

European Radionavigation Plan and pan-European time distribution

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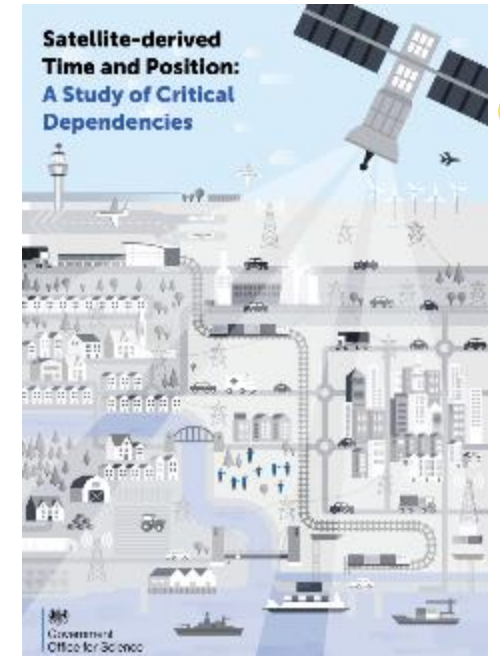
A-PNT Rationale

The GNSS (Galileo) is the backbone of modern PNT, yet there is a strong rationale for additional A-PNT development:

- The importance of PNT to EU Economy;
- Evolving international context increasing probability of PNT disruptions;
- The economical benefits of development and implementation of A-PNT in EU.

This is also noted by:

- US, UK and EU governmental studies.
- Feedback from EU stakeholders in preparation of 2023 ERNP.
- Public perception of the overreliance on GNSS of today's society.
- *The Economic Impact on the UK of a Disruption to GNSS*, London Economics, 2017
- *GPS Is Easy to Hack, and the U.S. Has No Backup*, Scientific American Dec 2019
- *Satellite-navigation systems such as GPS are at risk of jamming*, Economist May 2021



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.

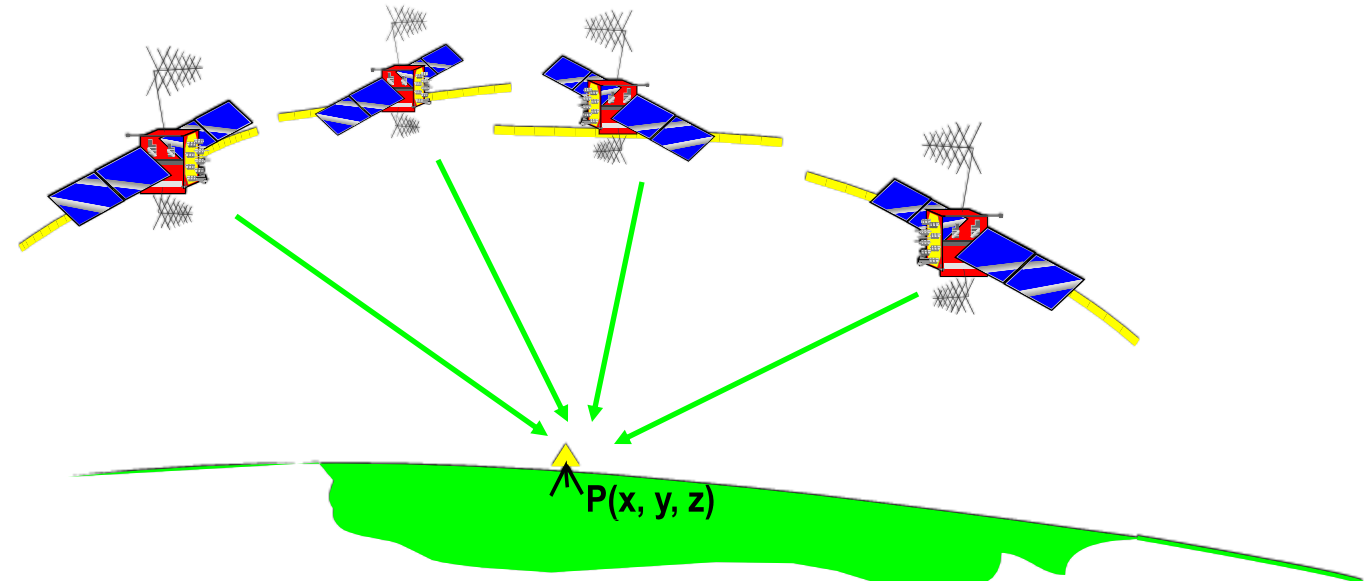


Figure courtesy of Professor T Moore, NGI, University of Nottingham

A-PNT Test Campaign Aim and Objectives

Call for Tender DEFIS/2020/OP/0007 was open to GPA countries.

