Tips and Tricks to finding GNSS Jammers – A Field Story

Authors:
- Darren McCarthy – Rohde & Schwarz
- Logan Scott – LS Consulting
- Alex Tkatch – Rohde & Schwarz

ROHDE&SCHWARZ

Agenda

- Statement of purpose
- Methodology
- Observations
- Lessons Learned

Disclaimer:

- There is no attempt to determine the intent of signals collected: intentional or unintentional

- The intent of the signals being collected is for use in research and development to further the interests of the GNSS services and receiver development communities

Statement of Purpose:

- Can we find signals of interest (SOI's) in use: PPD's or unintentional emitters that actual have a harmful effect on GNSS services
- Quantify the threat of SOI's jamming GNSS in a sample location
  - Can signals be found in the field that impact GNSS
  - Can these signals be captured and brought back to the lab
  - Can the results be duplicated or synthetically reproduced in a lab environment
- Ultimately ….if there is a database of threats that can be available for GNSS Rx industry to assess performance, this can improve Rx design and mitigate problems with harmful devices

Methodology:

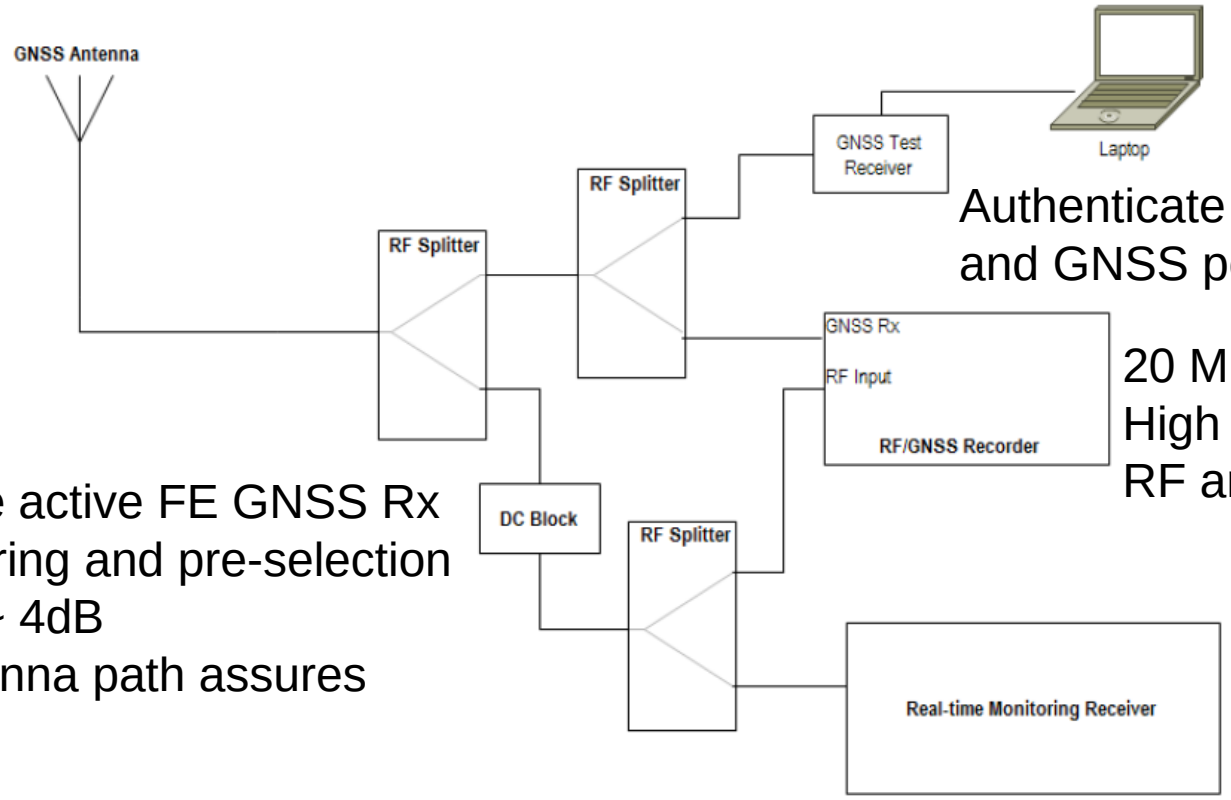
Mobile Integrated Monitoring System

But, too noticeable!

