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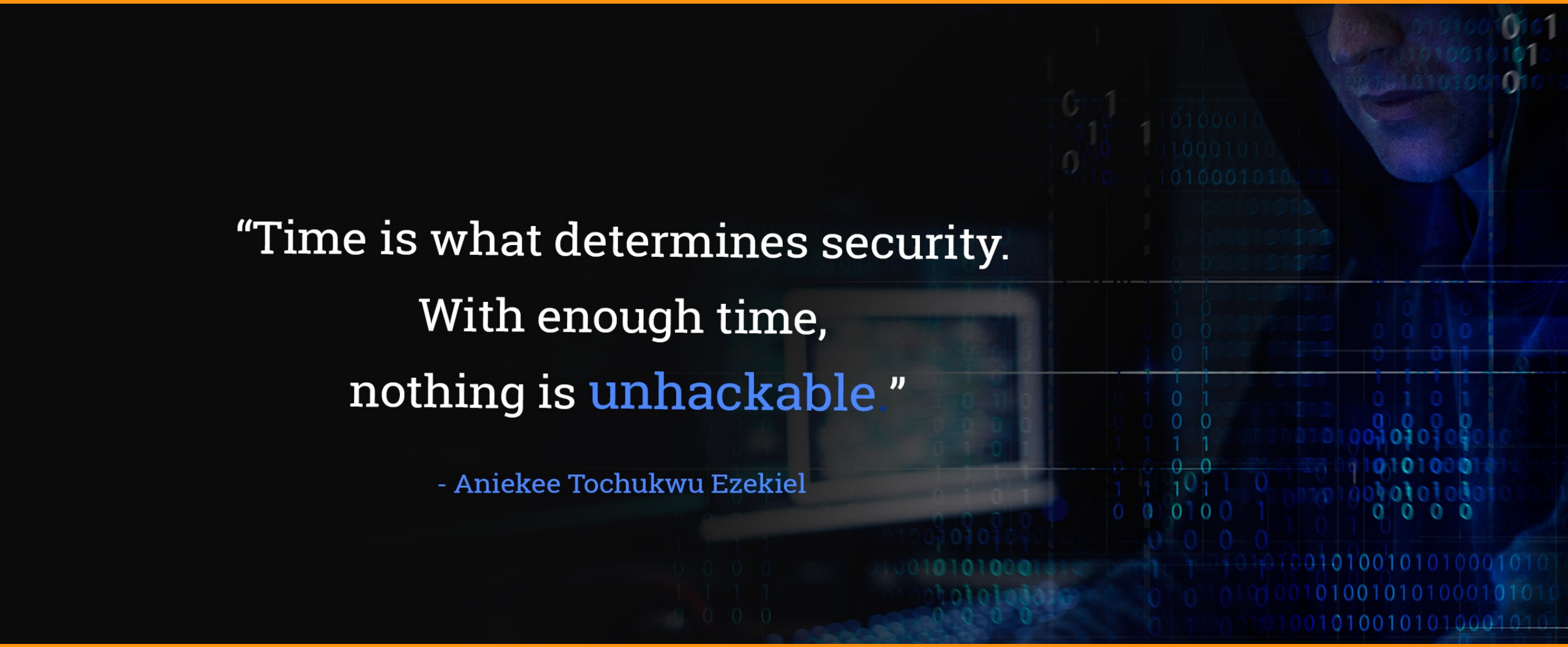
Spoofing & OSNMA for and risk in autonomous applications

Gustavo Lopez – Senior Market Portfolio Manager



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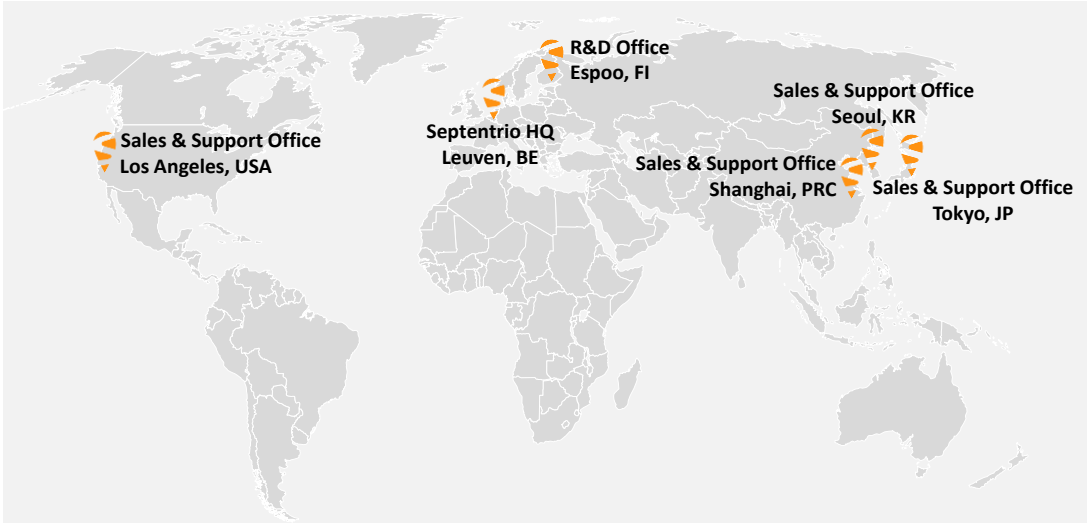
Septentrio, a leading provider of high performance GNSS solutions

- **25 years of leading GNSS innovation**
- Headquartered in **Leuven, Belgium**
- **160+ employees, 80+ of which in R&D**
- **Mission critical GNSS solutions** for the most demanding location and positioning applications globally
- Serving expanding OEM customer base, in emerging ***Autonomous Systems, industrial & critical infrastructure***
- Part of **Hexagon** (Sweden) since March 2025

Belgium HQ
Five additional sales and R&D centers globally



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Is Jamming or spoofing happening?