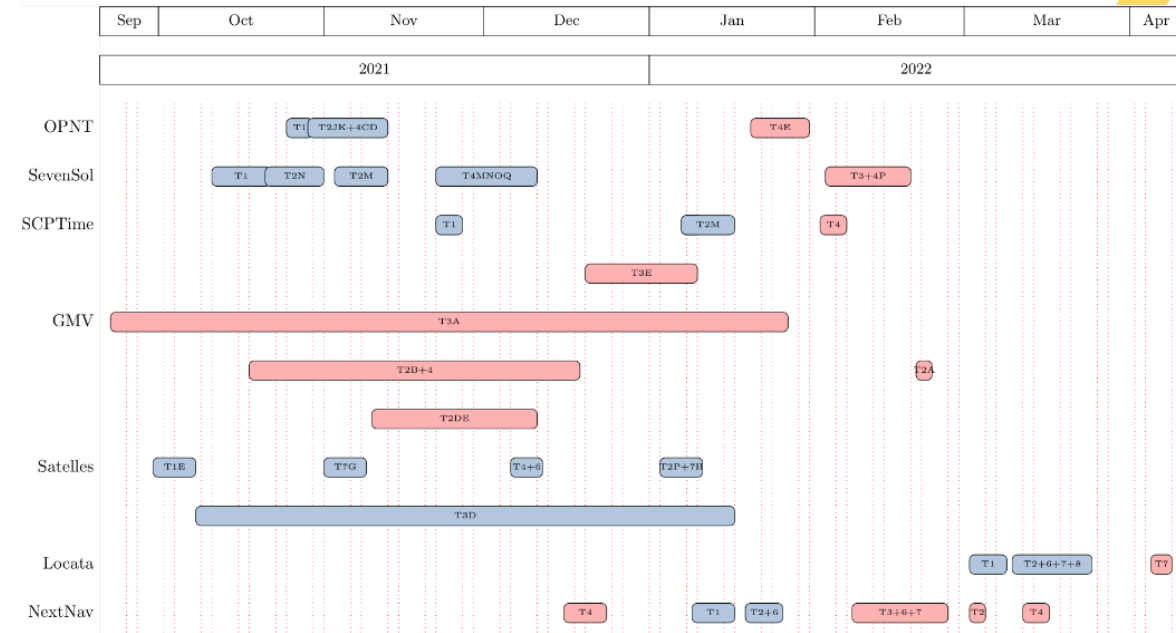
The objective was to assess mature A-PNT technologies (against defined KPIs) and to better understand its capacity and limitation. This included the performance over 1, 14 and 100 days and resilience to GNSS modes of failure.

Three major aspects of the project were:

- The testing campaign of the proposed technologies;
- A Technical Report with the results of testing and relevant technology description;
- An Implementation Report, discussing technology deployment in the EU.



A-PNT Technologies Tested



Company	Country based	Type of technology	Provision of
OPNT BV	Netherlands	optical wavelength modulation (fibre) and Over-the-Air (OTA)	Time and frequency transfer
7 Solutions SL	Spain	fibre	Time and frequency transfer
SCPTIME	France	electrical current modulation (fix telecom networks)	Certified time transfer
GMV AD SAU	Spain	Fix telecom networks	Time generation and transfer
Satelles Inc	USA	LEO, OTA	PNT
Locata Corporation Pty Ltd	Australia	<u>Pseudolite</u> , OTA	PNT
NextNav LLC	USA	<u>Pseudolite</u> , OTA	PNT

