Using the Swedish CORS Network SWEPOS for GNSS Interference Detection

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Introduction

- Funded by the Swedish Transport Administration
  - Swedish Defence Research Agency (FOI)
  - The Swedish Mapping, Cadastral and Land Registration Authority (Lantmäteriet)
  - Swedavia
- Scope of work
- Question: can we use SWEPOS to detect interference?
  - Lab testing of geodetic receivers (jamming and spoofing)
    - Not covered in the this presentation
  - Detection of interference in real life

Introduction

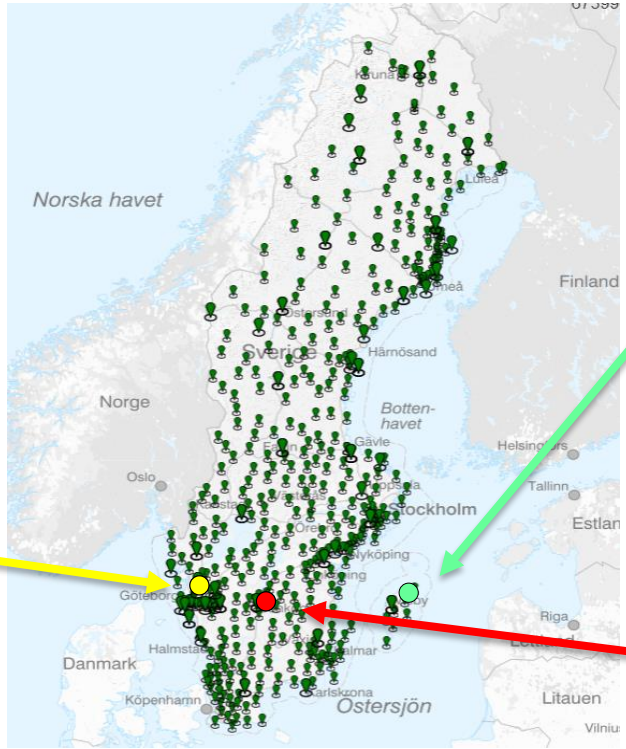
- SWEPOS station receivers – used for interference detection?
  - Reference system RF Oculus
    - Interference detection system developed at FOI
  - Interference, detected with both systems?
- L1 (1575.42 MHz)
- Needed measure for detection?
- RF Oculus installed at 3 SWEPOS stations close to airports
  - Detected around 50 interference events
- Only a few where missed

Selected SWEPOS stations for detecting interference events

Network of 450 stations

10-35 km between stations

Landvetter



Visby

Jönköping

Reference system RF OCULUS

- Monitors the L1-band
- Bandwidth 4 MHz
- Logs received power 10 times per second
- Detects an interference event when received power level > threshold
- Threshold = 5 dB above the ambient noise level
- Used thresholds for Visby, Landvetter and Jönköping are -64 dBm, -54 dBm and -85 dBm
- A large difference in the ambient noise levels

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SWEPOS receiver

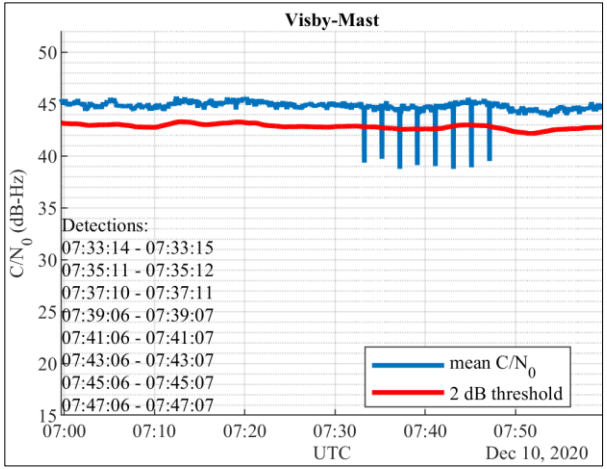
- Detections where performed by post-processing RINEX data from the stations
- C/N_0 from RINEX
- Detection when C/N_0 < threshold

