

6/2023 - 5/2025

NavCom X the modular PNT solution for rail



Introduction to the Project

The purpose of the project

To create a modular, high-performance **navigation and communication system** adaptable across industries, with a core focus on improving railway operations.

Users voice

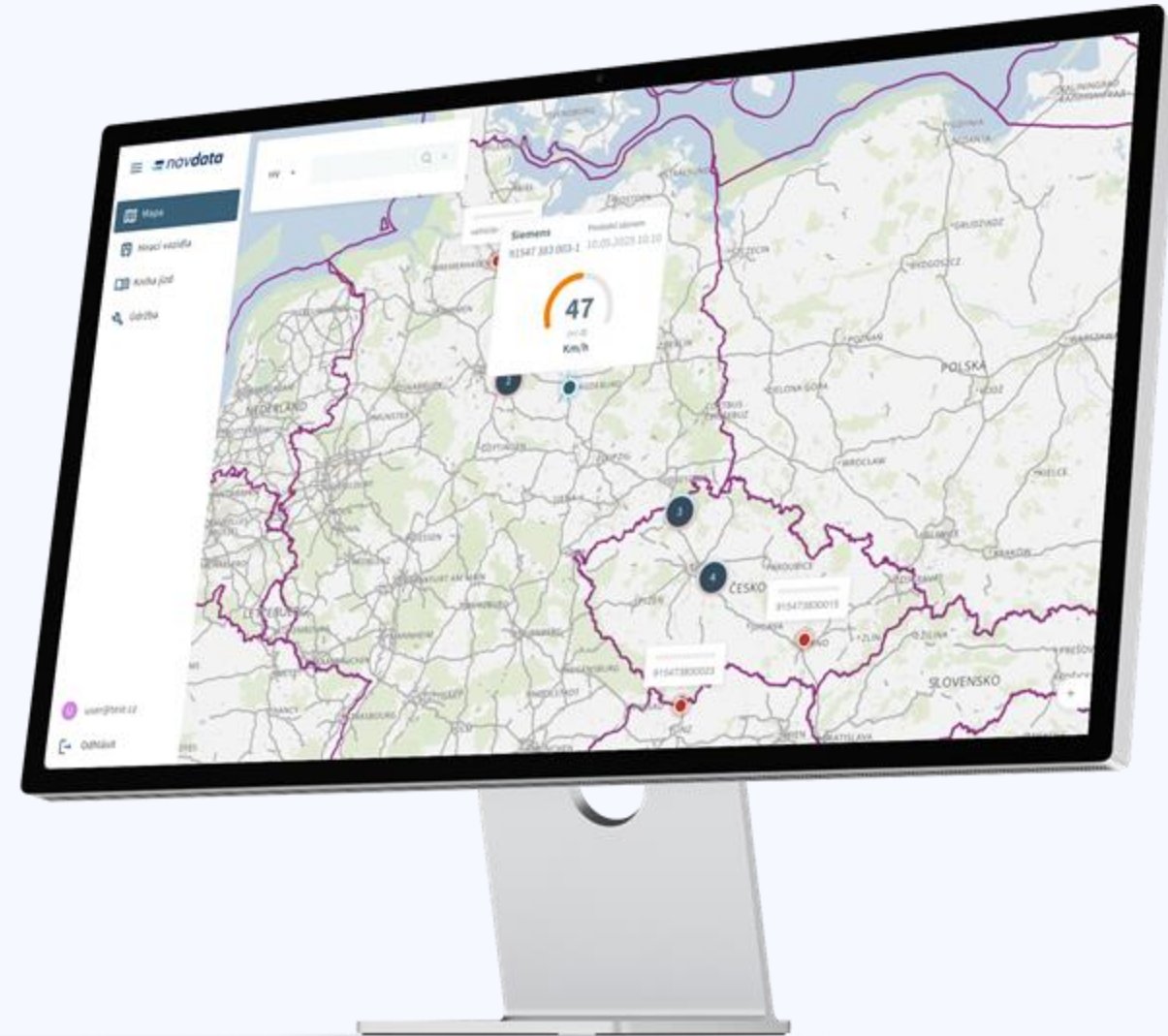
- Seamless plug-and-play setup
- Reliable in tough conditions
- Standalone precise positioning
- Works without external power or connectivity
- Tracks service intervals
- Real-time and historical data access

Use cases

- UC1 Test driver with battery option
- **UC2 Daily driver with display, sound option**
- UC3 Test driver performing diagnostics
- UC4 Smart tracker and logger