Methodology – blend in

Something closer to what we used

Methodology – but be prepared and maintain signal fidelity



Authenticate RF signal and GNSS performance

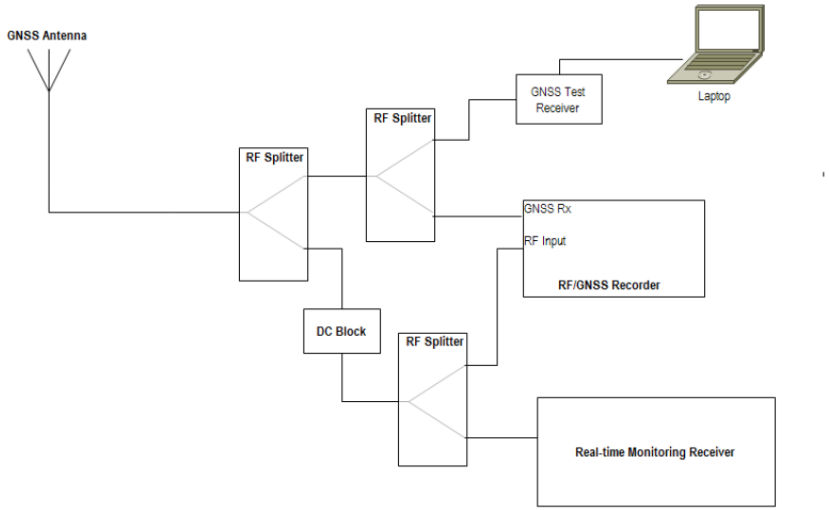
20 MHz / 16 bit I/Q
High DR Field recorder
RF and position replay

Use the active FE GNSS Rx
- Filtering and pre-selection
- NF ~ 4dB
- Antenna path assures

Real-time – 100% POI Rx (1.6 us)
160 MHz / 16 bit I/Q
High DR Field recorder

Methodology:

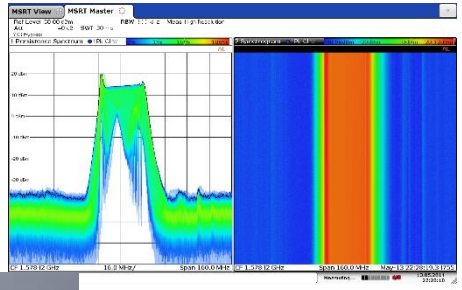
- Elements of the system
  - GNSS Antenna & Rx
    - What are the actual signals impacting the GNSS Rx
  - RF Recorder
    - What are the RF signals at the input of the GNSS Rx
  - Real-time Monitoring Receiver
    - When do you really have a signal of interest



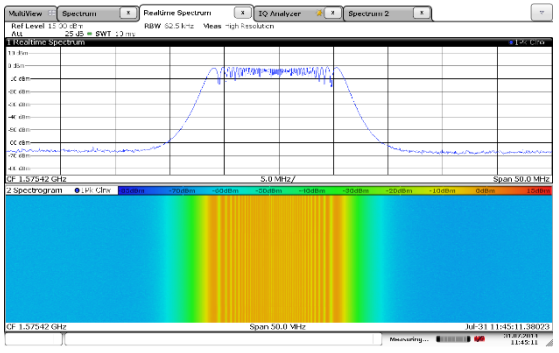
Tip #1 – Do not underestimate the importance of bandwidth and dynamic range

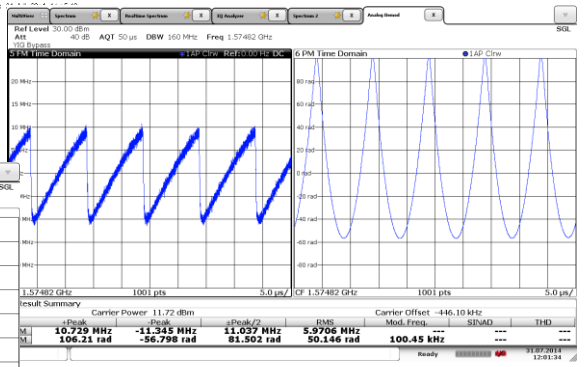
Methodology:

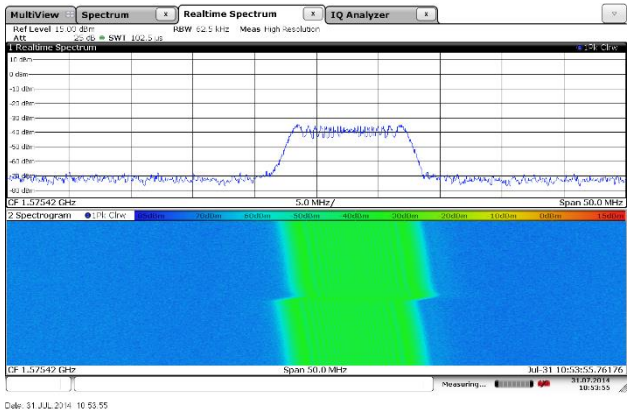
- Have some idea what you are looking for!