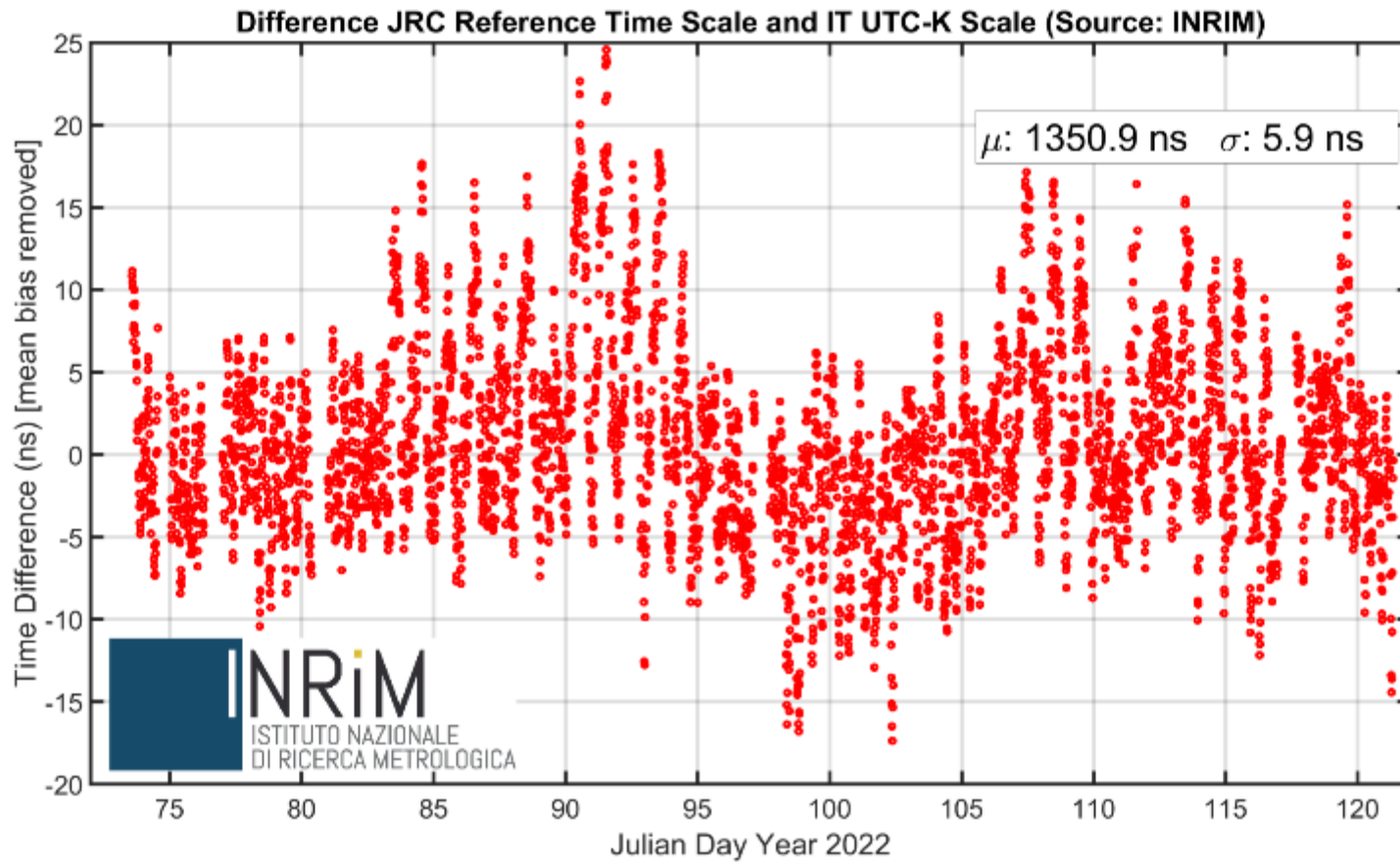


JRC SCIENCE FOR POLICY REPORT

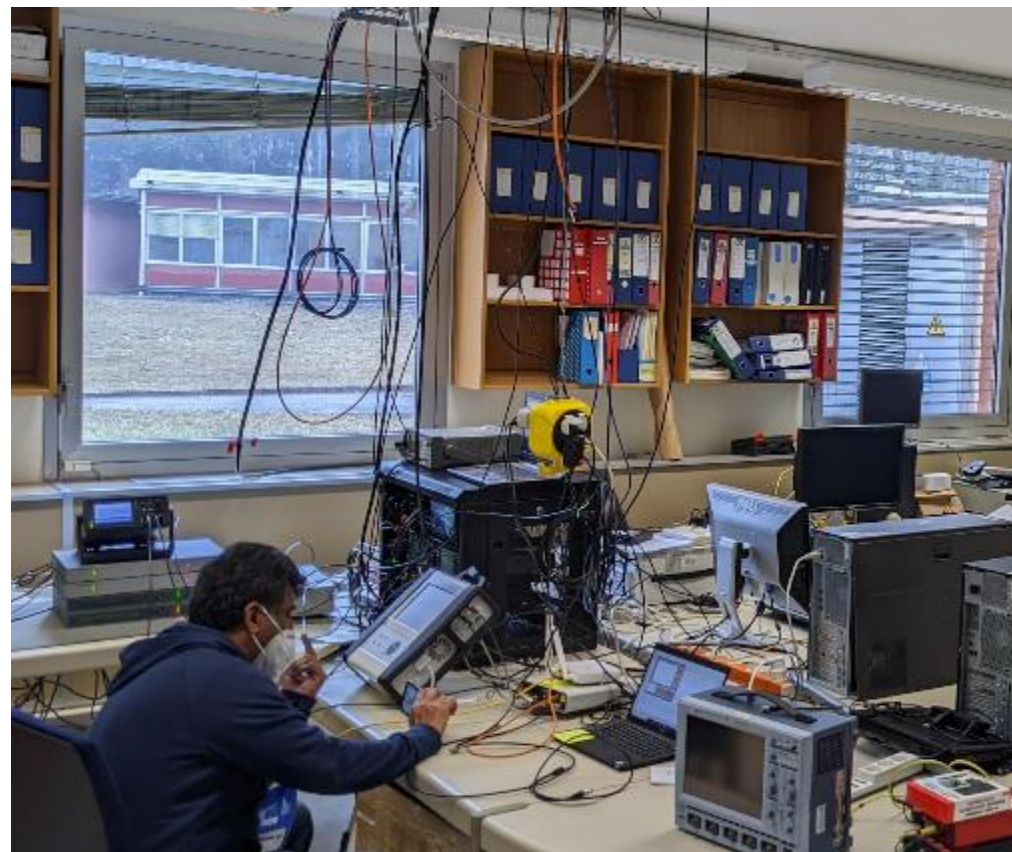
