# Alternative Position, Navigation and Timing (AltPNT) technologies Demonstration Day

European Commission, Joint Research Centre

18 May 2022, Ispra, Italy

## Plenary Session

# Agenda

- Introduction 14:00 – 14:15

- Alt-PNT project results 14:15 – 15:35

- Conclusions 15:35 – 15:45

# Introduction

L. BONENBERG (JRC.E.2)

# PNT and AltPNT

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

- **Positioning**, the ability to determine one's location and orientation in two or three dimensions. This position is referenced to local or, most commonly, a global coordinate system such as Galileo Terrestrial Reference Frame (GTRF), European Terrestrial Reference Frame (ETRF) or International Terrestrial Reference Frame (ITRF).

- **Navigation**, which is the ability to determine a path between current and desired position (relative or absolute), as well as navigate this path by applying corrections to course, orientation, and speed.

- **Timing**, which is the ability to acquire and maintain time either locally or globally (for example Coordinated Universal Time, or UTC). This also includes time transfer service.

As modern PNT is underpinned by the GNSS, such as European Galileo, independent systems are known as alternative or assured PNT.

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# AltPNT Rationale

- Overreliance on GNSS of today's society.

- Back up needed in case of an outage.

- To increase resilience of EU's economy.

- The economical benefits of the technology development and implementation.

Recent articles covering the topic:

- *US and UK governmental studies*
- *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*



Satellite-derived Time and Position: A Study of Critical Dependencies

Europe seeks alternative PNT services, deadline Jan. 13 – GPS World

Image: European Commission – JRC Ispra Italy Test Site

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# AltPNT Technologies Demonstration Objective

CfT, open to GPA, had objective to understand the mature technologies that could:

- Deliver positioning, and/or timing information independently from GNSS;
- Act as the backup in the event of GNSS disruption;
- (If possible) extend PNT provision to the environments where GNSS cannot be delivered.

The CfT requested three major aspects:.

- The testing of the proposed technologies → **the purpose of today's event.**

- A Technical Report with the technology description and including elements just as the TRL justification, the scalability and justification, the supported environments, any required licences, etc.

- An Implementation Report of the technology/service, including cost and schedule elements, if the technology were to be deployed in the EU.

# **AltPNT** Technologies Performance Requirements

- Provide **positioning and navigation**, or **timing** services or **both**;

- Act independent from GNSS and with no common points of failure;

- Resilient to GNSS failure modes and vulnerabilities;

- Able to cover the EU European territory including in-land waters;

- (If possible) extend PNT provision to the environments where GNSS cannot be delivered;

- TRL > 5 for position/navigation OR > 6 for timing services;

- **Minimum performance**, for at least 1 day, upon GNSS loss:

  - Positioning Accuracy (Horizontal and/or Vertical $95\%) < 100m$

  - OR Timing Accuracy to UTC $(3\sigma) < 1\mu s$

  - Availability $> 99\%$ .
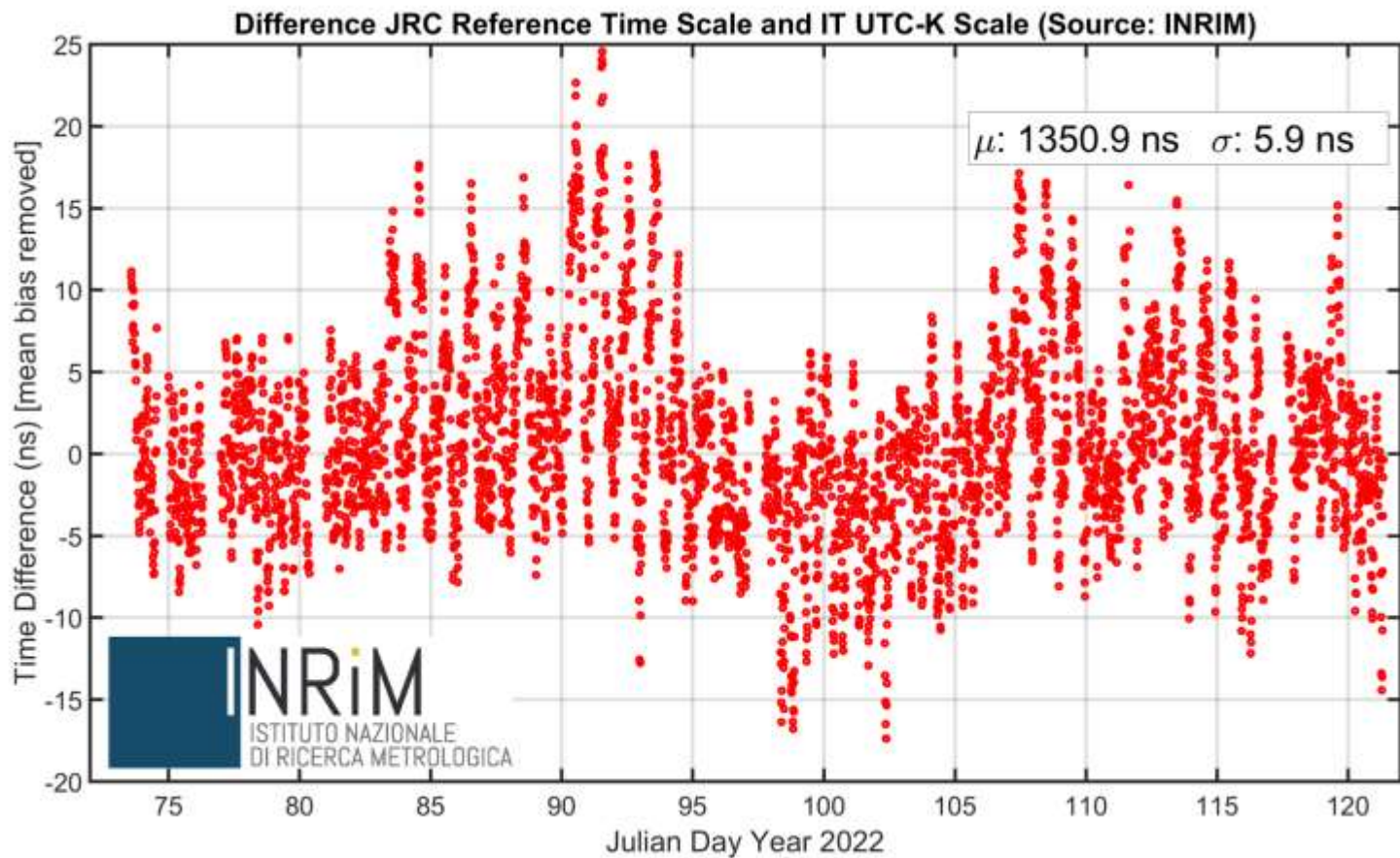
# Timetable of the AltPNT Testing
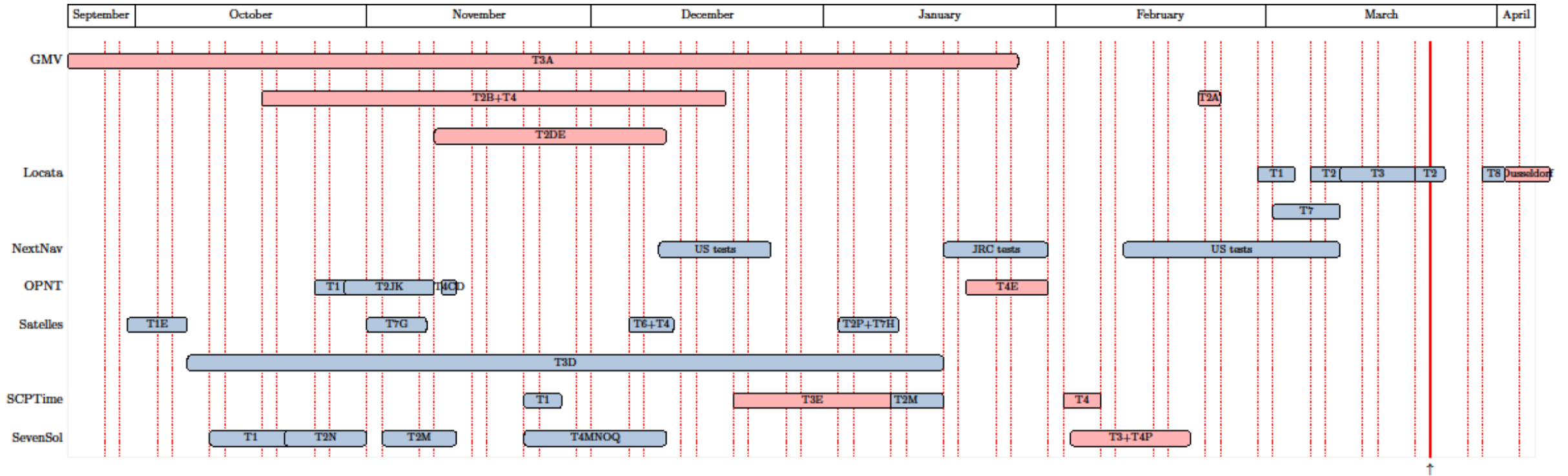


