Building National Timing Grid of Ireland Using Low-Cost GNSS Receivers

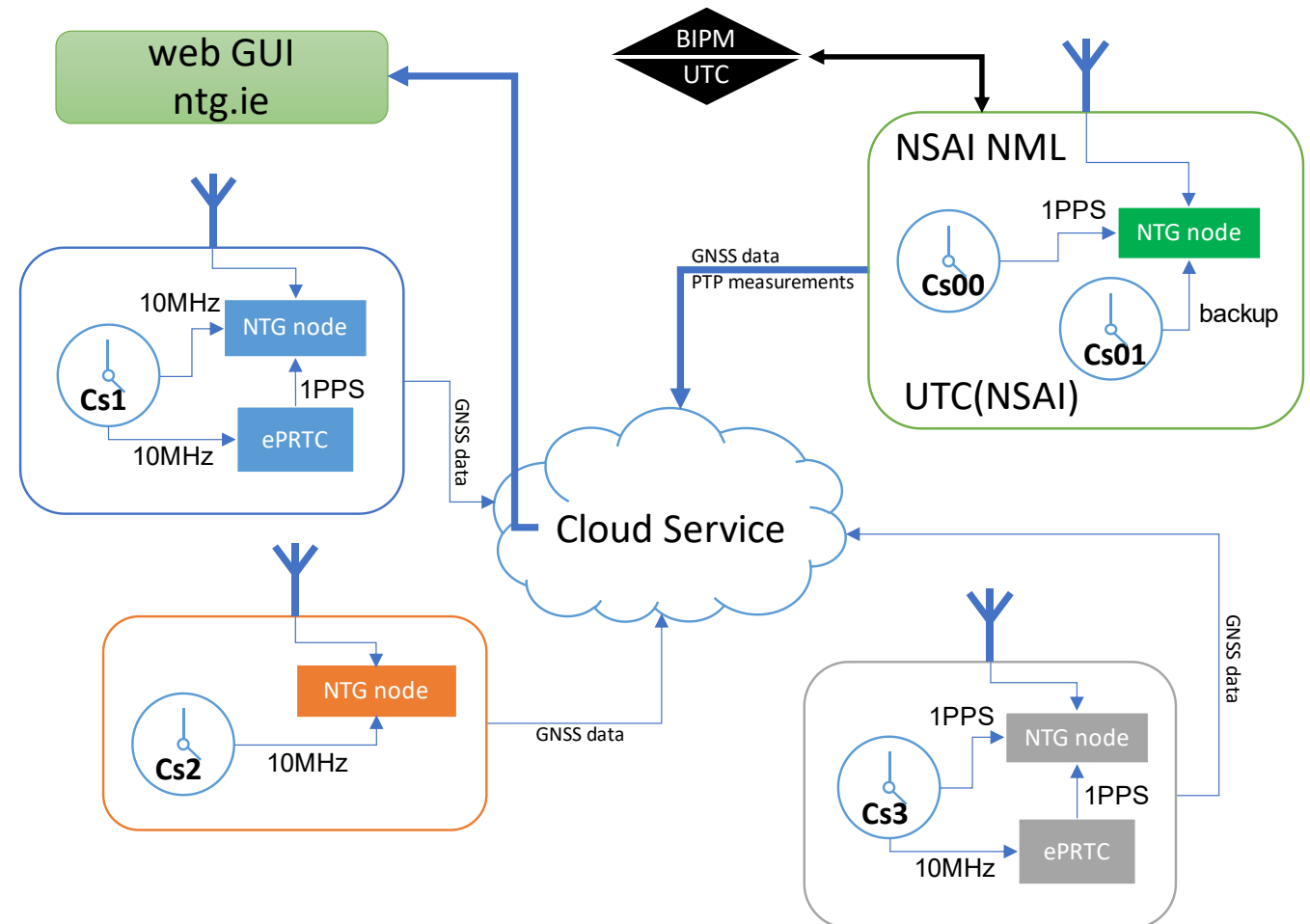Zdenek.Chaloupka@TimingSolutions.ie

David.Fleming@nsai.ie

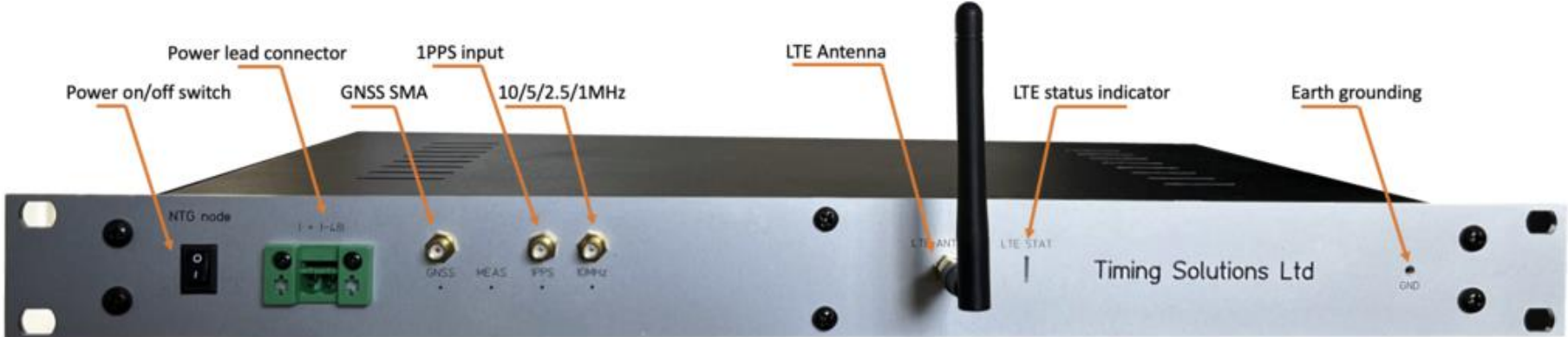# Positioning, Navigation and Timing (PNT) Dependency

- **Positioning, navigation, and timing (PNT) systems** are **essential** for everyday activities like GPS/GNSS navigation, enabling accurate directions and location tracking for drivers, cyclists, and pedestrians.

- PNT technologies assist in **logistics**, **aviation**, and **maritime operations**, ensuring efficient and safe transportation systems worldwide.

- **Time and timing distribution** has become increasingly important for **Critical Infrastructure** sectors such as telecommunications, energy grids, transportation, emergency, financial services, and data centers.

- The most common time distribution methods are dependent on **Global Navigation Satellite System (GNSS)** signals and data.

