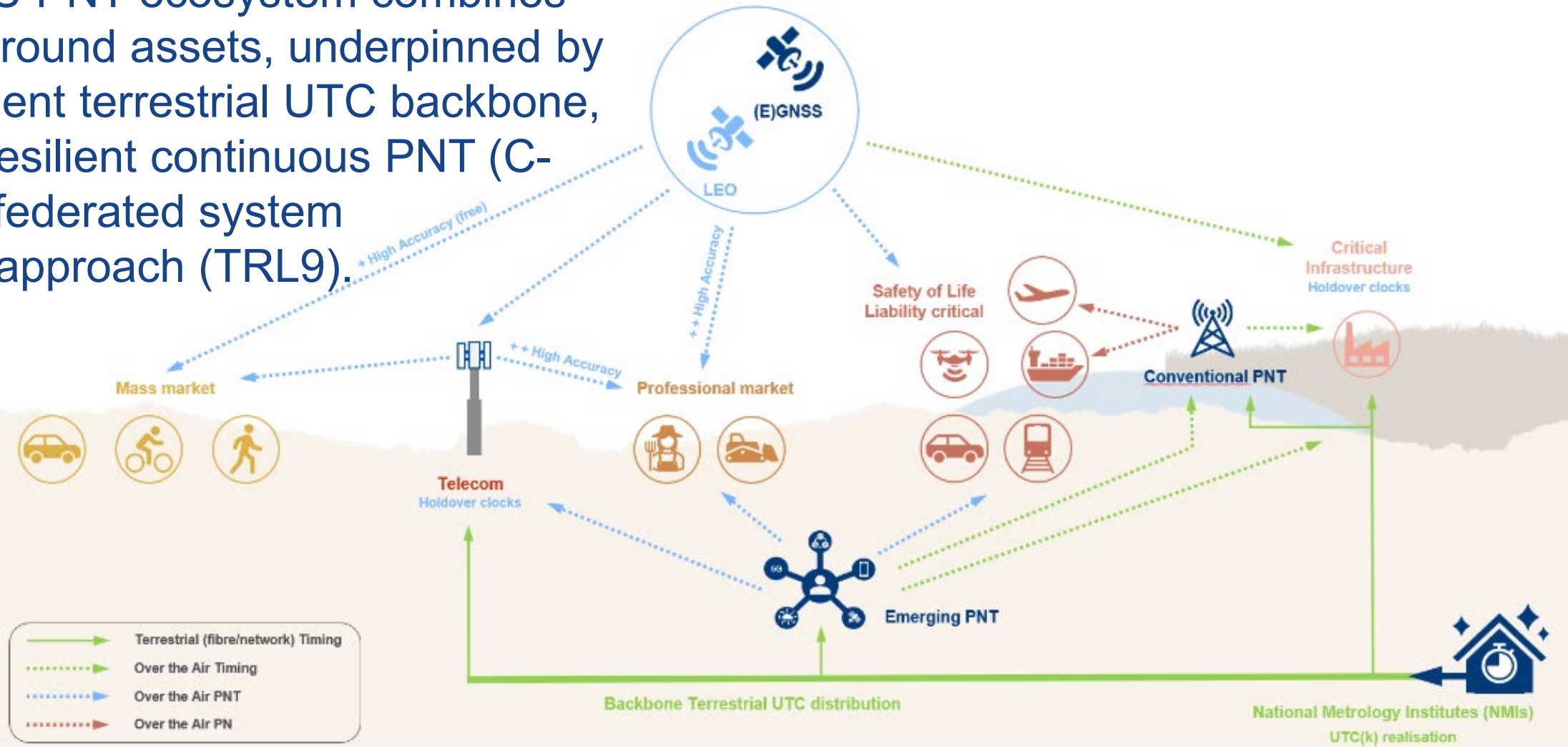
Excellent time transfer, time generation is limited.

Stringent cybersecurity and resilience demonstrated.

Need to re-consider PNT statistics.

ERNP EU C-PNT medium-term vision

Proposed EU PNT ecosystem combines space and ground assets, underpinned by an independent terrestrial UTC backbone, to create a resilient continuous PNT (C-PNT) using federated system of systems approach (TRL9).



