“Real-Time GNSS Monitoring System for Poland (RTGMS)”

Consortium:

National Institute of Telecommunications (leader)

Head Office of Geodesy and Cartography

RTGMS

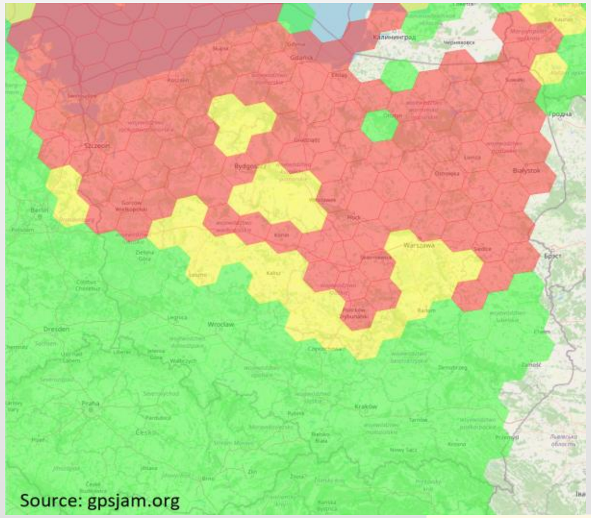
Motivation

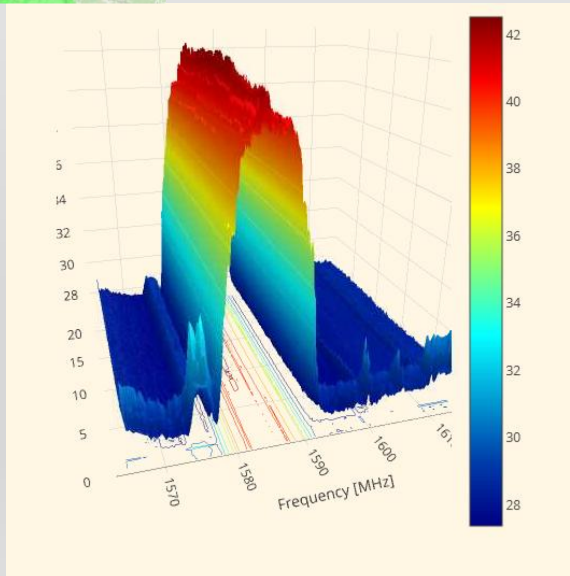
HEAD OFFICE OF GEODESY AND CARTOGRAPHY

- GNSS systems are nowadays **crucial** for the correct operation of various branches of economy (transportation, aviation, maritime, telecommunications, agriculture, etc.) and for security and safety on a national level

Motivation

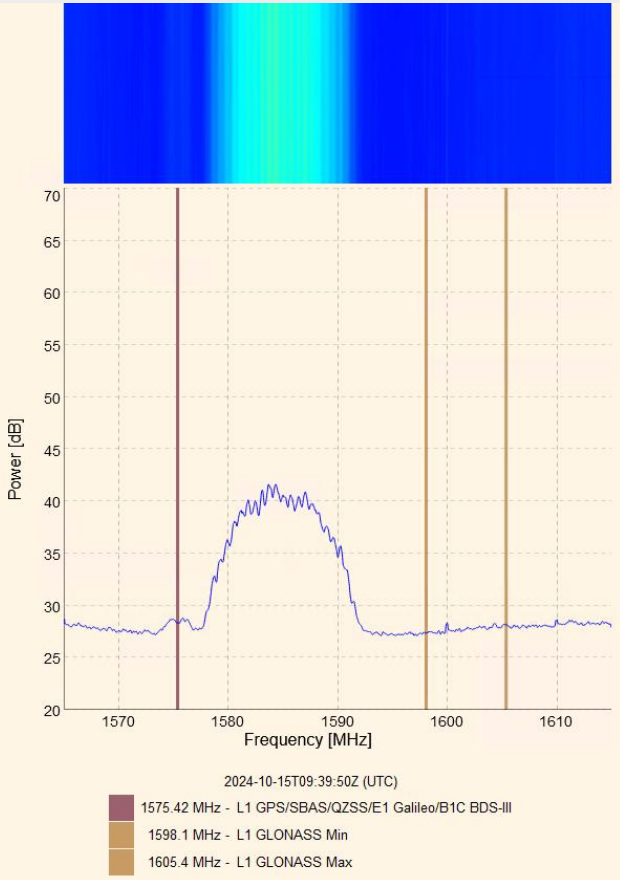
- Intentional or unintentional interference of GNSS bands are becoming an issue (jamming, spoofing, meaconing)
- Huge increase of such incidents especially after the Russian Federation invasion on Ukraine has been observed in Poland specialy in northern-eastern part of Poland
- GPSJAM.org service for monitoring the aviation GNSS bands is NOT a solution to this problem!