- Over-reliance on **any single source of timing** (GNSS, or other) poses **risk** to **Critical Infrastructure** sectors and could have a potential to adversely impact **national economy**.

- Governments start to notice, e.g., loss of PNT added to UK's National Risk Register in 2023.

- Steps towards **PNT resiliency and security**
  - be **aware** -> monitor your systems!
  - **independently verify** your sources of data!
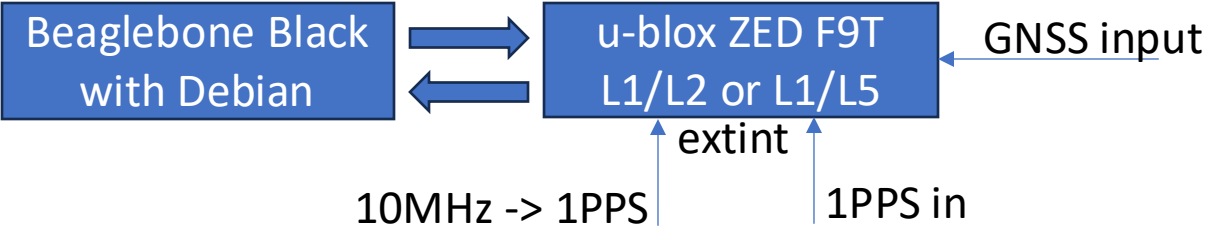
NSAI NML – National Timing Grid of Ireland

- **NTG** is a cooperation between **NSAI NML** and **Timing Solutions** and **Data Edge** to underpin Cs atomic clock across Ireland.

- Multiple **external companies** are contributing with their **Cs clock**: Vodafone, Eir, ESB Networks, Irish Rail.

- Based entirely on GNSS data and signals.

- Clock comparisons are generated using GNSS Common in View algorithm, but in near real-time.