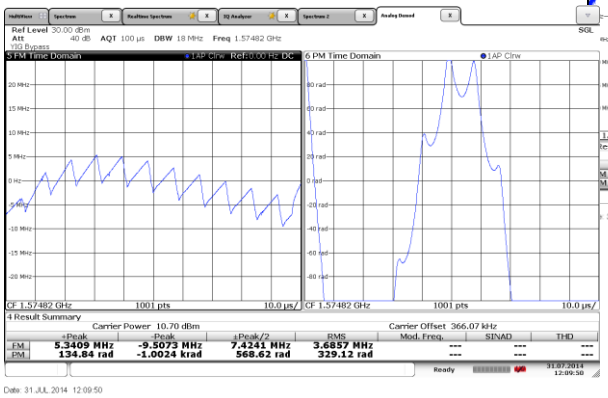


Courtesy of Logan Scott, LS Consulting







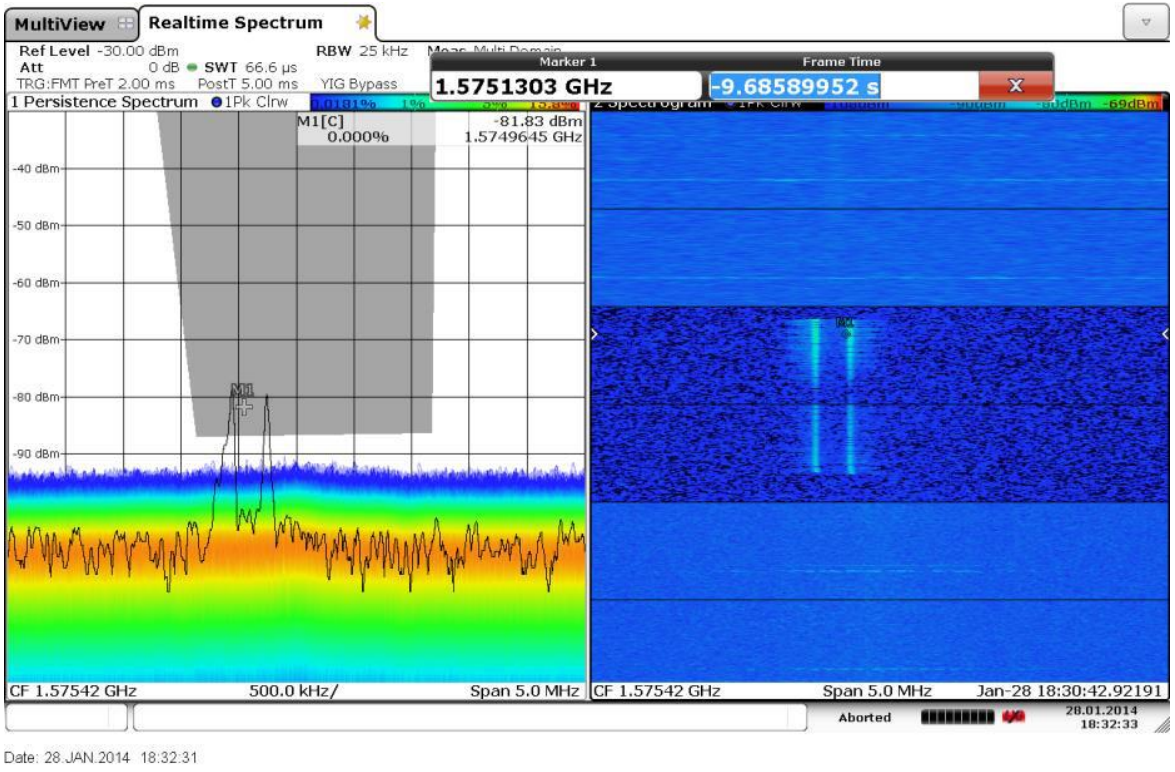


Observations

Avoid false positives

- Prior runs had shown need to observe the environment in real-time

- 100’s of events
  - FSK signals
  - Pulse
  - Broadband noise

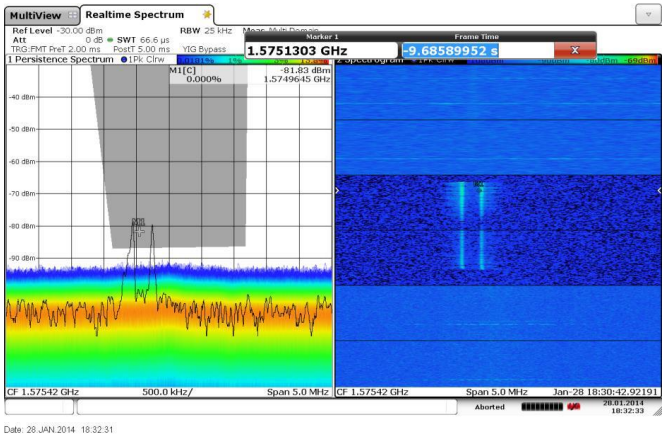


Observations

Avoid false positives

- What are these false positives

- What are they?
  - FCC Part 15.231
    - 260 – 470 MHz
    - 315 MHz X 5 = 1575 MHz