- **Various Recent Incidents:**
  - GNSS jamming/spoofing in conflict zones
  - GNSS jamming/spoofing in maritime navigation
  - UAV loss or accidents (e.g. Light drone shows)

Thousands of flights to and from Europe affected by suspected Russian jamming

About 46,000 aircraft have logged GPS problems over Baltic Sea since August, says report

EasyJet a
according to

Flights in ar
suspected Ru

GNSS Jamming and Spoofing Events Present a Growing Danger

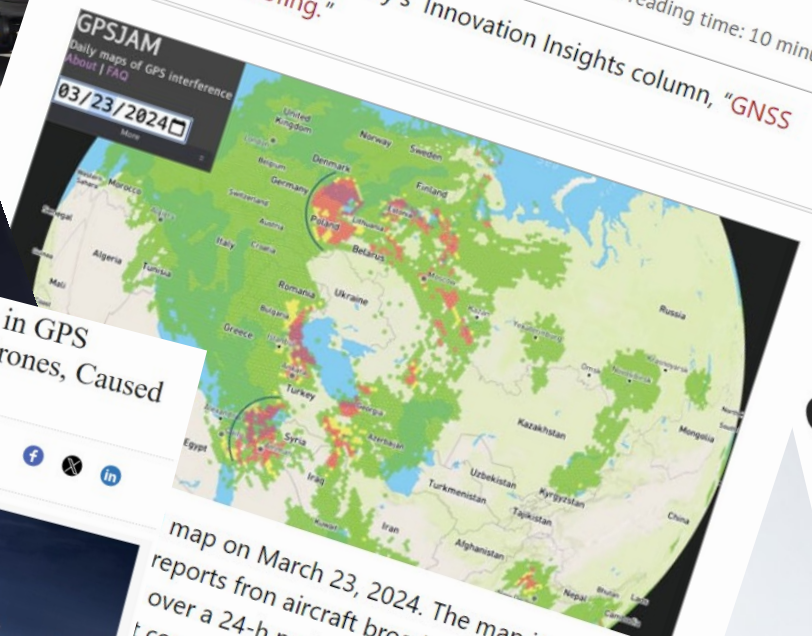
Many reports of jamming and spoofing come from conflict zones

Innovation: Recent GPS jamming in regions of geopolitical conflict

May 24, 2024 - By Dong L. Wu, Ph.D.

Est. reading time: 10 minutes

Click to read Richard Langley's Innovation Insights column, "GNSS jamming and spoofing."



map on March 23, 2024. The map
reports from aircraft bro
over a 24-h

Drone display at Hong Kong Wine & Dine Festival cancelled after 40 machines damaged by 'external parties' jamming GPS signal

- Police investigate incident that caused some drones to fall into Victoria Harbour and led to two shows being scrapped on Saturday

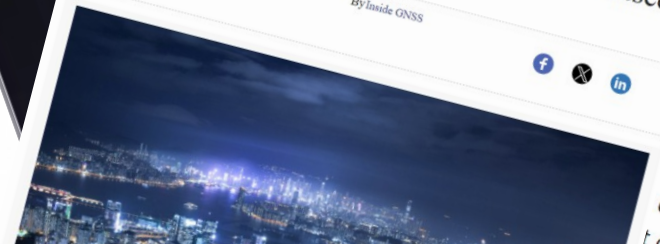
COMMENTS: 8

PUBLISHED : Sunday, 28 October
UPDATED : Sunday, 28 October

Criminal Investigation Underway in GPS Jamming Incident That Crashed Drones, Caused HK$1M in Damage

October 31, 2018

By Inside GNSS



UK flights are facing 'extremely dangerous Russian jamming': Report

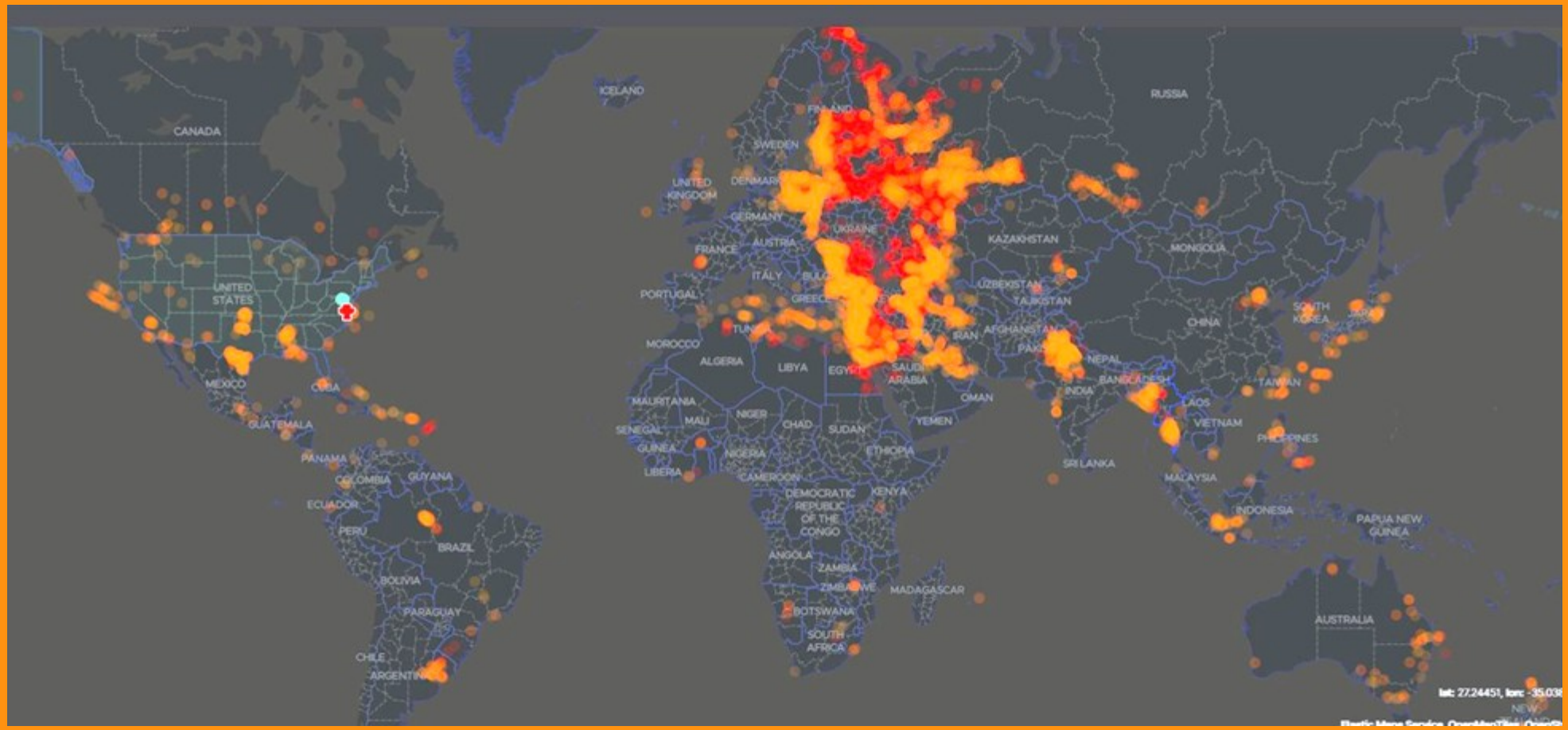
London, UK • Edited By: Sneha Swaminathan • Updated: Apr 23, 2024, 12:33 AM IST

rport is only 10 kilometers from Norway's border with Russia, and some 50 km from the nearest military training gr
. Photo: Thomas Nilsen

ntensified GPS jamming is side effect of Russia's self-protection Kola bases

The jamming now seen practically every day in airspace over eastern Finnmark is likely a s of Russian electromagnetic defence measures for their own military installations, says Nic with the Norwegian Communications Authority.