- Fast reporting and alerts are critical to maintain resiliency of timing distribution.
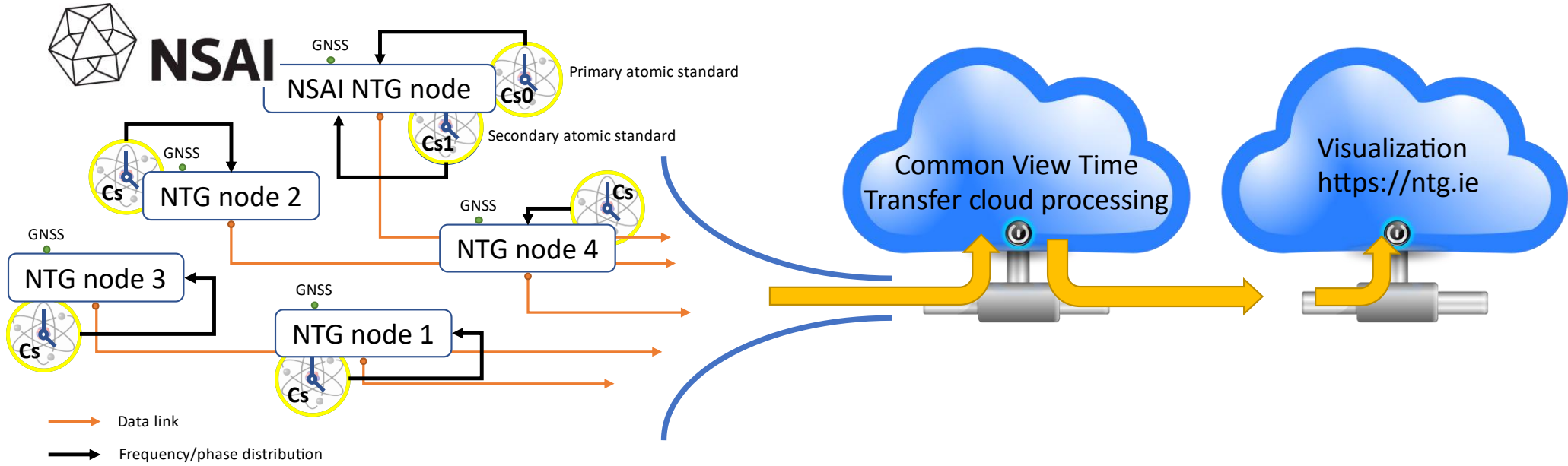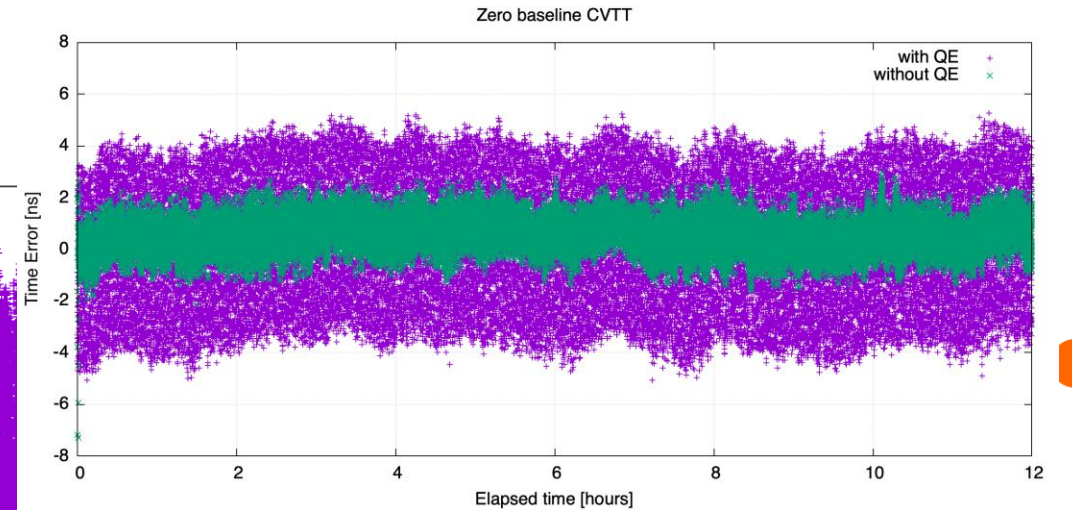
NSAI NML – NTG node

Power on/off switch Power lead connector GNSS SMA 1PPS input 10/5/2.5/1MHz LTE Antenna LTE status indicator Earth grounding