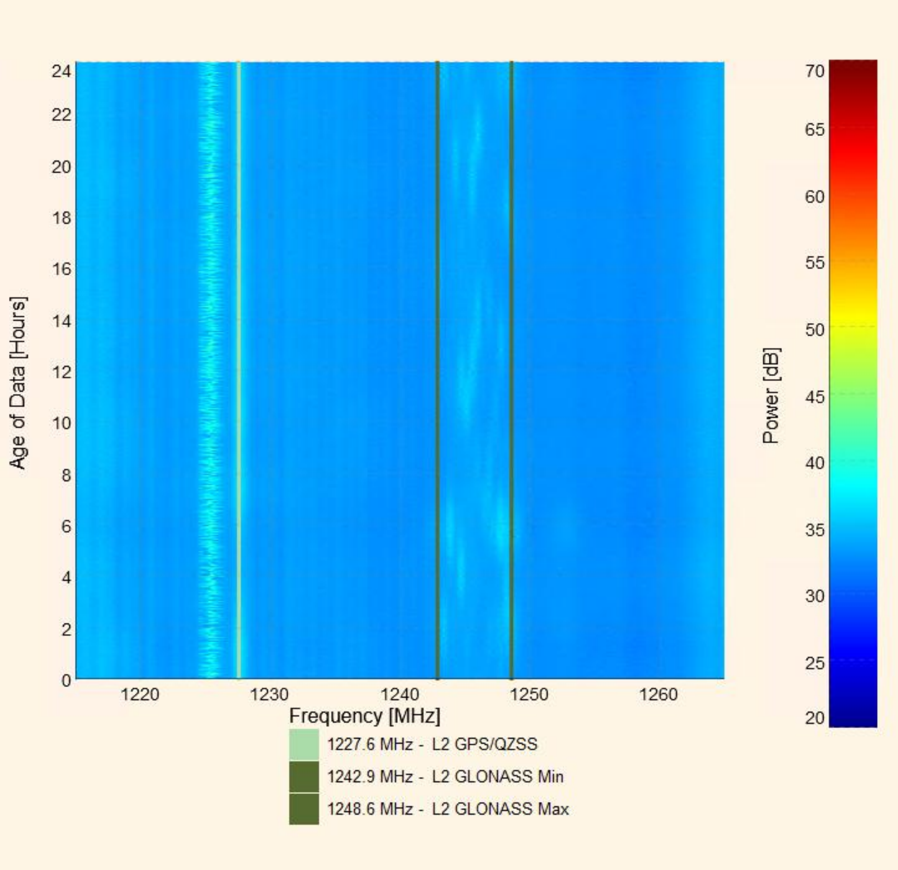


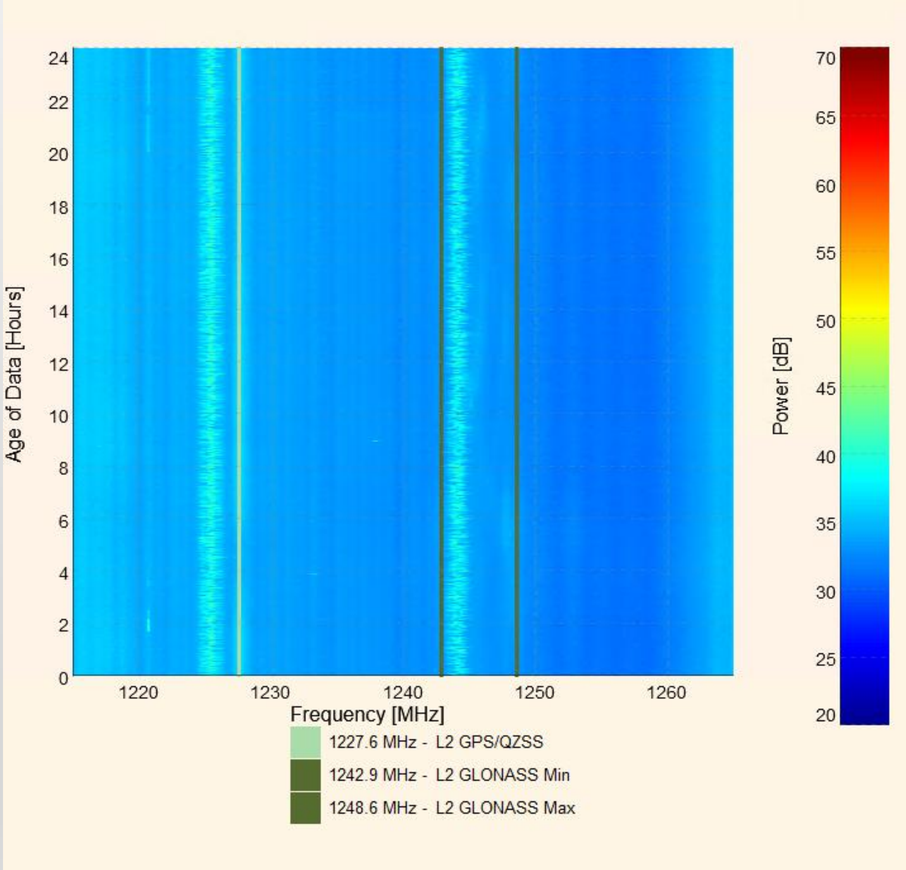


Motivation

- Examples from our reference stations:





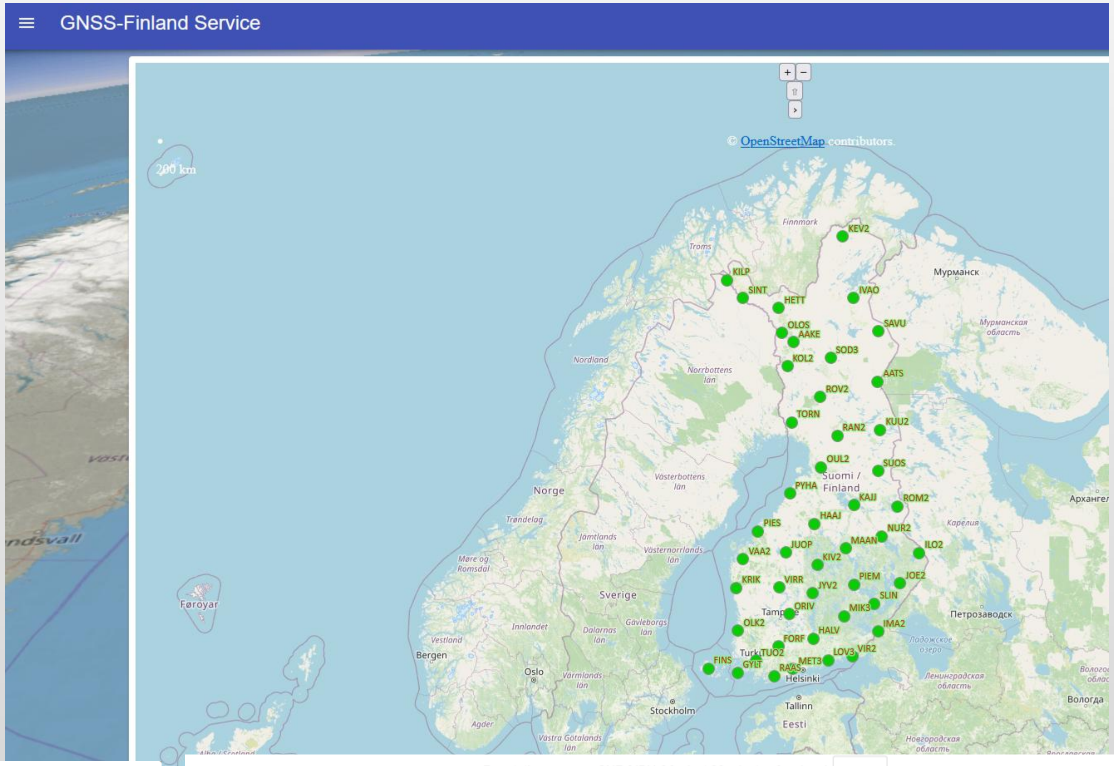


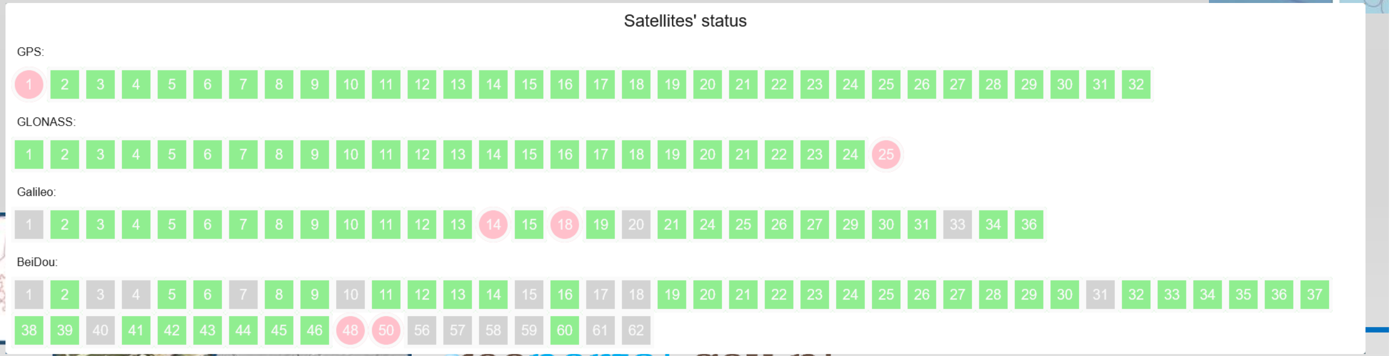
Examples of similar systems

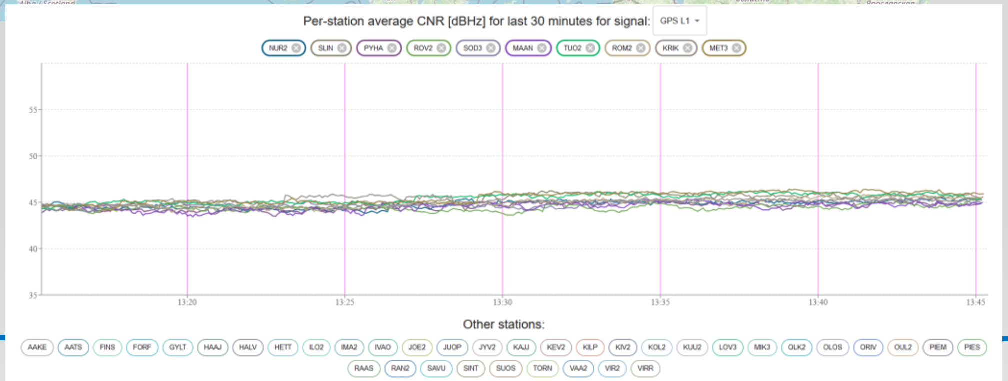
GNSS-Finland Service

https://gnss-finland.nls.fi

- Based on CNR analysis
- Very good for general overview of the whole network
- Good point for start





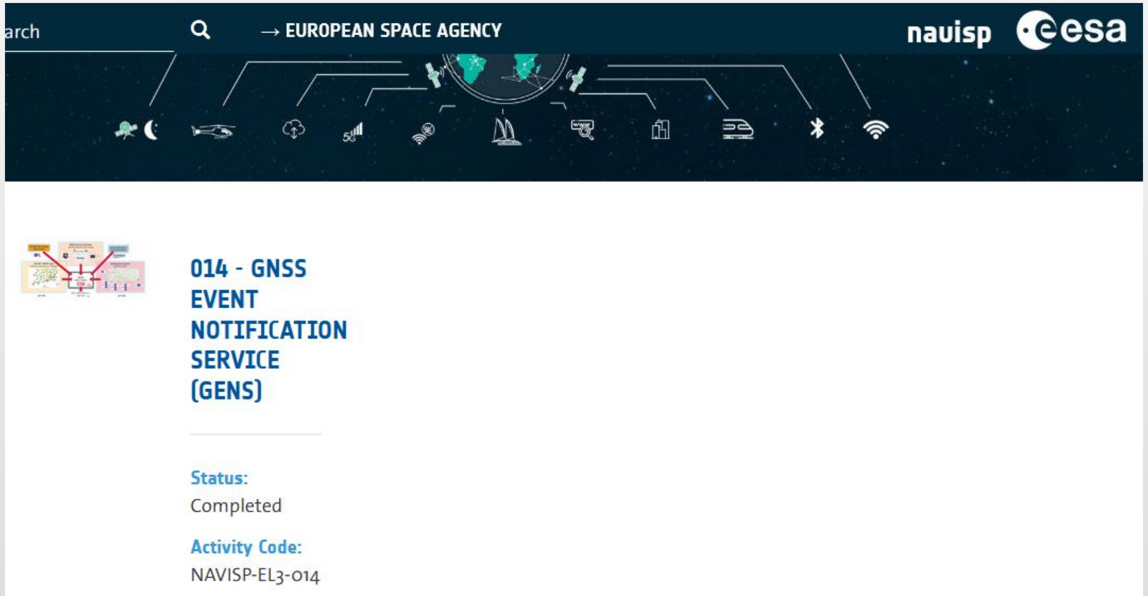


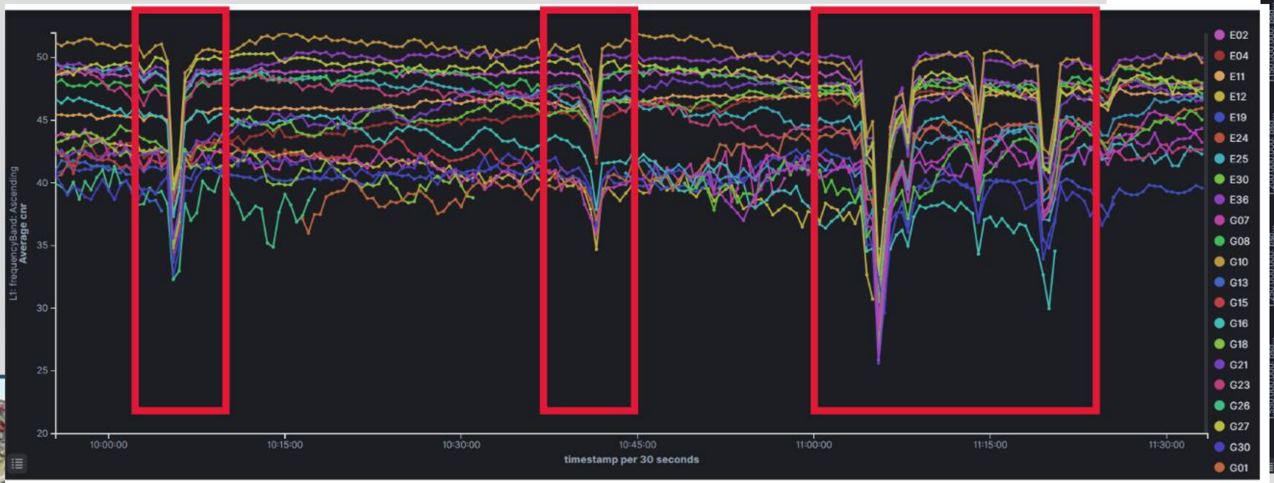
Examples of similar systems

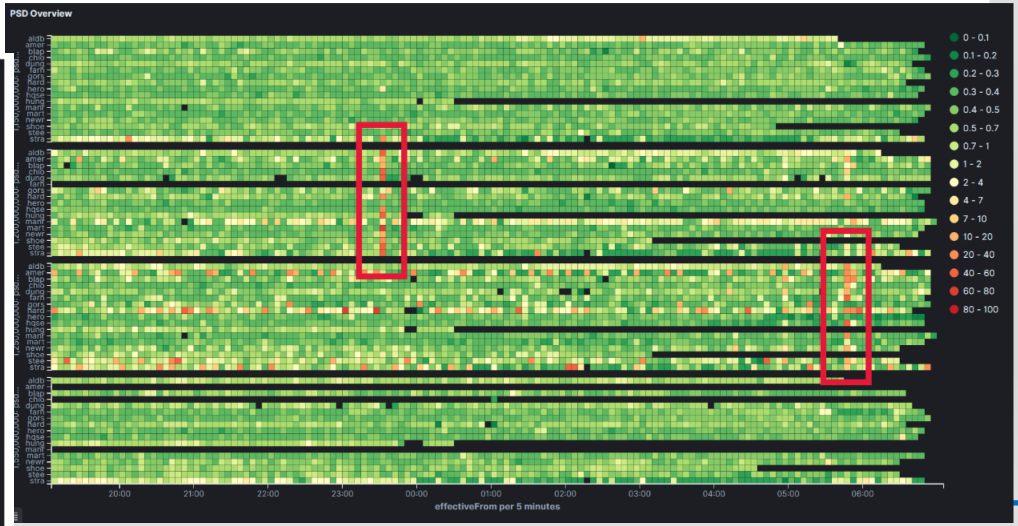
- **GNSS Event Notification Service (GENS) – Great Britain**
- ESA NAVISP project 014

