Challenges and Issues for backing up GNSS for Synchronisation and Position

Tony Flavin
Manger, Strategic Research

INC 2019

Resilient timing

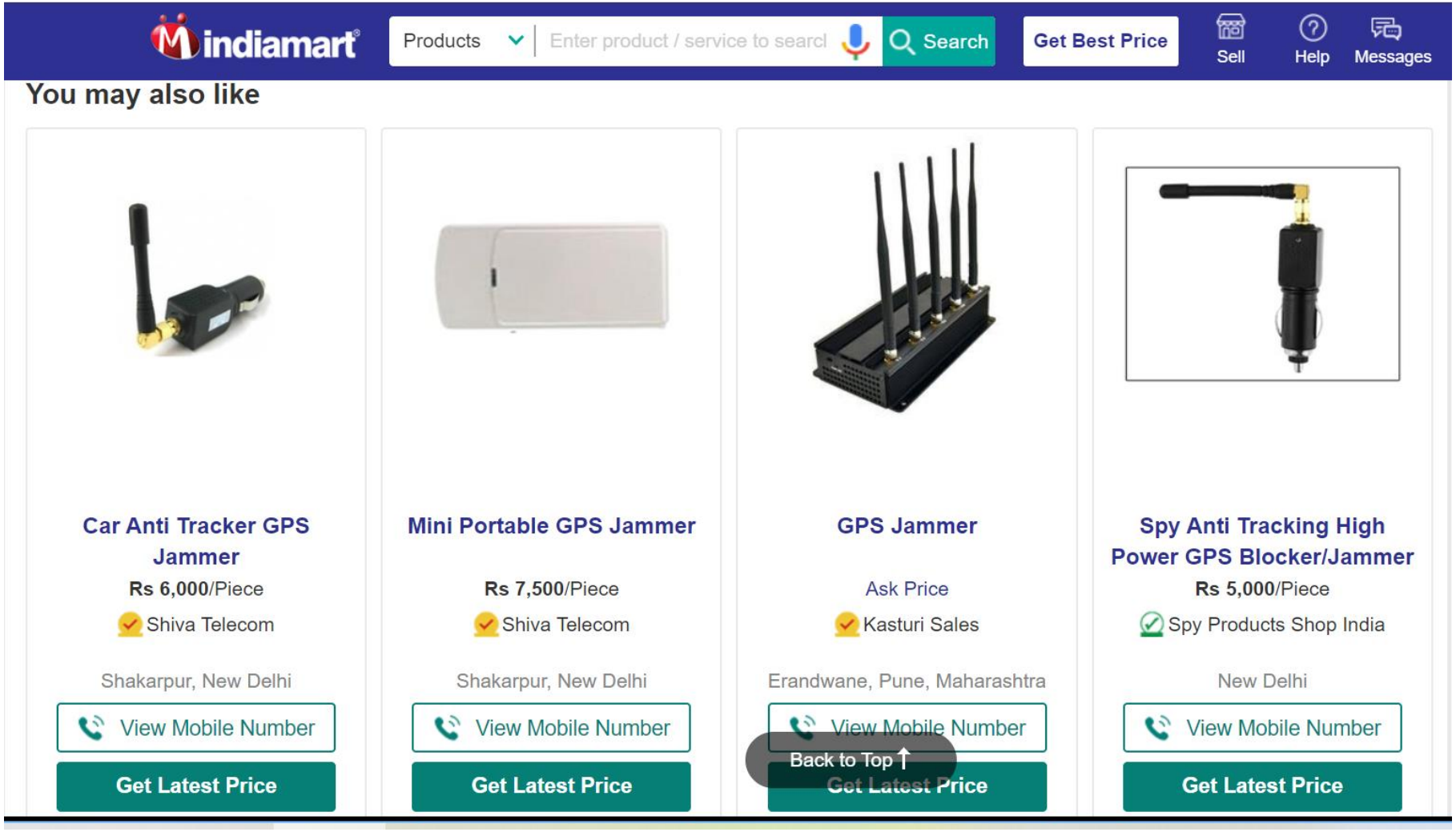
- Has been around for along time
  - This is Munich
  - Multiple Sundials!

Resilient PNT – What does this mean for GNSS?

