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GPS P(Y) vs Galileo PRS interference field test

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Agenda

- GPS P(Y) vs Galileo PRS
- Objectives
- Team
- Field test
- Future

GPS P(Y)

- Encrypted satellite navigation signals
  - Precision code, high accuracy
  - Authentication
- Defence applications

Galileo PRS

- Encrypted satellite navigation signals
  - Increased robustness to interference
  - Authentication
  - Denial of unauthorized users
- Public sector and defence applications




Objective of field test

The objective is to assess position performance in case of interference of receivers processing the secure GNSS signals for Galileo Public Regulated Service (PRS) and GPS P(Y).

Research questions:

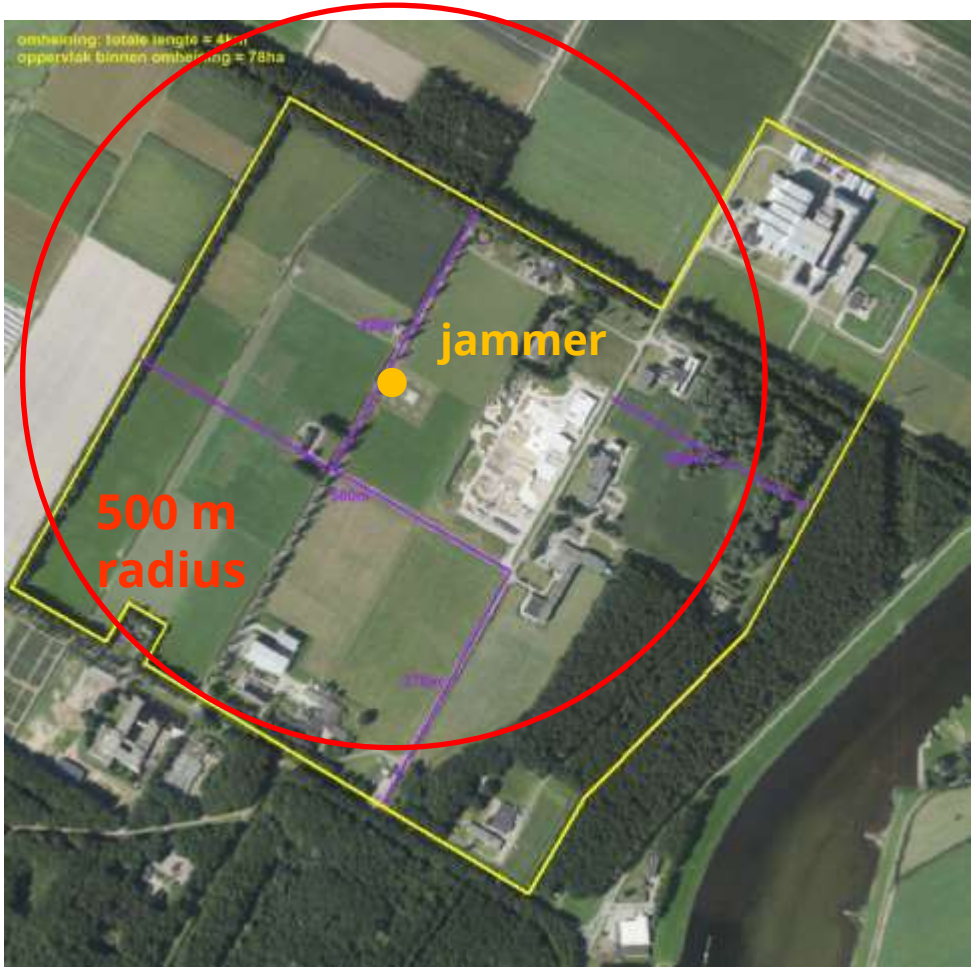
- Which GNSS system is more robust to interference?
- Which GNSS signals are most vulnerable to interference?
- Do encrypted GNSS signals show a reaction in case of spoofing?