1U format

Beaglebone Black with Debian → ← u-blox ZED F9T L1/L2 or L1/L5 ← GNSS input
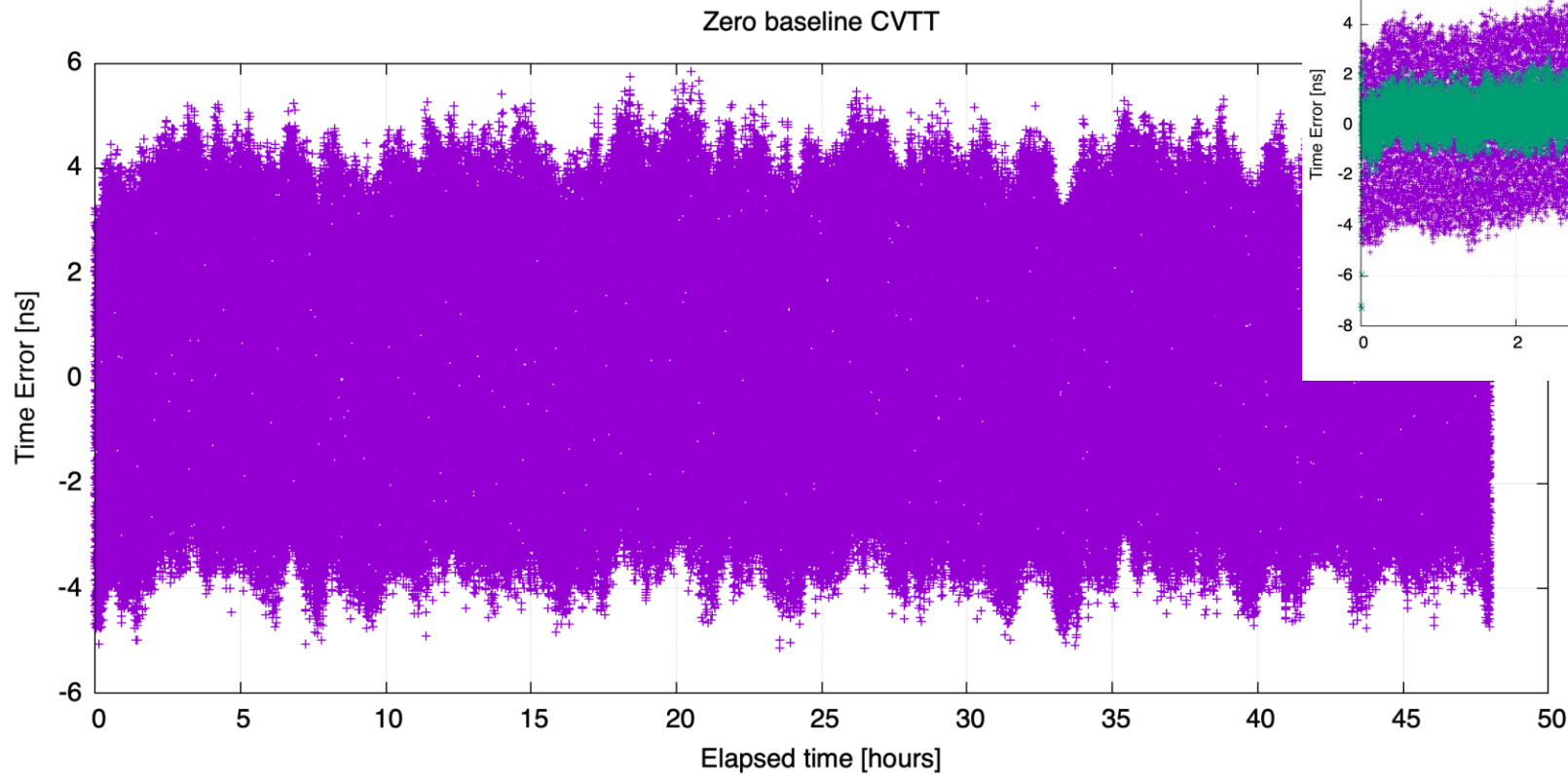
extint

10MHz -> 1PPS   1PPS in

small form format

NSAI NML – NTG data flow

National Timing Grid of Ireland

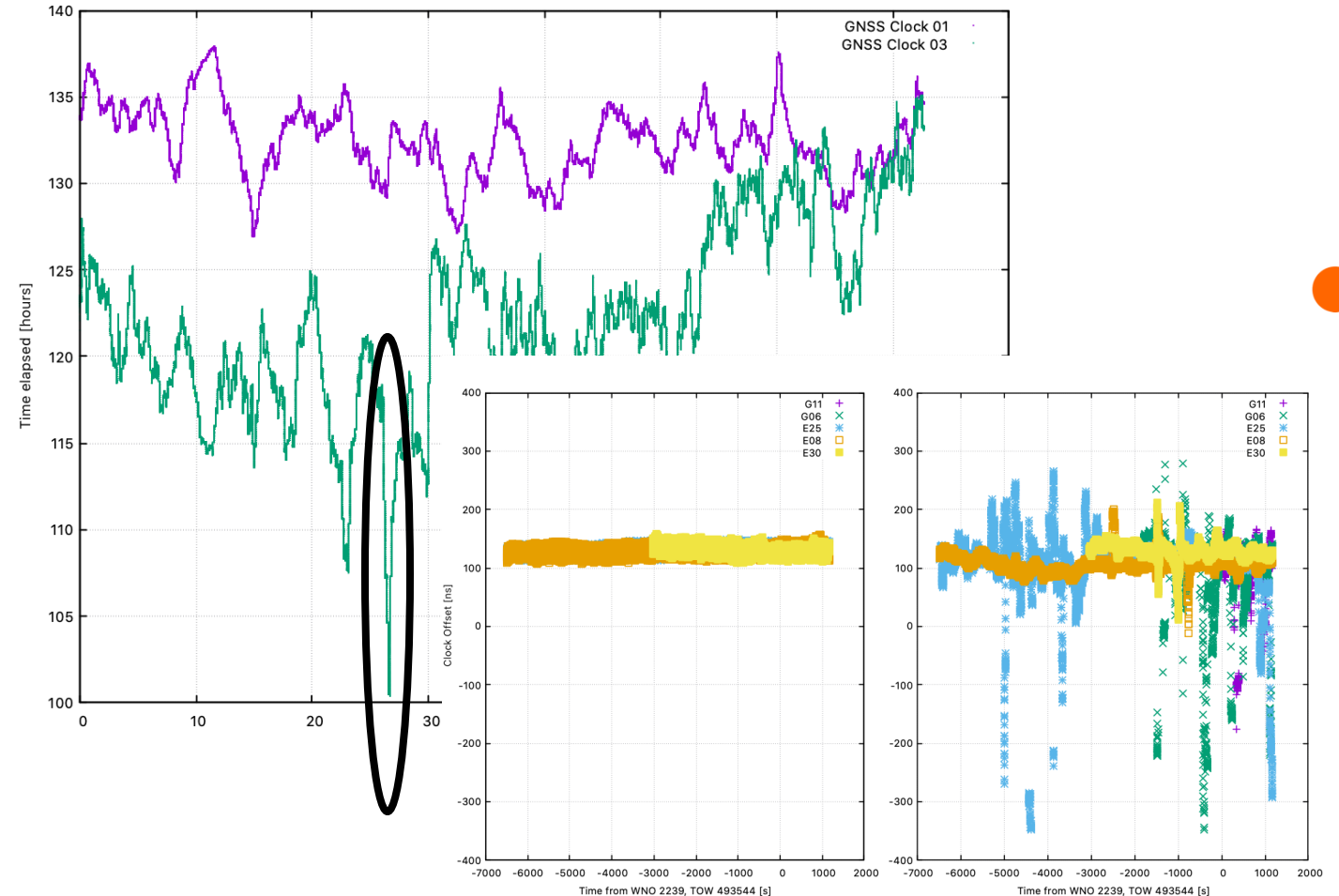# NSAI NML – NTG zero baseline (code)