Introduction to the Project

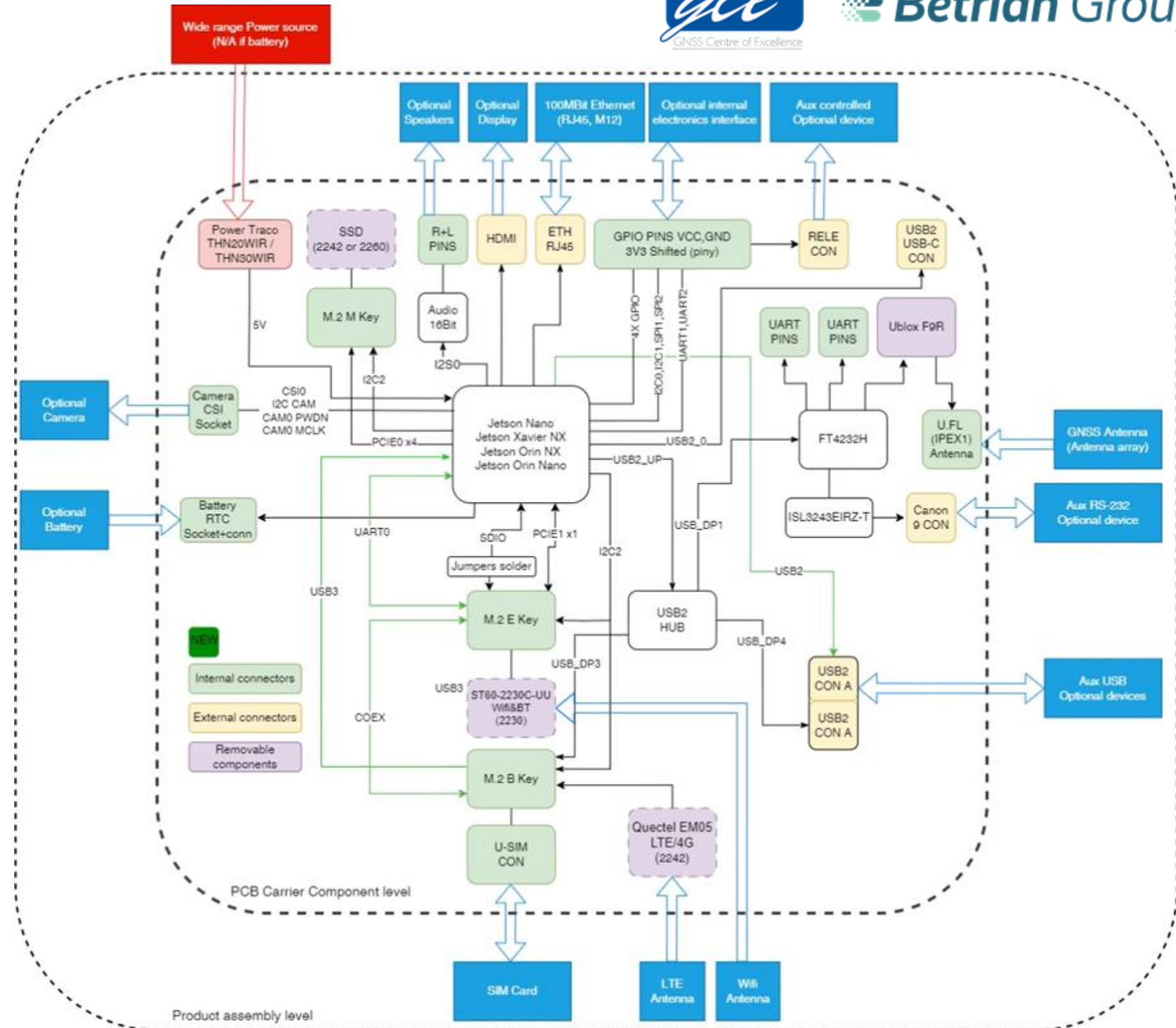
Key Achievements



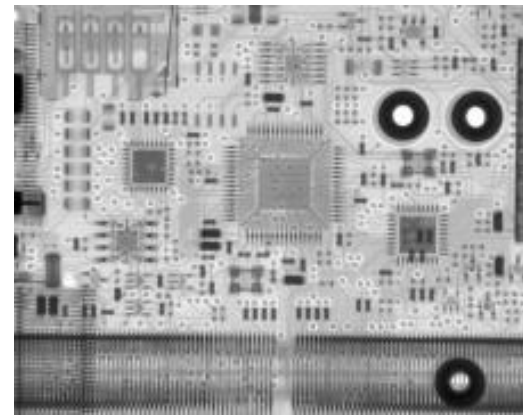
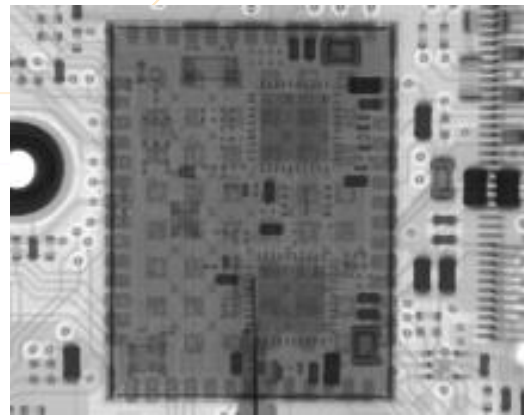
Complete development of the NavCom X hardware and software platform. Successful field validation in real operational conditions. Proven resilience and efficiency in mission-critical railway use cases.

HW - motivation

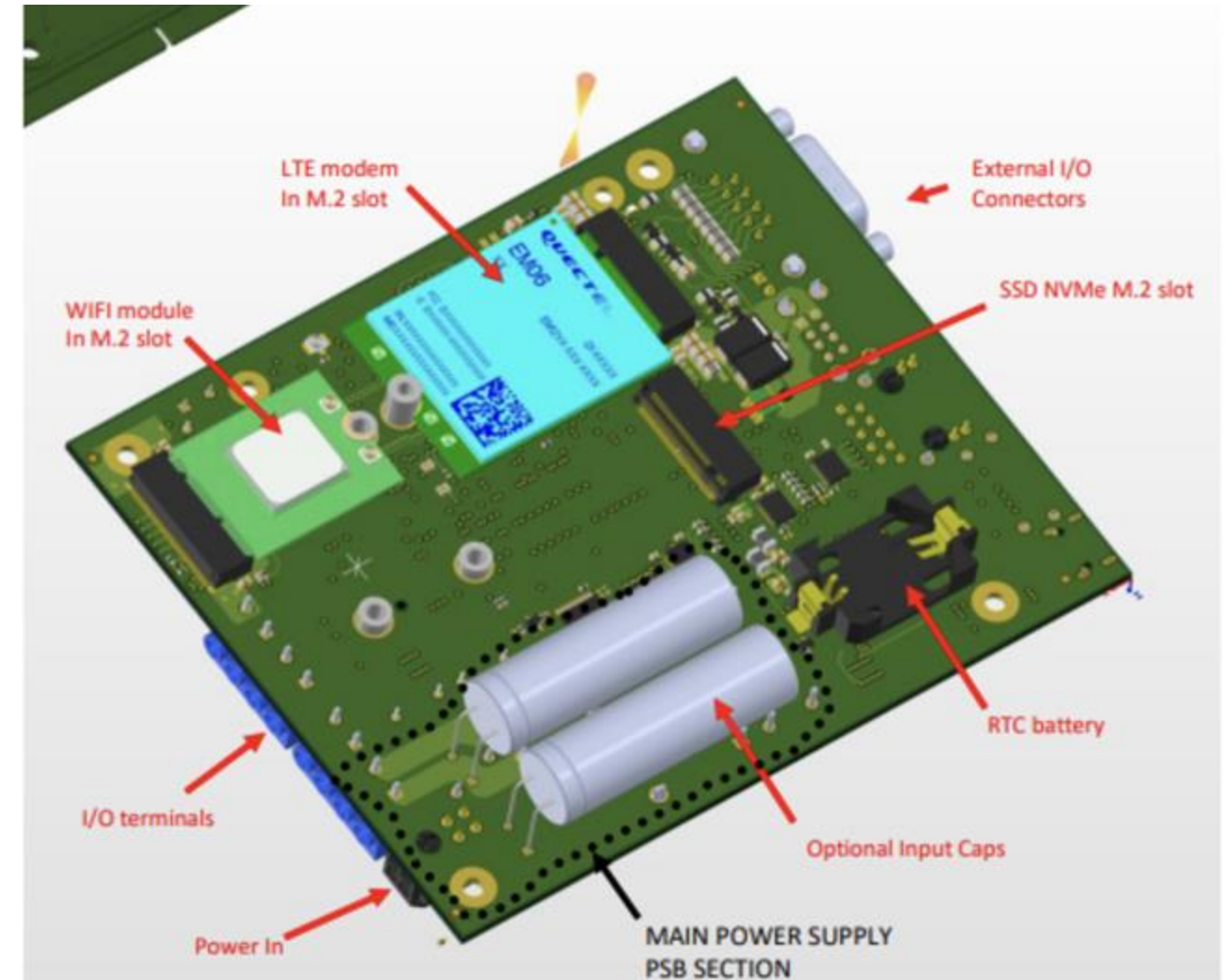
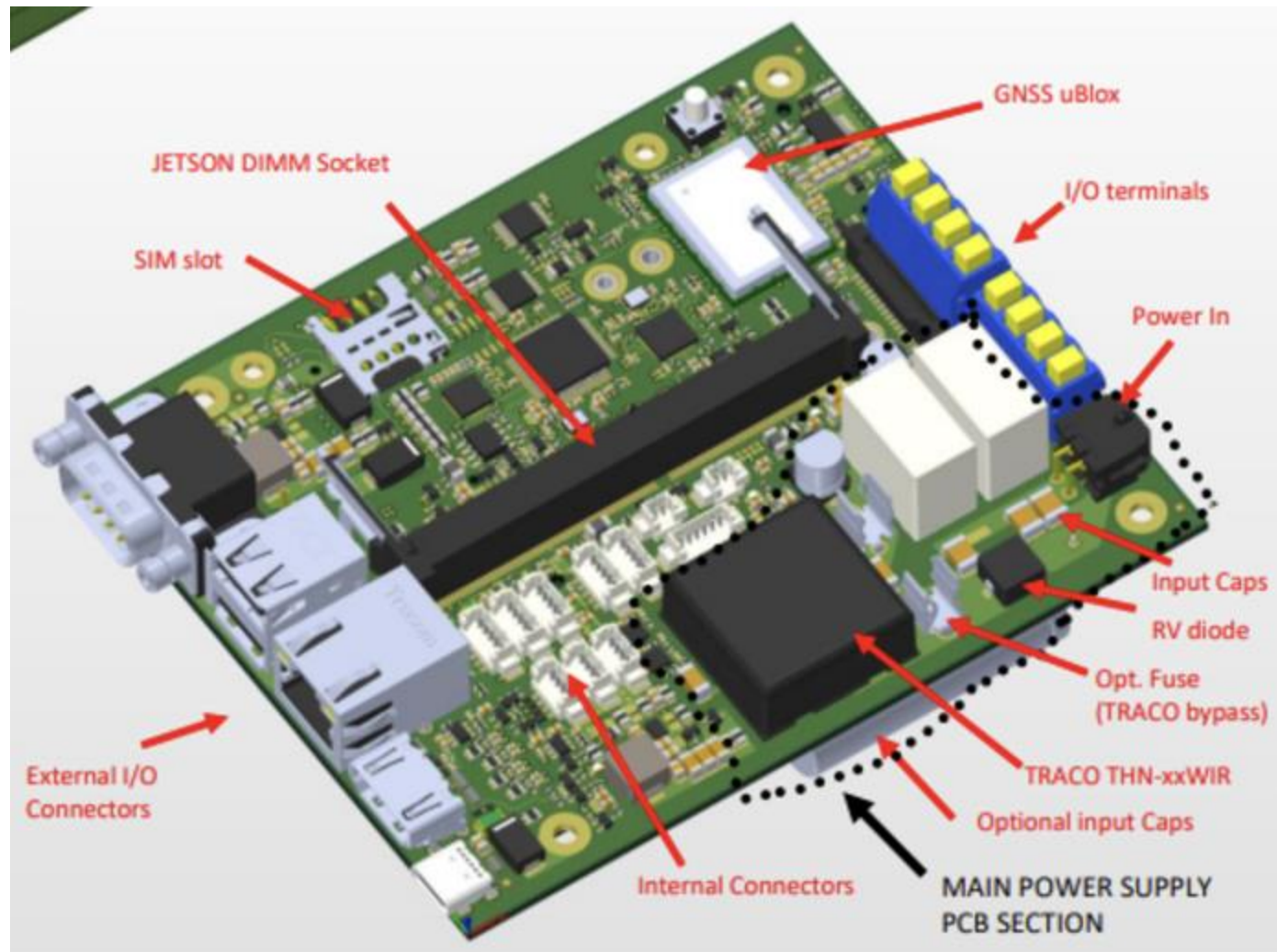
- Need to build a Railway computer - block diagram
- EN50155 inspired
- Custom hw development needed
 - Locomotive cabine attenuation -> **uBlox F9R**
 - Performance w/ AI -> **NVIDIA Jetson SOM**
 - Jetson Scalability -> **Custom Carrier board**
 - Environment -> **Railway power supply, battery**
 - Independent connectivity -> Wifi + LTE modem
 - Logging -> large NVMe disk
 - LoRa comm -> Radio modem interface
 - User interface -> Display, speaker, camera,...
 - Other -> GPIO, Relays, Ethernet, USB,...
- Some trade-offs building the system on carrier board
 - Jetson Scalability -> cost vs perfo vs energy eff.
 - Power Supply -> robustness vs unified design vs volt. flexibility