- Oct 2020 - call for tender published
- Aug 2021 - Six companies awarded + one additional participant
- Oct-April'22 - Testing conducted on site
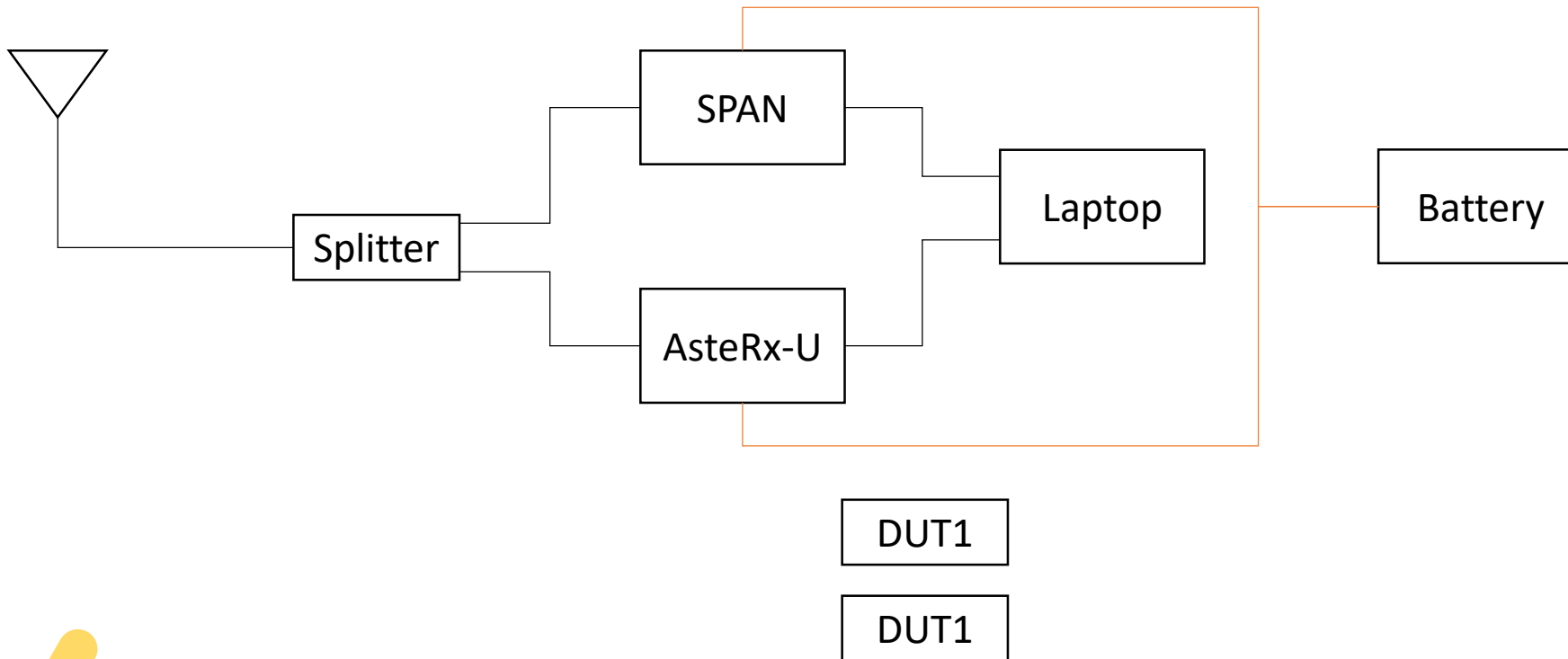
# JRC Time Reference

# JRC Time Reference Traceability to UTC(IT)



Difference JRC Reference Time Scale and IT UTC-K Scale (Source: INRIM)

$\mu$: 1350.9 ns   $\sigma$: 5.9 ns

# **AltPNT** Outdoor Reference Platform

A reference platform, consisting of SPAN IMS, was used to provide reference position for device under test.



```
         Antenna
            |
         Splitter ──┬── SPAN ──── Laptop ──── Battery
                    └── AsteRx-U ──┘

         DUT1
         DUT1
```

