

# Spectrum monitoring using the Swedish CORS network

2021-05-11

# Agenda

- Project description
- SWEPOS overview
- FOI:s GNSS detection system RF-Oculus
- Lab setup
- Installed systems
- Status today
- Preliminary results
- Future work

# Project details

- Title: "Robust Satellitnavigering"
- Funded by the Swedish Transport Administration
- Partners:
  - Swedish Defense Research Agency FOI
  - Lantmäteriet, the Swedish mapping, cadastral and land registration authority
  - Swedavia, owner, operator and developer of a network of Swedish airports
- Period 1/8 2020 – 31/8 2021
- Financing, total 1.8MSEK (€180K)
  - Total 1700 working hours

# Goals

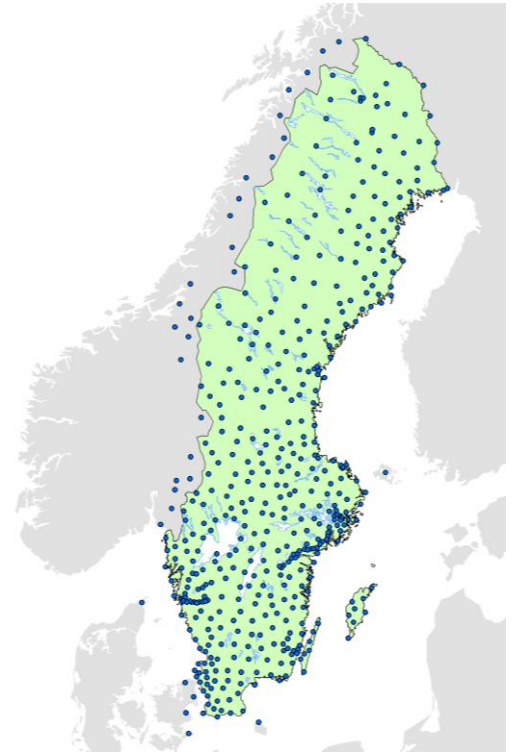
- The main goal is to investigate if and how the Swedish CORS network stations closely located to airports, could be use to discover and map GNSS interference to be able to continuously determine and control the quality of the GNSS data in the Swedish CORS network.
- **This is achived by using data from CORS network stations and data from FOI:s interference detectionsystem co-located at locations close to Swedish airports.**
- Algorithms based on data from the CORS-receivers should be investigated/developed to detect interference and this data should be compared to the data from the FOI:s developed interference detection system.
- FOI will perform interference testing in lab on selected geodetic receivers used in the Swedish CORS-stations, and also evaluate performance on selected detection algorithms.

# Project Reference group

- MSB (Swedish Civil Contingencies Agency)
- Swedish Police (National Operations Department, NOA)
- Swedish Customs
- Swedish Transport Agency
- LFV, provider of air traffic management and air navigation services

# SWEPOS® - A national CORS-network

- A national network of permanent reference stations (CORS, Continuously Operating Reference Station) and a part of the national geodetic infrastructure
- The investment is covered mainly by governmental funds
- The operation costs including future upgrades are covered by user fees
- Distances between stations, normally 35 - 70 km, closer in some areas (infra-structure projects)



# SWEPOS® - A national CORS-network

- 53 class A and 405 class B stations.
- Often located in a “quite” place to get good performance, not optimal for interference detection.
- Trimble NetR9 and Alloy receivers, Septentrio PolaRx5, remaining NetR9 will be phased out 2021 – early 2022



# RF Oculus (FOI)

- RF interference detection system for L1
- Software defined radio (SDR)
- COTS GNSS receiver (Civil GPS L1)
- Computer with HDD storage
- Measures power continuously
- Store relevant measures ( $C/N_0$ , IR, time, position etc.) when limits are exceeded
- Network connection to server



