Standardisation of GNSS Threat reporting and Receiver testing through International Knowledge Exchange, Experimentation and Exploitation [STRIKE3]

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National Space-Based PNT Advisory Board
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Redondo Beach, California

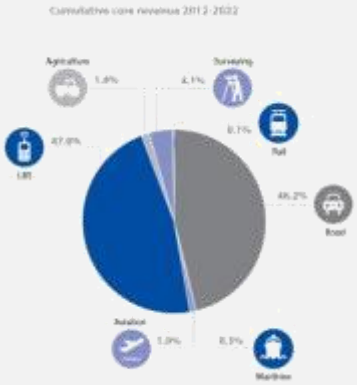
An initiative to protect our GNSS…

- Project funded by European GNSS Agency (GSA) under the H2020 Framework Programme for R&D

- Start date = 1 February 2016
- Duration = 3 years

STRIKE3 Project Rationale

- 6% of European GDP depends on GNSS (800BEuro)
- At the same time, GNSS vulnerabilities are being exposed and threats to degradation and denial of GNSS services are increasing.



1. Monitor
2. Detect
3. Characterise
4. Mitigate
5. Protect

- STRIKE3 provides a response at an international level to ensure that there is:
  i. a standard for GNSS threat reporting and analysis
  ii. a standard for assessing the performance of GNSS receivers and applications under threat.

Monitor, Detect, Characterise, Mitigate, Protect

STRIKE3

Threats

3. STRIKE3 international monitoring and reporting network

STRIKE3 Sensor 3

STRIKE3 Sensor 2

STRIKE3 Sensor 1

5. System of Systems

1. STRIKE3 monitoring and reporting standard

STRIKE3 centralised server

STRIKE3 server

4. STRIKE3 Threat database

2. STRIKE3 threat testing standard

GNSS signal simulator (eg, SPIRENT)

Vector Signal Generator (digital threats)

Commercial GNSS receiver under test

STRIKE3 testing standard

6. Advanced technologies
(Threat mitigation techniques)

STRIKE3 receiver testing

STRIKE3 International Network

At a range of infrastructures

- Major City Centres
- City-ring roads
- National timing labs
- Motorways/Road network
- Airports
- GNSS infrastructures
- Power stations
- Railway
- National Border (*)
- Port (*)

At a range of locations

- United Kingdom
- Sweden
- Finland
- Germany
- India
- France
- Poland
- Czech Republic
- Spain
- Slovakia
- Slovenia
- Netherlands
- Belgium (*)
- Croatia (*)
- Latvia (*)
- + 3 countries inside EU
- + 4 countries outside EU

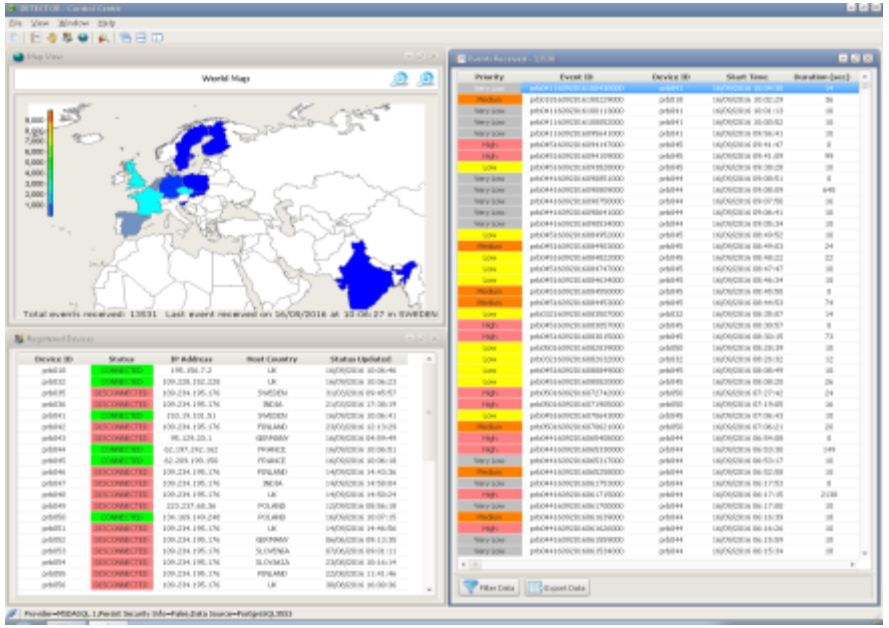
25 monitoring sites





STRIKE3 “DETECTOR” equipment

- **GSS100D** – Interference detector
  - GPS/EGNOS/Galileo L1/E1
- **GSS200D** – Interference detector
  - multi-GNSS, multi-frequency



- Dedicated STRIKE3 project server
- Autonomous and persistent monitoring
- Records events in secure database