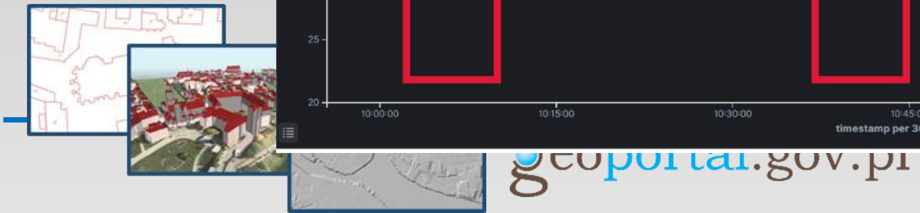
- More sophisticated analysis

- Ordnance Survey RTK network- Trimble Alloy receivers



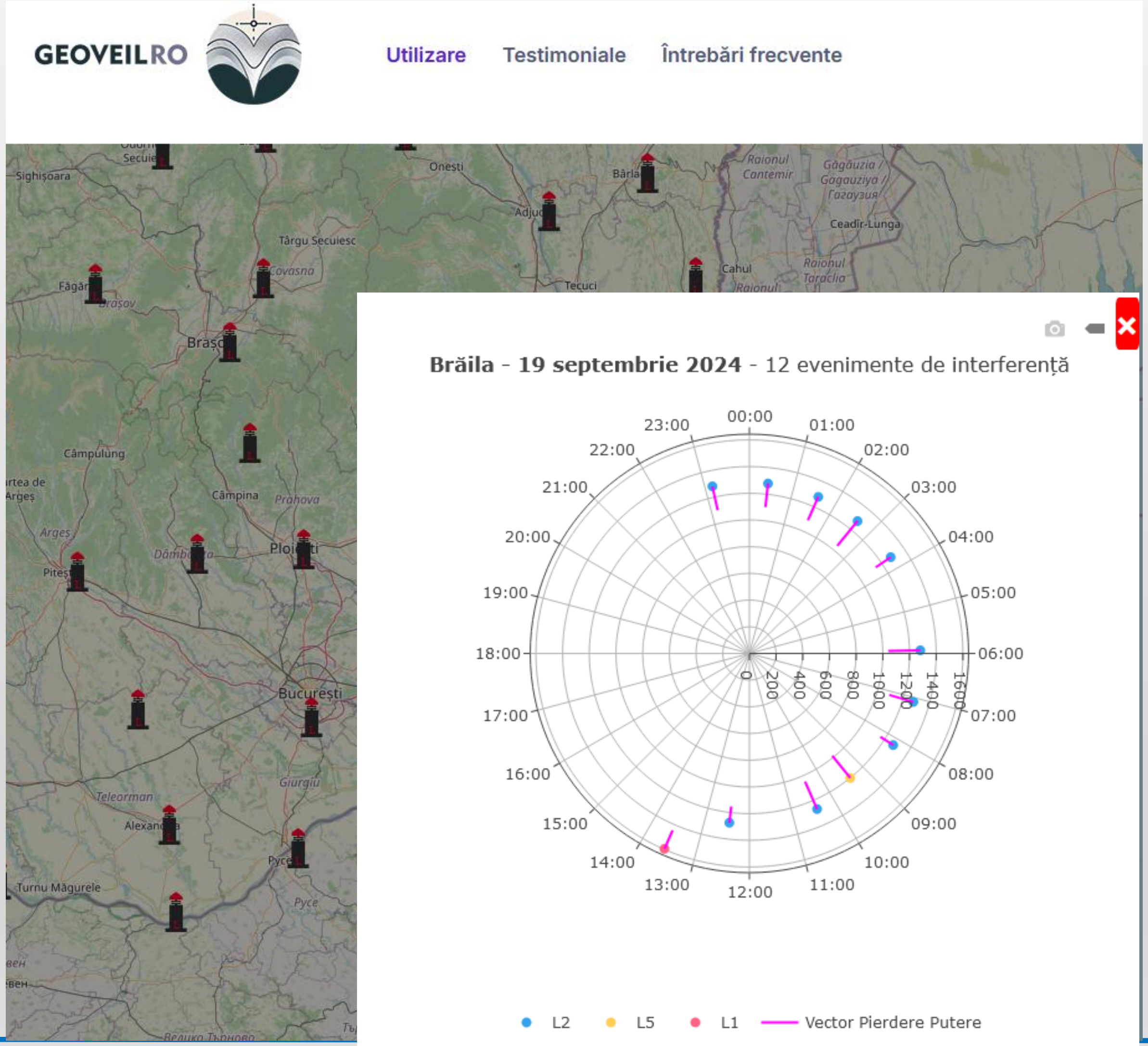






Examples of similar systems

- **GEOVEILRO service**
- Monitoring service based on Leica GR30 receivers
- Solution based on receiver's API
- Monitoring of interferences detected by receivers



RTGMS

Description of RTGMS

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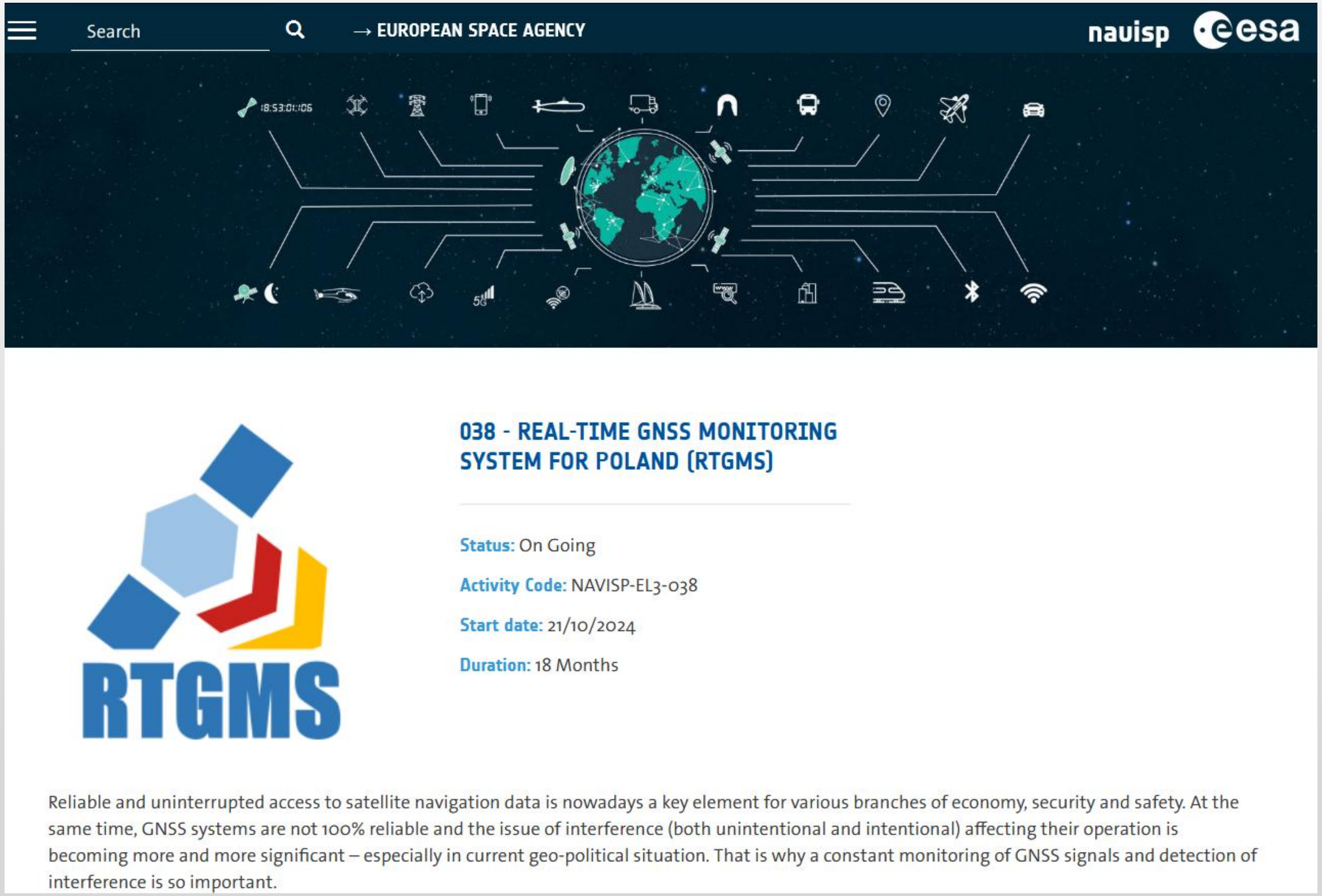
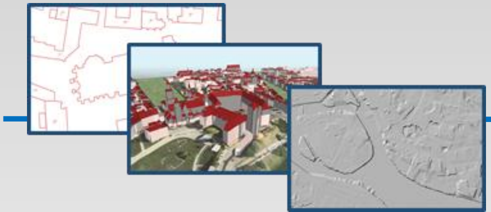
In cooperation with National Institute of Telecommunication ESA – NAVISP project for monitoring of GNSS signals interferences.