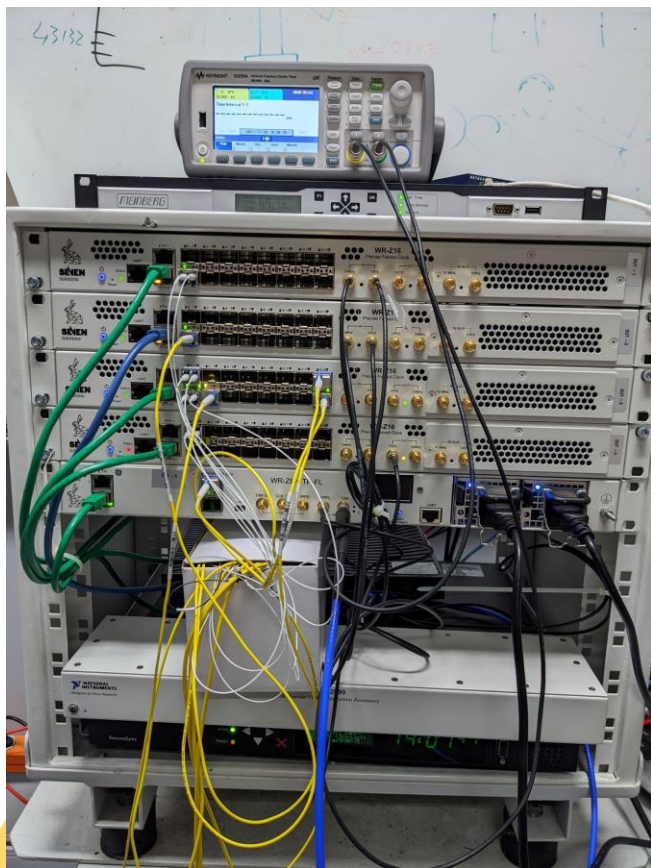
Assessing Alternative Positioning, Navigation and Timing Technologies for Potential Deployment in the EU