HW - layout

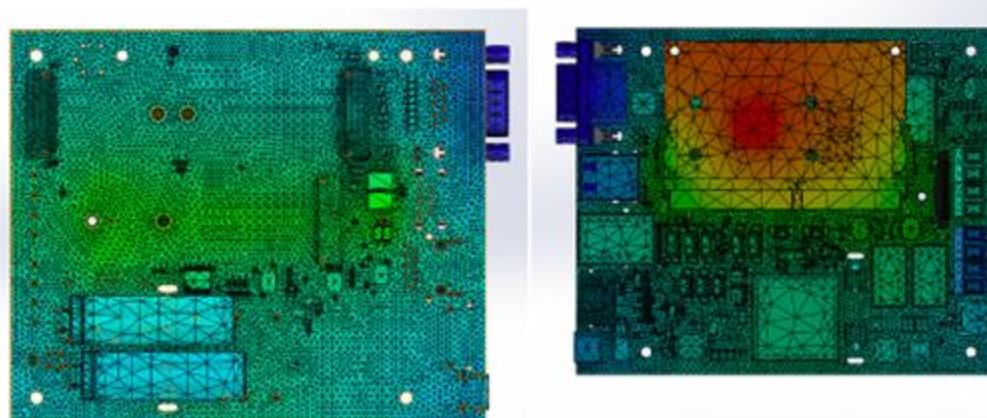
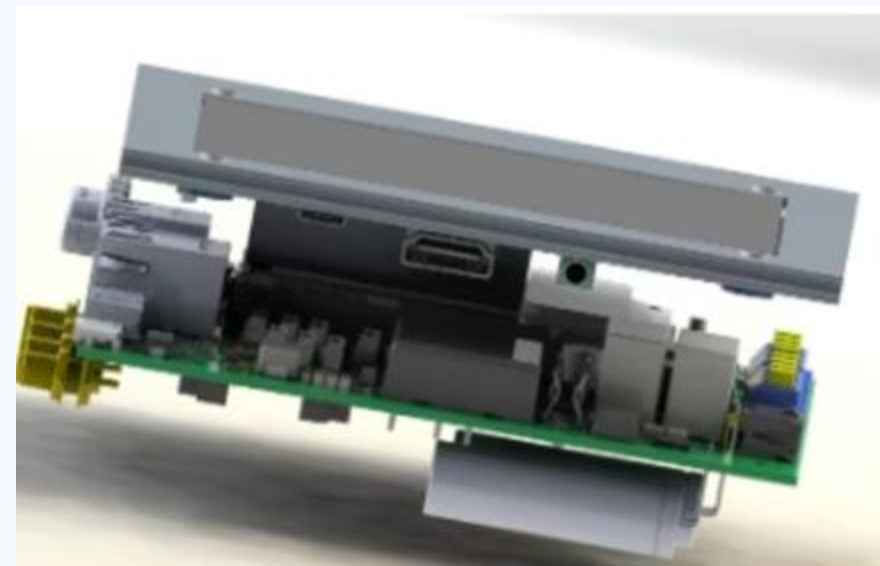


- components count: 2 000
- PCB layers: 6



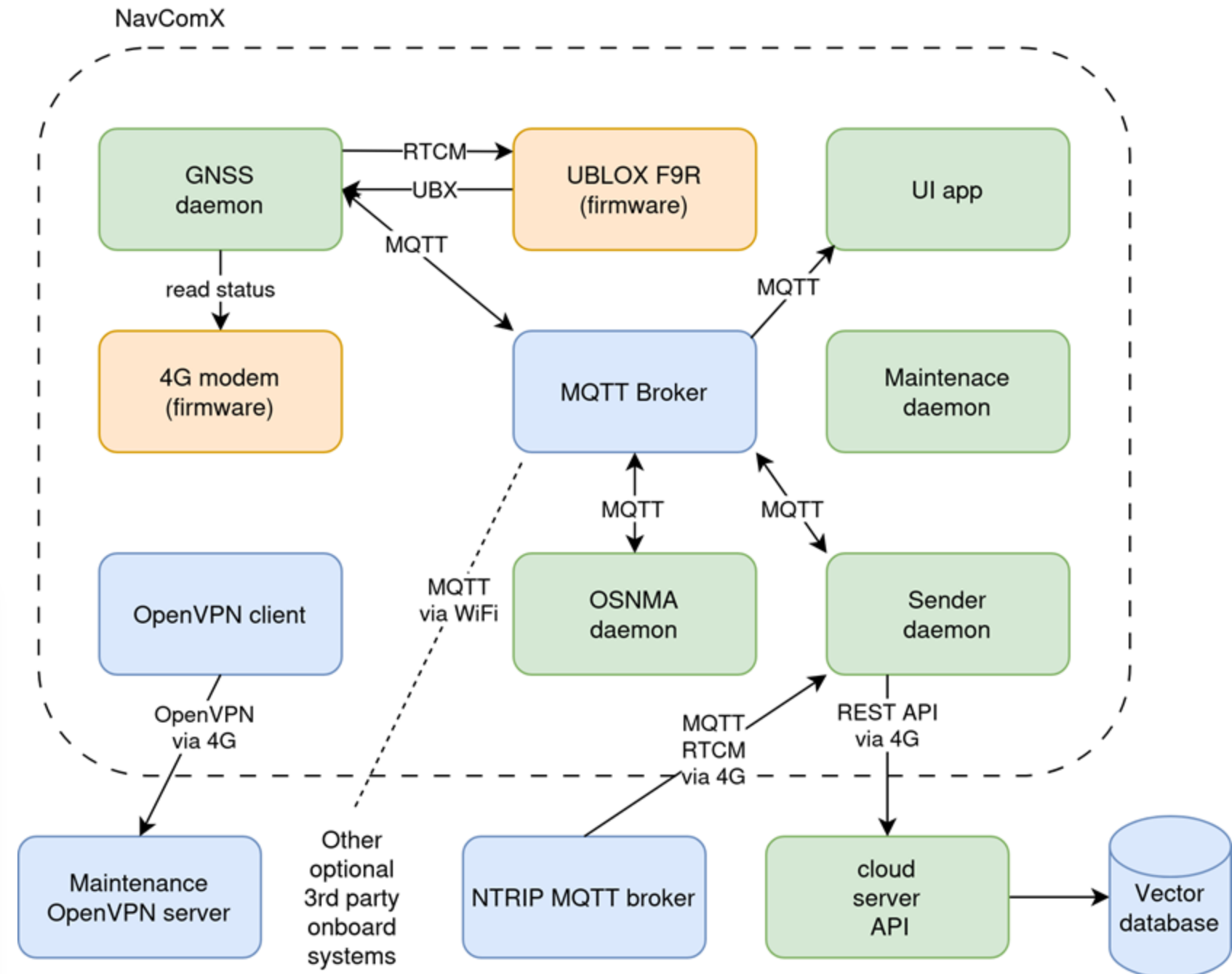
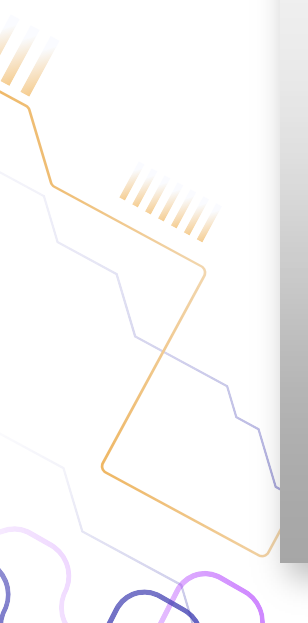
HW - housing and product design