#EUSpace



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Lots of jammers near French airport

by Editor | Jul 21, 2023 | Blog

Image: Shutterstock

What's New: A media item about **multiple jammers disrupting operations at a French airport.** As soon as the authorities found one, they found another, then another!

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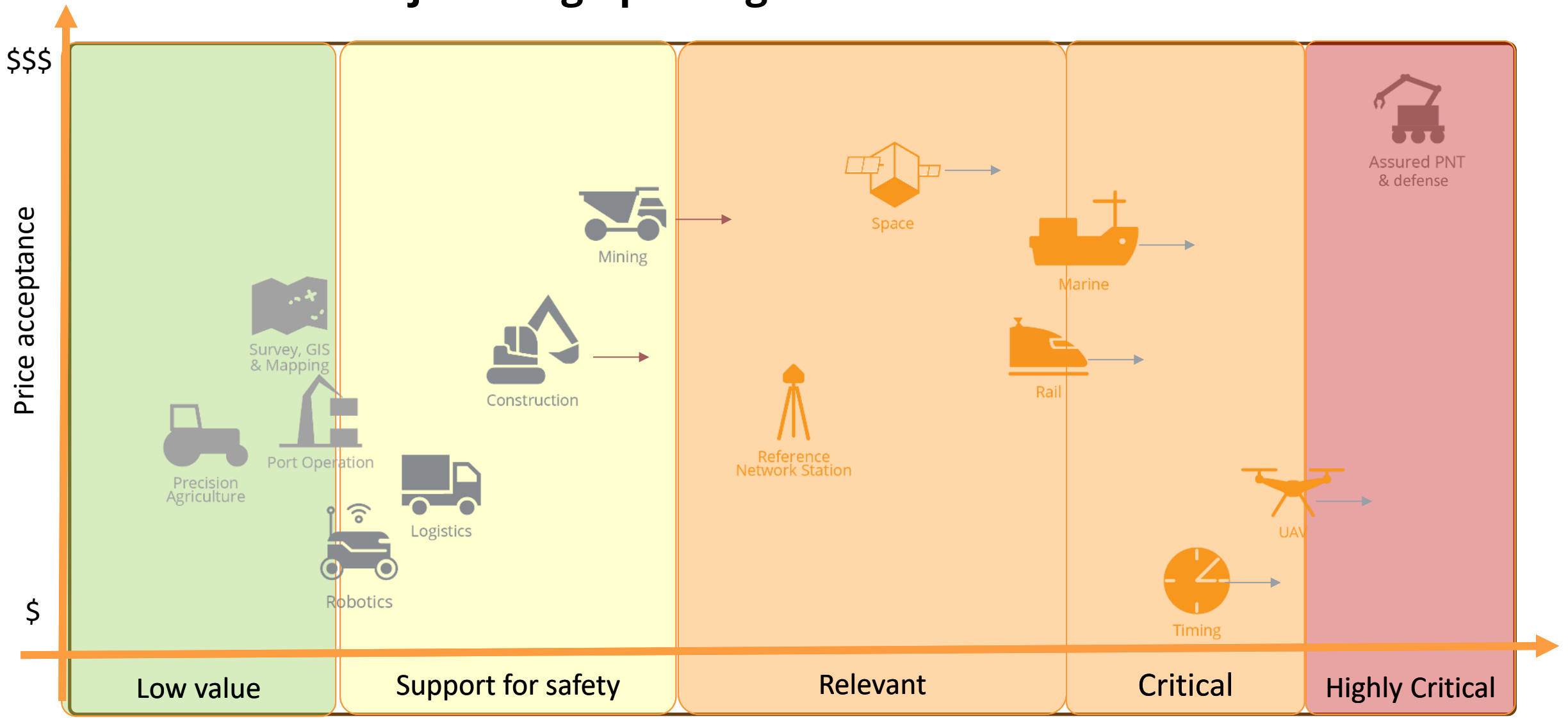
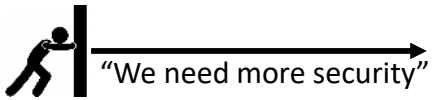
Markets and Anti-jamming/spoofing resilience needs



Resilience



OSNMA & Septentrio

Septentrio has been part of several initiatives with EUSPA & ESA for testing/validating OSNMA

Septentrio started focus on spoofing detection/mitigation thanks to Fantastic EUSPA project

Started with PolaRx5 and mosaic-T GNSS receivers as part of some of these projects

Galileo OSNMA started to be rolled in all Septentrio receivers since 2021

Today OSNMA is integrated (and is being used) in all Septentrio products

Field Aware Navigation and Timing Authentication Sensor for Timing Infrastructure and Centimeter level positioning

ROOT assessed the benefits of OSNMA to boost 5G sync resilience.

OSNMA officially deployed and being used in all Septentrio products

Interference Types

	Jamming *Drowning out GNSS Signal* → **No position**	**Spoofing** *Overruling GNSS with fake GNSS signal* → **Wrong position**
Unintentional	• **Other Systems in GNSS bands** Radar, Amateur radio,... • **EMC Issues** Displays, cameras, lidars,... *Clock harmonics etc.*	• **Repeaters** *Production tests,* *Maintenance hangars*
Intentional	**Devices designed to wipe-out GNSS** Personal Protection Devices *(web-shops)* Military Jammers	• **Commercial SDR** (low cost) gps-sdr-sim • **GNSS simulator + Amplifier** • **GNSS Repeaters** (meaconing)
	Increased occurrences **More sophisticated attacks**	**Increased occurrences** **Easier to replicate** **Attention needed (not many solutions)**