# AltPNT Outdoor kinematic testing

So kinematic tests could be conducted in different environments across campus.
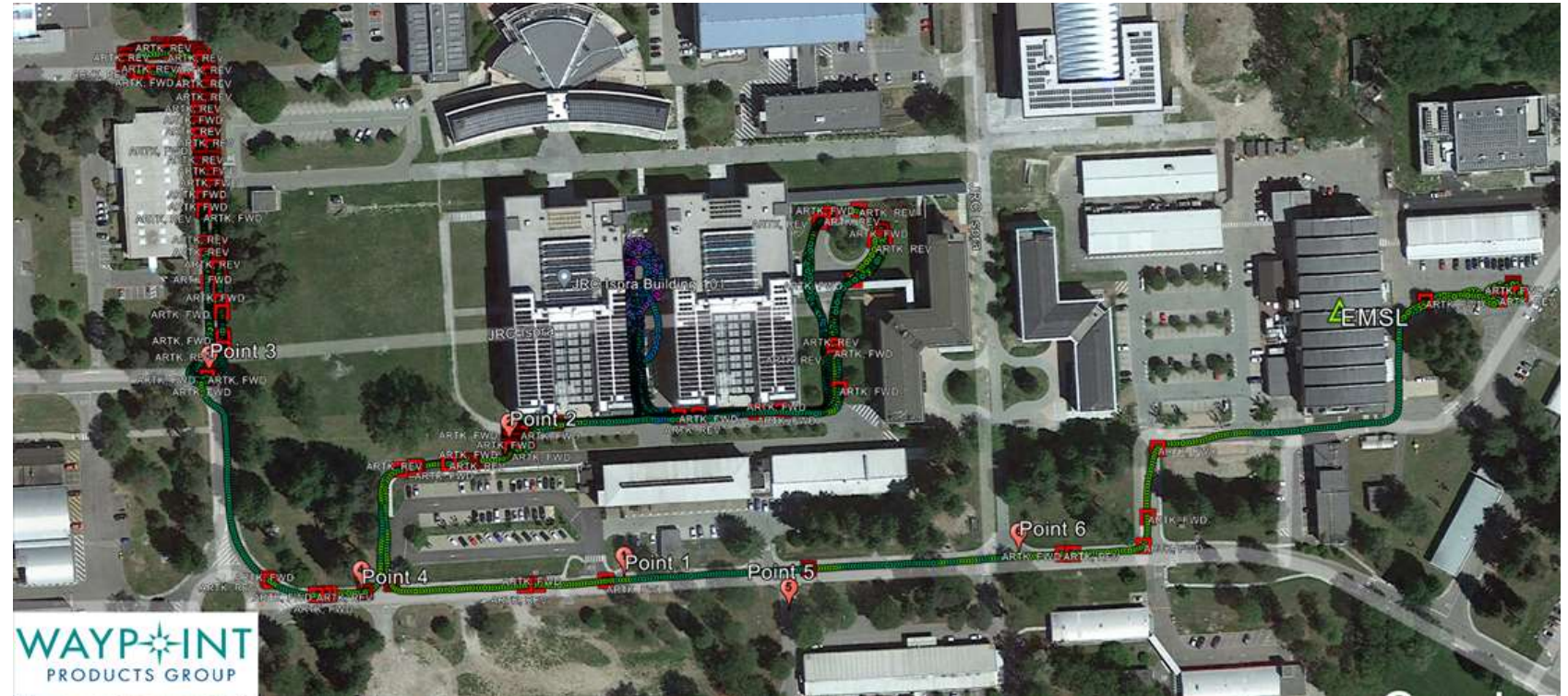
# AltPNT Indoor – Establishing Height Reference