- Simple Industrial low volume design
- [video](#) - Exploded animation
- Is it not just a bulky tablet?
 - A lot Better GNSS
 - External antennas
 - Robust built and robust power supply options
 - Custom set of Interfaces - fit for application
 - Energy efficiency



Firmware description

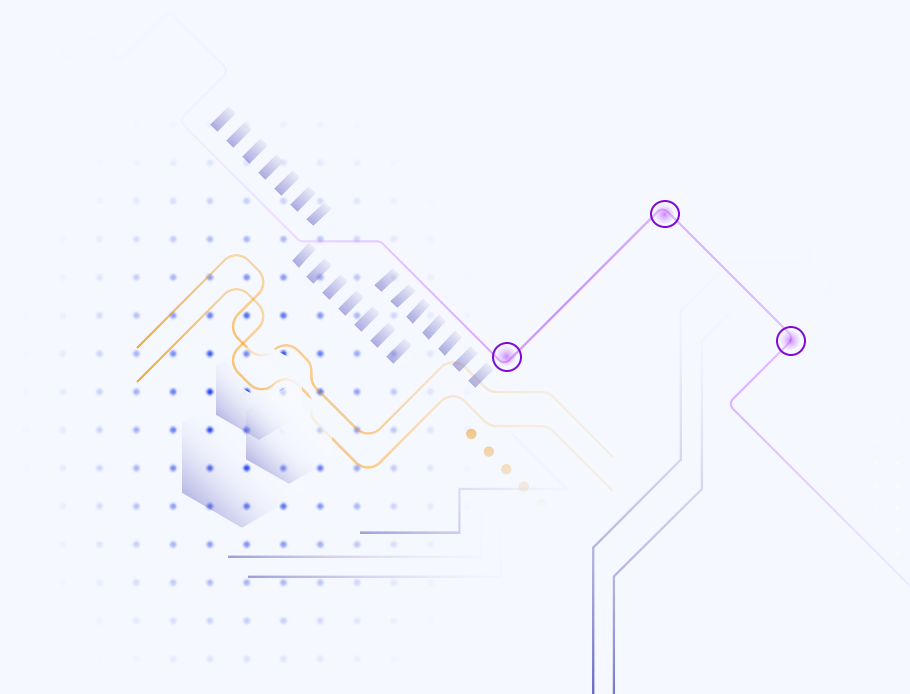
- MQTT Broker
- GNSS daemon
- Sender daemon
- OSNMA daemon
- Maintenance daemon
- UI app



SW description

- User app - [link](#)
- Maintenance web

navcom x					Devices Software Version				
					+ add new device + add new software + add new version - delete device				
navcom x 1	+	navcom x 2	+	navcom x 3	+	navcom x 4	+	navcom x 5	+
osnma actual version: V target version: VI	o	gnss actual version: IV target version: IV	o	gnss actual version: IV target version: IV	o	osnma actual version: VI target version: VI	o		
sender actual version: II target version: II	o	osnma actual version: IV target version: V	o	osnma actual version: V target version: V	o	sender actual version: I target version: I	o		
		sender actual version: I target version: I	o	sender actual version: II target version: II	o				
navcom x 6	+	navcom x 7	+	navcom x 8	+	navcom x 9	+		