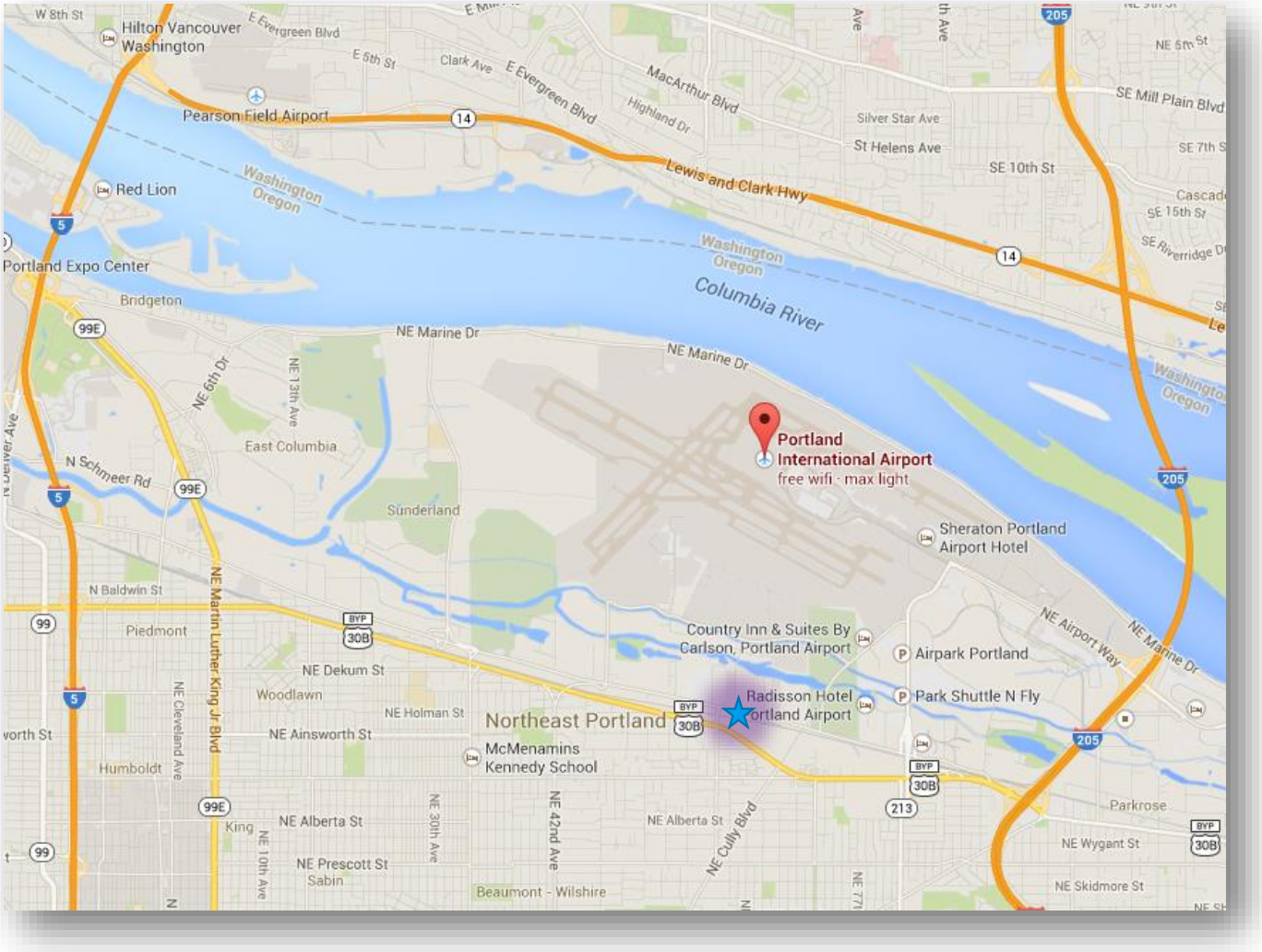


- Some cannot be ignored

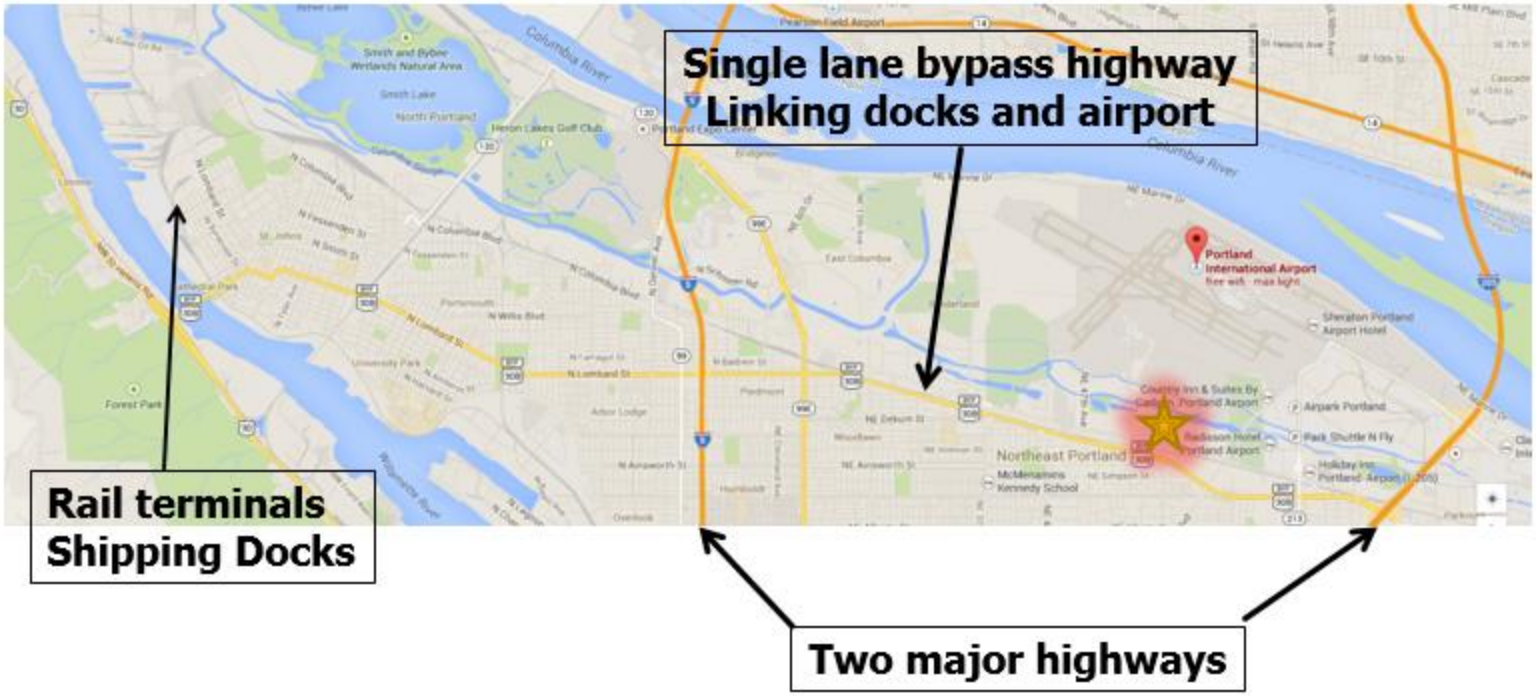
  - PIM of Cellular stations – fixed position
  - Bi-directional amps for cellular coverage – fixed position