Pilot coverage is planned for most affected region northern-east part of Poland.

In case of interference alerts will be sent to registered users.





RTGMS Motivation

- Development of the concept, initial **pilot implementation** and functional tests of **national, Polish system for GNSS signals monitoring** – **RTGMS**
- **Early detection of interference** and/or unavailability of GNSS signals on the territory of Poland
- Web based service to present online results in real-time
- Generating **alarms** regarding any instances where satellite navigation systems may work incorrectly
- **Support for** national, governmental and business **entities** that require correct and stable operation of GNSS
- **Creation of experience background**, so that the network could be expanded from the pilot stage into the full-coverage system following the completion of this project

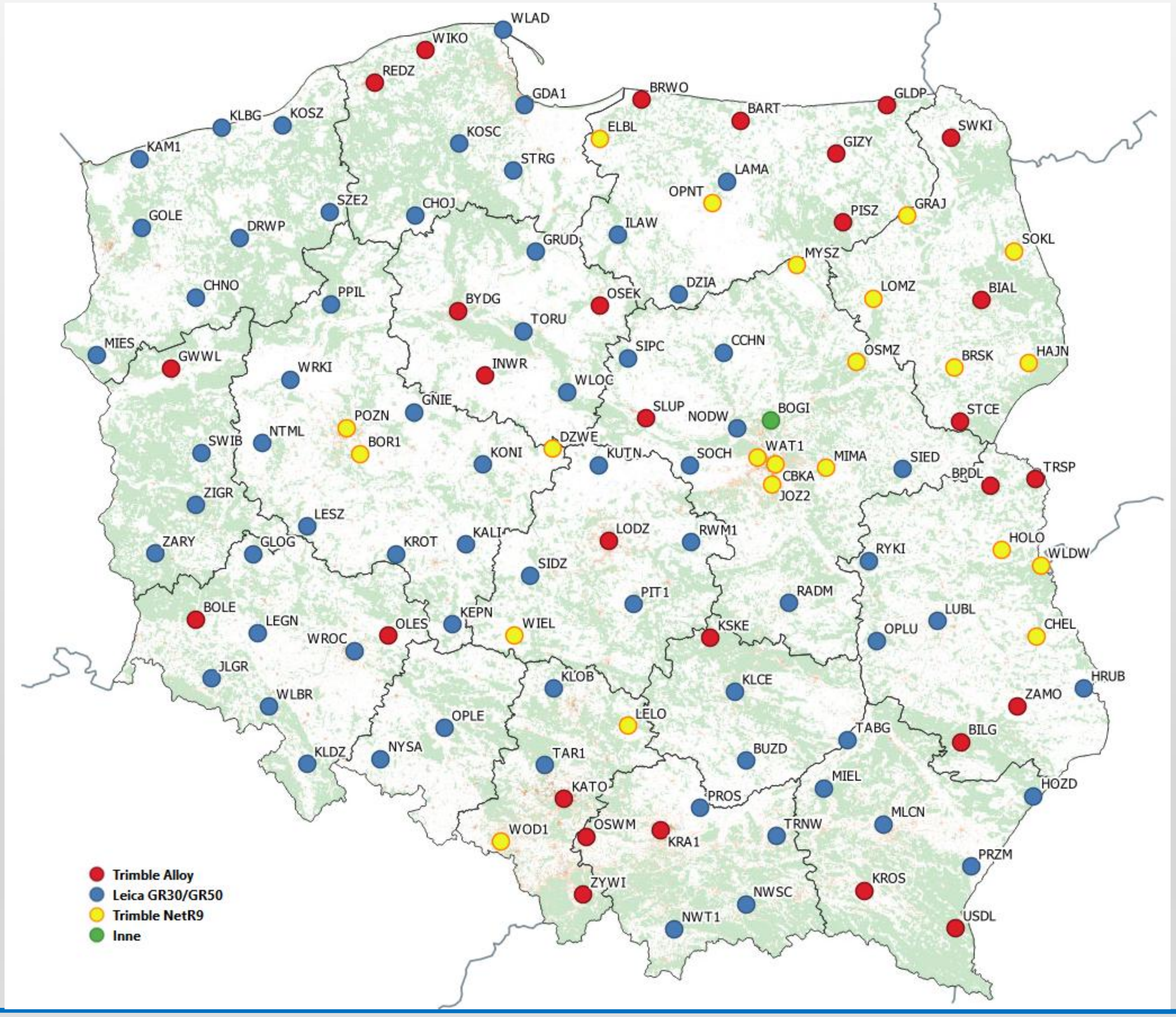
Functionalities of RTGMS

- Coverage of selected areas of the Polish territory (eventually – the entire territory), via a network of monitoring stations – locations of ASG-EUPOS stations.
- Utilization of the existing infrastructure of the ASG-EUPOS network; its reference stations could be expanded and modernized in order to equip them with the RTGMS capabilities.
- The current functionality of the ASG-EUPOS network and its services should remain unchanged