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EU UTC terrestrial backbone proposal

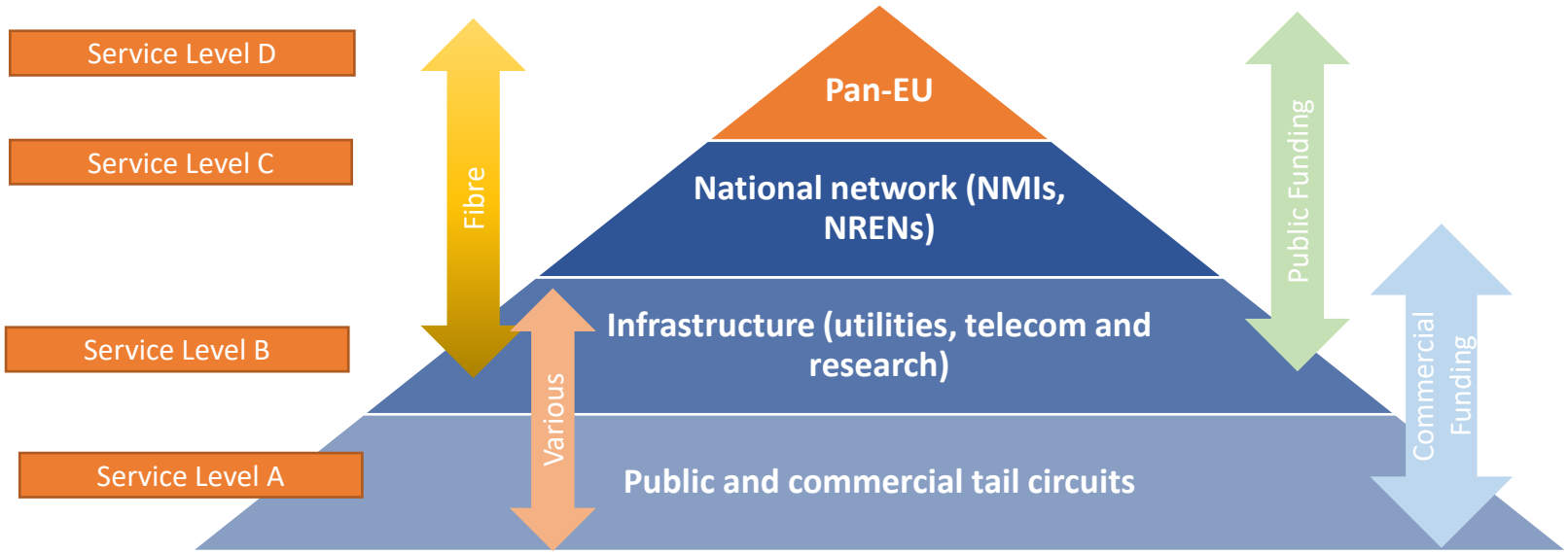
Proposal:

- Expand National Metrological Institutes (NMI) into a pan-European network;
- Enhance the existing use cases enable time connections to Critical Entities (CE), as regulated by CER Directive. This also increase GNSS/PNT resilience;
- Provide NDP (National Distribution Points) across MS to enable commercial and public use.

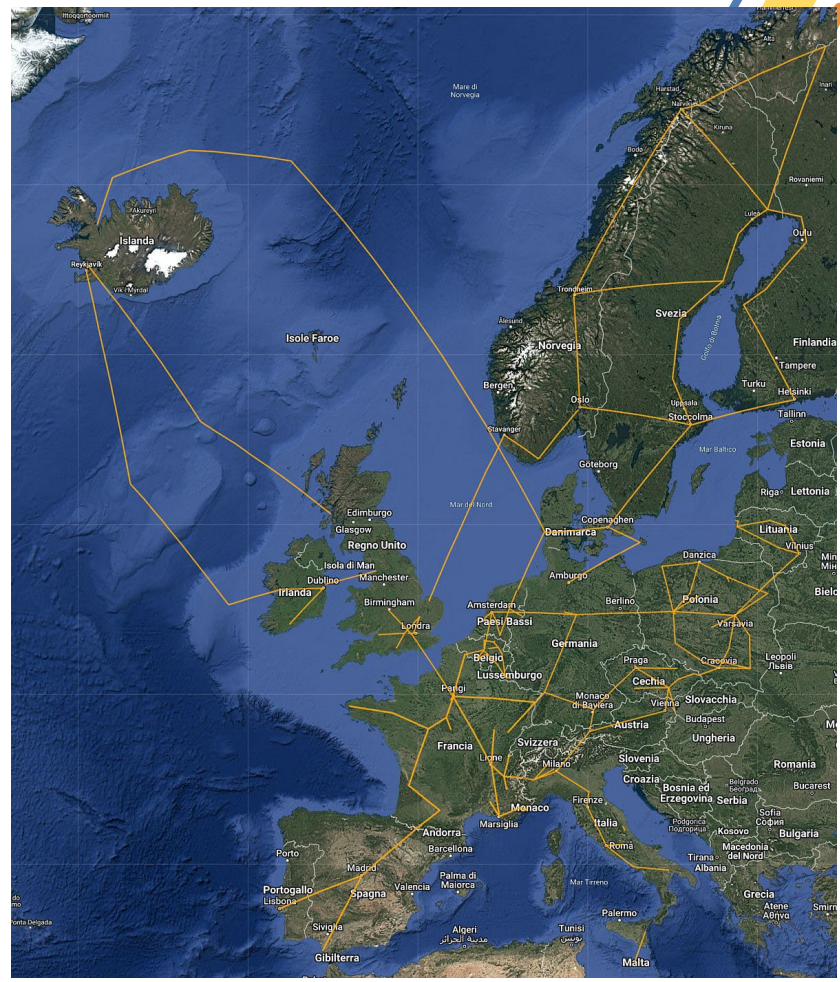
User requirements review:

- JRC/EURAMET questionnaire show strong support for fibre-based time distribution
- EUSPA T&F consultations indicate the need for resilient time traceable to UTC.
  - Galileo Timing Service (GTS) suggest UTC Maximum Tolerable Error (MTE) of 1000, 100, and 30 ns for most demanding ones (as per EUSPA consultations).
  - Achieves the EN/CENELEC and IEEE P1952 proposed standards.

EU C-PNT terrestrial time proposal



modified from GÉANT proposal



- UTC Maximum Tolerable Error (MTE) of 1000, 100, and 30 ns for most demanding ones (as per EUSPA consultations).
- Interconnect existing infrastructure, discuss interoperability of MS owned fiber networks.
- Funding with responsibility (rules, regulations) leading to neutral network.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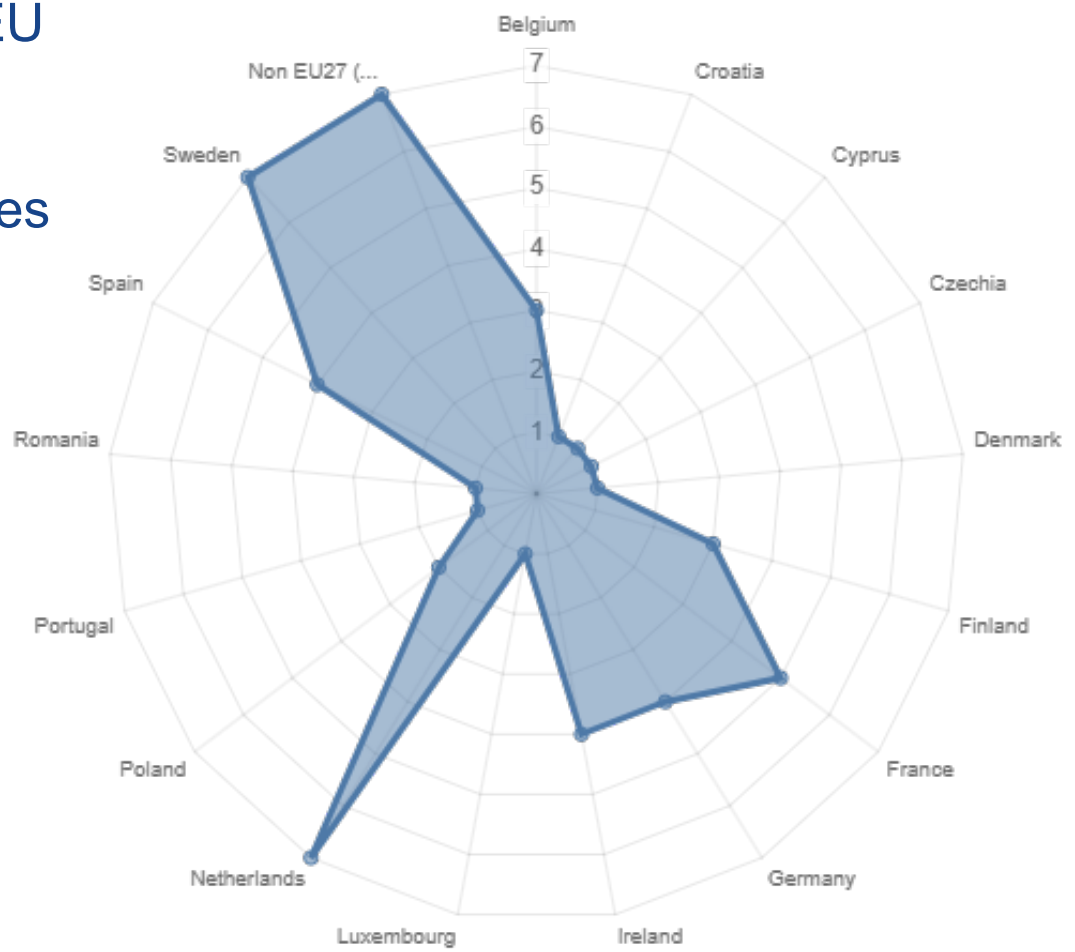
Capacity and
Consensus building