Total Station and GNSS receiver was used to establish floor heights

# **AltPNT** Indoor - Establishing Position Reference

Total Station and GNSS receiver was used coordinate reference points inside building to the global (ETRF) reference frame.
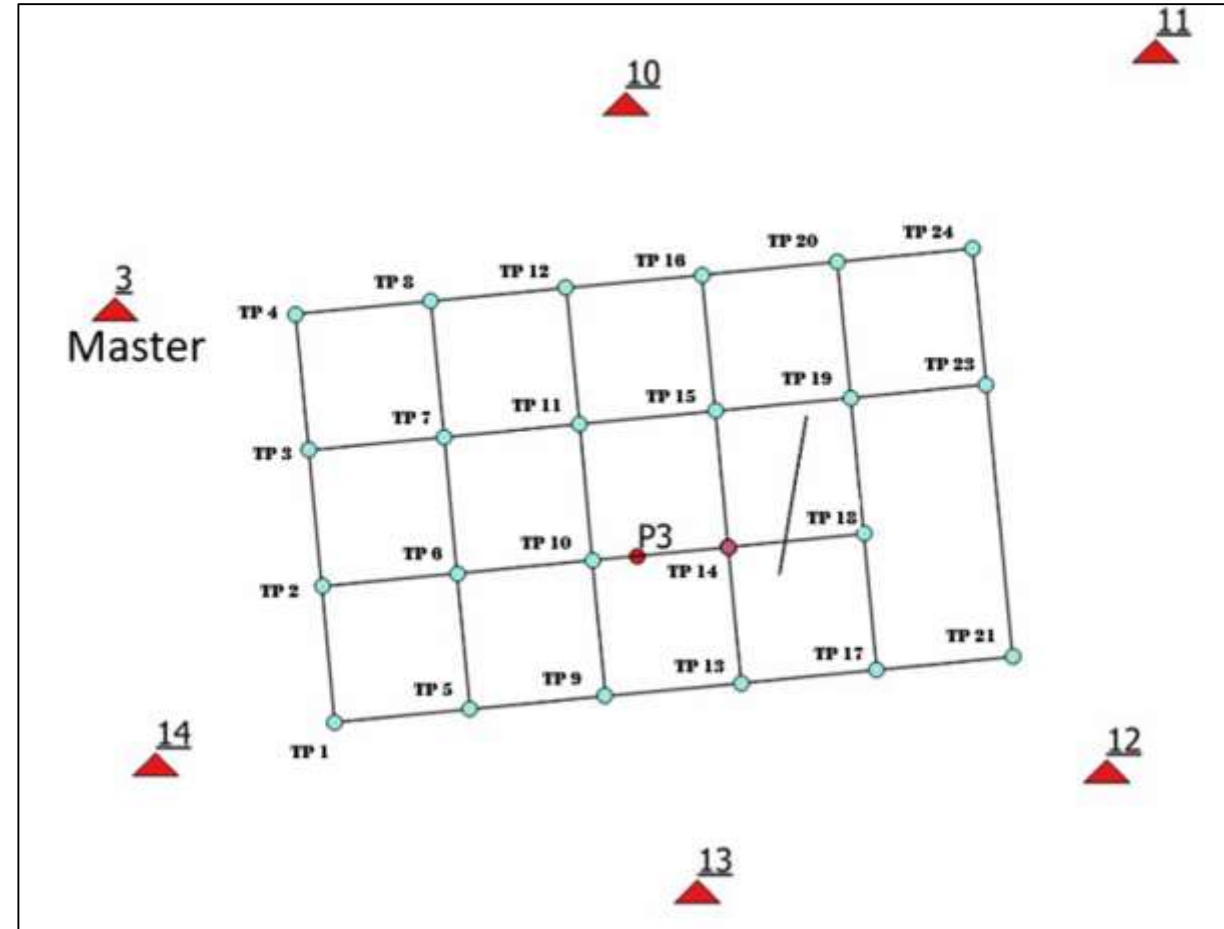
# AltPNT Indoor – Establishing Position Reference