  - PPD's! – on the move

- *Tip #2 – Do not underestimate the importance of signal detection*

Observations – Location, Location, Location



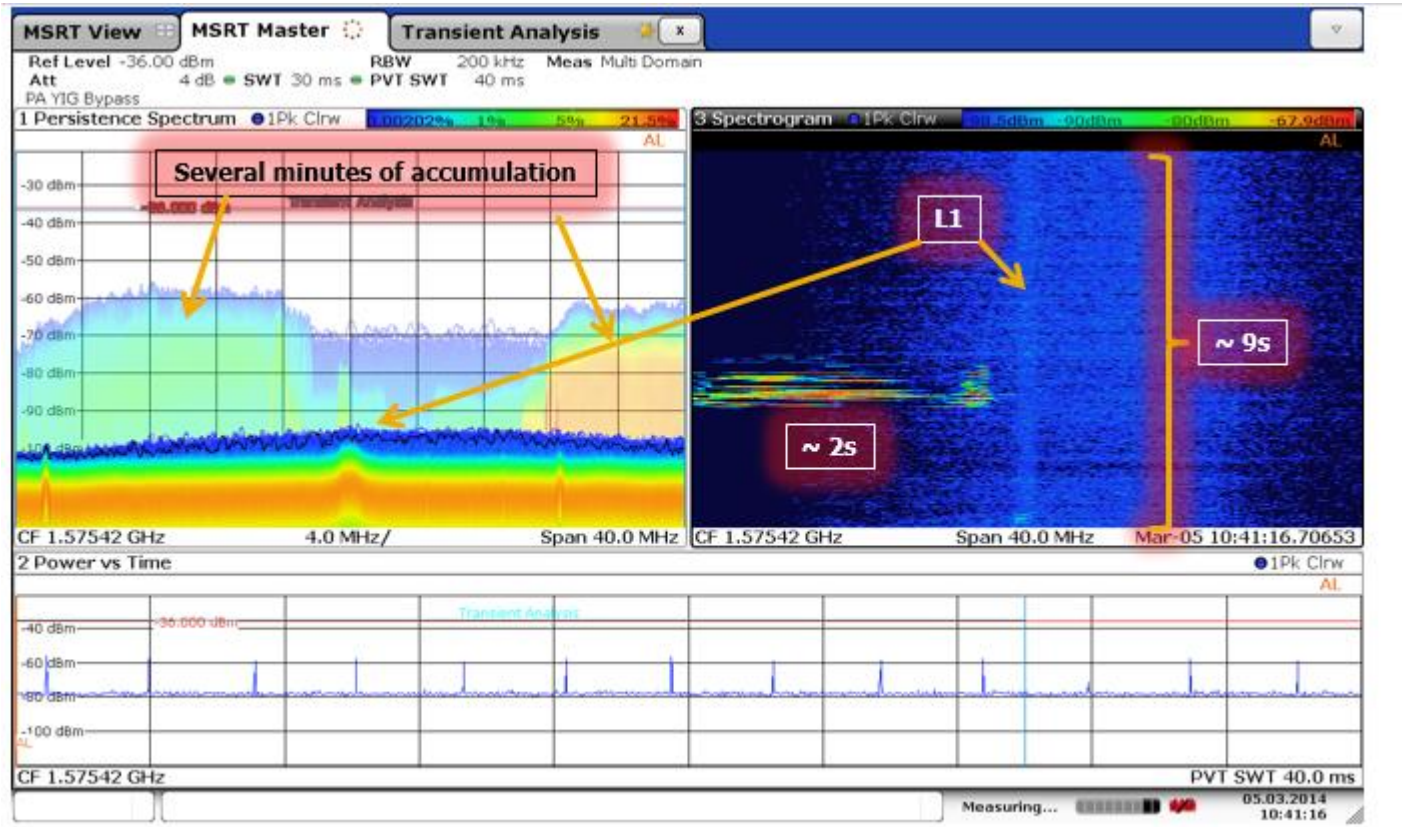
Observations – Location, Location, Location