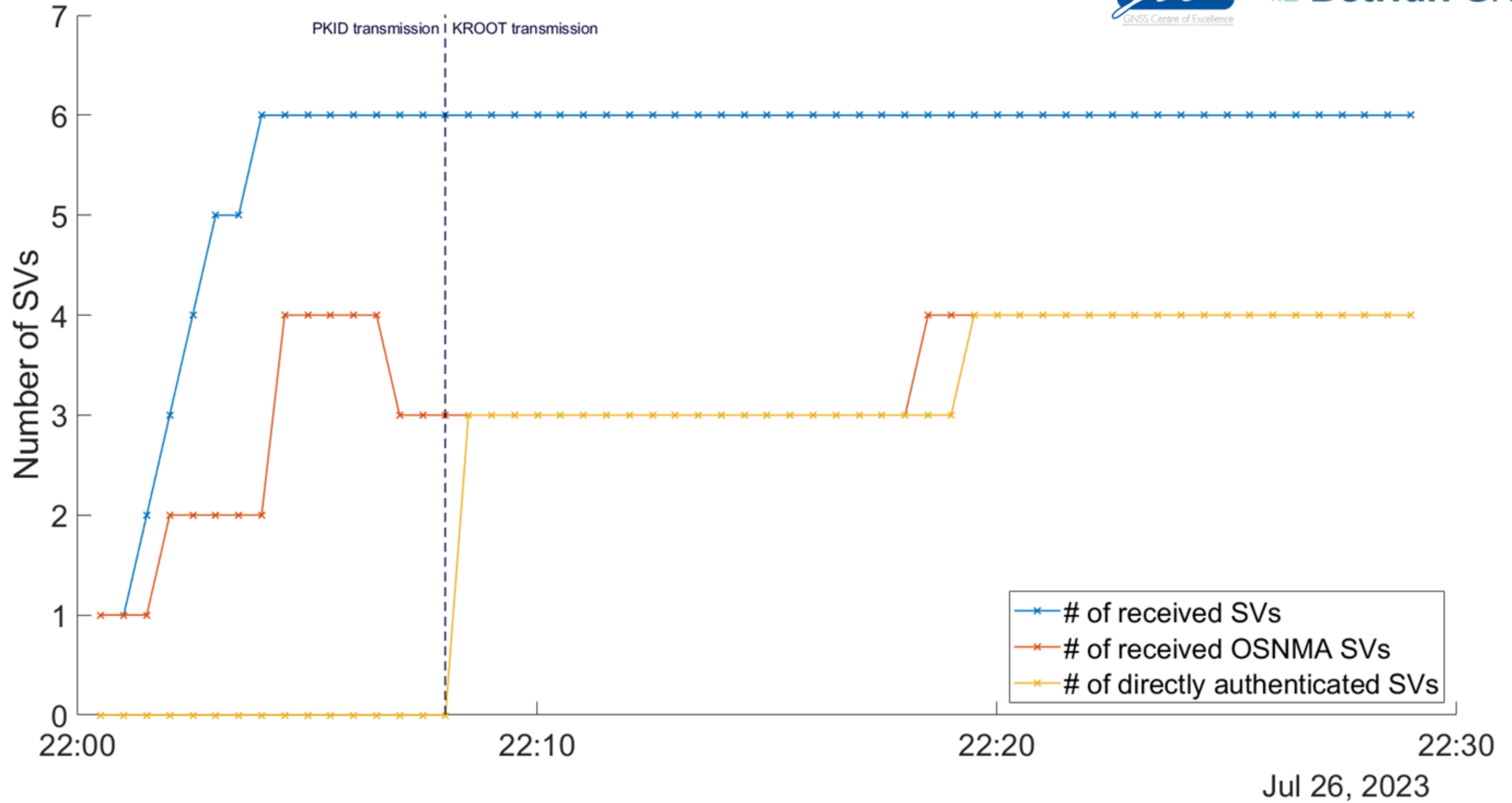
Galileo OSNMA integration

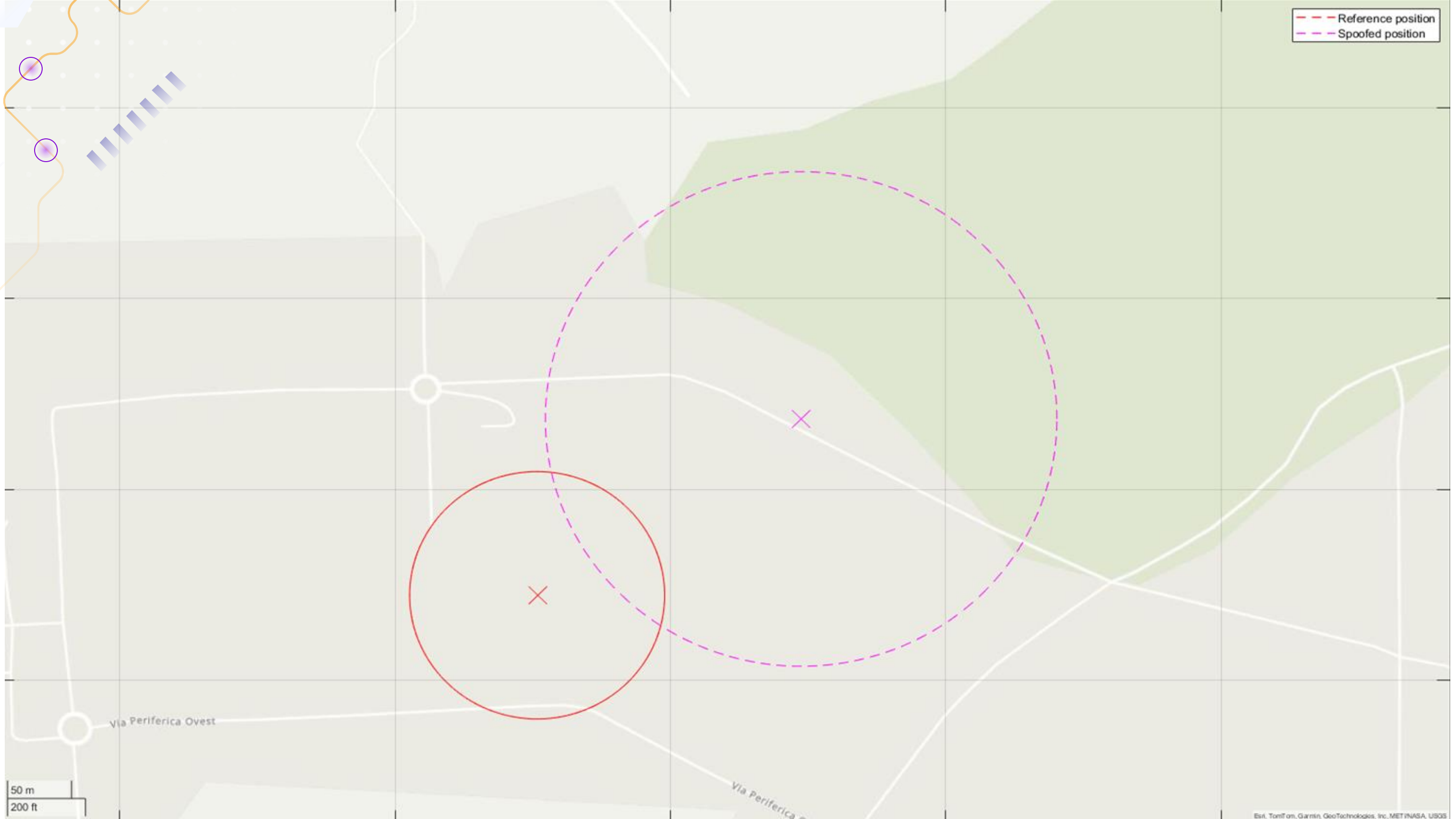
- 01 — Galileo Open Service Navigation Message Authentication
 - is a data authentication function for the Galileo Open Service
 - worldwide coverage
 - freely accessible to all users
- 02 — Provide navigation message authentication as means to mitigate spoofing impact
- 03 — Project was part of the OSNMA Public Observation Test phase



Galileo OSNMA integration

- 01 — In house integration of Galileo OSNMA processing
 - before OSNMA processing was natively part of the chipsets
- 02 — The implementation was done in line with the receiver guidelines
- 03 — First tests were using SDR & test vectors provided by EUSPA
- 04 — The main testing campaign was conducted at JRC
 - OSNMA process scenarios (cold, warm, hot start)
 - Spoofing resilience scenarios (HIL, GNSS E1 spoofing)





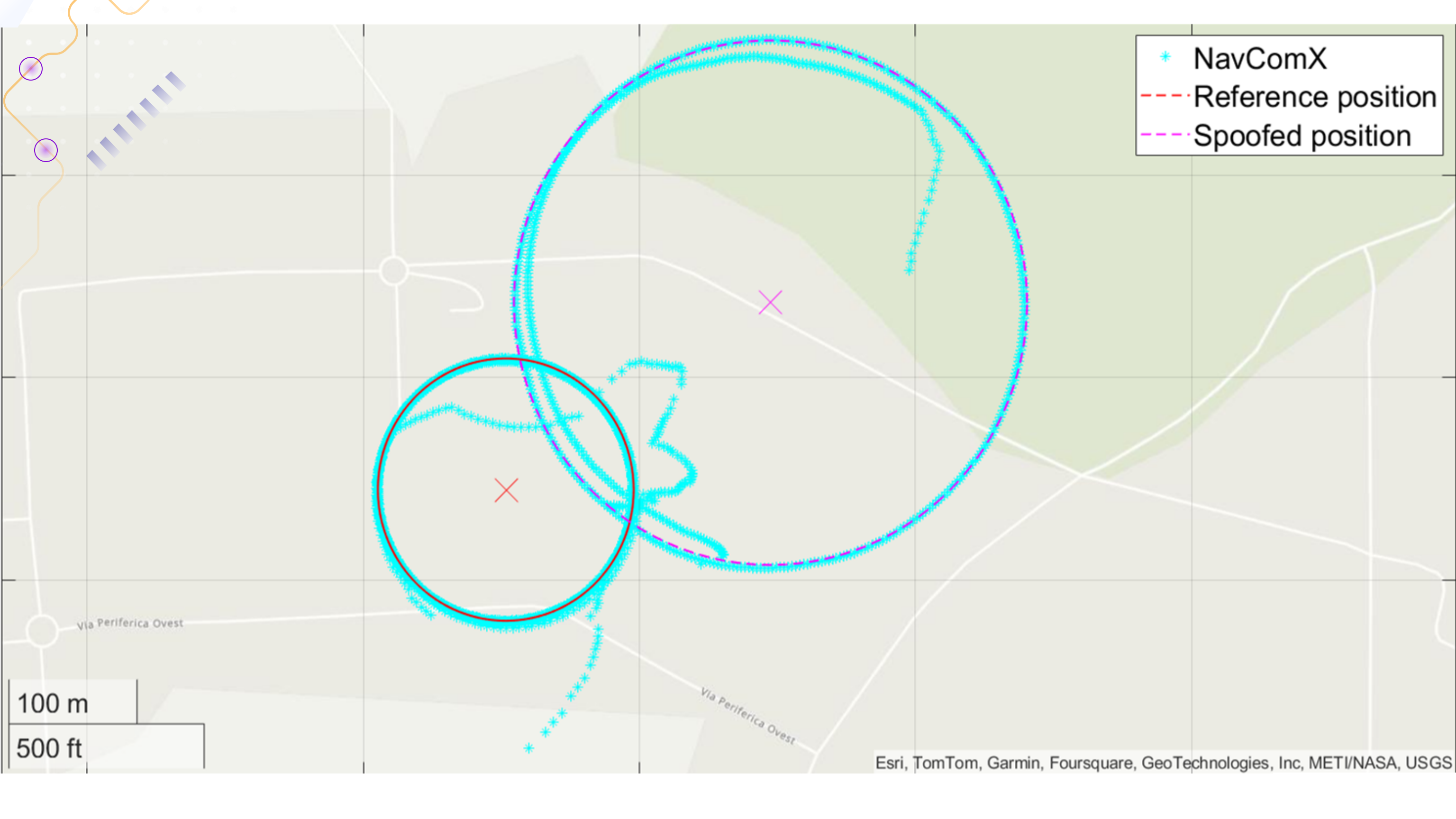
--- Reference position
--- Spoofed position