Description of RTGMS

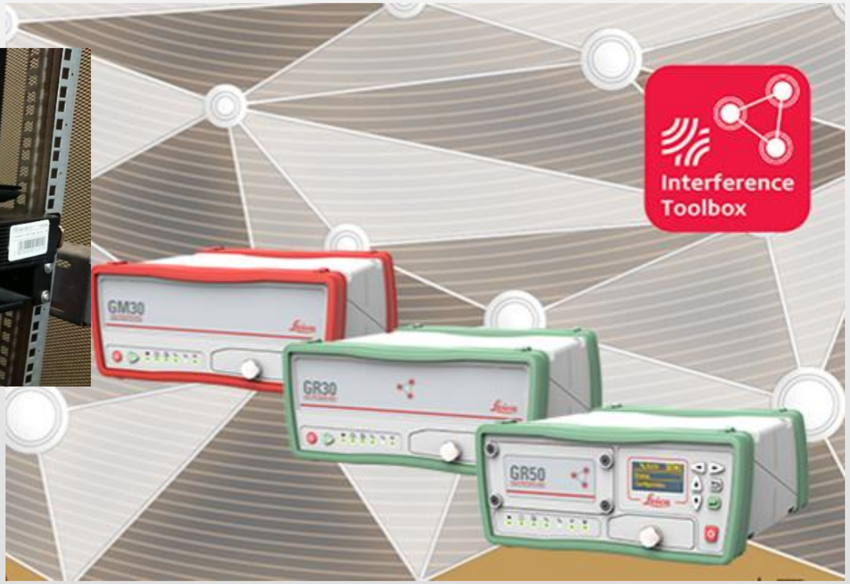
- **GNSS receivers:**
- **Leica GR30 and GR50** (65 stations)
- **Trimble Alloy** (28 stations)
- **Septentrio PolaRx5** (soon 18 stations)

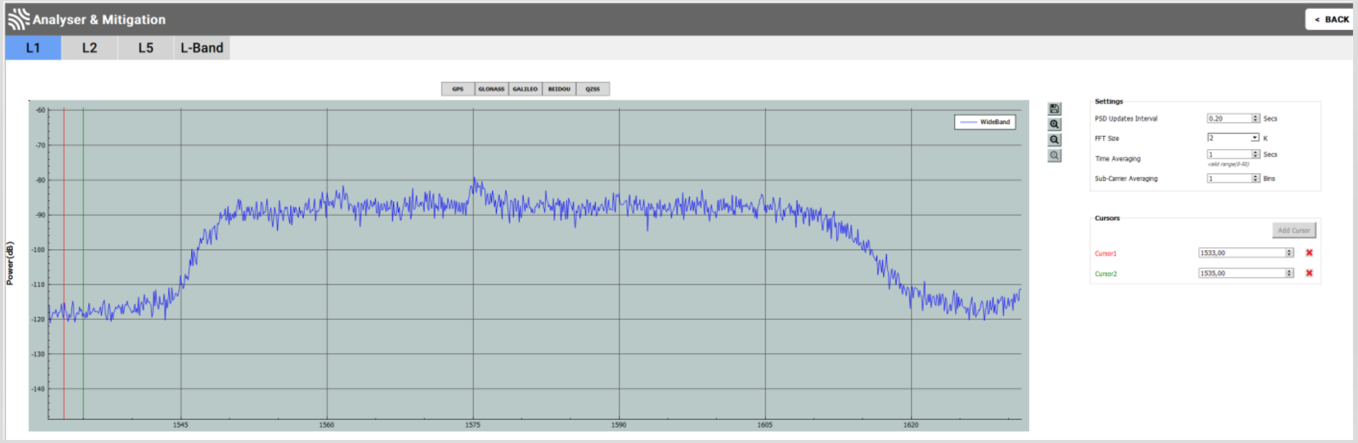
- **GNSS antennas:**
- **ChokeRing antenas from Trimble, Leica and Septentrio**



Implementation existing HW

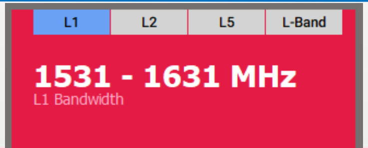
- **Leica Geosystems GR30 and GR50**
- **interference diagnostic output**
- **Interference Toolbox**
- FFT stream could be recorded
- Only 1 Freq analysis in the same time
- Notifications from receiver- but should be used carefully