Tip #3 – Have some idea of where signals of interest might be located

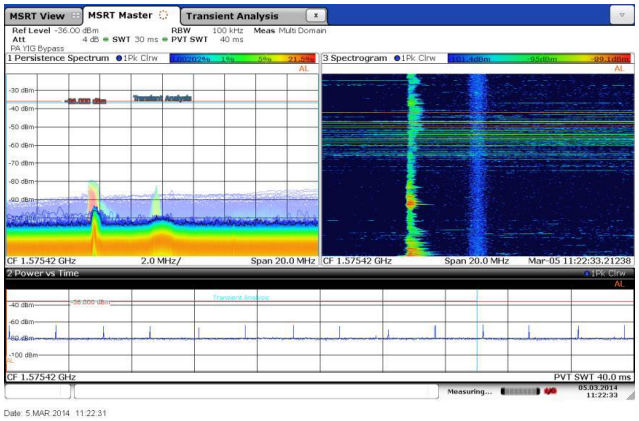
Observations – Fixed or Mobile

Every 3rd or 4th truck appeared to have a signal of interest near L1 …..but with a moving SOI and Fixed GNSS receiver ….the temporal interference was not an issue



Observations – Mobile it is!

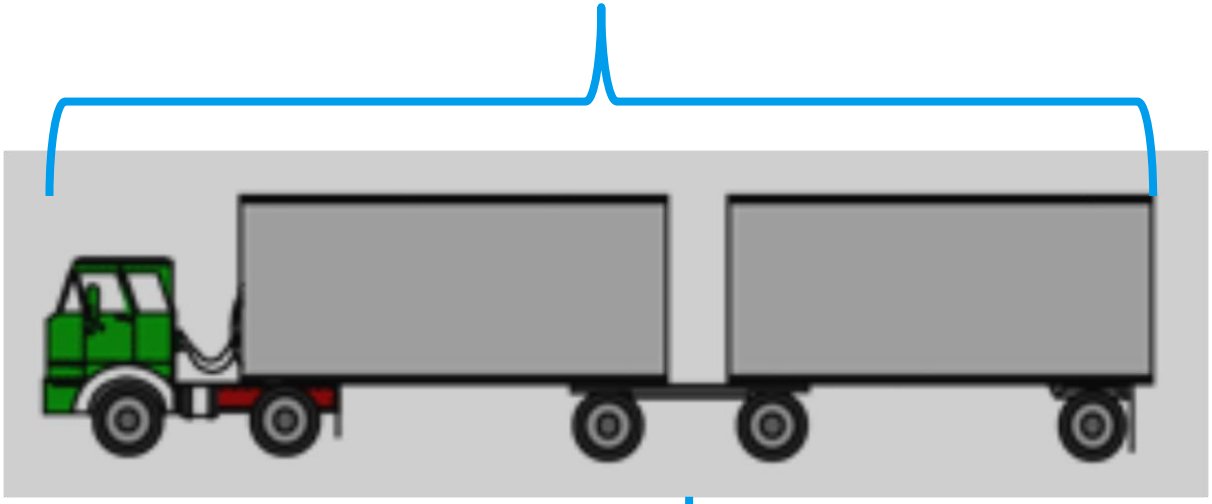
- If the signal is mobile, the only way to see if the low level signal would jam a receiver is to follow the signal



Tip #3a – Do not get noticed, you are not enforcing, just observing!