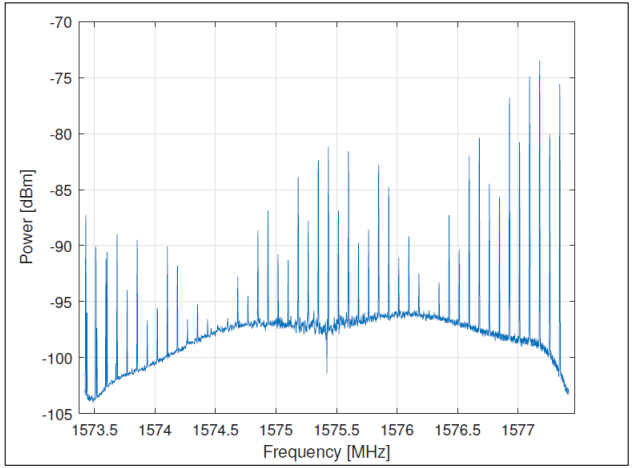
- Threshold = 2 dB below expected value derived from earlier values
- Two of the locations had two antennas, RF Oculus was connected to one of them

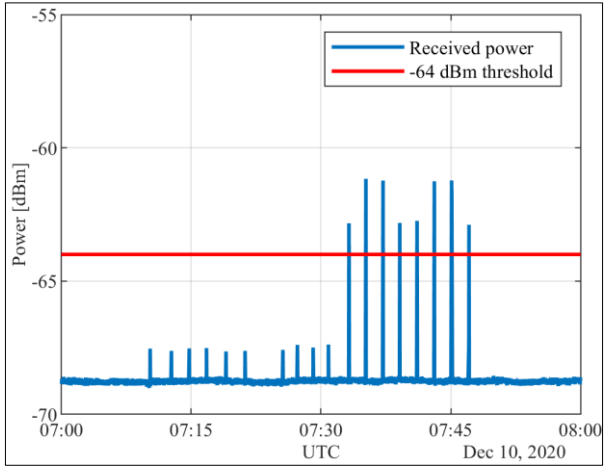
Next - detected interference events

- One example from each location
- Mean value C/N_0 from SWEPOS receiver
  - Used threshold
- Received power from RF Oculus
  - Used threshold
- Power spectrum