Reference points were used to establish testing grid, which was used, alongside total station, for testing.
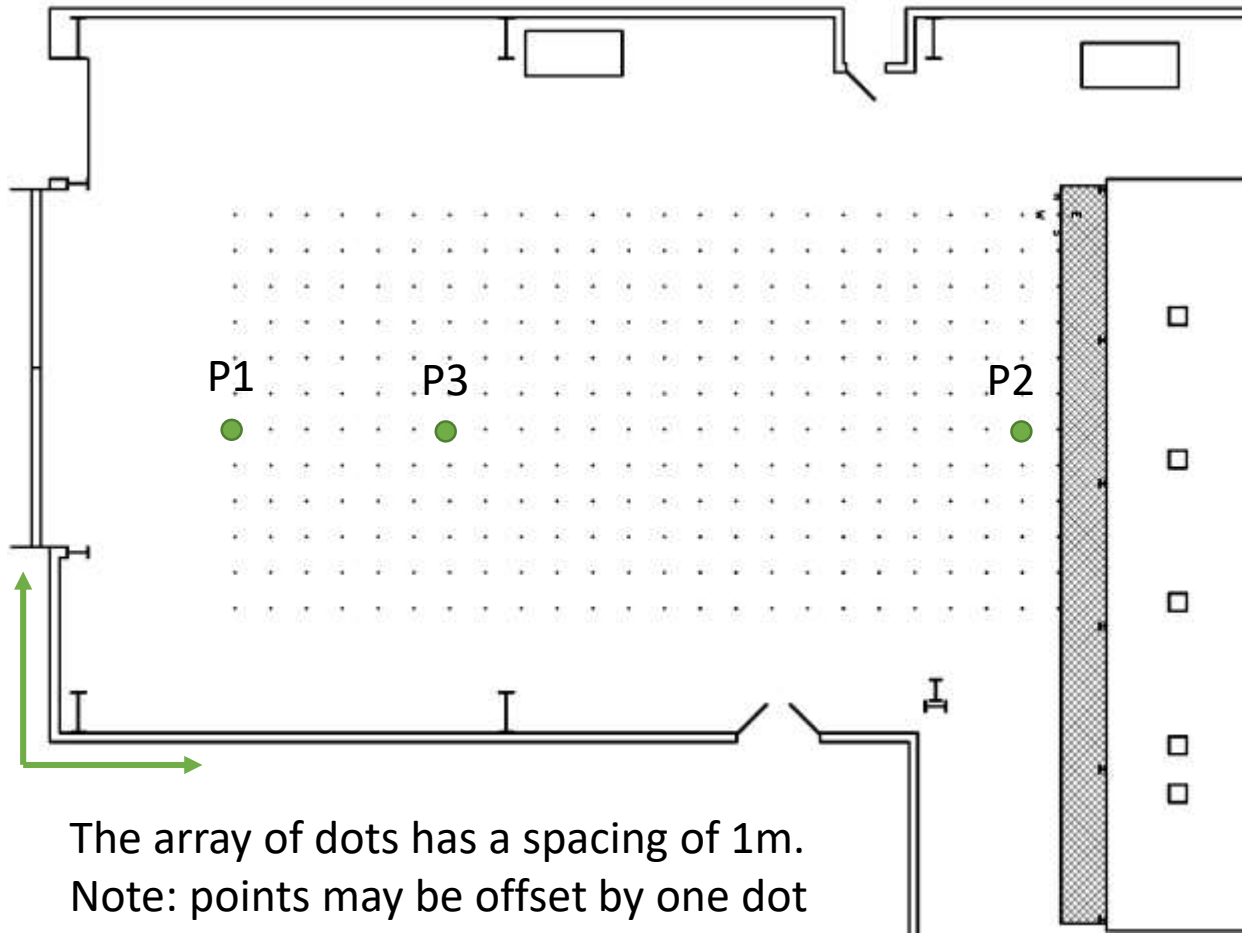


The array of dots has a spacing of 1m.
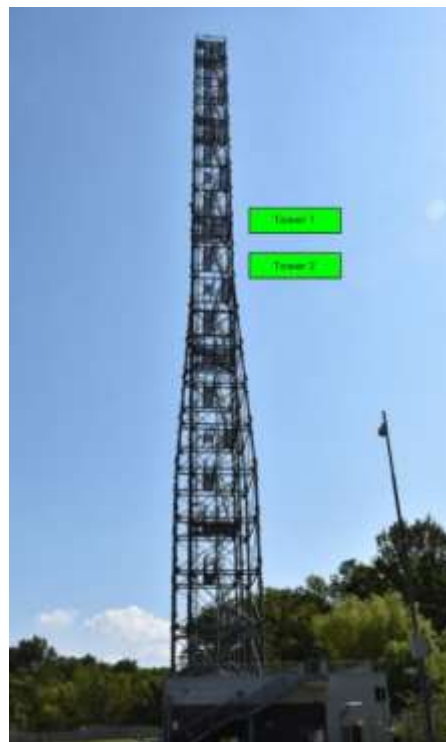Note: points may be offset by one dot vertically

# AltPNT Indoor - Positioning Demonstrations

# JRC Site installations and Permits

# **AltPNT** Test Campaign Results

**Presented by:**

- OPNT BV
- Seven Solutions SL
- SCPTime
- GMV Aerospace and Defence
- Satelles Inc
- Locata Corporation Pty Ltd
- NextNav LLC

- Marco Gorter
- Benoit Rat
- Sebastien Teot
- Ricardo Píriz
- Michael O'Connor
- Nunzio Gambale
- Ganesh Pattabiraman

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# Conclusions

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# **AltPNT** Time Generation

Participants demonstrated sub microsecond time keeping, independently from GNSS, for

- 1, 14 and 100 days using stand-alone atomic clock

- 100 day time keeping using LEO constellation

They also demonstrated that EU unique geographical spread of National Metrology Institutes (NMI) offer independent UTC time source.