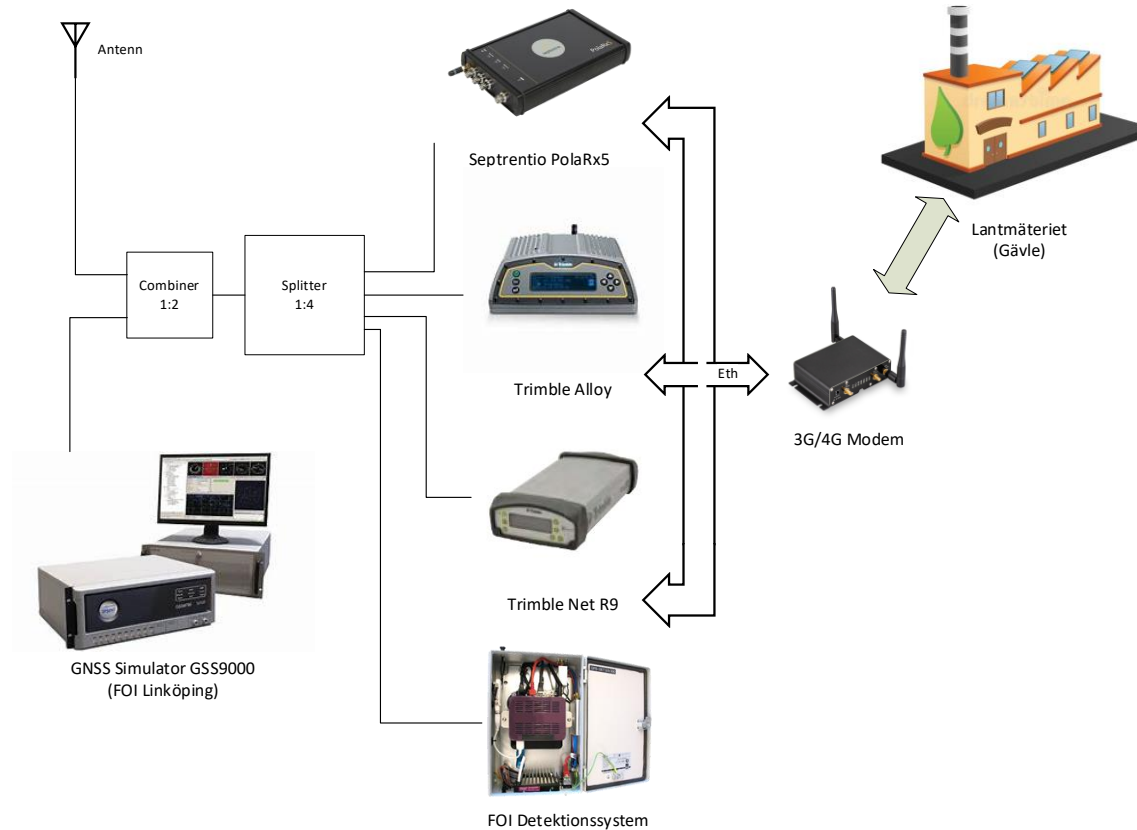


# Setup FOI - Lantmäteriet

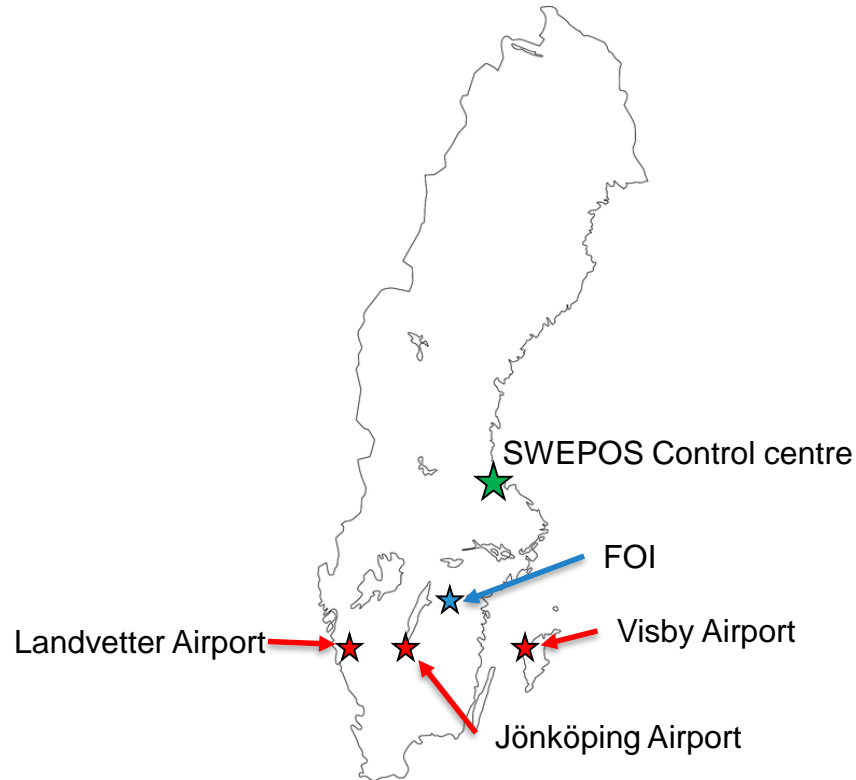
- Three models of SWEPOS-receivers are located in FOI lab (Linköping) and connected to SWEPOS-network (Gävle)
- FOI GNSS interference detection system (RF-Oculus) connected in parallel with the GNSS-receivers to detect and record interference signals
  - FOI will perform interference and spoofing testing on the geodetic CORS-receivers in the lab using a Spirent GNSS-simulator GSS9000.
  - The setup gives a possibility to expose the CORS-receivers for interference (and spoofing) in FOI-lab, while at the same time monitor the receiver behaviour and influence on the CORS network monitoring software at the cadastral headquarter in Gävle.
  - Assures that we will get relevant data even if the live-sites are "quite", ie low number of real-life interference incidents.