The team

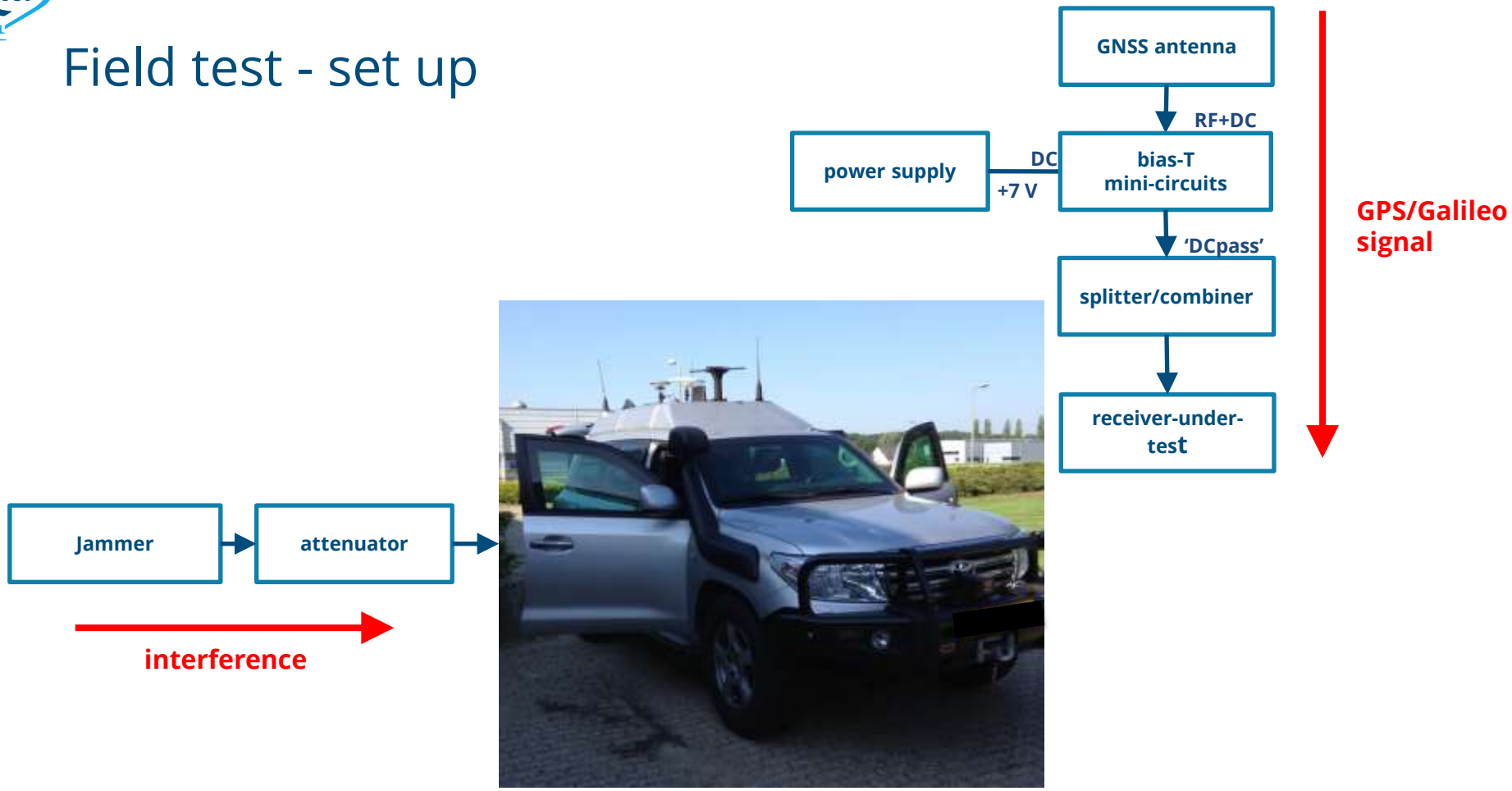
Organisations involved	Contribution
Folkline	GNSS Security Advisor for the Government of The Netherlands (since 2004). Folkline has defined the research questions. Availability of equipment.
Koninklijke Marechaussee/BSB	Knowledge of GPS equipment and procedures. Supported the field test. Availability of equipment.
NLR	Knowledge of GPS and Galileo services and performance. Knowledge of GNSS signal characteristics. Knowledge of interference techniques. Availability of equipment.
CGI	Supported the configuration of Galileo equipment during field test.
NSO	Enabled the field test.
IenM	Enabled the field test.
NDA/CPA	Took care of the transport of classified equipment. Coordinated the PRS procedures for key management and authorisation. Authorized and audited the field test.
Agentschap Telecom	Knowledge of interference techniques. Enabled the field test by the provision of an experiment permit to allow intentional interference at NLR premises in Marknesse. Interference field measurements.

Field test – NLR Flevoland

- No fly zone up to1500 ft with the possibility to extend to 3500 ft.
- License to Experiment given by the Agency of Telecommunications.
- Measurements in the field to control the range of the interference.