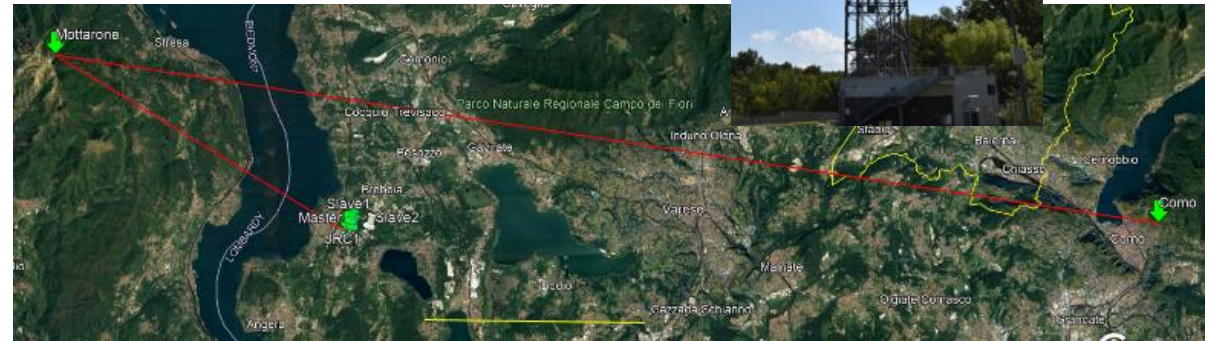
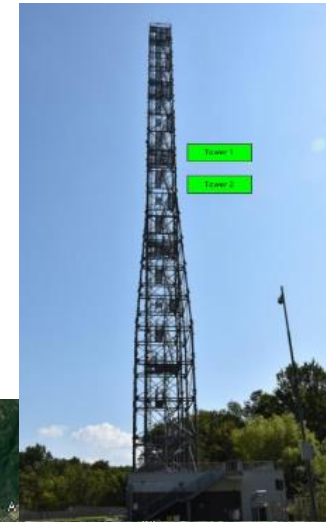
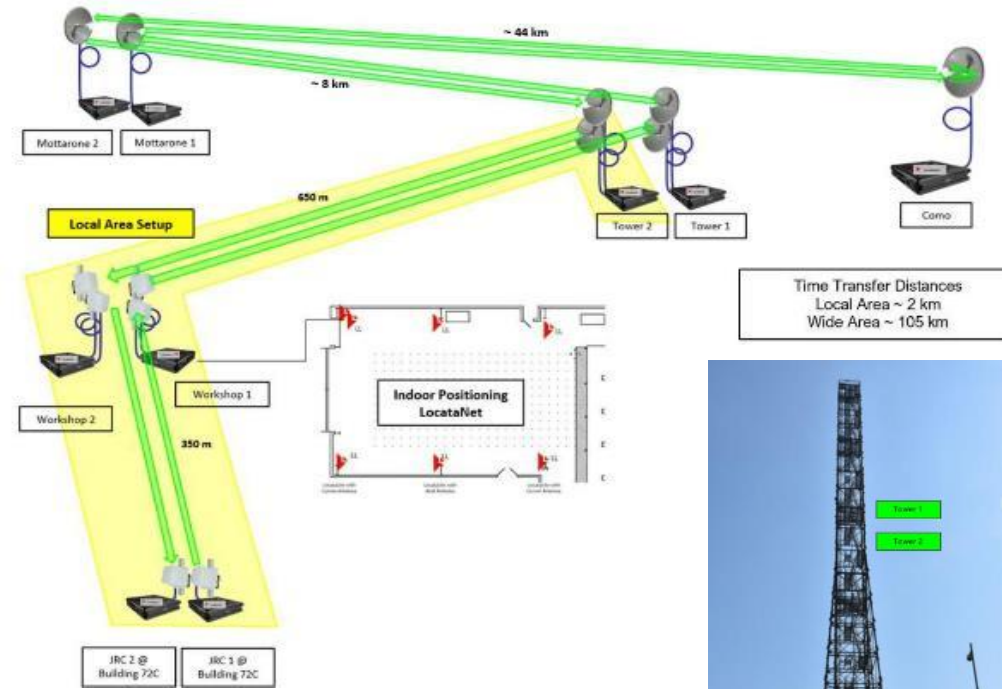
JRC Time Reference Traceability to UTC(IT)