Market Consultation Market Consultation on **Terrestrial Time Backbone** Service Operations traceable to UTC

- 54 responses from industry and infrastructure from 17 EU MS, plus 8 from the US, UK, UA and Switzerland
- Majority of participants indicated that more precise UTC would enhance their services and also allow for new ones

- Proposed backbone can address concern over GNSS jamming and cybersecurity
- Need for clear governance roles and responsibilities of different stakeholders
- Need for sustainable funding and effort coordination between MS.
- Need for standardisation to maintain interoperability.
- Resilience and protection of marine cables and critical infrastructure.
- Strong interest in 1-100 ns accuracies.



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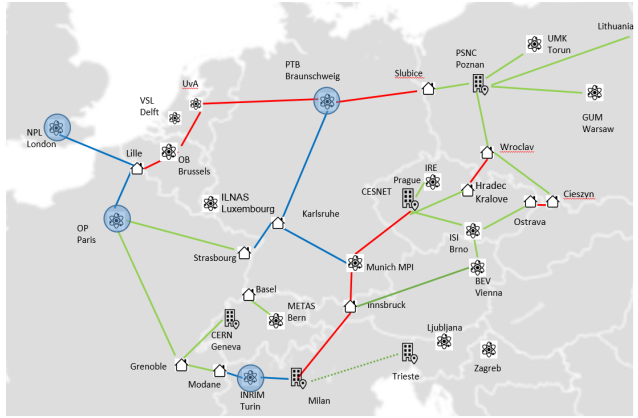
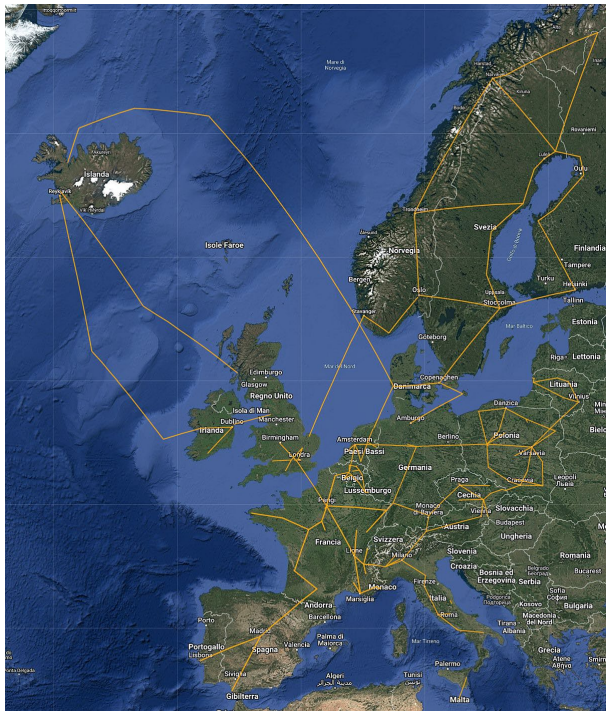
CPNT User cases for UTC timing (excluding PNT)

GÉANT 2nd SIG-TFN (12-13 March, Ispra)

The goal of the meeting was to discuss the pan-European timing network and explore the interoperability between the member states / NRENs and the possibility of commercial use while maintaining existing obligations and use cases.

Participants include NRENs, NMIs and other bodies from Member States, telecom industry representatives, EURAMET, GÉANT and the European Commission.





Stated ambition to connect all EU27 and beyond.

Discussion on commercial aspects.

- 24/7 operability needs raised by telecommunication;
- Operational concerns raised by NMI/NRENs.