** Other equipment is provided by other STRIKE3 partners*

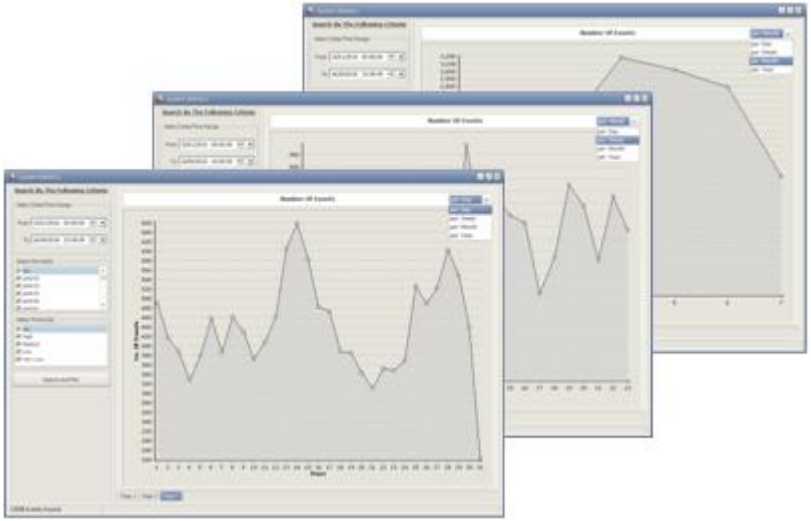
STRIKE3 “Stakeholders”

A range of entities/functions:

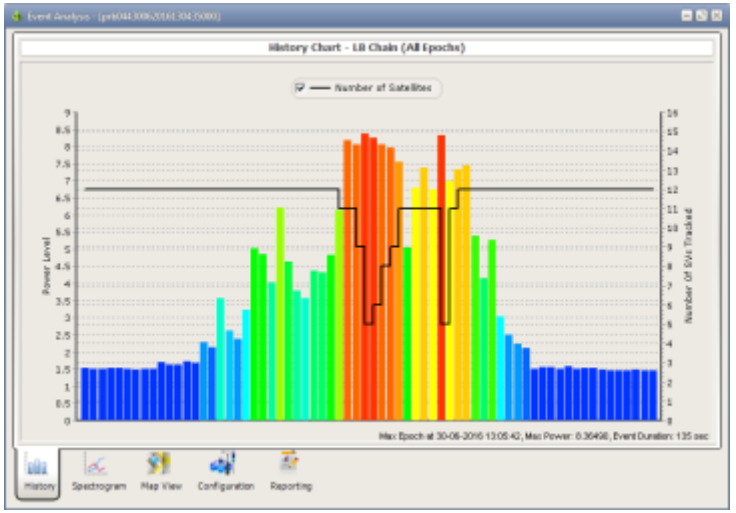
- Government agencies
- Frequency regulators
- Road operators
- Tolling operators
- Airport operators
- Air Navigation Service Providers
- Power grids

A range of concerns:

- What is the scale of the problem?
- How do the results compare at different locations?
- Are there any patterns at my site? At other sites?
- What is the impact on GNSS receivers in the vicinity?
- What is the risk and what options exist to reduce the risk?