# Setup FOI - Lantmäteriet

SWEPOS



# Geographical setup



# Visby



CORS station relatively  
close to DME and runway,  
1400 m

# Landvetter



Parking garage, 700 m to  
runway



# Jönköping



CORS station close to  
DME and runway, 700 m  
to parking, 1.2 km to  
runway

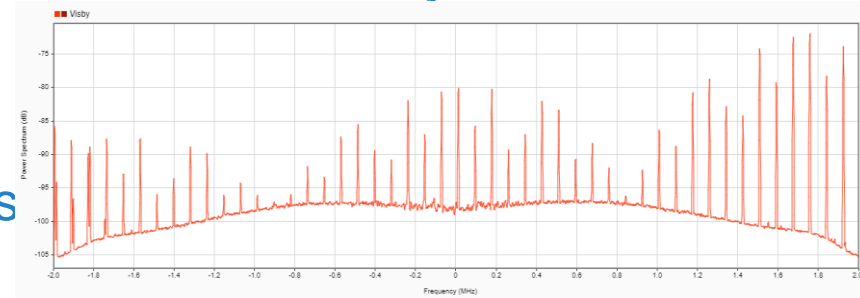
# Status 2021-05-11

- Three FOI (RF-Oculus) interference detections systems installed (co-located) at three SWEPOS sites
  - Visby, Landvetter, Jönköping
- FOI has three GNSS-receivers on loan for lab testing
  - Receivers installed and connected using 3G/4G modems to SWEPOS monitoring centre and using FOI roof antenna and GNSS-simulator.
  - These receivers are setup in a specific test-net so it will not influence normal SWEPOS functionality.
  - Interference and spoofing testing done
- Abstract for ION GNSS+ 2021 submitted and accepted
- Final report will be finished in August 2021

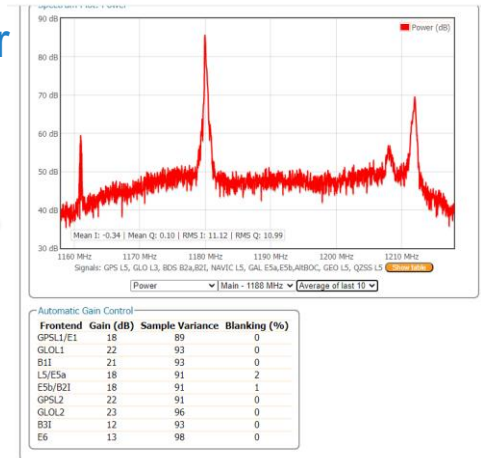
# Some results

- Interference has been seen on all three SWEPOS sites...
- Latest receiver generation can display spectrum and some receivers have possibility to download spectrum data.
- Some receivers also have information when jammed and/or spoofed that might be useful in combination with other data.
- Useful algorithms for interference detection are investigated.

Visby



Landvetter





# Future work

- Sweden has a need to monitor Galileo PRS frequency bands
  - Discussions with MSB (Swedish Civil Contingencies Agency) to use SWEPOS-network for monitoring E1/E5
    - Pre-studie will probably start in 2021
    - Use results from current project

Questions?

Thanks for your time!