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Pan-European optical fibre roadmap proposal

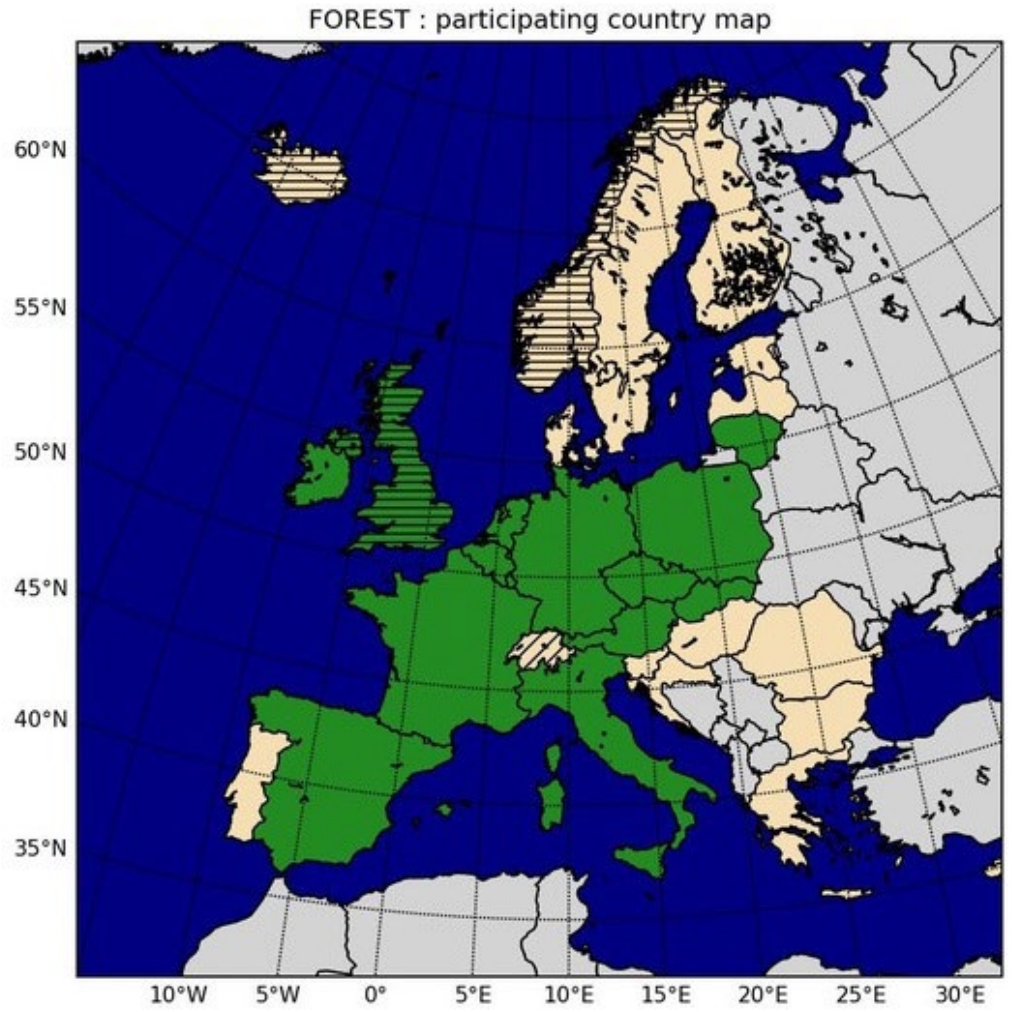
ESFRI

FORESt

FOREST Partners from 15 countries

AT, BE, CZ, DE, ES, FR, IE, IT, LT, LU, MT, NL, PL, SK, UK.

+ CERN + GEANT + EURAMET



+ governance body

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Summary

This is a proposal and not a policy.

Critical first step for EU PNT Ecosystem **is the UTC timing backbone**

- This should **advance existing collaborations and efforts** not to be parallel to each other;
- Understand what could enable commercial utilisation and identify user cases
- Discuss regulations and standards needed on EU and Member State (MS) level through GÉANT and EURAMET.

Capacity, consensus and awareness building:

- Utilise regulations (CER, NIS2) for critical infrastructure and cybersecurity;
- Engage with international bodes (ITU-T) and partners;
- Building awareness (ERNP and through dedicated events).
- JRC also suggest to look into options of interacting with partners close and further away.

Ongoing work

- JRC is supporting **building consensus and technical understanding** to foster improved time distribution within EU27.
- Work is ongoing to establish clear governance roles and responsibilities for stakeholders.

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