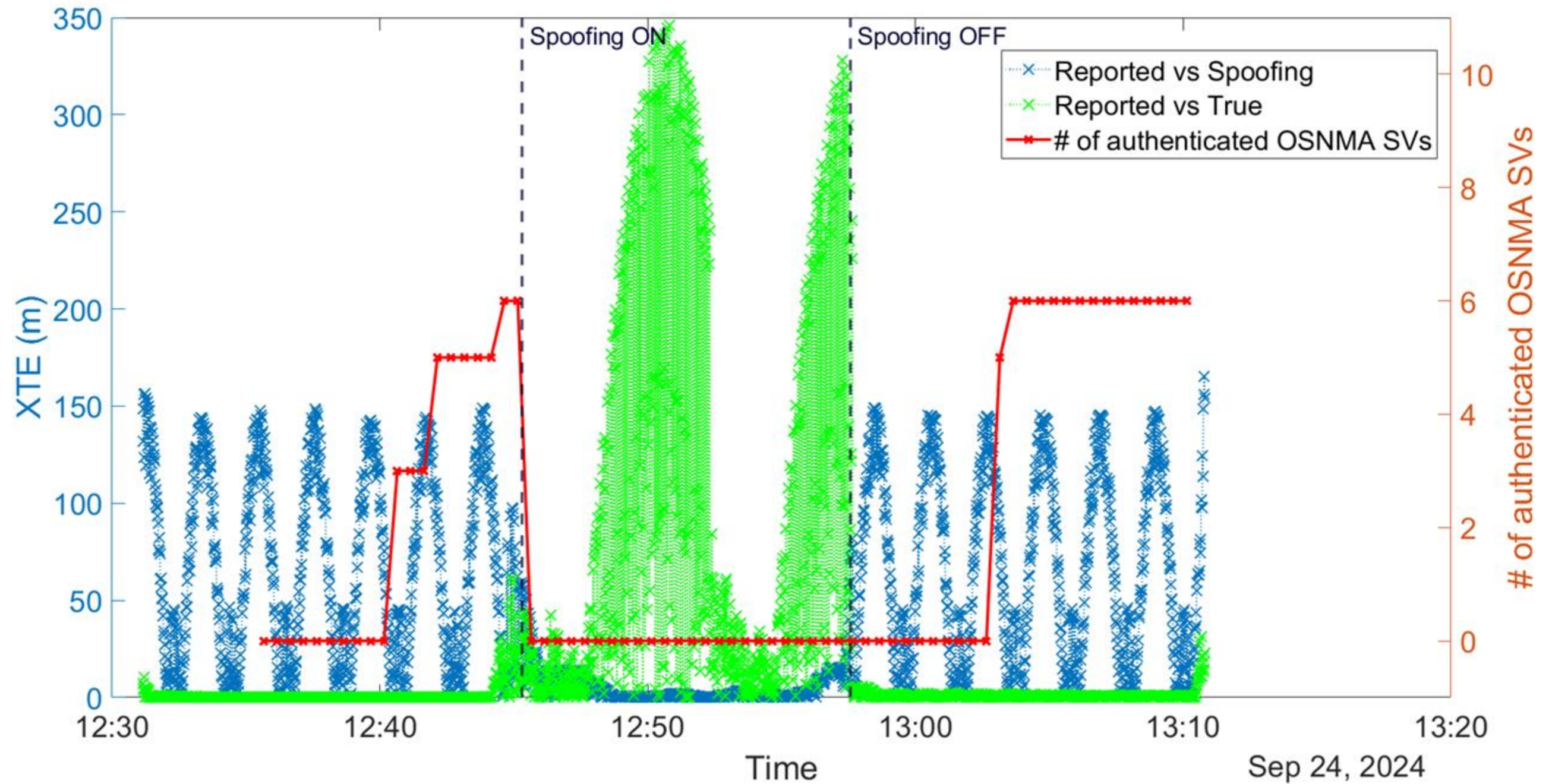
50 m

200 ft

via Periferica Ovest

Via Periferica





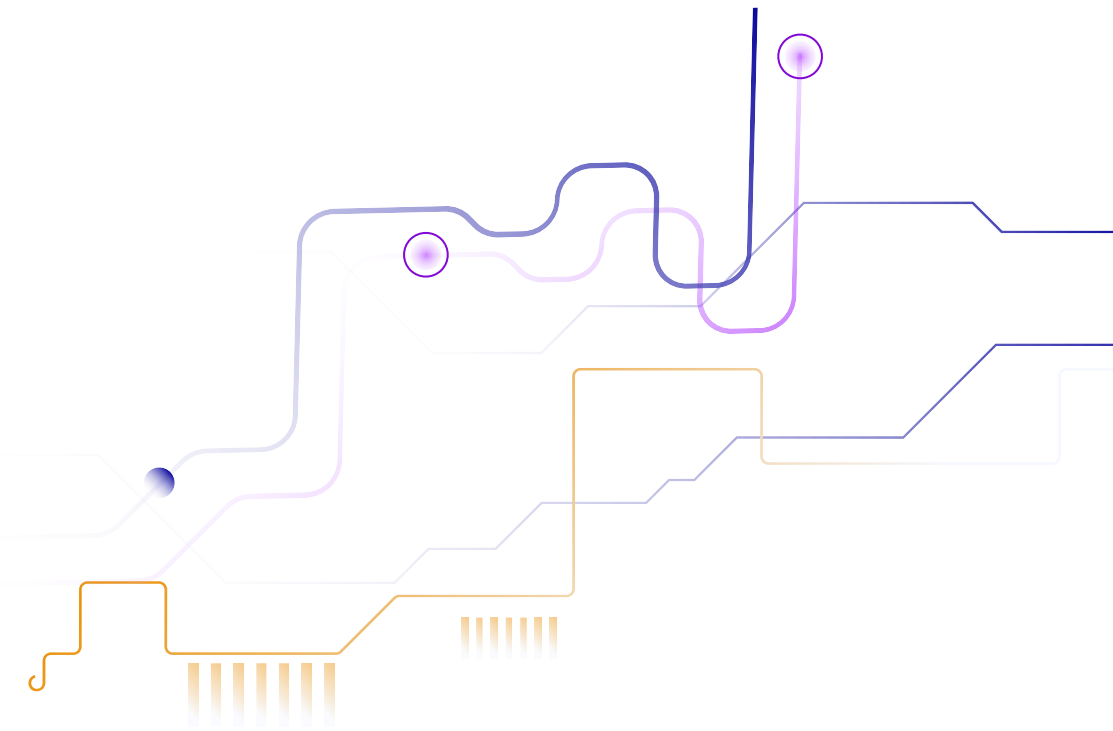
Galileo OSNMA integration

- Galileo OSNMA does not instruct on how to interpret the authenticity information
 - Options were to either have “only” authenticity indication OR
 - authenticity indication + PVT
- Missing cross authentication + limited # of GAL OSNMA SV
- Proprietary authenticity indicator
 - Easy to use
 - **4 possible values:**