Location Visby, 2020-12-10

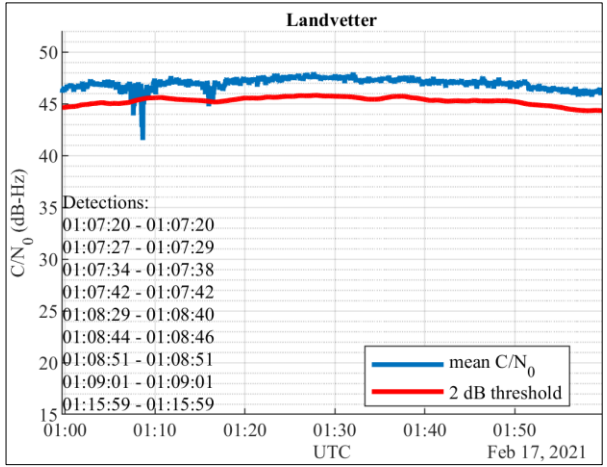


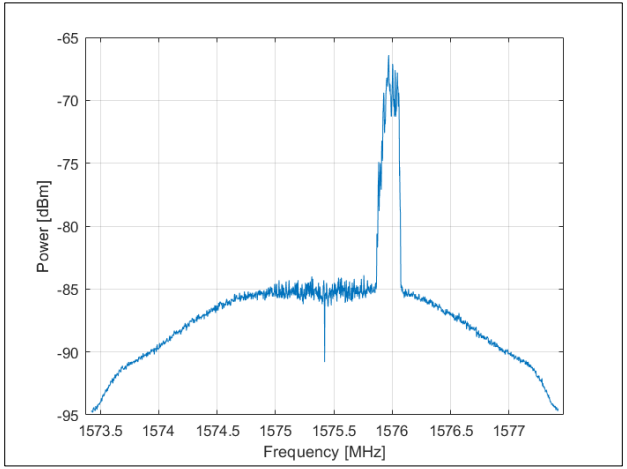


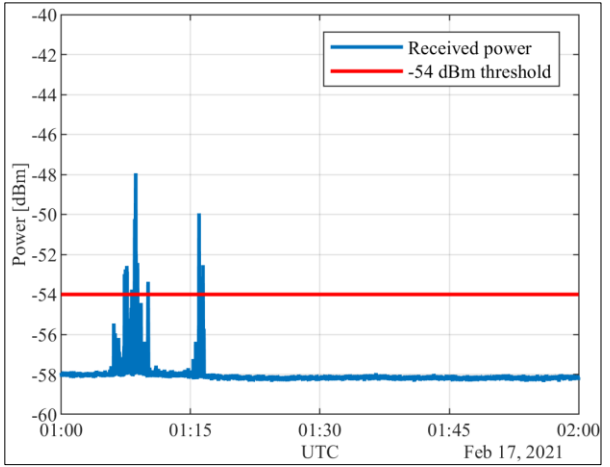


Both SWEPOS receiver and RF Oculus detected 8 interference events
Spectrum is shown in the center plot