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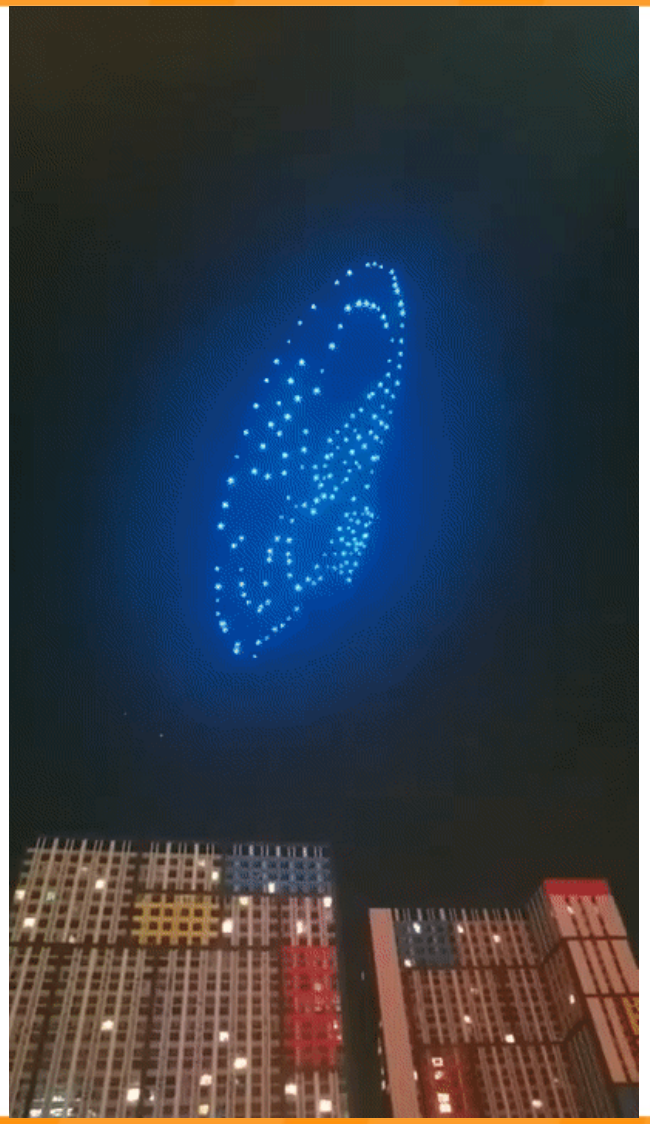
Not this :(



JAMMING
Light drones

Drones are seen forming Chinese characters (left) before they fell out of the sky

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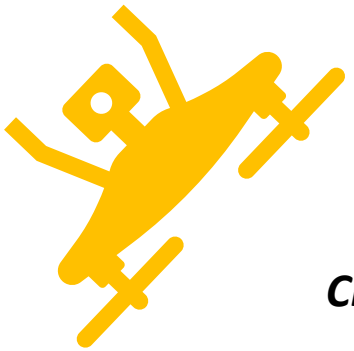
Spoofing Detection: Goal => Authentication has a key role

- **Problem:**
  - Spoofing injects fake GNSS signal into receiver

  → Wrong position or timing

    → Potentially catastrophic system malfunction

Hacked GNSS



Crash!

- **Solution:**
  - Spoofing Detection: Receiver alerts user to attack

  → User switches to backup system

    → Relative position or timing:

    - Position attack → Dead reckoning with INS
    - Timing attack → Holdover to high accuracy oscillator (OCXO)

Hacked GNSS → INS

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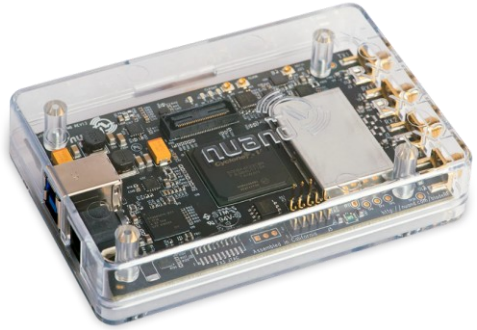
How can SPOOFING be done?

GNSS Spoofers (GPS Simulators):

$ $$$

SDR + Free Software



Portable Simulator

Highly Advanced Simulator

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How can SPOOFING be detected?

SDR + Free Software

Portable Simulator

Highly Advanced Simulator

→ **Detect Signal Anomalies & Inconsistencies**

→ **Spoofing Flag**

But don't make it react on the real thing

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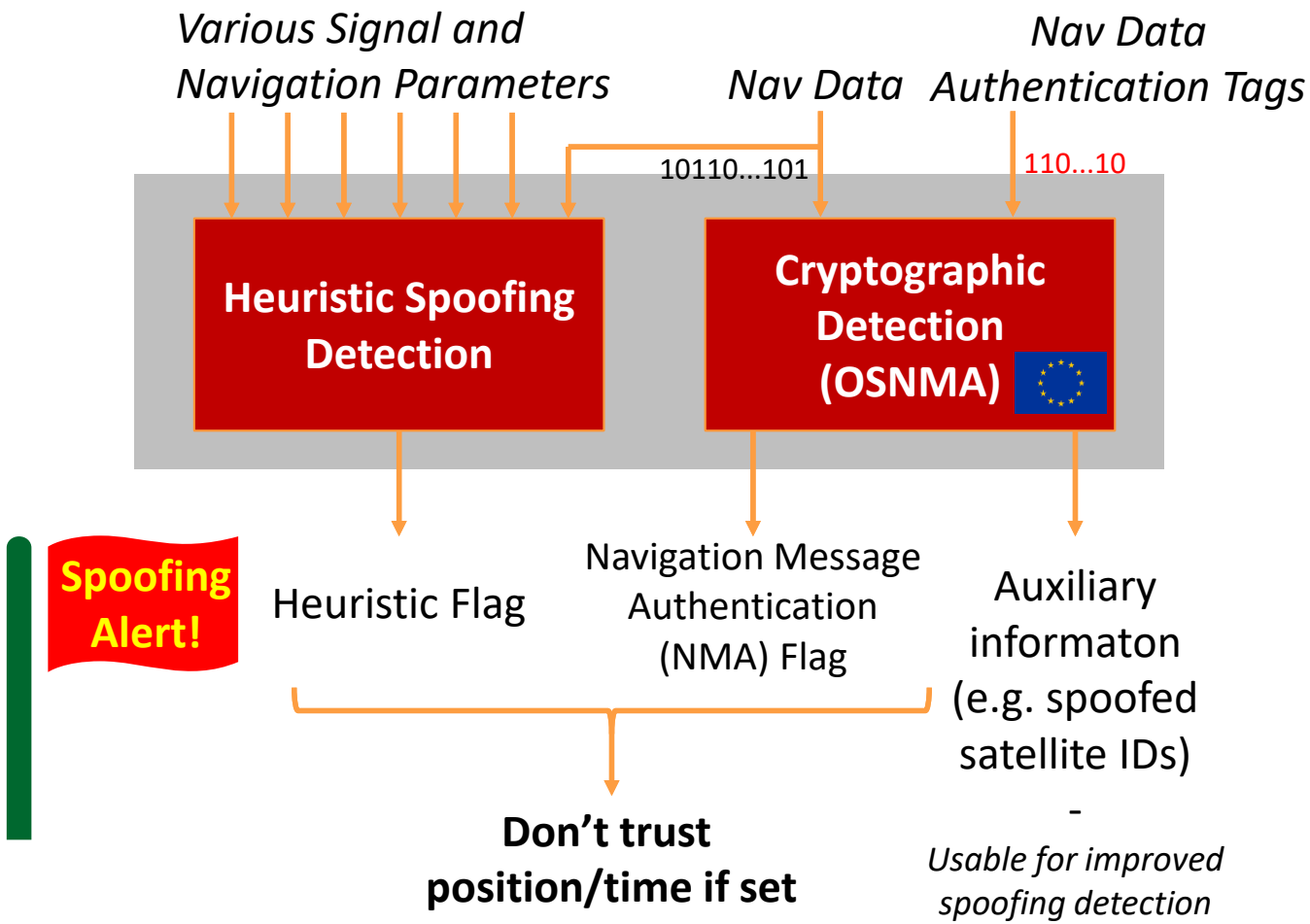
Septentrio's Spoofing Detection Architecture