Field test - set up



Field test - GNSS receivers

Two classified receivers:

- A GPS P(Y) code receiver of the Netherlands Ministry of Defence
  - operated in dual-frequency mode (L1 and L2)
- A Galileo PRS receiver of ESA
  - operated in dual-frequency mode (E1 and E6)

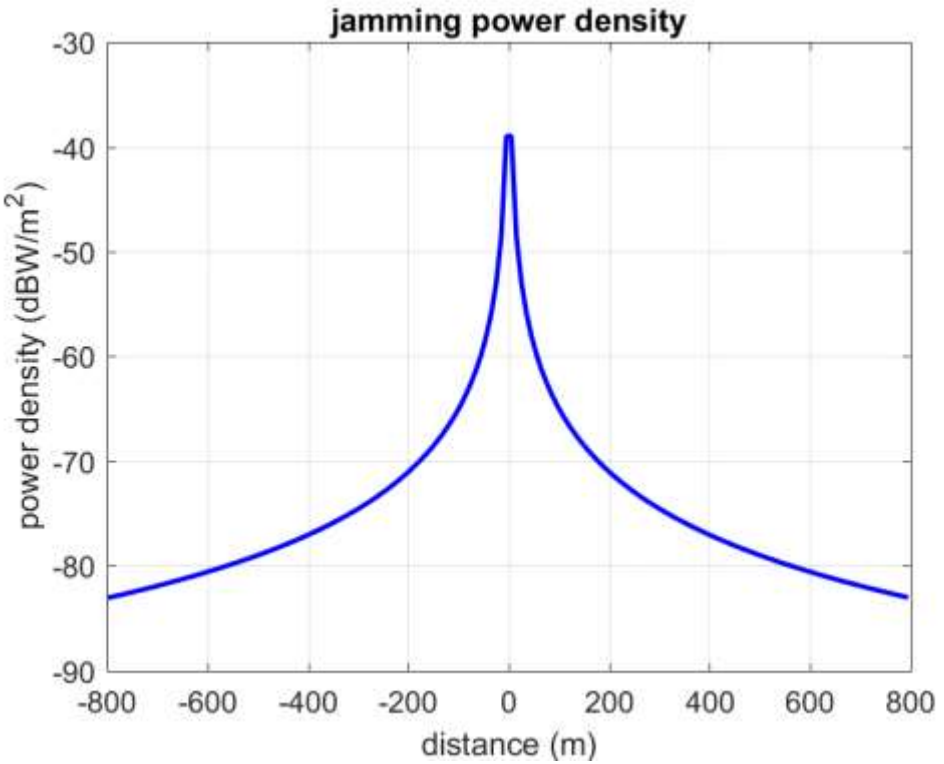
Reference receiver:

- Septentrio AsteRx3
  - operating in dual-frequency and multi-GNSS modes, covering both GPS L1 and L2, and Galileo E1 and E5 frequencies.
    Note: Frequency band E5 was not jammed during the test.

Field test – jammer settings

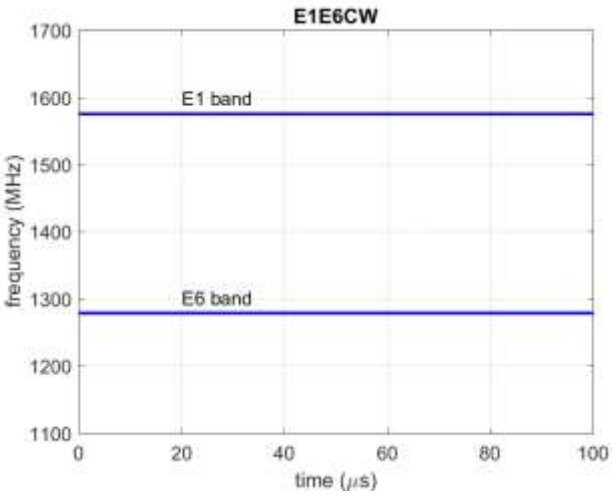
- Jammer power:
  0.025 Watt, 14 dBm
  (per frequency band)

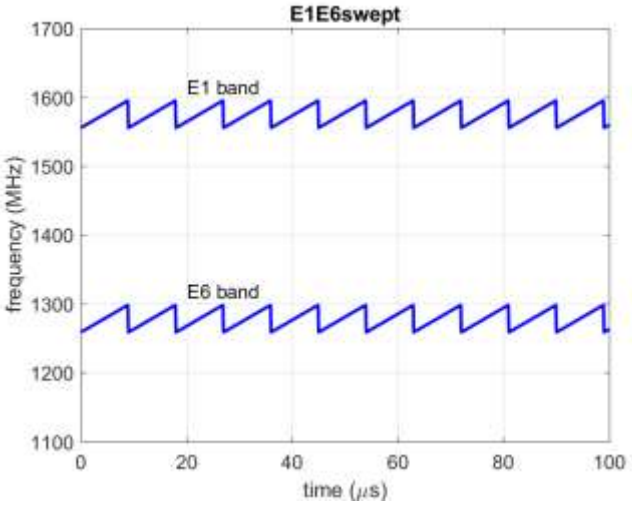
- GNSS Satellite signal strength:
  -132 dBW/m^2



Free-space propagation assumed.