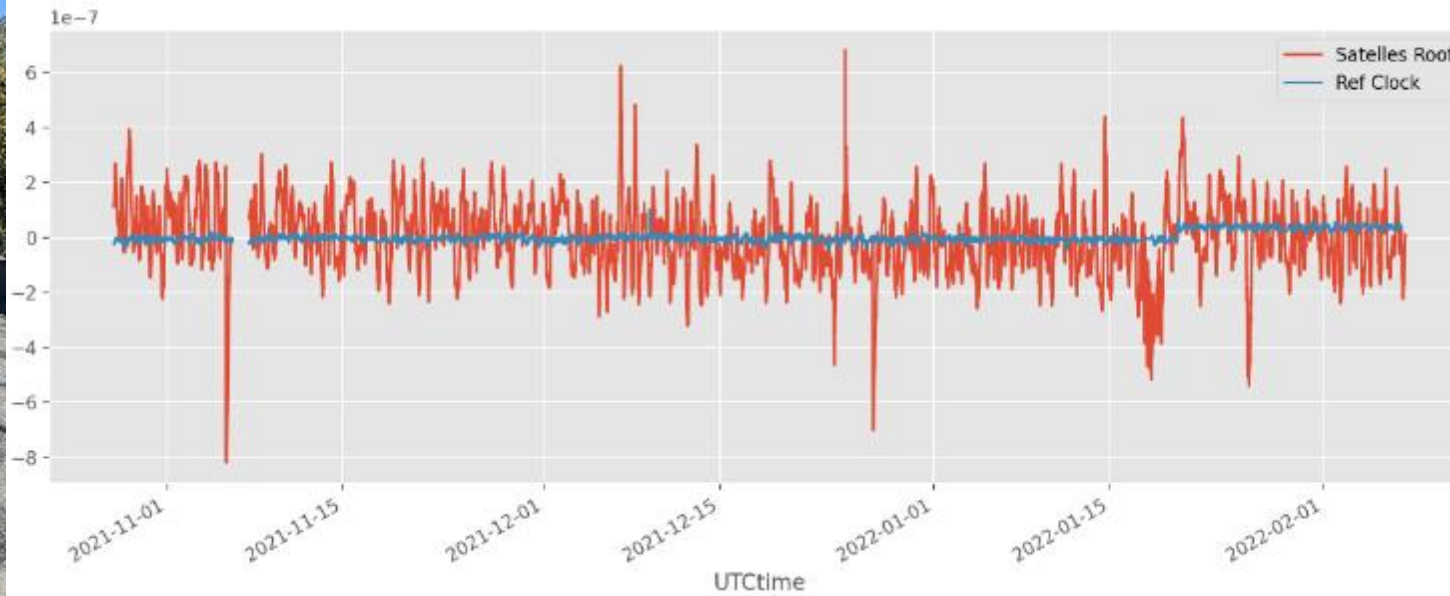
A-PNT Time Transfer Testing



A-PNT Radio Beacons (pseudolites) deployment



A-PNT LEO Indoor and Outdoor Testing



Results of the **A-PNT** Test Campaign



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 quantitate assessment** of the tested technologies.

Excellent time transfer, time generation is limited.

Stringent cybersecurity and resilience demonstrated.

The European **Radio Navigation Plan**

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**.