No Calibration Required – Working out-of-the-box

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Easy OSNMA configuration on Septentrio GNSS & Galileo enabled receivers

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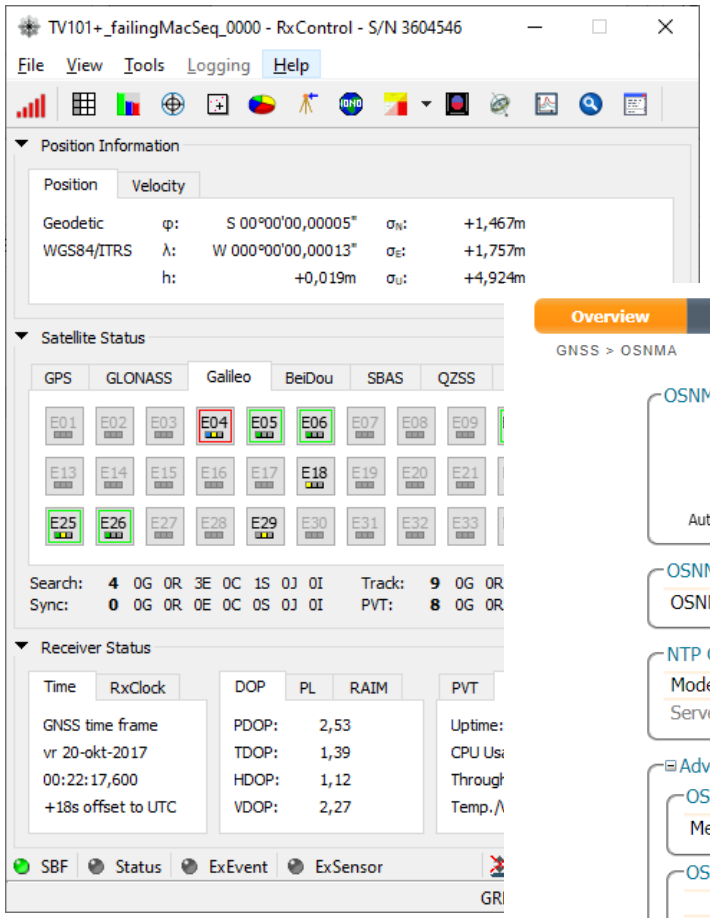

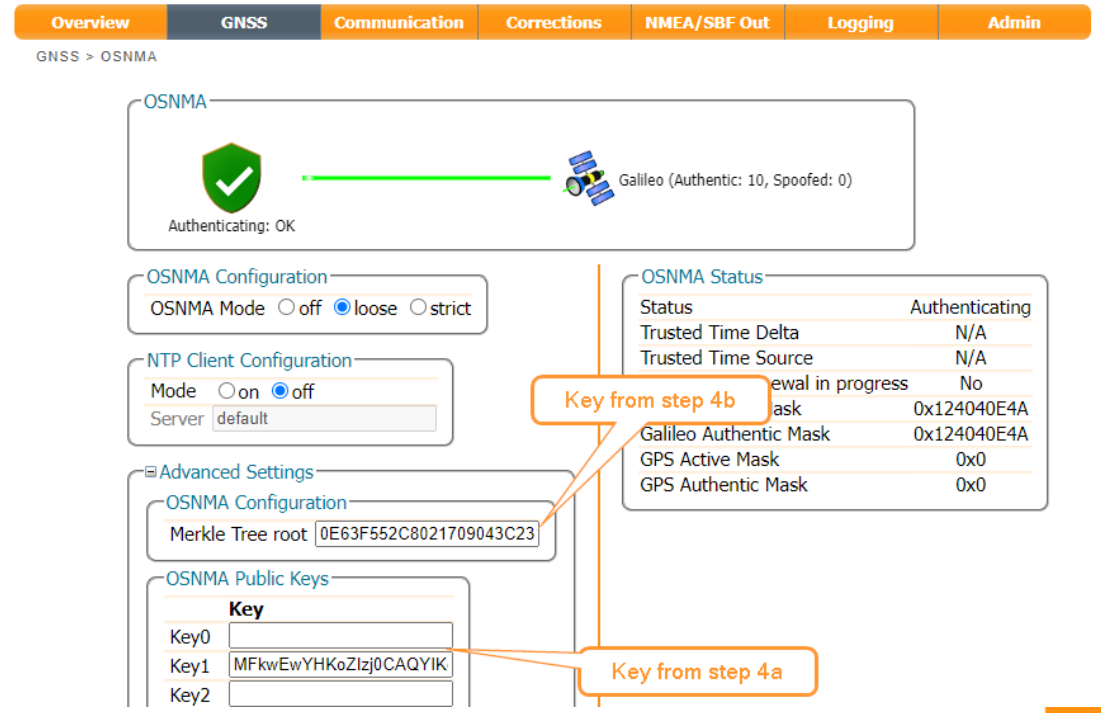

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Spoofing Detection

Spoofed Coordinate → User Informed

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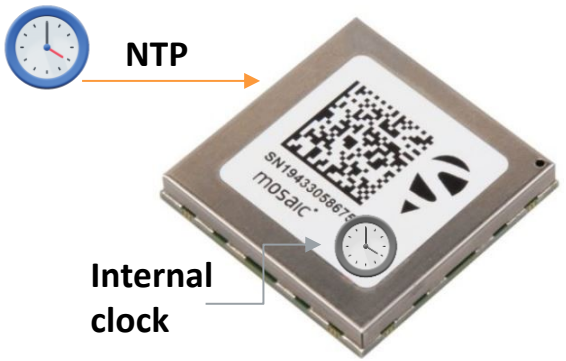
Receiver	Position		Status
mosaic-X5 S/N 3603240	Lat: N0°0'0.0000"	0.289m	Tracked Sats: 23
IP Address: 0.0.0.0	Lon: E0°0'0.0008"	0.330m	Time: 2022-10-24 00:04:52
Uptime: 0d 00:04:10	Hgt: -0.439m	0.779m	Temp: 37.00 °C