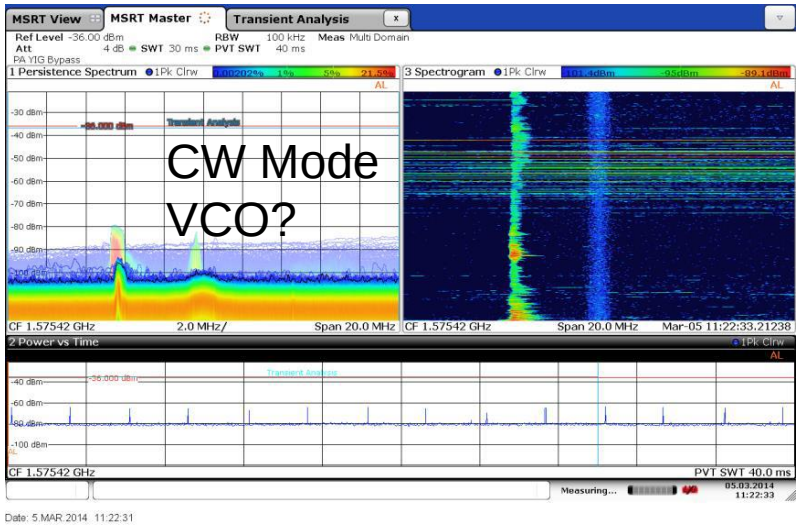
Observations – Correlating the results

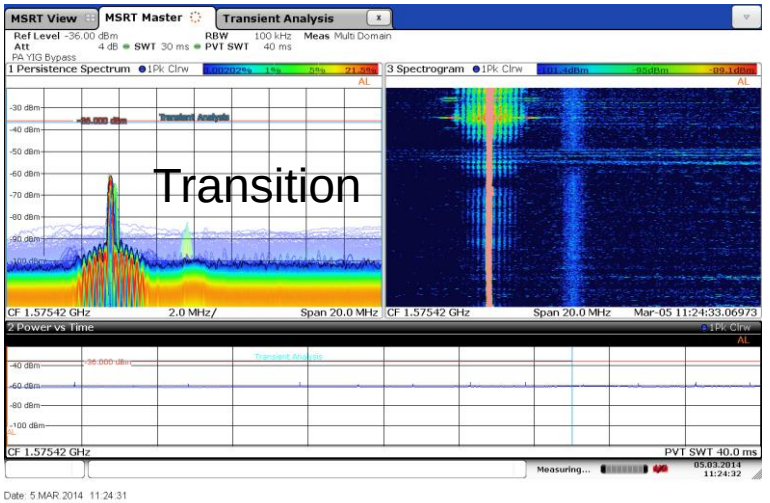
Length of vehicle ~ 100’ (30m)