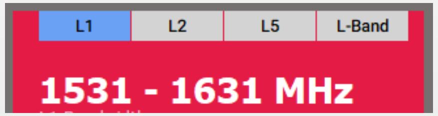


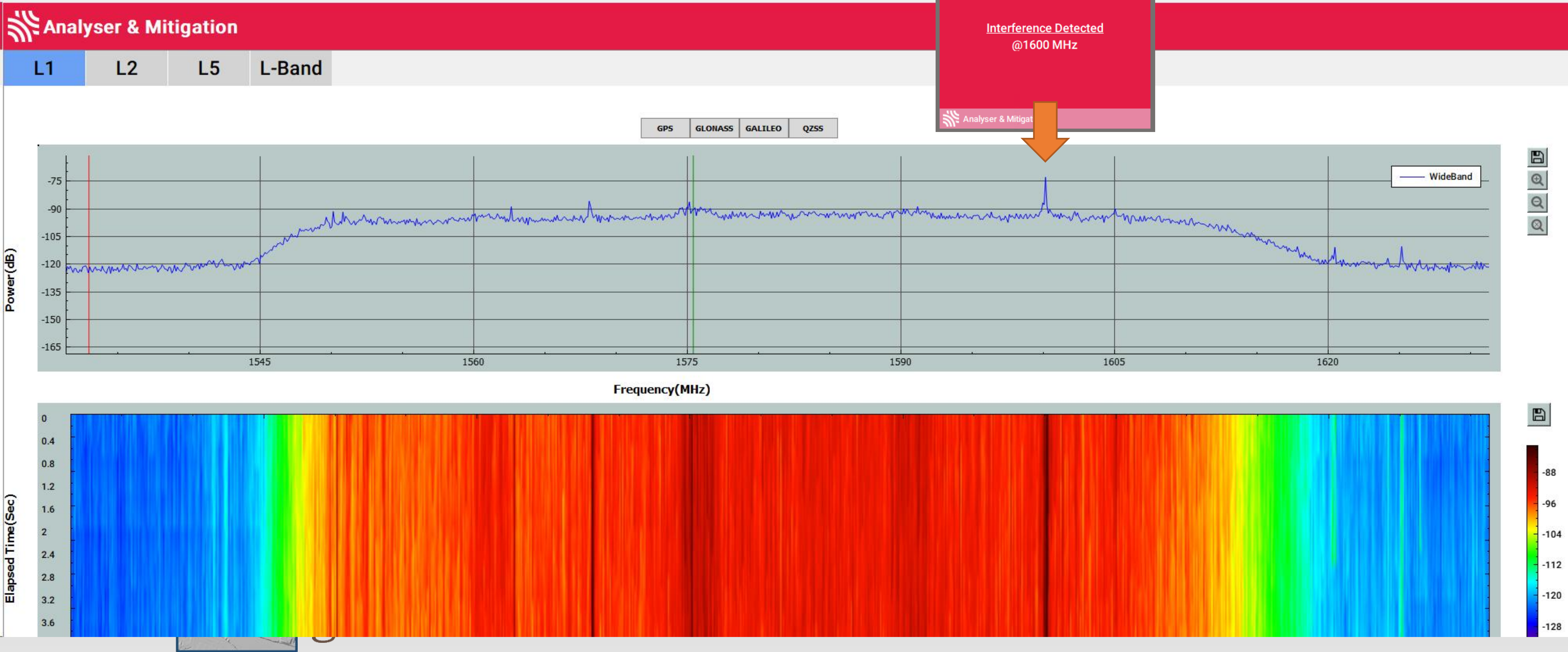


Implementation existing HW

- **Leica GR30 - example**







RTGMS

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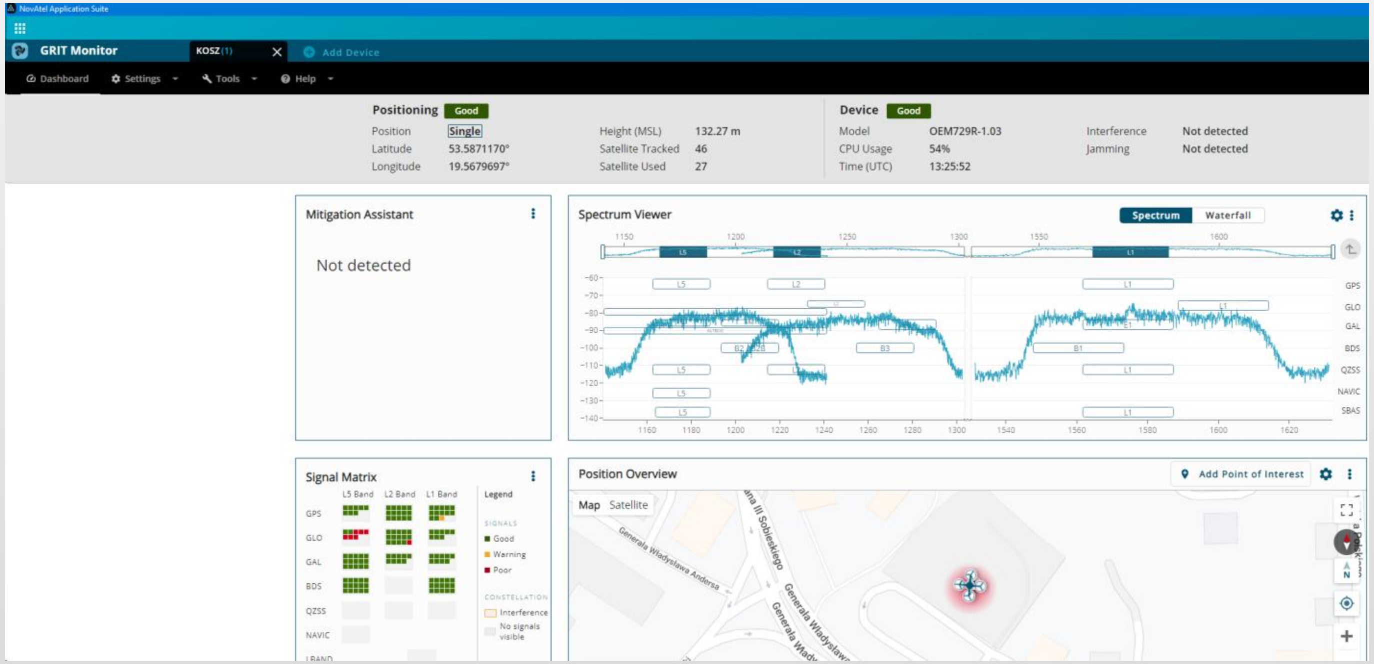
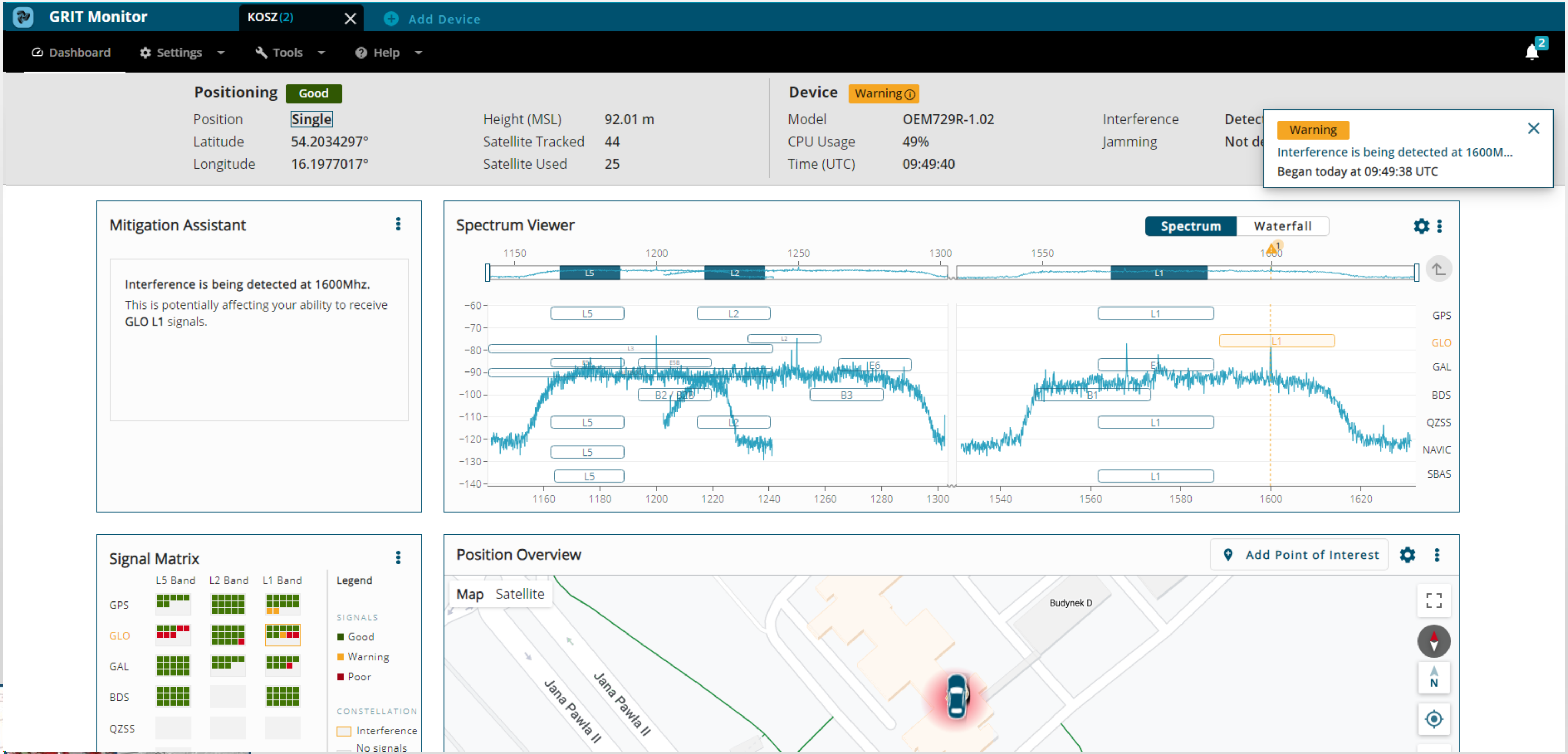
Implementation existing HW

- Leica Geosystems GR30 and GR50
- interference diagnostic output
- **Novatel GRIT Monitor software**
- 3 bands analysis (L1/L2/L5)
- Some map overwiew