Zero baseline CVTT

Zero baseline CVTT

with QE
without QE

Time error for the zero baseline is entirely driven by the internal clock granularity (125 MHz).
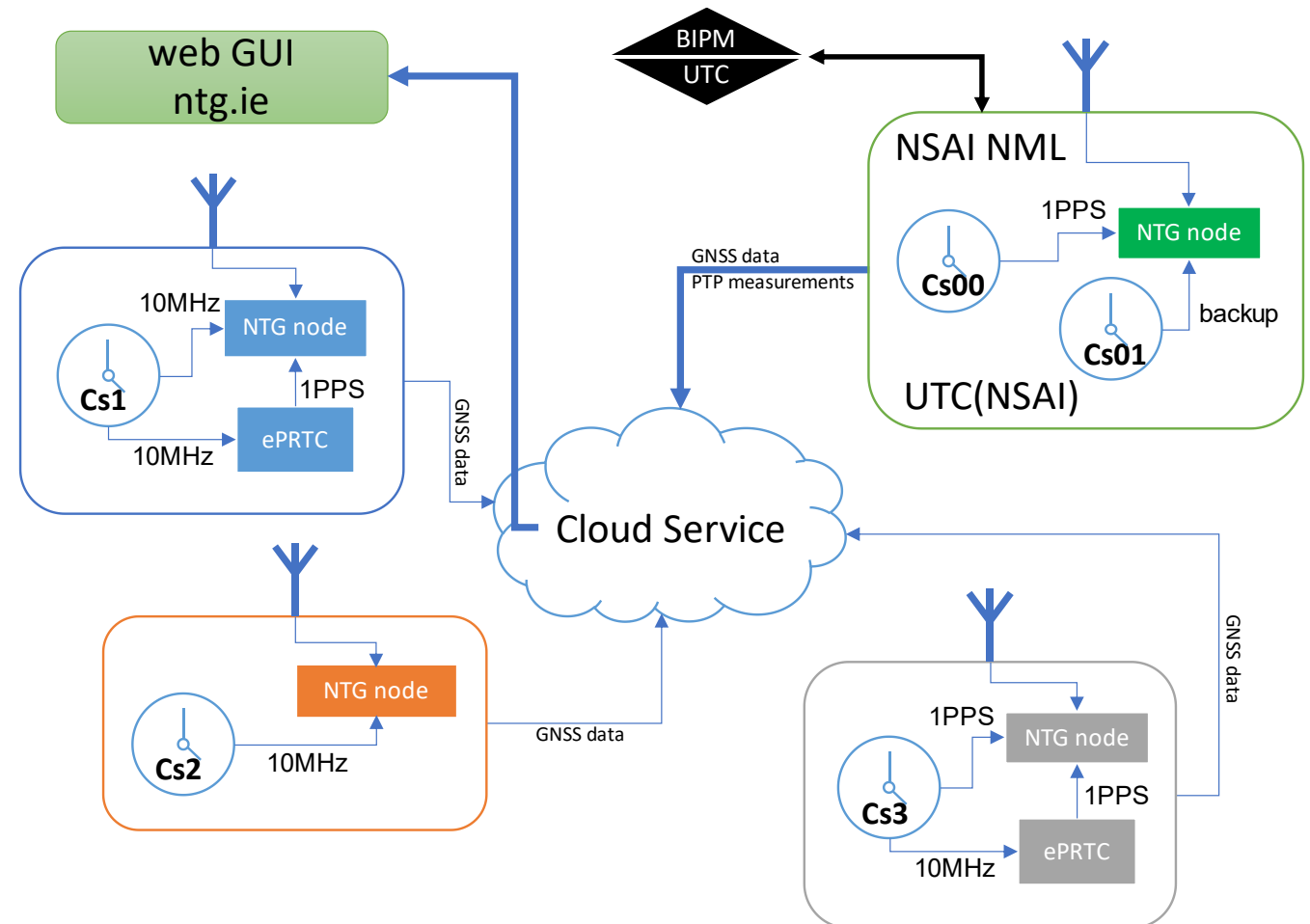
NSAI NML – National Timing Grid of Ireland

- Hard realities of "industry standard GNSS" installations.