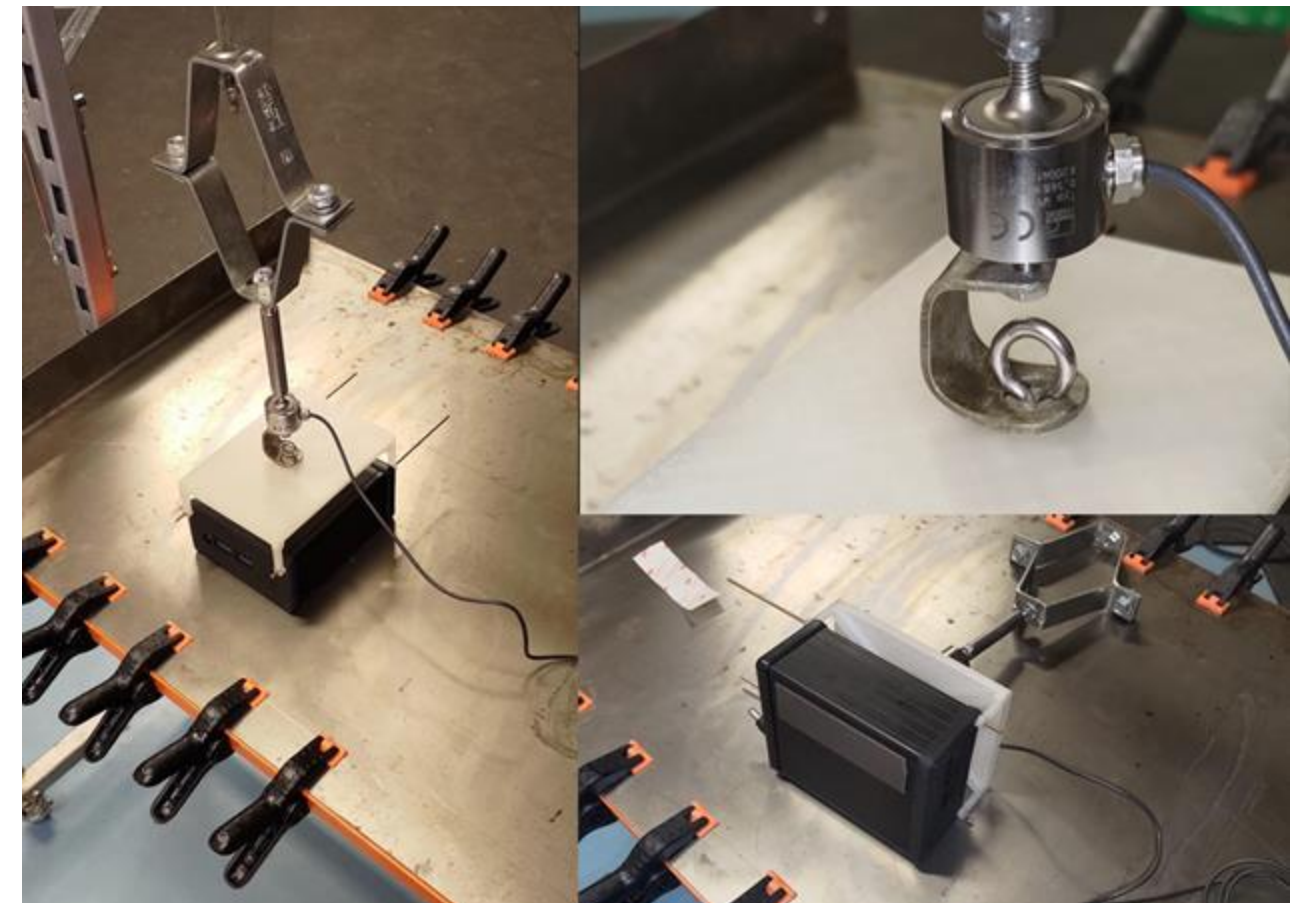
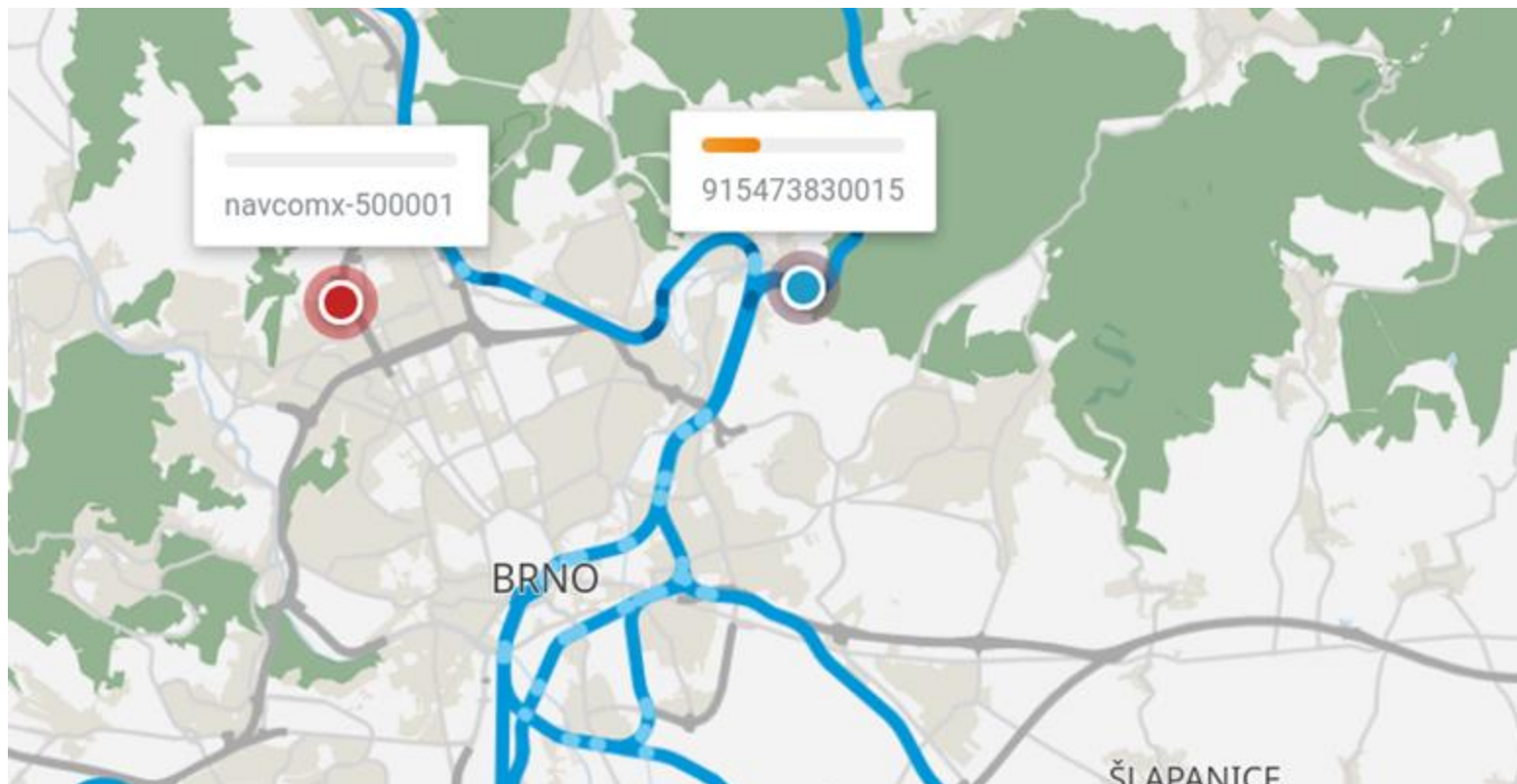
NavCom X testing campaign

- At the start of the project, a series of user consultation meetings was conducted
- 111 user requirements were identified
 - some overlapping across user
- 46 system requirements formulated
- Comprehensive testing campaign defined
 - 20 individual tests
 - tests in operational conditions



NavCom X testing campaign

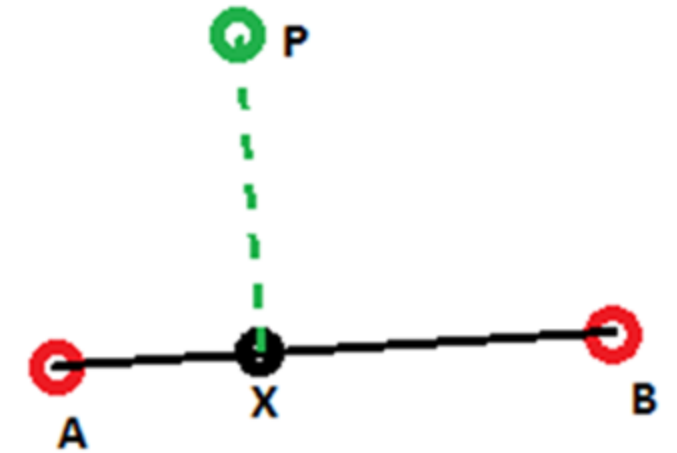
- Mechanical and electrical verifications
- Connectivity, UI, and data management verifications