Jamming and Spoofing

- Jamming is really easy – and cheap
  - Just make a lot of noise in the correct frequency band.
- Spoofing is really hard.
  - Need to take over existing constellation signal with a higher power signal
  - Random constellation won't work as the receivers already have ephemeris data – so this must match initially.
  - Now you can start to move things around or add/remove satellites from the ephemeris data – this takes a long time so only really suitable for stationary/fixed receivers.
  - Not impossible though and still not expensive.
  - Most likely for shipping and slow moving targets

Easily available with simple web searches
No Dark Web required.



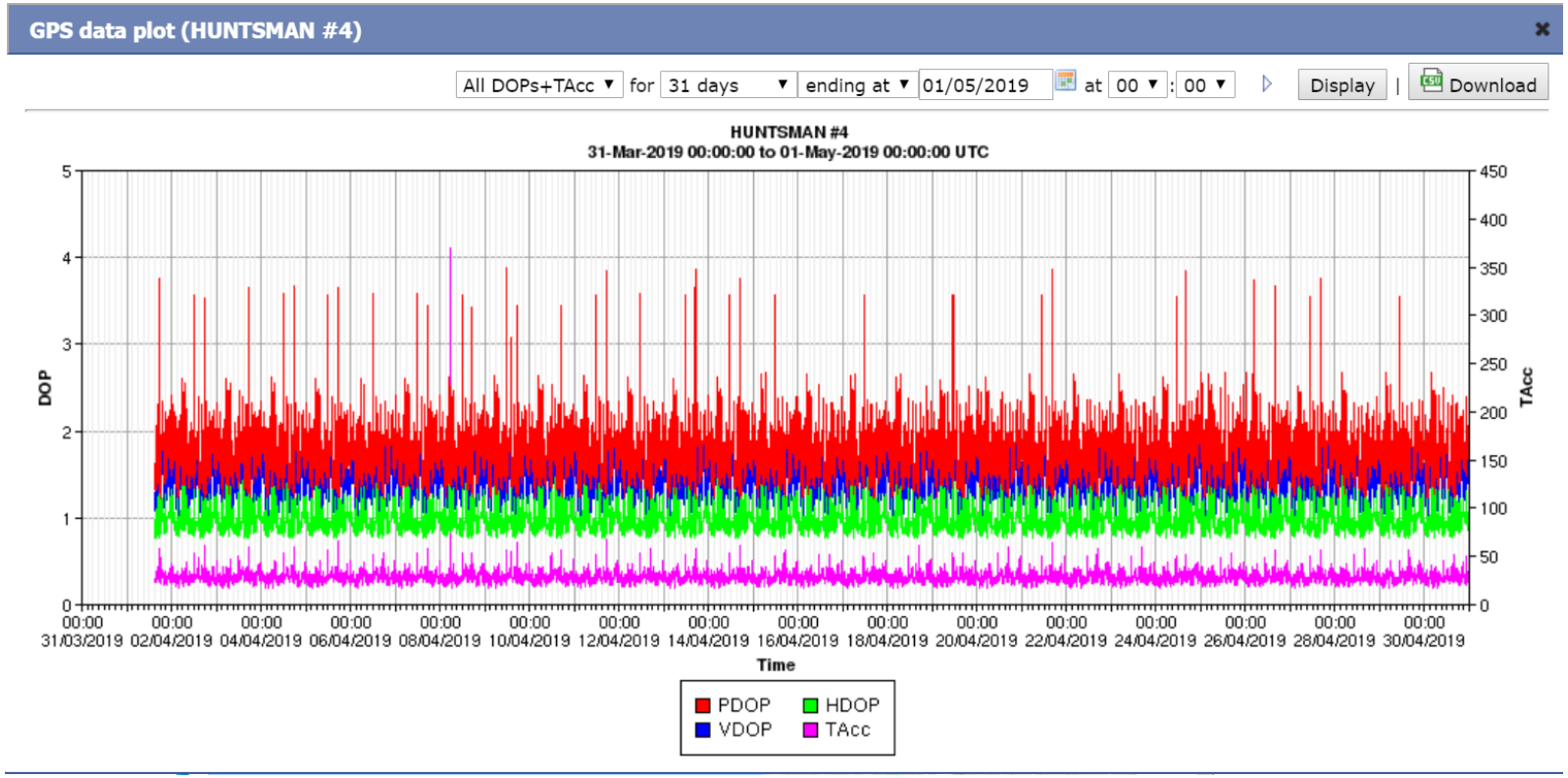
Jamming Drive-past

Jamming detection is easy

- If only it were
  - Jamming signals are still remarkable low level
  - Other “legal” low level interferers need to be accounted for
  - Local noise changes with time
  - Difficult to produce an algorithm that can cope with this and give reliable detection
  - False negatives are not popular!