- Most GNSS receivers have installations with L1 only antennas.

- Open sky visibility is not always the case.

- Requirements on a completely separate internet connection for NTG traffic.

NSAI NML – National Timing Grid of Ireland

- **GNSS** is the **weak** link, obviously.
- Planning a **terrestrial backup** (fiber) at the moment.
- Find financing is difficult, but more importantly, finding a gov. **representative**, or gov. **department** taking responsibility is challenging.
- Working closely with HEAnet to have fiber access to other NMIs.
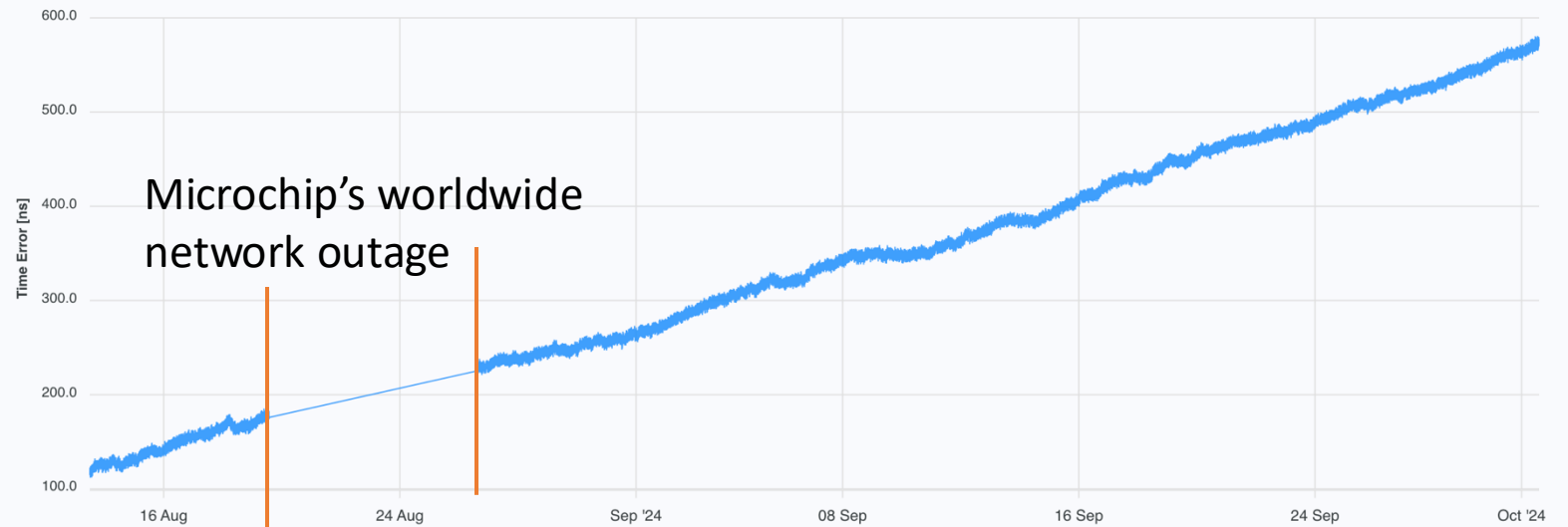- Looking/testing alternatives: Low Earth Orbit (LEO) Iridium's STL.