T3A
Time Offset



22 Oct 2021 15:00 UTC

2 Feb 2022 10:30 UTC

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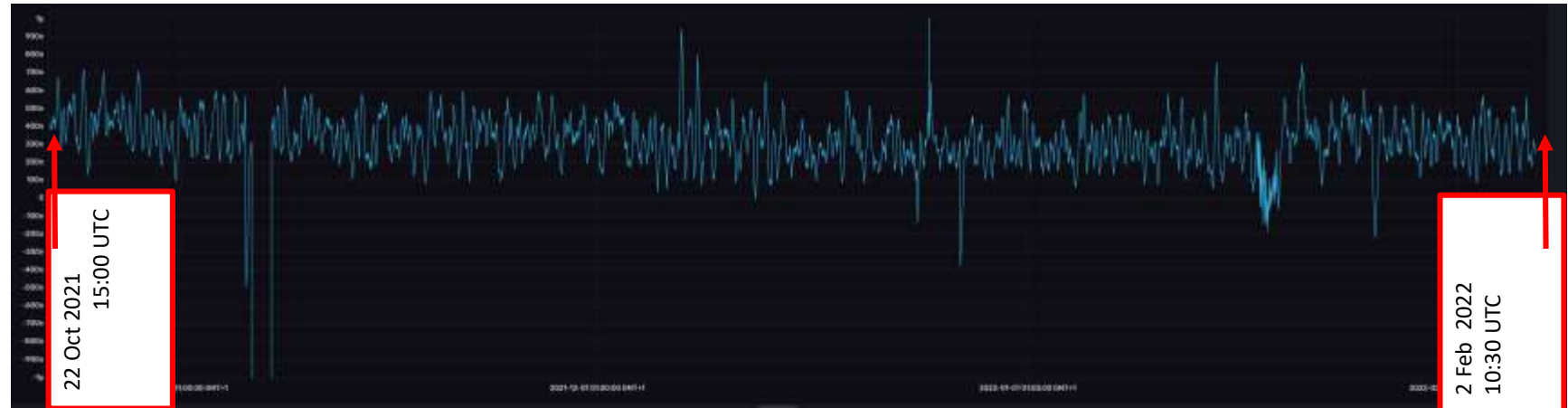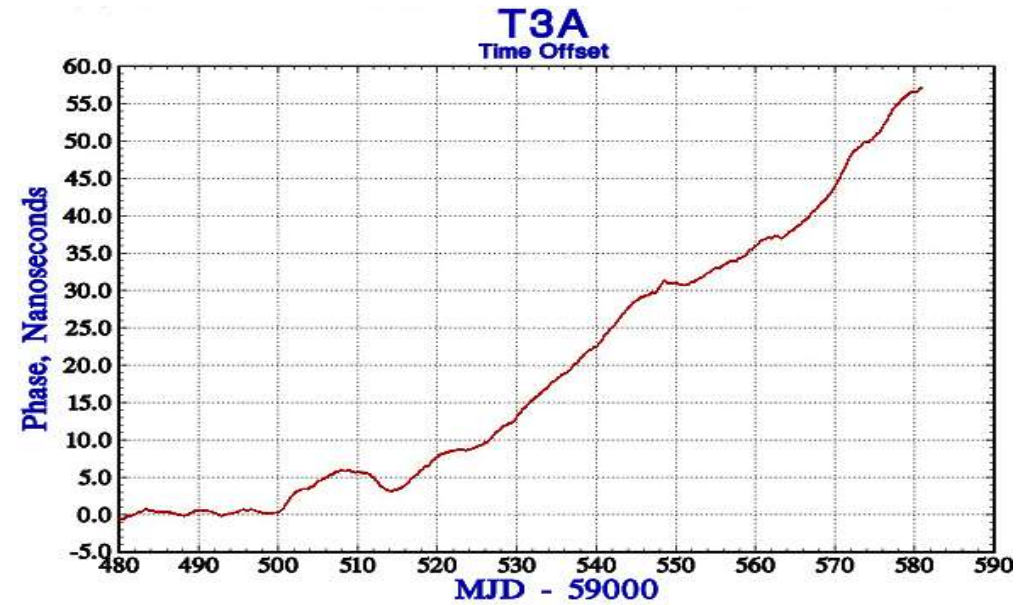
# **AltPNT** Time Distribution