Formulate the problem

- "Entities are not to be multiplied beyond necessity." Occam's Razor

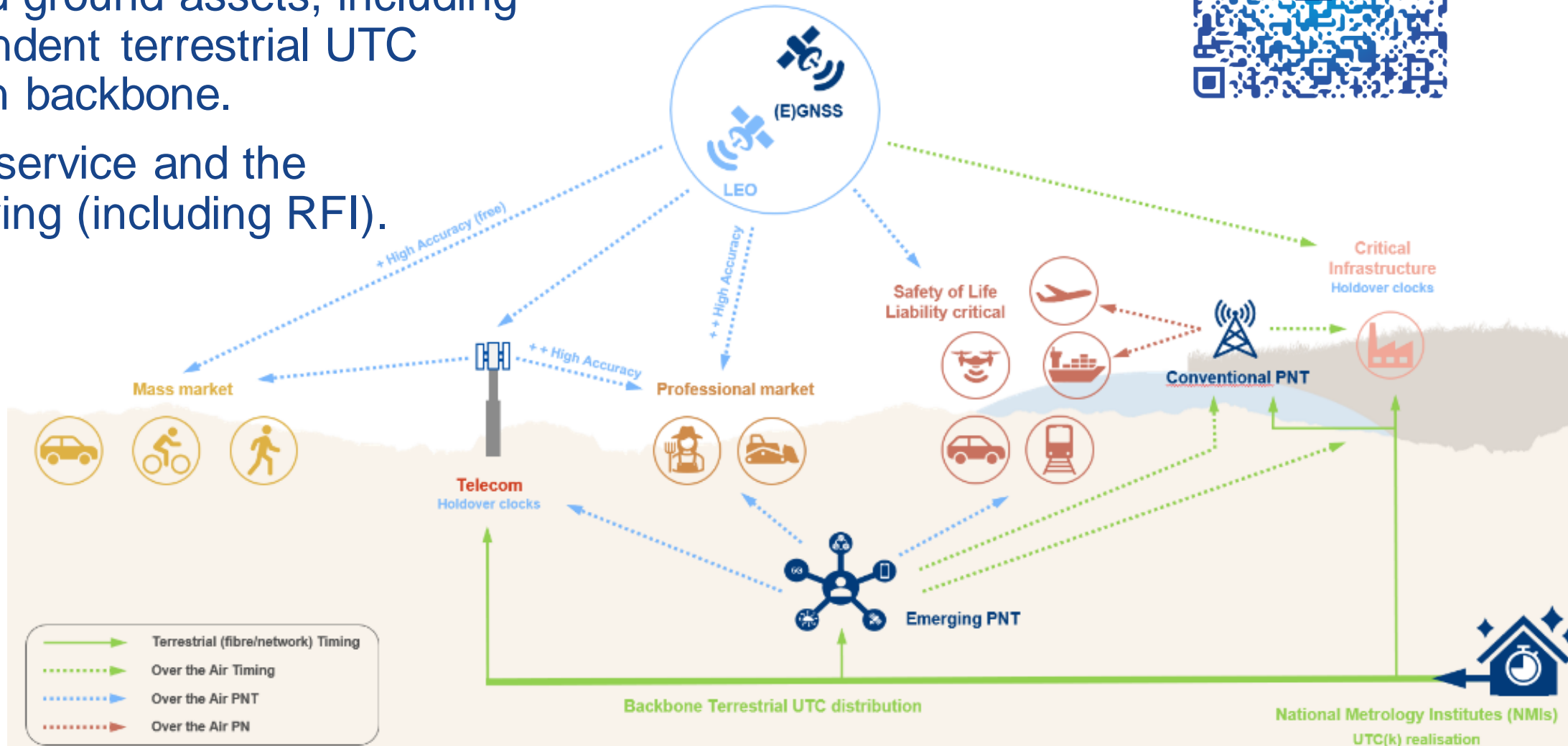
→ **IDEAL SOLUTION** ←

- "(...)there is always a well-known solution to every human problem — neat, plausible, and wrong." H.L. Mencken

The EU C-PNT SOSA

Space and ground assets, including an independent terrestrial UTC distribution backbone.

Improved service and the CI monitoring (including RFI).



A-PNT to C-PNT Findings Summary

GNSS is the essential underpinning and **emerging PNT** should be **complementary** part of the EU PNT, using system of systems approach (SOSA):

- First step should be to **provide the timing backbone** by interconnecting European NMIs;
- Supported by the industry standards to ensure (as a minimum) interoperability to UTC and ETRS89;
- Further steps - Investigate the feasibility of identifying dedicated terrestrial spectrum for C-PNT use and how it could be integrated/standardised in devices.

This is on top of ongoing EC efforts to enhanced the resilience of EU PNT:

- evolution of Galileo and EGNOS, and design of IRIS2;
- regulations (CER, NIS2) for critical infrastructure and cybersecurity;
- education and awareness (ERNP).



ERNP and discussed reports are available at

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