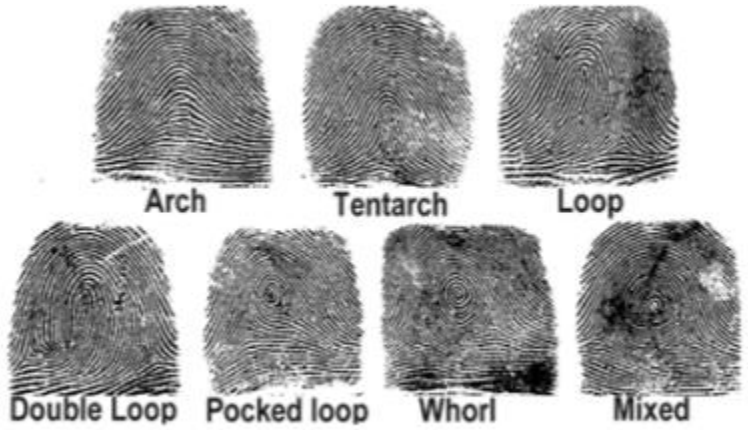
Number of events per location per time

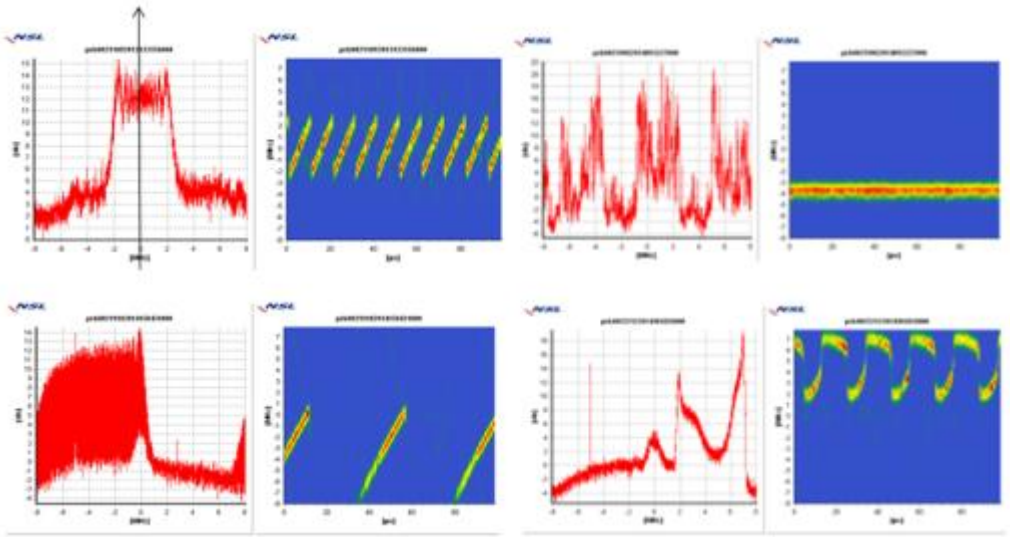


Impact of an event on “Satellites in view”

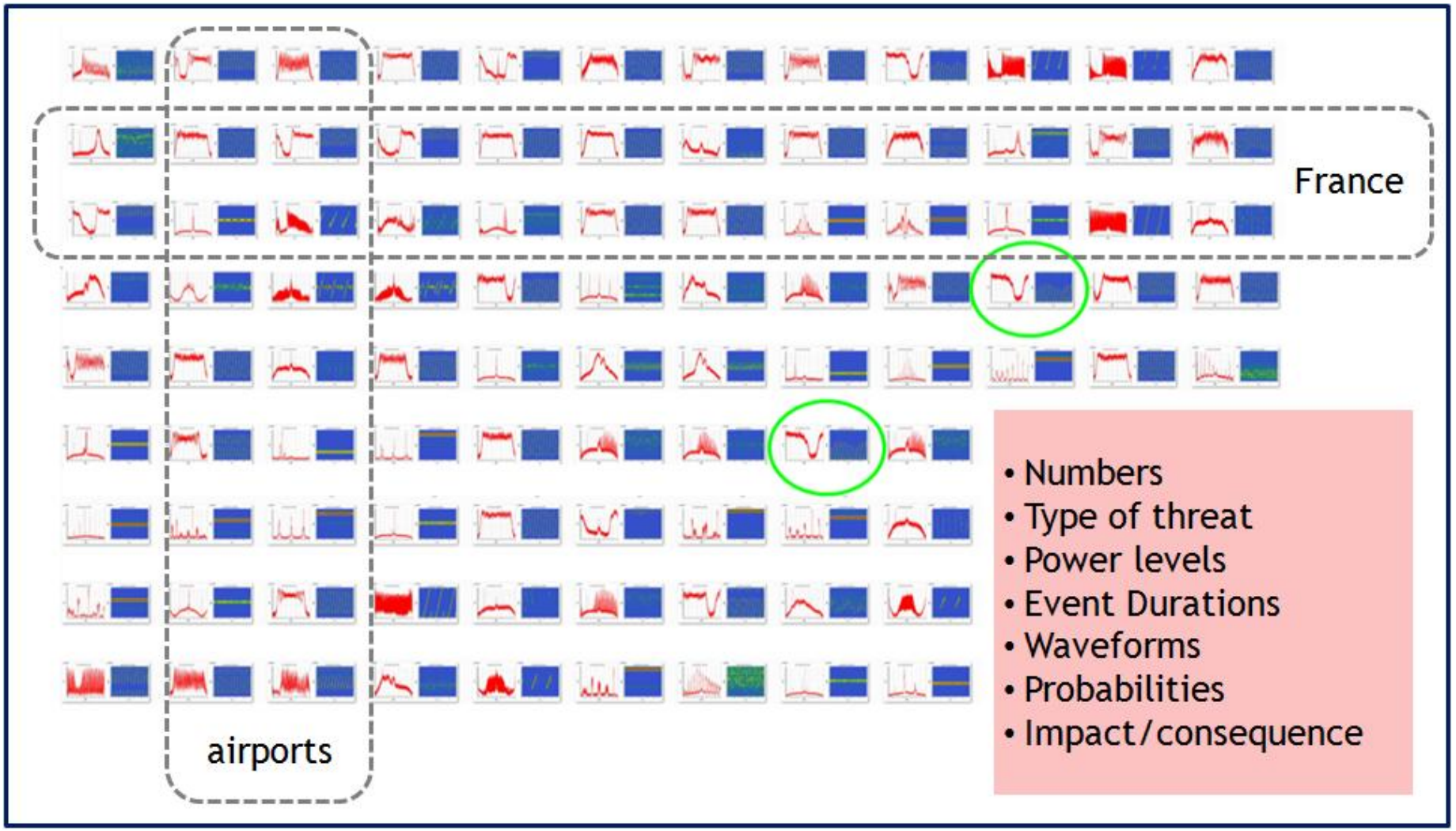
STRIKE3 “Fingerprint”