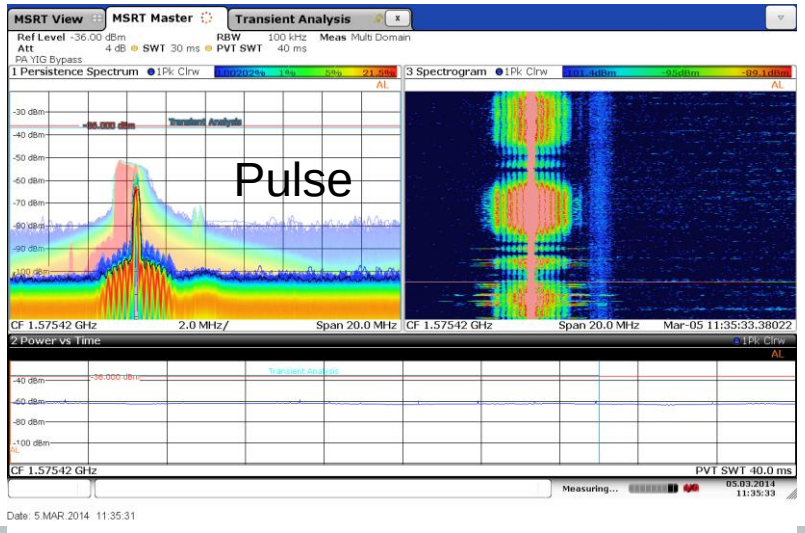


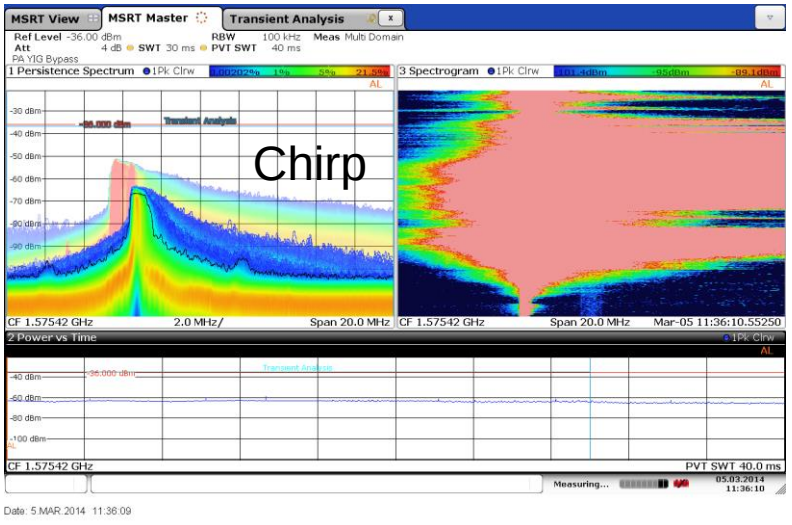
Correlated loss of GNSS signal ~ 100’ (30m) +/- 50’ from cab

Observations – Tracking the signal …through modes









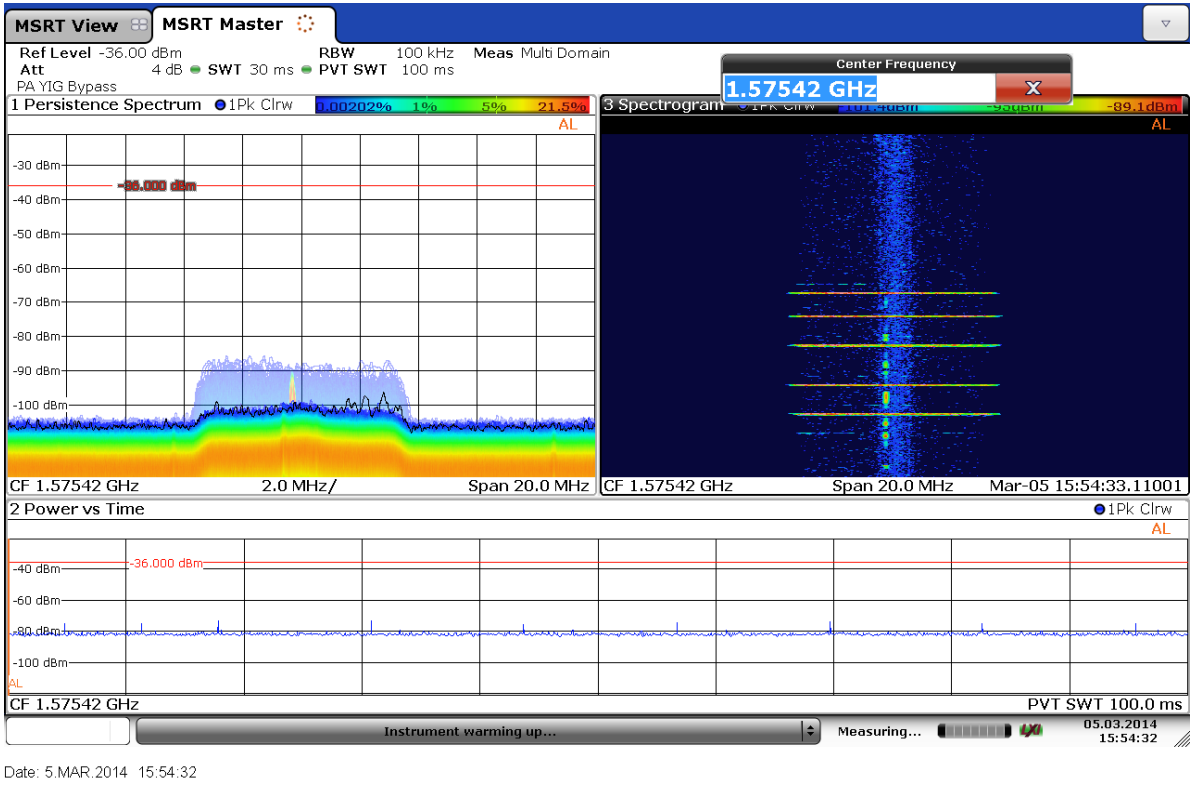
Lessons Learned

- Have a good understanding of your environment and what you are looking for!
  - Mobile signals vs fixed
  - Impact of multi-path and fading on spectrum of signal
  - Vehicle shadowing and urban canyons vs. RF jamming

- Know the proper location where signals are likely to be
  - simplifies the task of collection

Lessons Learned

- Remember rule #1 – jammers are not compliant devices or well behaved ……>> 20 MHz for PPD's



Thanks

- Special thanks to Logan Scott – LS Consulting
  - Encouragement on collection of the signals and the creation of a signal library
  - Knowing where the SOI's might be

  - For more information and questions

darren.mccarthy@rsa.rohde-schwarz.com