Standalone | Internal
Overall Quality | Logging
Corrections | Spoofing!
OSNMA

Overview | GNSS | Communication | Corrections | NMEA/SBF Out | Logging | Admin

Authentication of GALILEO L1 Signal Failed!
Cryptographic method to authenticate navigation data
Network Time Protocol (NTP) for OSNMA time synchronization

Spoofing Detected with Heuristic Methods:
Waveform anomalies, navigation data anomalies, inconsistencies



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OSNMA modes on mosaic

OSNMAmode = off :

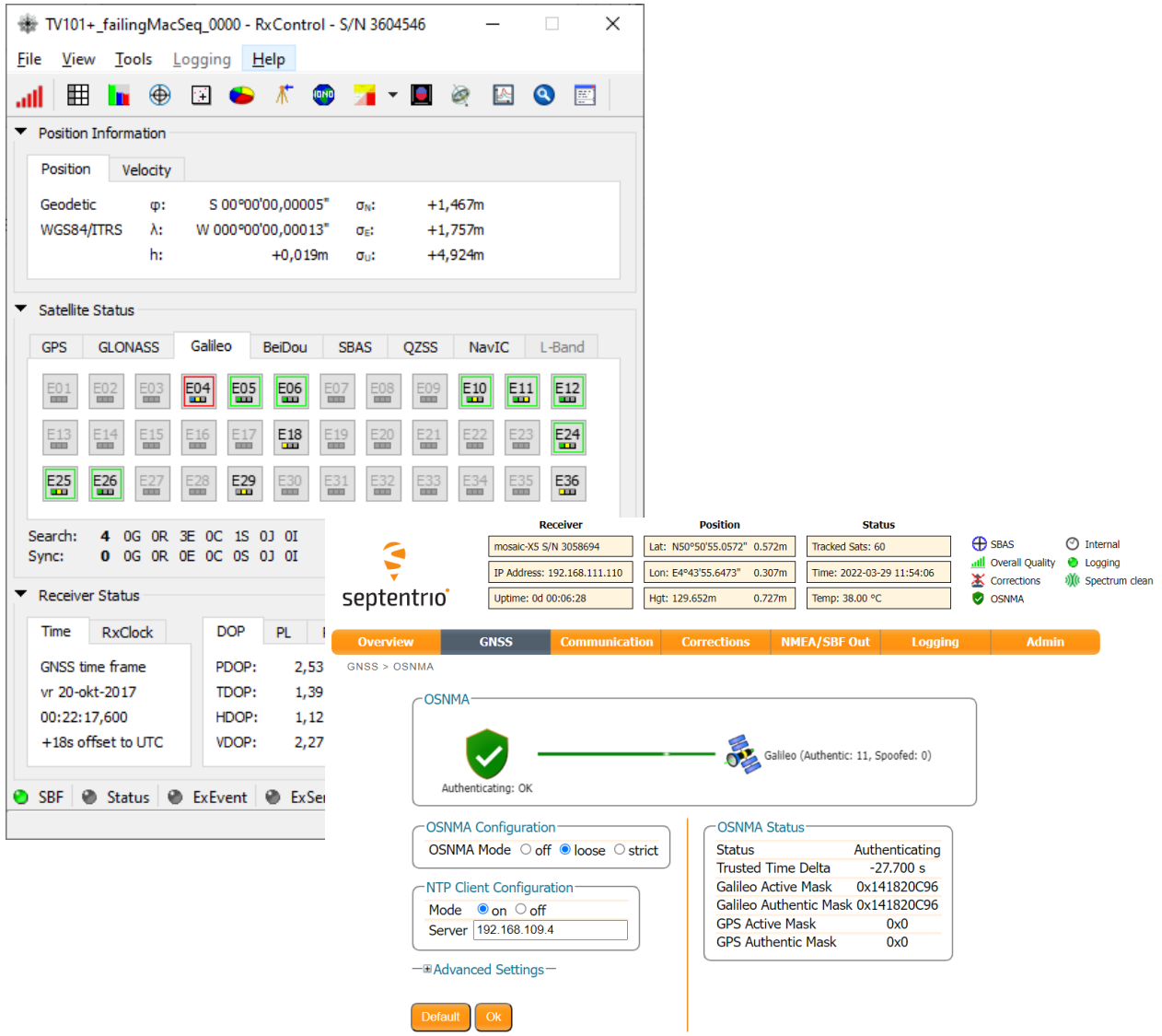
- All PVT modes supported
- All constellations used
- All satellites used

OSNMAmode = loose :

- All PVT modes supported (standalone, SBAS, DGPS, RTK, PPP, ...)
- All constellations used
- Unauthentic satellites removed

OSNMAmode = strict :

- Most PVT modes supported (standalone, DGPS, RTK, ...)
- Galileo-only
- Only authentic satellites used



Norway Jammertest

- **Advanced outdoor jamming & spoofing tests**
  - Very remote location avoids impact
  - Multi-constellation, multi-frequency spoofing!
  - Large variety of jamming and spoofing scenarios
- **Organized by Norwegian governmental agencies**

Statens vegvesen
Justervesenet
Norsk Romsenter
Norwegian Space Agency
Nasjonal kommunikasjons-myndighet
FFI Forsvarets forskningsinstitutt
Norwegian Defence Research Establishment
TESTNOR