1. Size, pressure, patterns
2. Identify distinguishing features
3. Classify the signature
4. Identify different “families”
5. Identify new “families”
6. Preserve the evidence
   - Create a catalogue
   - Reference for future events
   - Automatic pattern recognition





STRIKE3 “Database” [58,000 events]



STRIKE3 Results [4 sites, 7 days]

Site1: Critical National Infrastructure (Power substation)
Site2: Major Airport
Site3: GNSS tolled motorway
Site4: Capital City centre

Start time: 00:00:00 Saturday 26/11/2016
Stop time: 23:59:59 Friday 2/12/2016

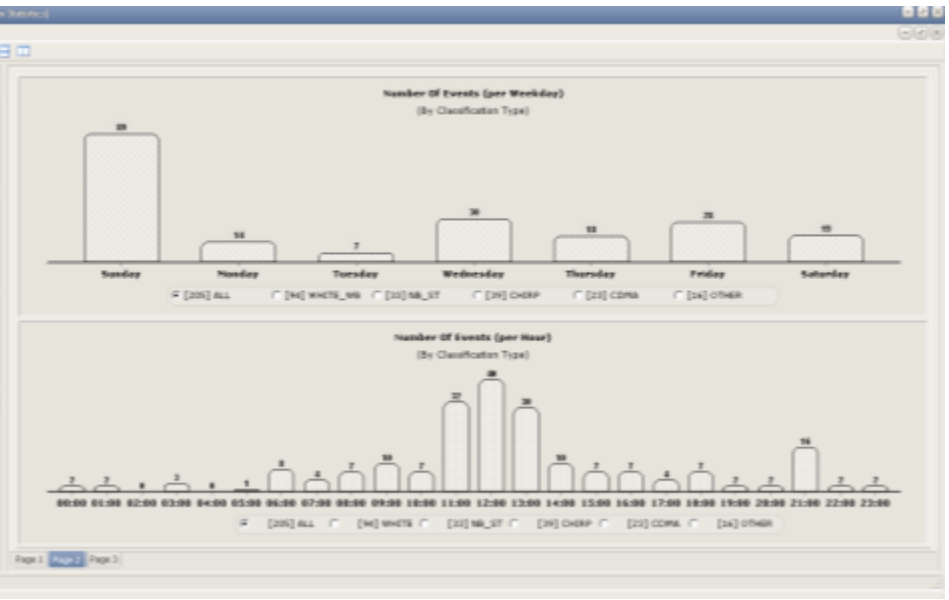




Site 1: Power substation

Antenna splitter feeding GPS clock and DETECTOR

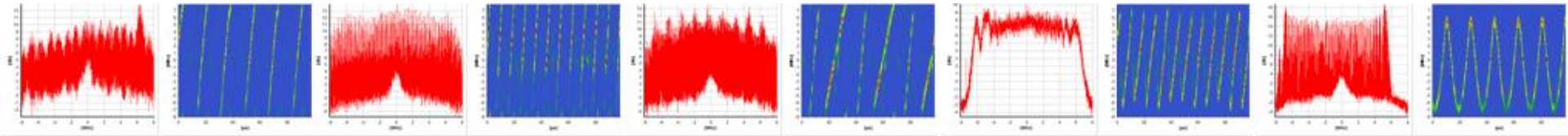
Site 1: Power substation



205 interferences

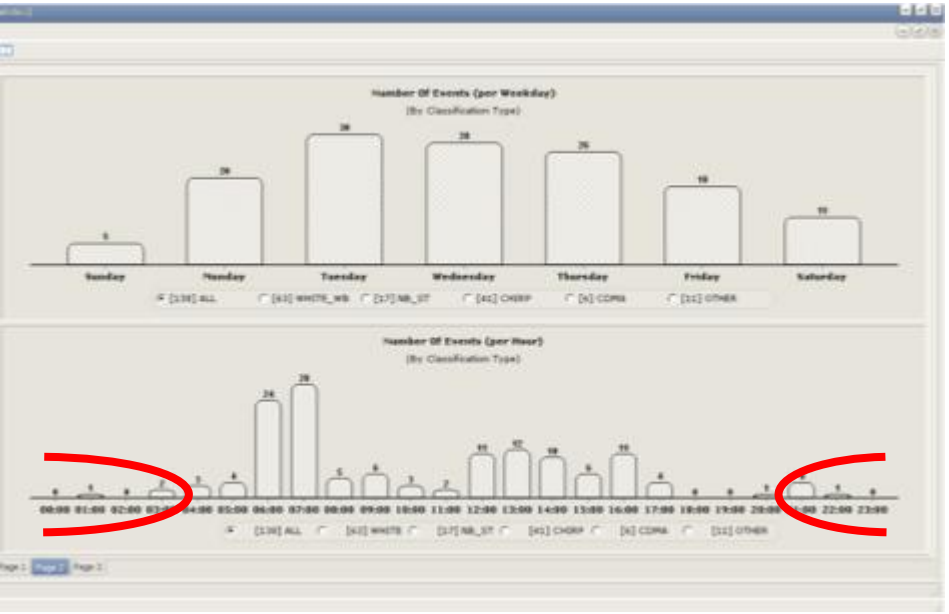
39 Chirp Jammers

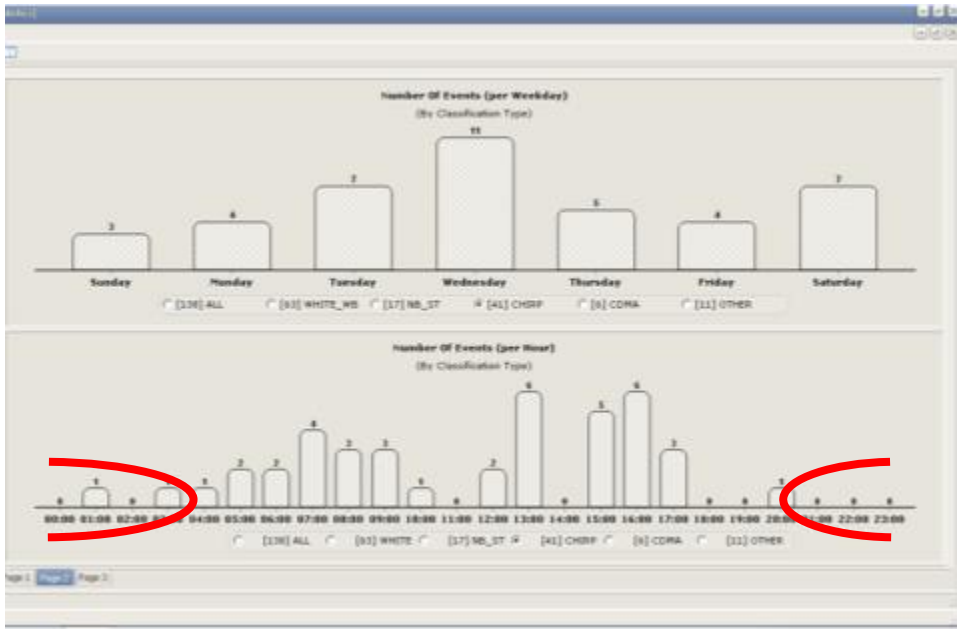
Site1: Example waveforms



Site 2: GNSS tolled motorway

Site 2: GNSS tolled motorway

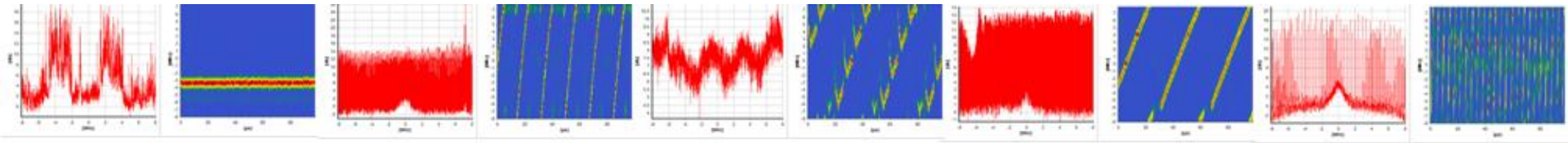