Location Landvetter, 2021-02-17





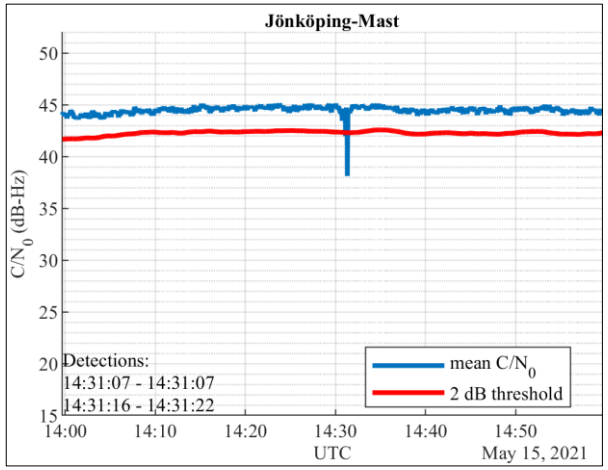


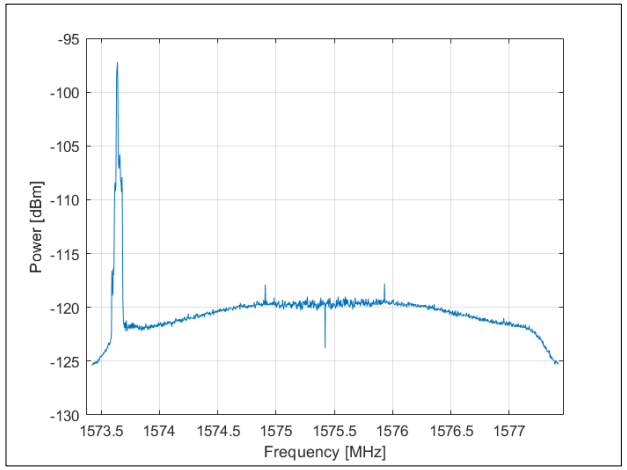
SWEPOS receiver
9 events

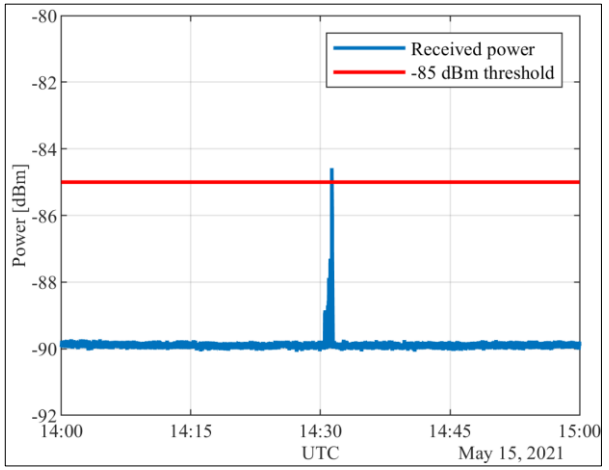
Power spectrum
narrowband interference

RF Oculus 6 events

Location Jönköping, 2021-05-15







SWEPOS receiver
2 events

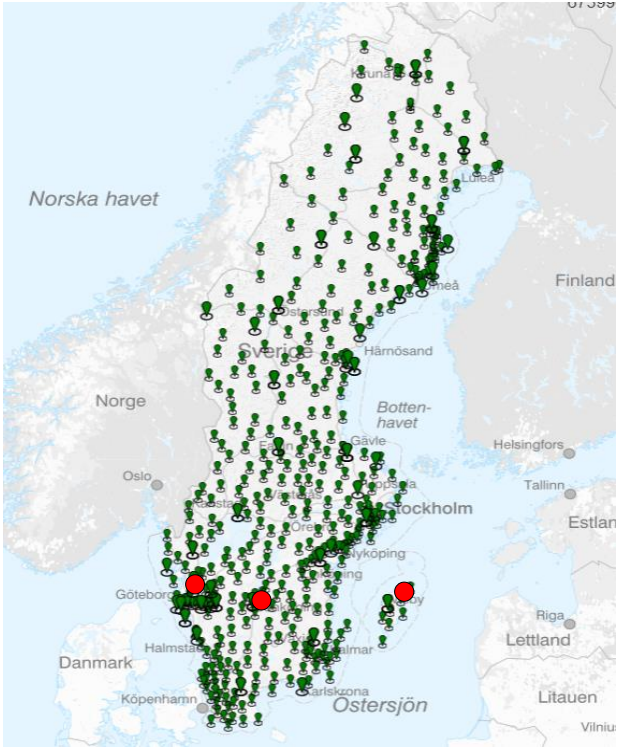
Power spectrum
narrowband interference

RF Oculus 1 events

Detected interference events

Location	Date and UTC	RF Oculus detections	SWEPOS detections
Visby	2020-11-25 14:00–15:00	3	0
	2020-11-26 08:00–09:00	3	3
	2020-11-27 07:00–08:00	1	1
	2020-11-27 08:00–09:00	1	1
	2020-11-30 07:00–08:00	1	1
	2020-12-10 07:00–08:00	8	8
	2021-03-24 12:00–13:00	9	9
	2021-03-25 11:00–12:00	4	4
Landvetter	2020-12-13 22:00–23:00	1	1
	2021-02-17 00:00–01:00	8	9
	2021-02-17 01:00–02:00	6	9
	2021-02-26 13:00–14:00	1	7
	2021-05-13 14:00–15:00	1	0
	2021-05-13 15:00–16:00	4	1
Jönköping	2021-05-15 14:00–15:00	1	2
	2021-05-15 15:00–16:00	1	2
	2021-05-26 13:00–14:00	1	2

Detected	Detected, but the numbers differ	Not detected



Conclusions

- SWEPOS stations: can give useful and valid interference detections
  - GNSS data: C/N_0 measurements
- Almost all interference events detected of both systems
  - When not
    - different measures and thresholds
    - to short interference durations
    - or to low power
    - or both to short and low power

Conclusions

- SWEPOS stations located at places with little or low levels of interference
  - Future installations with aim to monitoring interference
- High-grade receivers with built-in interference mitigation capabilities
  - Internal interference message instead of only RINEX data
- Some stations may need to be complemented with other infrastructure to detect and report interference when capabilities increase

Questions?

- Mikael.alexandersson@foi.se
- Report:
- Robust satellitnavigering med Swepos
  - Kan Swepos-nätet användas för attdetektera störning i GNSS-banden?
  - FOI-R--5187—SE, ISSN 1650-1942