NavCom X tests in operational conditions

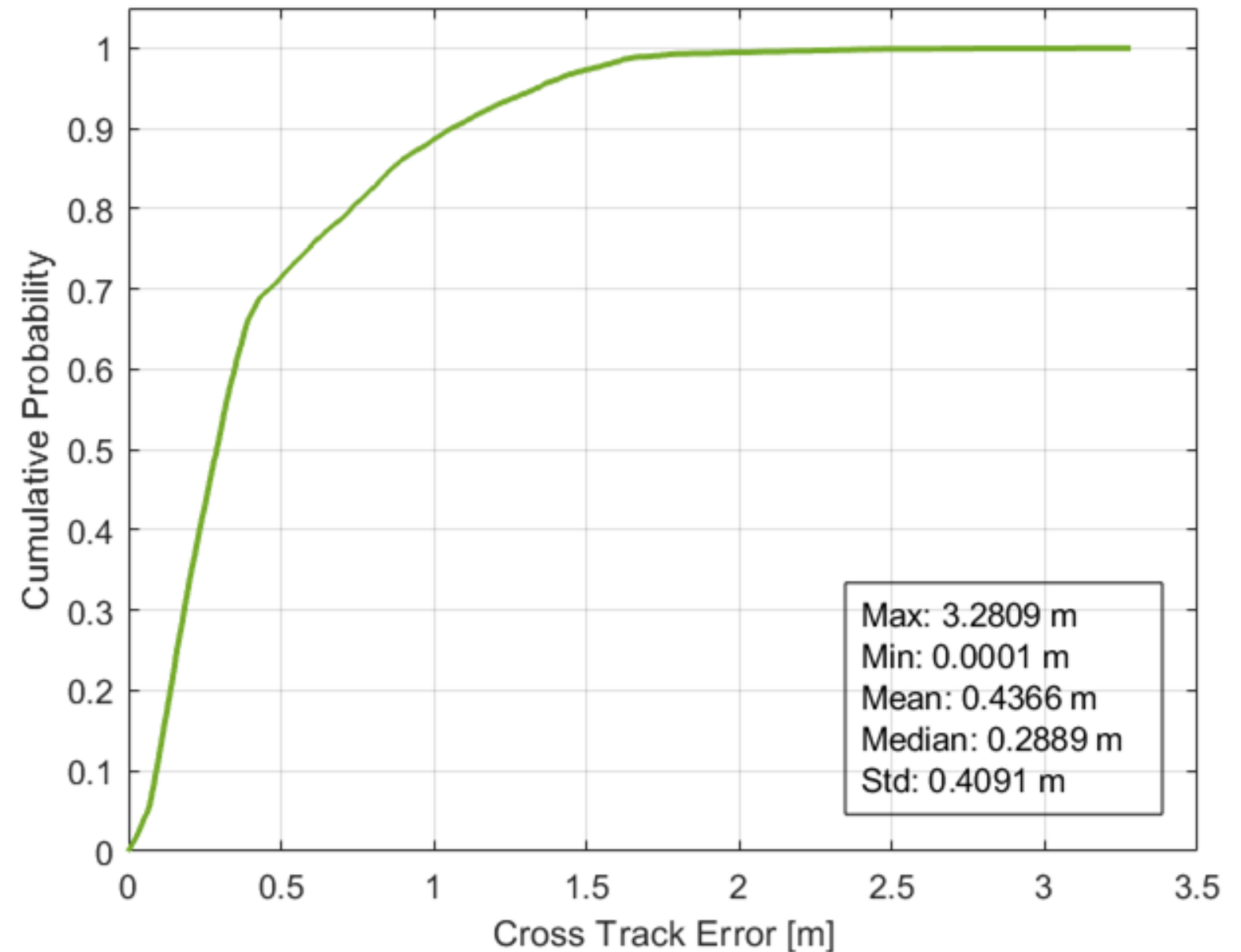
- **Conducted at the Velim test rail circuit in CZE**
 - operated by the Railway Research Institute (VUZ)
 - two circuits
 - smaller - 4km, max 80km/h
- **Scenarios:**
 - different speeds
 - two locomotive types
 - L1 jamming

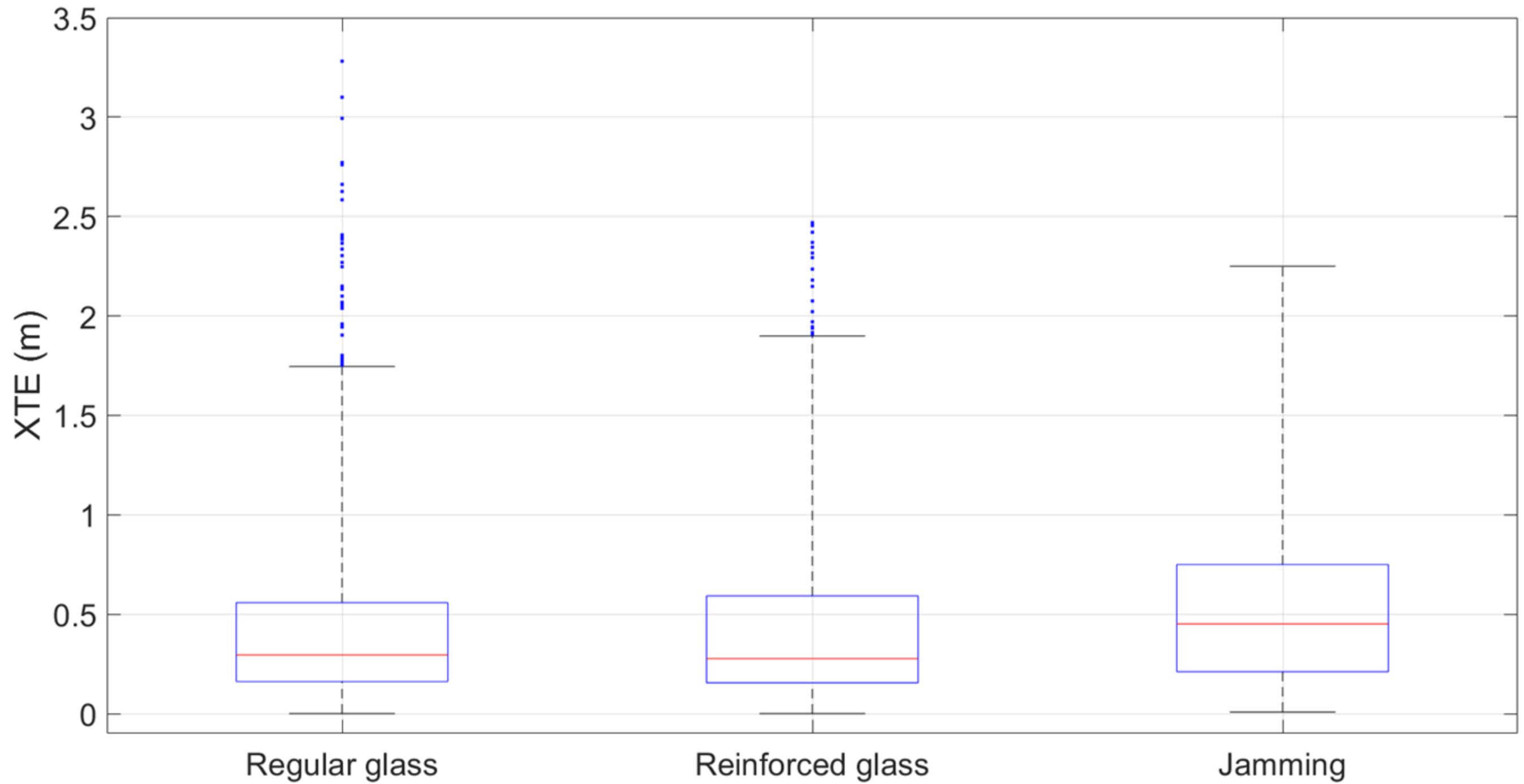




NavCom X tests in operational conditions

- The 95th percentile XTE value was 1.337 meters
- SR was 1.5m





NavCom X testing campaign

- Requirement for navigation performance met!
- L1 jamming resilience demonstrated
- OSNMA authentication implemented
- All HW and SW requirements met
- Battery life requirement exceeded
- In case you need testing any GNSS applications on testing rail circuit Velim, you may contact GNSS Centre of Excellence
 - Not only rail application → anything that can be placed on a wagon



Conclusion

Key Results

- ✓ Developed a high-performance, flexible, and energy-efficient positioning system
- ✓ Successfully validated in real-world, demanding environments
- ✓ Demonstrated reliability, precision, and resilience under pressure
- ✓ Advanced the use of **GNSS** technology for safe, efficient rail navigation

Impact

NavCom X delivers a scalable, proven solution for precise tracking and system-wide efficiency. It enhances safety, optimizes operations, and sets a strong foundation for future innovation — not only in rail, but across transport industries.

Next Steps



What's Coming Next

We'll focus on improving energy efficiency, expanding modular features, and deepening OSNMA integration. Real-time data analytics, cloud connectivity, and a more intuitive user experience are also on the roadmap — along with robust certification and environmental testing.



New Opportunities

We plan to roll out NavCom X in **new industries and regions**, adapting it to fit a broader range of needs and use cases.



Vision for the Future

We'll continue working closely with our users, evolving the system based on their feedback — ensuring **NavCom X** stays relevant and future-ready in precision navigation and transport.



Thank you for your attention
to our presentation on the NavCom X project!

We welcome any questions or feedback
you may have about our navigation and communication system.



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