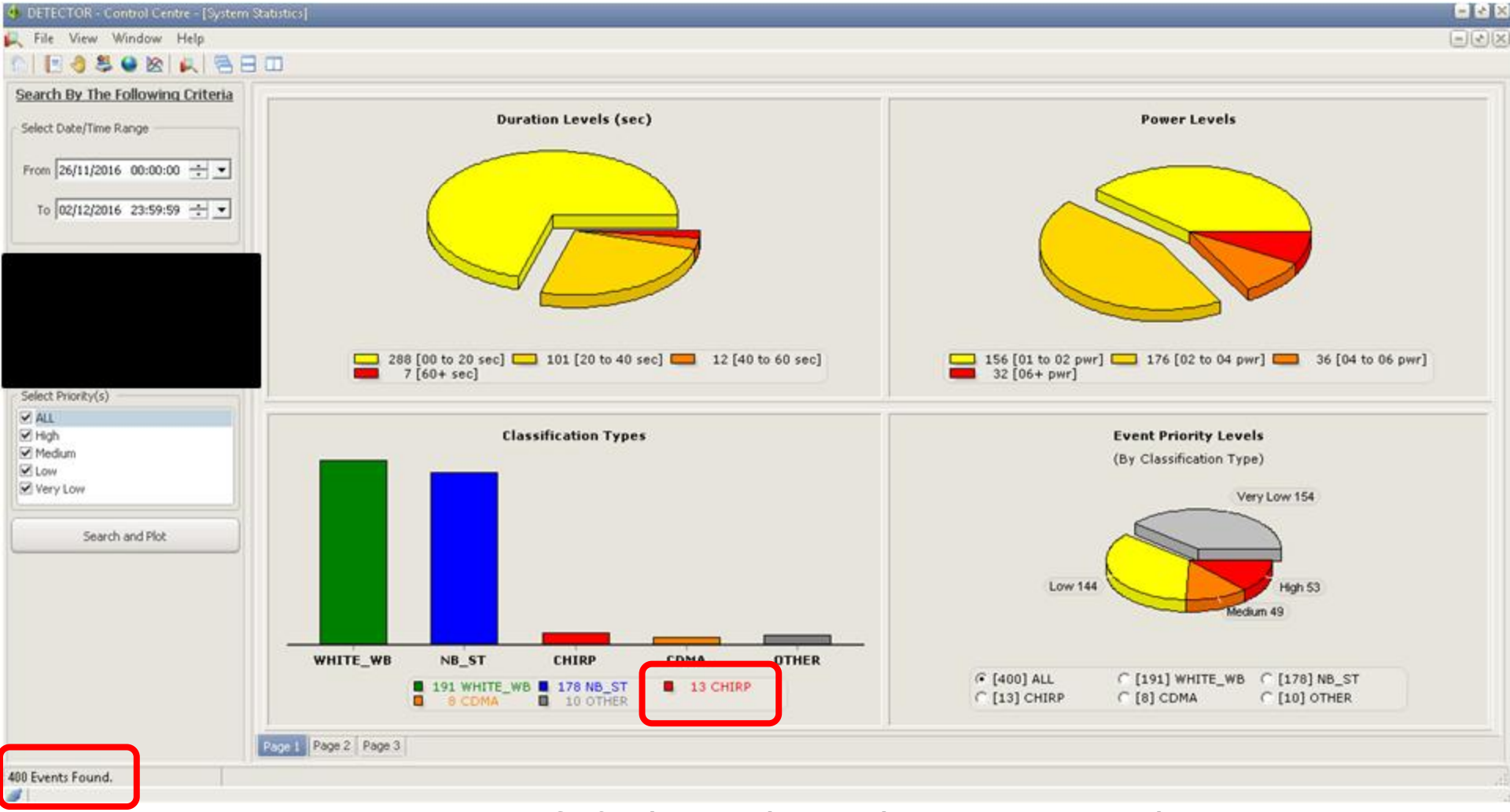
138 interferences

41 Chirp Jammers

Site2: Example waveforms

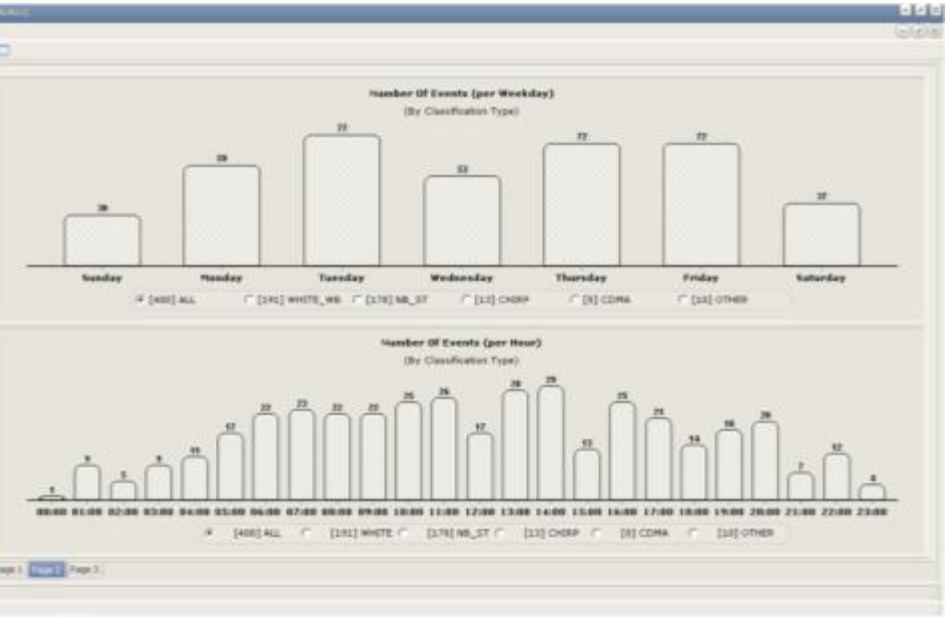


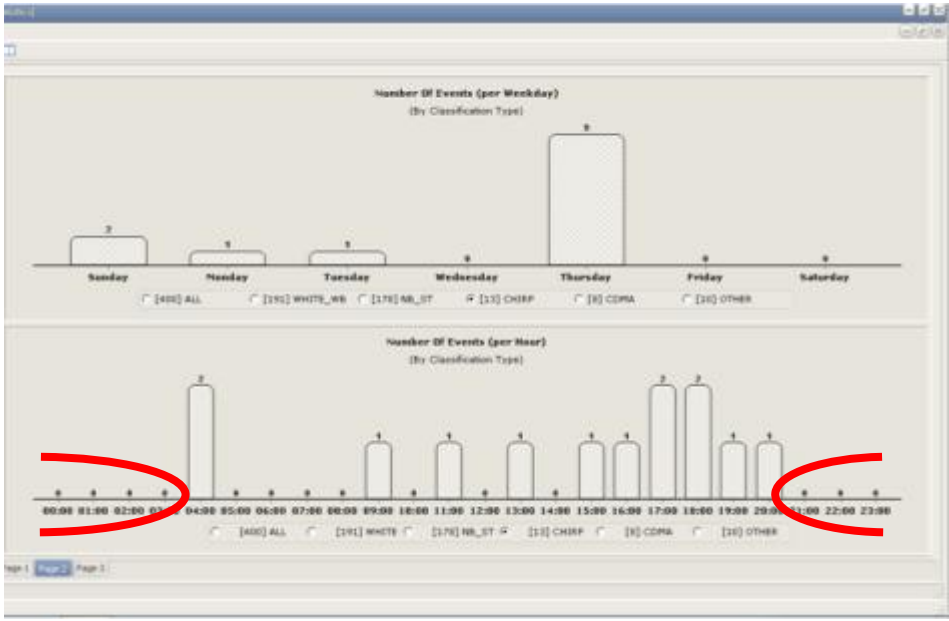
Site 3: Major Airport



DETECTOR located outside airport grounds

Site 3: Major Airport

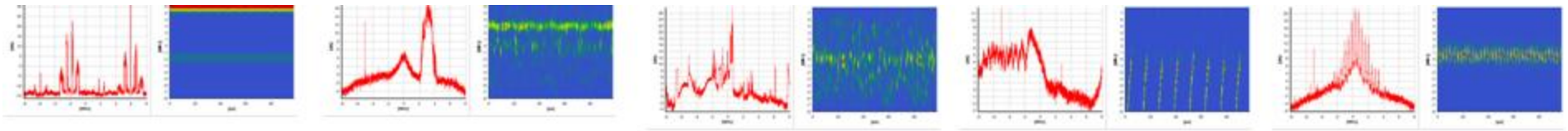




400 interferences

13 Chirp Jammers

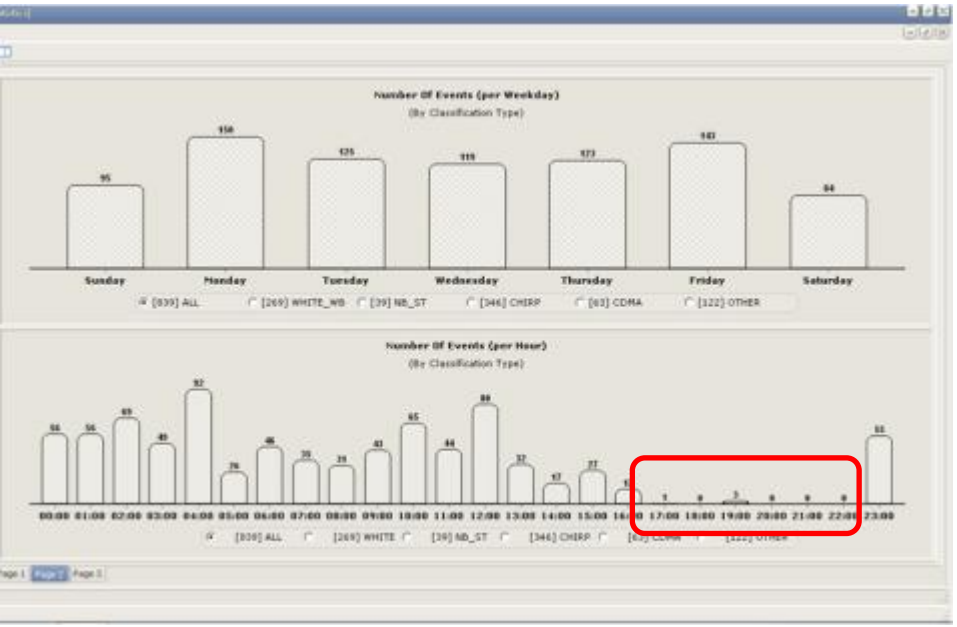
Site3: Example waveforms



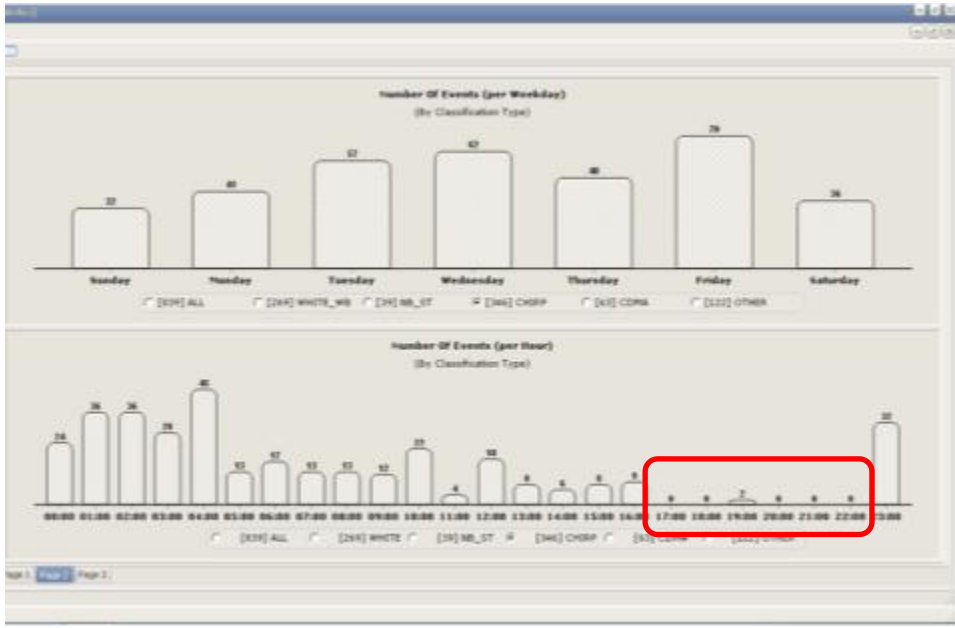
Site 4: Capital City