UTC(NSAI) at NSAI NML and National Timing Grid of Ireland – real time visualisation
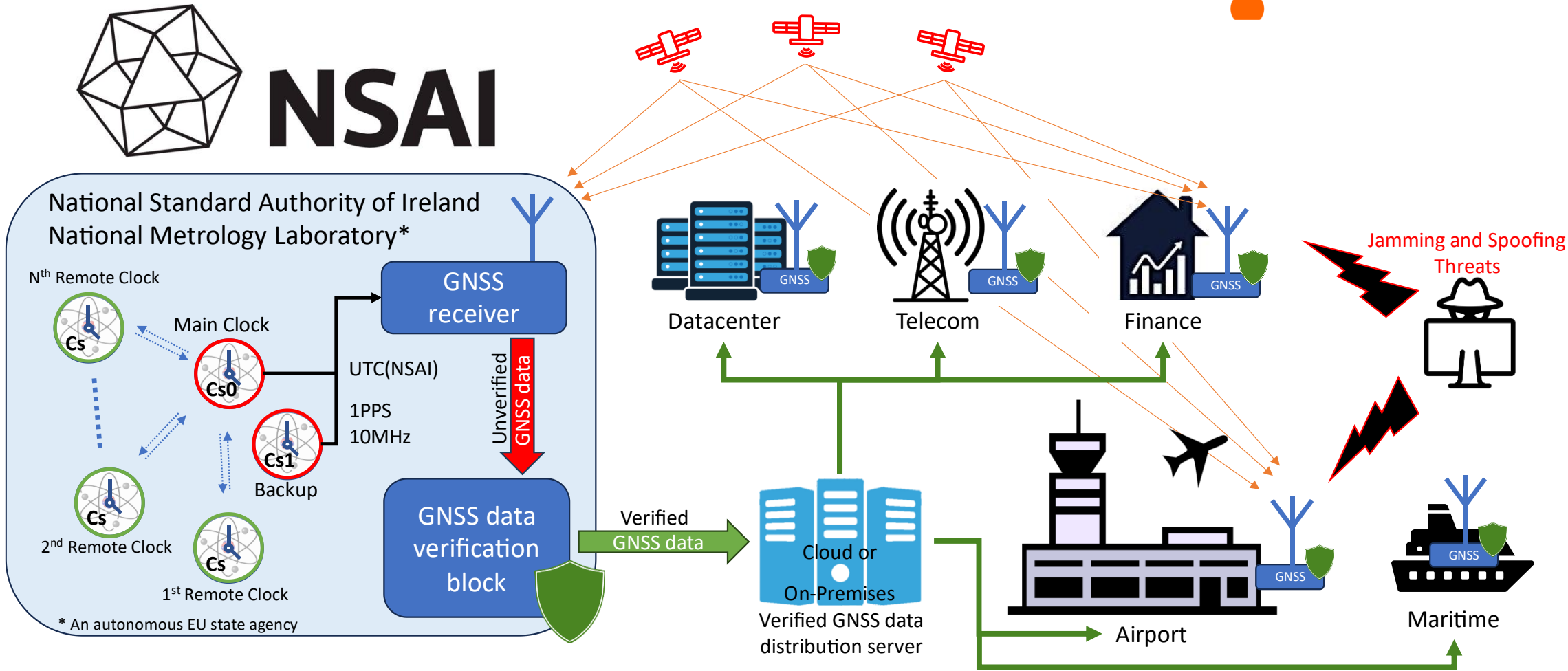

Microchip's Cork Laboratory

Time Error Series
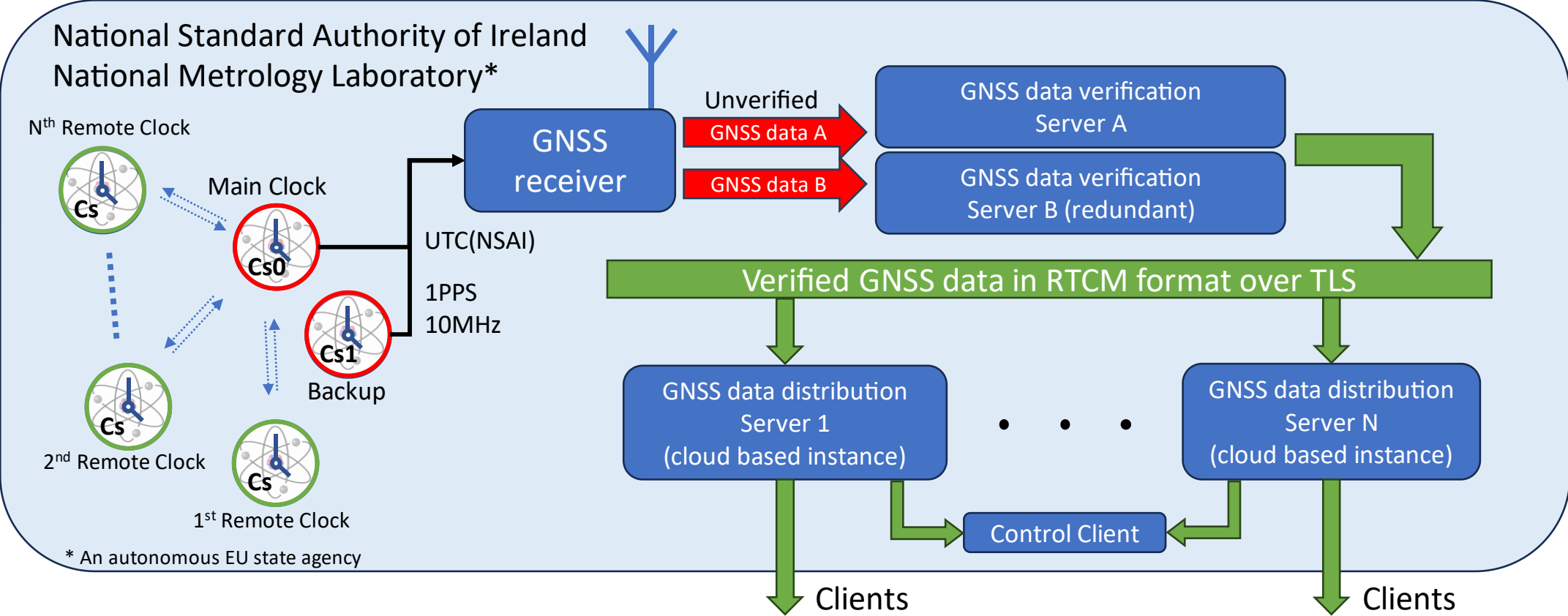
Microchip's worldwide network outage

NTG next steps

- **GNSS data** (navigation data part of the satellite signal) is essential for PNT computation.