- **Participants:**
  - Authorities
  - Industry
  - Academia

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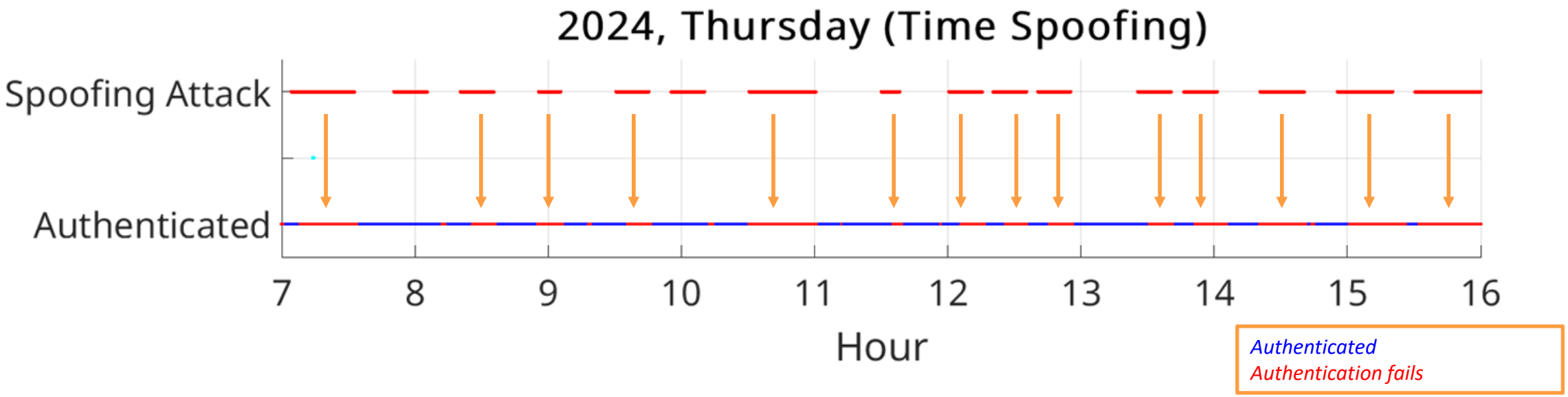
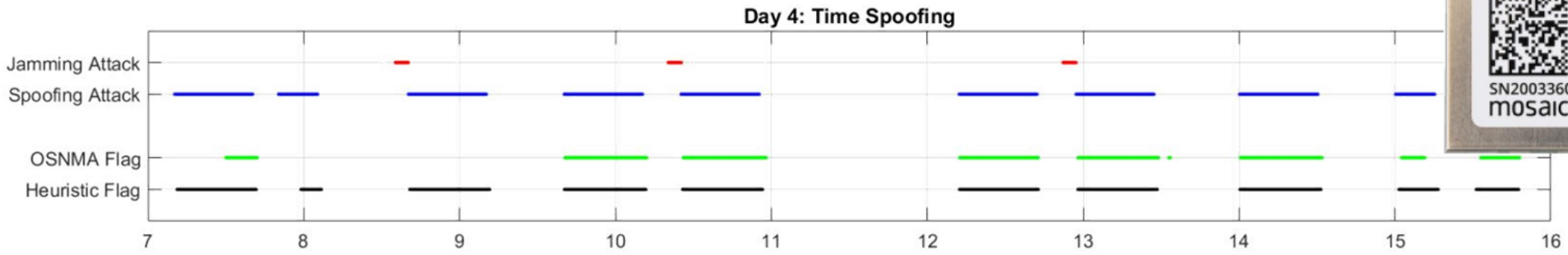
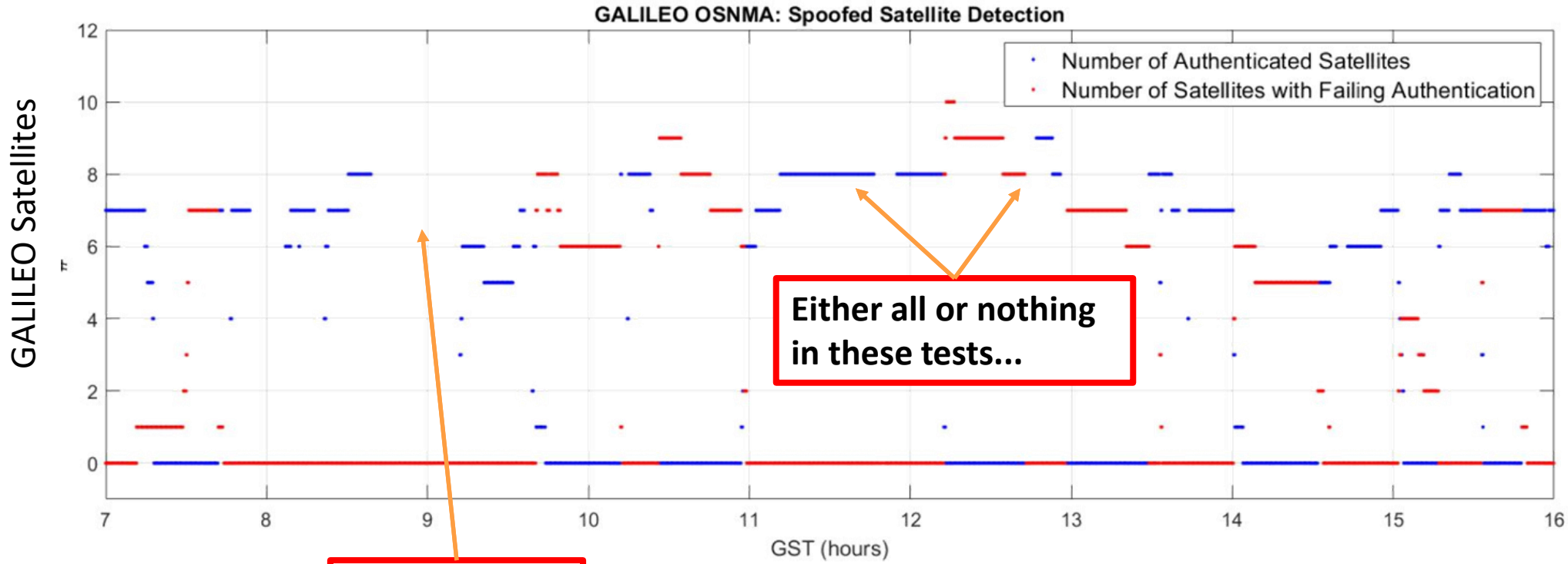
Norway Jamming Test: Time Spoofing

GALILEO Open Service Navigation Message Authentication (OSNMA):
As expected = Authentication fails during spoofing helping to properly notify end-user



Time Spoofing: Cryptographic Detection with OSNMA





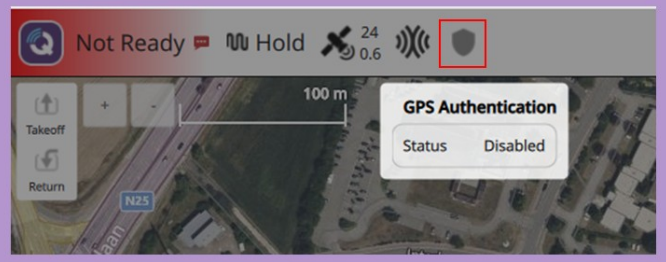
Either all or nothing in these tests...