Lots of RFI (incl jammers). Few high power events.

Site 4: Capital City

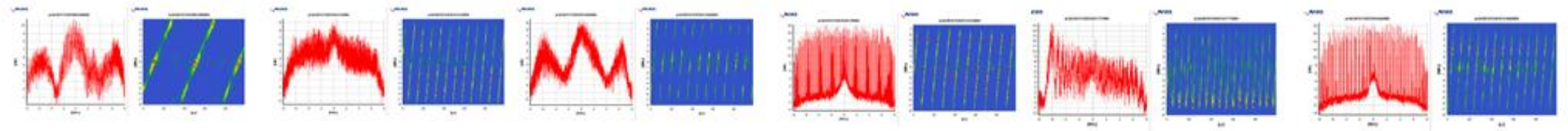


839 interferences

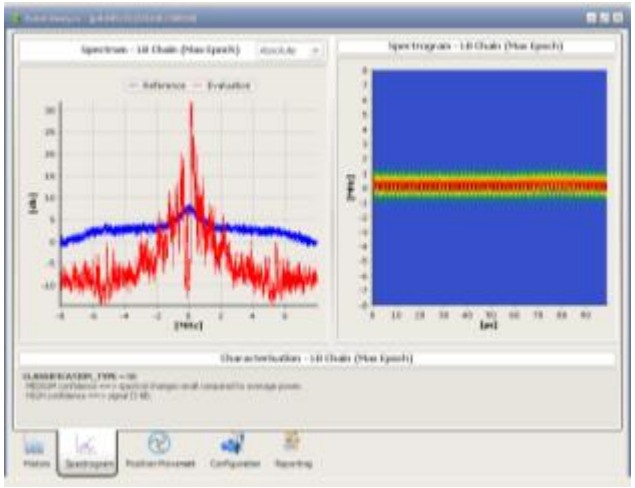


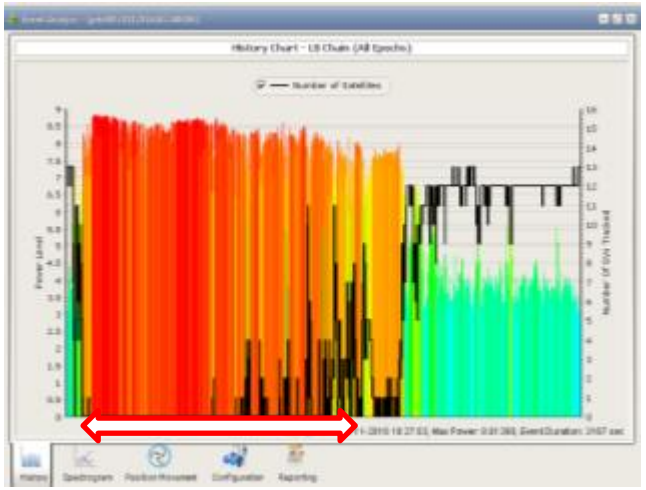
346 Chirp Jammers

Site4: 346 jamming events generated from 6 jammers



Event of the week…





- Start Time (UTC): 28/11/2016 10:23:48
- Duration (sec): 3167
- Max Power: 8.813935
- Loss of GNSS and positioning errors (70m max)

STRIKE3 Risk Assessments

- Analyse STRIKE3 data to compute **PROBABILITY** and **IMPACT**
- Use STRIKE3 database over time to (re)assess **RISK** at the site(s)

Site	Type	Probability	Duration	Power	Complexity	Impact	Risk
1	CNI	?				?	?
2	Motorway	?				?	?
3	Airport	?				?	?
…	…	…				…	…

- Use **RISK** based approach to develop business/investment cases

(1) Protect? ***(2) Toughen?*** ***(3) Augment?***





thank you

If there is an interest in hosting a STRIKE3 sensor (for 6 months) then please get in touch.

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