Field test - Jamming characteristics





CW = Continuous Wave

Interference injected on 1 frequency.

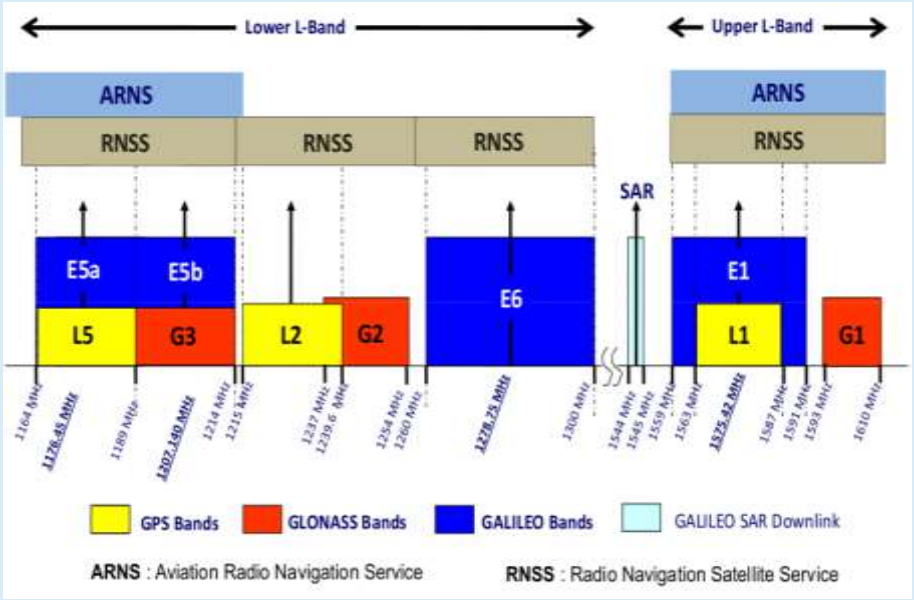
- 14 dBm

Sweep: interference spread over a frequency band.

- sweep range 40MHz
- sweep rate 9 micro second

Field test - Test scenario's

- 2 Jammers: L1 CW en L2 CW
- 2 Jammers: E1 CW en E6 CW
- 2 Jammers: L1 Sweep en L2 Sweep
- 2 Jammers: E1 Sweep en E6 Sweep
- 1 Jammer: frequency hopping L1, L2, E6



Note: 2 jammers were used to interfere on 2 frequency bands simultaneously.

Field test - impression

Classification of collected data is EU SECRET.

- EU EGNSS PSI regulations applicable.

All receivers can be jammed.

Position accuracy of classified receivers better than OS receivers under test.

- Dual frequency mode
- Single frequency mode

Galileo PRS receiver operated in 3D and 2D mode (assuming receiver at geoid height).

Field test - Conclusions

Limited data set, performance results are non-conclusive!
More research required.

Waiting for Galileo Full Operational Capability (FOC) status.

PVT availability and accuracy may be improved by:
- Availability of anti-jamming antenna
- Receiver combining GPS and Galileo secure signals
  => Coverage of 3 frequency bands

Operational usage of keys:
- Important to maintain similar procedures to manage and load keys for GPS and Galileo!

Future – Application areas

Need for Galileo PRS tests to:

- Raise **awareness** and **train** the user community
- Derive **user requirements**
- **Validate** Galileo PRS based solutions for critical applications

High potential in combining Galileo PRS with other services!

User segment	PRS application	Concept
Critical infrastructure	Robust PVT (e.g. timing services)	Galileo (all services)
Military services	Robust PVT	GPS P(Y) & Galileo PRS
Security services	Reliable PVT	Galileo PRS

Future – How to continue

- NL CPA office and procedures available.

- Raise awareness in user community.
  - Use cases
  - Demonstrations using Galileo PRS
  - Funding opportunities

EU/GSA:

- pre-operational PRS receivers.

Need for:

- Lessen classification of PRS test results.
- Receiver development for multi-GNSS solutions including Galileo PRS.

Dedicated to innovation in aerospace

Fully engaged

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