- **GNSS receivers** are part of **ICT** (Information and Communication Technologies) infrastructure in many sectors, e.g., energy, transportation, and communications.

- Focus on the upcoming **NIS2 Directive** to enable support **compliance** for wider industry, **NSAI NML** and **Timing Solutions** worked together on **Verified GNSS Data Service**.

- **Verified GNSS data service** provides simple and effective **spoofing detection** for different industries: telecom, power utilities, financial applications, transportation, (airports, airplanes, maritime), etc.

- Distributing UTC(NSAI) using NTG node through 1PPS interface, and/or enabling traceability for external devices.

NSAI NML – Verified GNSS (GPS) Data Stream

NSAI NML – Verified GNSS (GPS) Data Stream

National Standard Authority of Ireland
National Metrology Laboratory*

N^{th} Remote Clock

Cs

Main Clock

Cs0

Cs1

Backup

2nd Remote Clock

Cs

1st Remote Clock

Cs

* An autonomous EU state agency

UTC(NSAI)

1PPS
10MHz

GNSS receiver

Unverified
GNSS data A

GNSS data B

GNSS data verification Server A

GNSS data verification Server B (redundant)

Verified GNSS data in RTCM format over TLS

GNSS data distribution Server 1 (cloud based instance)

• • •

GNSS data distribution Server N (cloud based instance)

Control Client

Clients

Clients

NSAI NML – Verified GNSS (GPS) Data Stream

NSAI NML – Verified GNSS (GPS) Data Stream
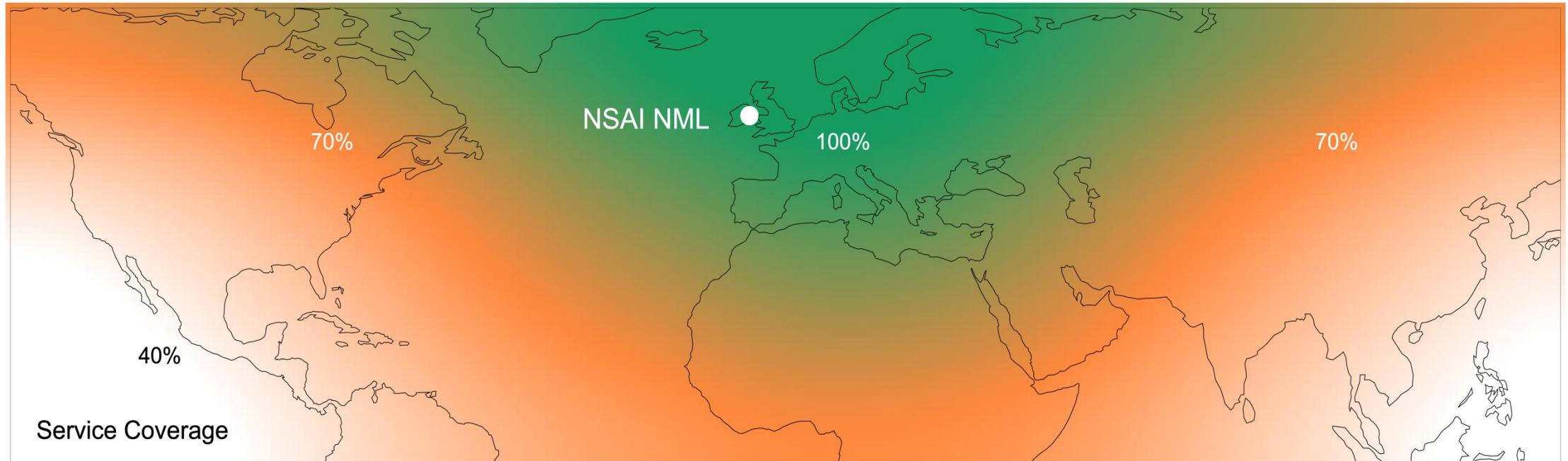
NSAI NML – Verified GNSS Data Stream Service Coverage is EU wide

Verified GNSS Data Stream: Benefits

- NSAI NML Verified GNSS Data Stream provides access to more secure **Position**, **Navigation** and **Timing**.

- Enables **exceptional resiliency** against **spoofing** and GNSS satellite **data errors**.

- The verified GNSS data stream provides **verification** for **all constellations** and **all signals**.

- Provides support for **NIS2 Directive compliance** for wider EU industry.

- NSAI NML's GNSS Data Verification Service is available in **EMEA**.

- Happy to collaborate with other NMIs.

Thank you for your attention