- Sub-nanosecond accuracy time transfer using fiber networks and over the air with a radio link.

- Secure and resilient NTP, PTP time service provision over the network.

- Time traceability using verified chain from Paris.

- Indoor and outdoor OTA Terrestrial and LEO time distribution.

- OTA Time transfer of 105 km using 1mW of transmission power.
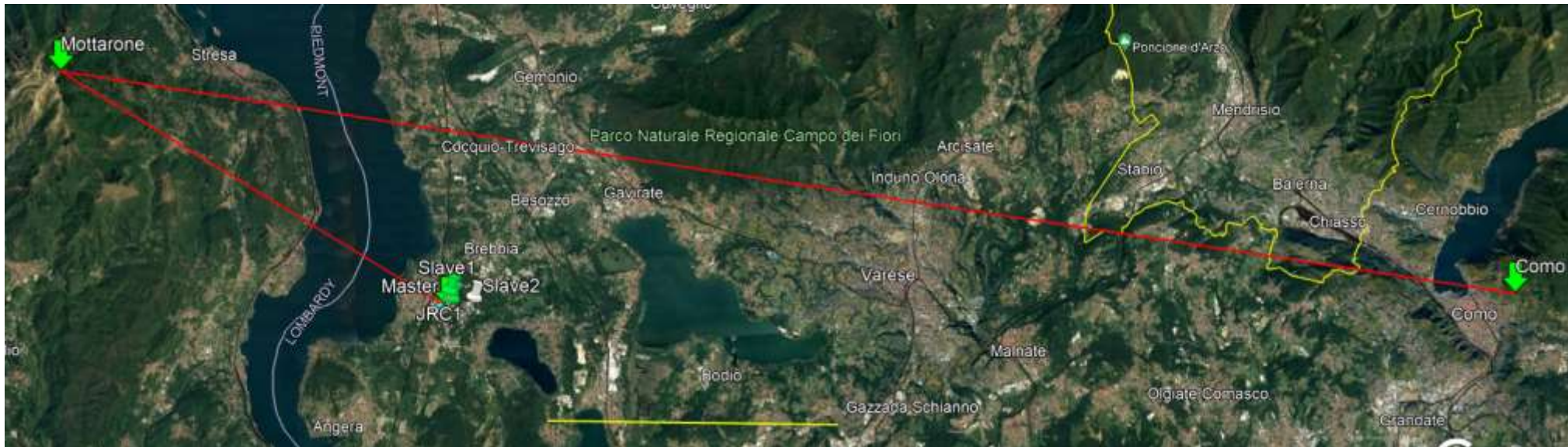
# **AltPNT** Position

- Indoor and outdoor positioning using terrestrial and LEO.

- Terrestrial systems operating in the global reference frame.

- Below 3 m barometric height estimation outdoor and indoor  using terrestrial infrastructure.

- Cm level position indoors and outdoors using terrestrial infrastructure.



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# **AltPNT** Resilience

- Resilience to failures - components, links and time source redundancy

- System and service Monitoring

- Modern programming features, OTA updates, cybersecurity


- Time traceability

- Terrestrial system providing advanced fallback, fulfilling safety of life requirements.

# Technology Panel

I. ALCANTARILLA-MEDINA (DEFIS.C.2)

# AltPNT Test Campaign Results

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- SCPTime
- GMV Aerospace and Defence
- Satelles Inc
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- NextNav LLC

- Marco Gorter
- Benoit Rat
- Sebastien Teot
- Ricardo Píriz
- Michael O'Connor
- Nunzio Gambale
- David Knutson

# Closing Address

I. ALCANTARILLA-MEDINA (DEFIS.C.2)

# AltPNT Feedback

Your feedback is appreciated (on the event, technologies presented and for future work).

You can write to us on **DEFIS-GNSS-ERNP@ec.europa.eu**

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