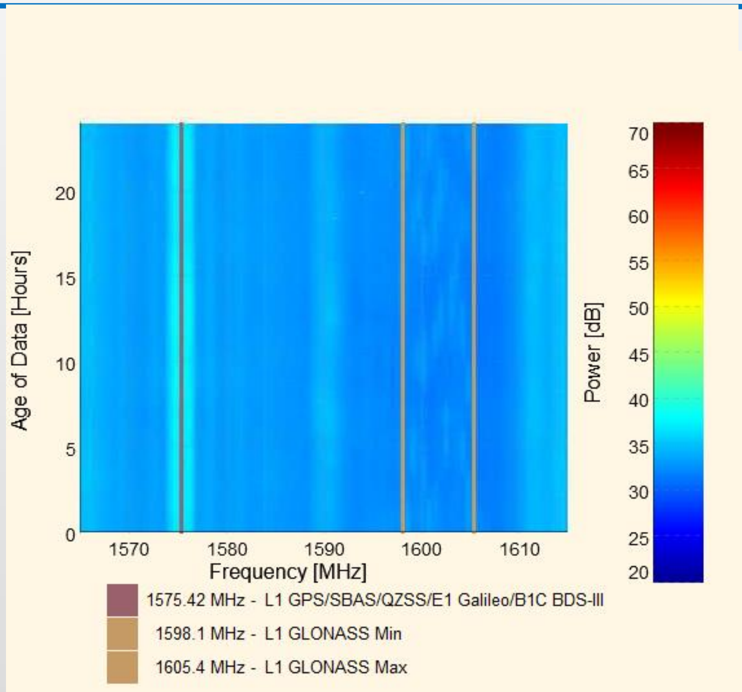


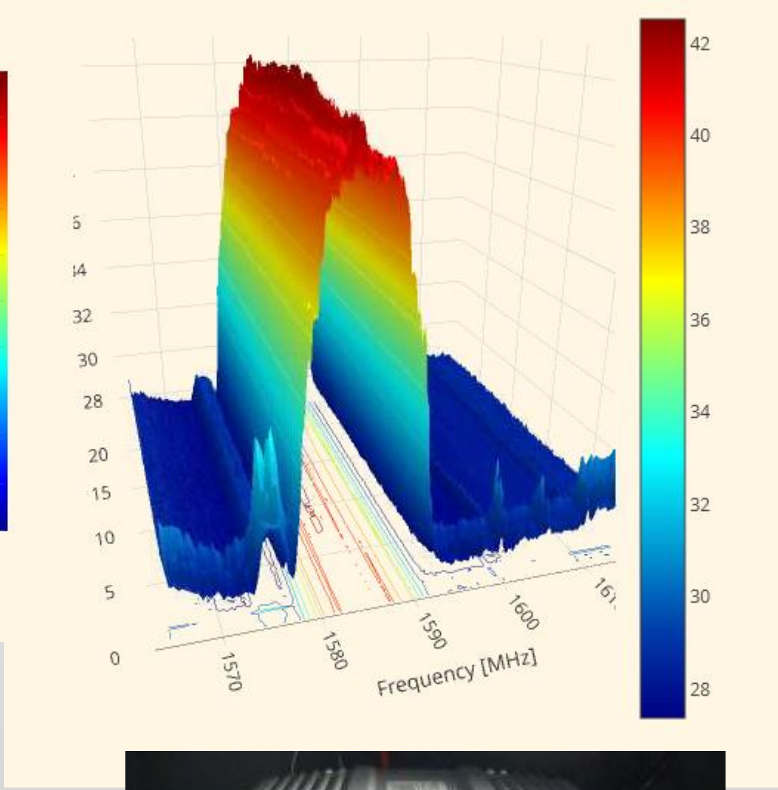
Implementation existing HW

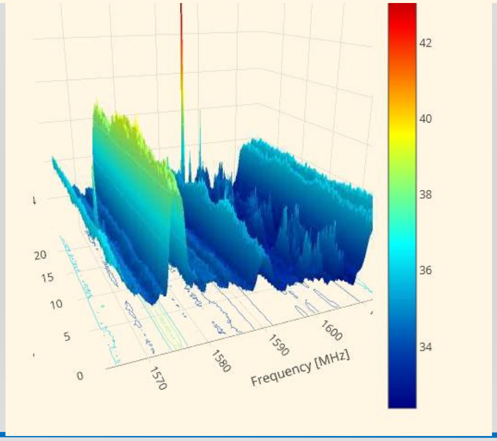


Implementation existing HW

- **Trimble Alloy receiver**
- **Implemented Spectrum Analyzer into receiver**
- **Cooperation with Trimble to use also another data in project**







Implementation existing HW

- **Trimble Alloy receiver**
- **GNSS RAIM support**
- **Integrity of signals checked onboard of receiver**

$GPGBS message in NMEA format

Trimble. Alloy Help

Output Messages > NMEA-0183 messages > NMEA-0183 message: GBS

NMEA-0183 message: GBS

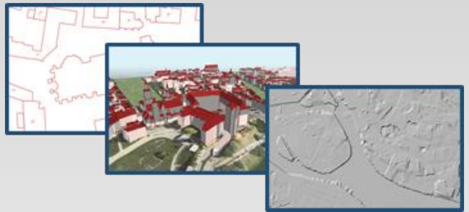
GNSS satellite fault detection (RAIM support)

An example of the GBS message string is:

```
$GPGBS,015509.00,-0.031,-0.186,0.219,19,0.000,-0.354,6.972*4D
```

GBS message fields

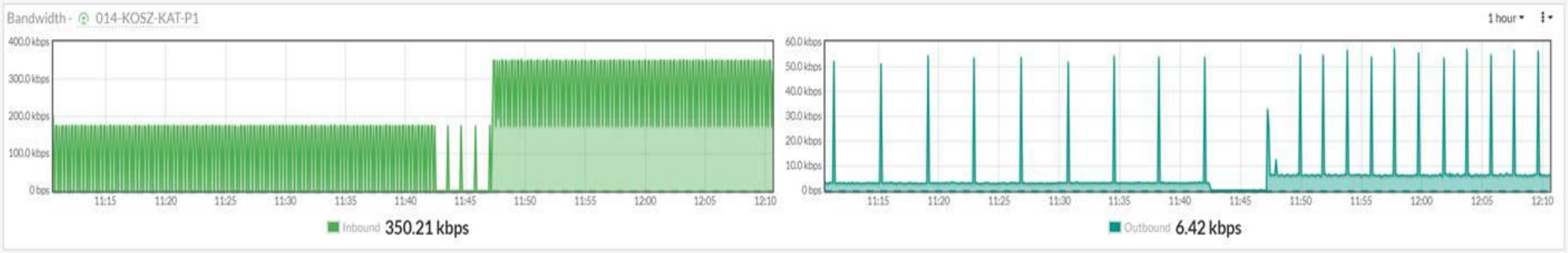
Field	Meaning
0	Message ID $--GBS. Talker ID can be: GA: Galileo GB: BeiDou GP: GPS. To provide information specific to the GPS constellation when more than one constellation is used for the differential position fix. GL: GLONASS. To provide information specific to the GLONASS constellation when more than one constellation is used for the differential position fix. GN: Combined GNSS position. GNSS position fix from more than one constellation, for example, GPS and GLONASS. GQ: QZSS
1	UTC of position fix
2	Expected error in latitude, in meters, due to bias, with noise = 0
3	Expected error in longitude, in meters, due to bias, with noise = 0
4	Expected error in altitude, in meters, due to bias, with noise = 0
5	ID number of most likely failed satellite
6	Probability of missed detection of most likely failed satellite
7	Estimate of bias, in meters, on the most likely failed satellite
8	Standard deviation of bias estimate



Implementation existing HW

- **Bandwith tests of existing communication links**

Leica GR30 – datastream with L1/L2/L5 is 350kbps (for only L1 it is 190kbps)



Thank You!!

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