Not enough GAL satellites

Authentication (integration in Autopilots for UAV)

septentrio part of HEXAGON promoting & driving OSNMA integration within open-source autopilot ecosystems.

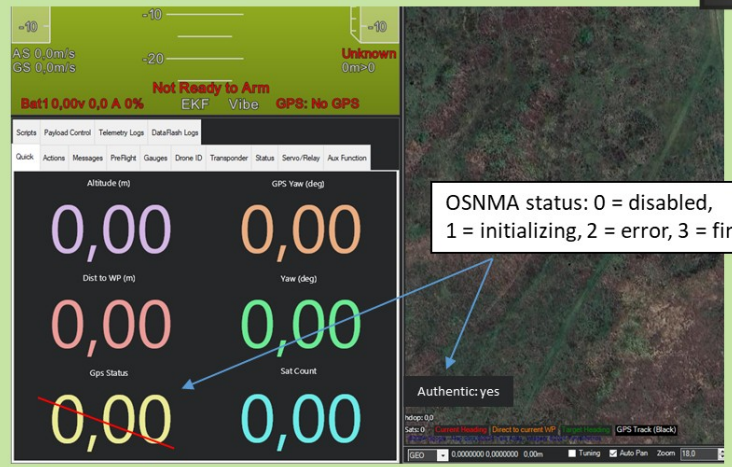
QGroundControl



	n/a	Disabled	Unknown
	OK		
	Initializing		
	Failed		

MissionPlanner

Thomas suggested



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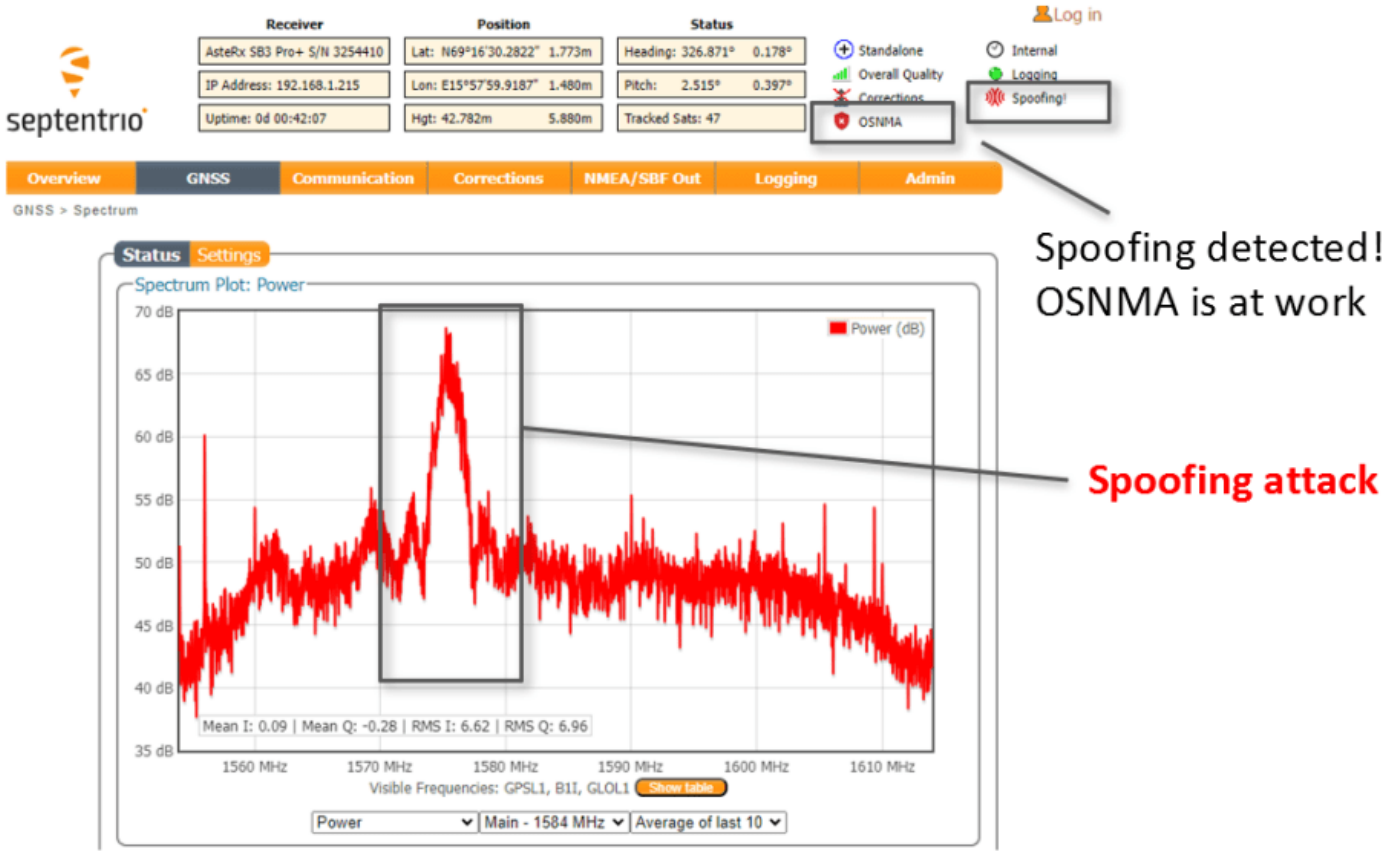
Monitoring of GNSS jamming & Spoofing – in receiver



Conclusions

- OSNMA is an important step towards addressing security concerns in **different market applications**

Septentrio is **committed to resilient products**, making OSNMA a key milestone

OSNMA is now available in commercial Septentrio products

  - Housed products, OEM boards, mosaic GNSS modules

- OSNMA is **being used** by customers in various industries (additional resilience)
- While OSNMA alone is not sufficient, it provides **a crucial additional layer of anti-spoofing** alongside heuristics and other techniques
- While Spoofing is an important threat, this one goes **often along jamming**
  - => GNSS equipment requires other protection mechanisms beyond pure OSNMA alone

CELEBRATING 25 YEARS
OF SECURE & ROBUST GNSS POSITIONING

Thank you

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