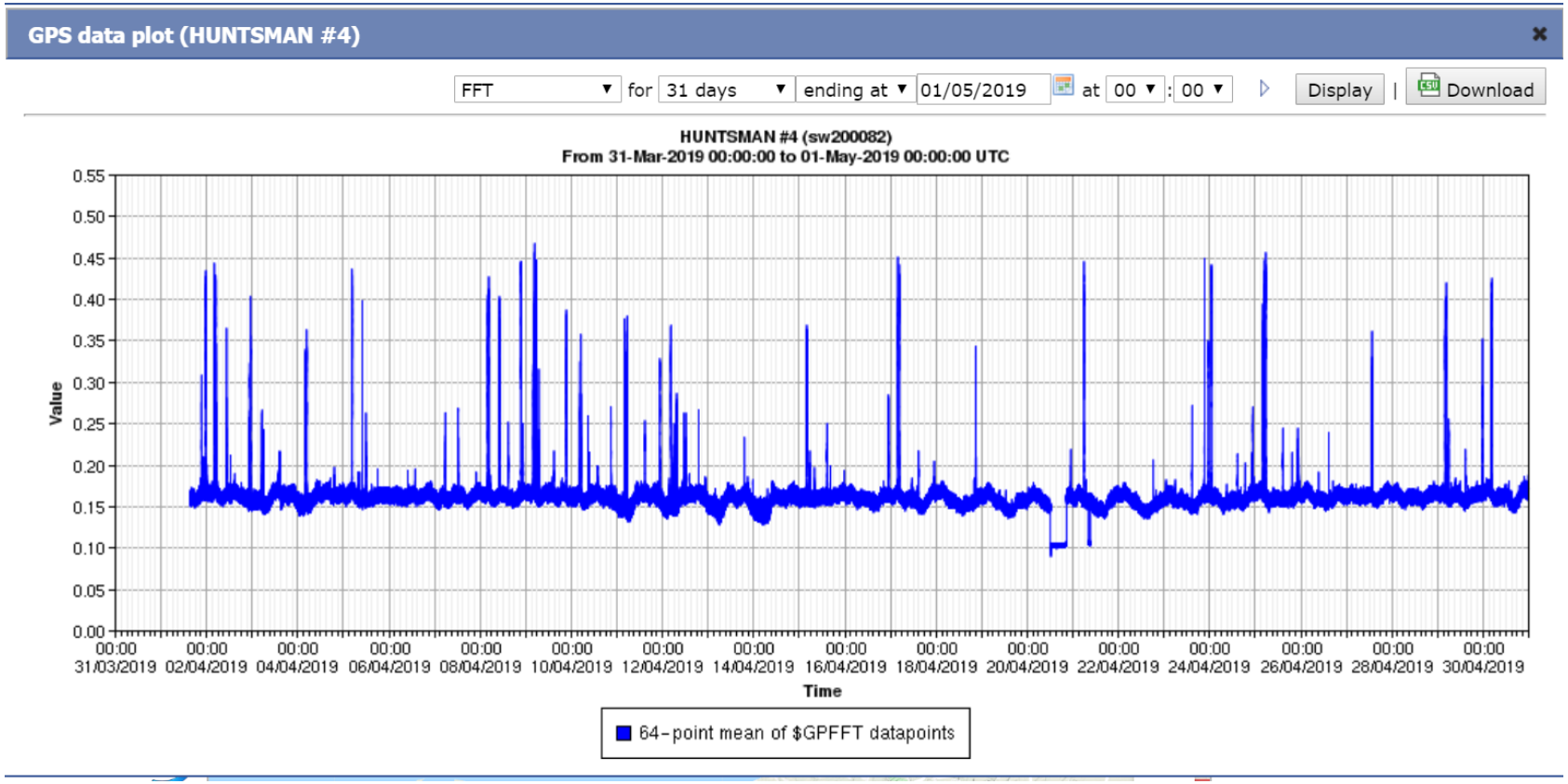
Long term monitoring - London

- April this year
  - Not much to see from the DOP measures, but PDOP is spikey



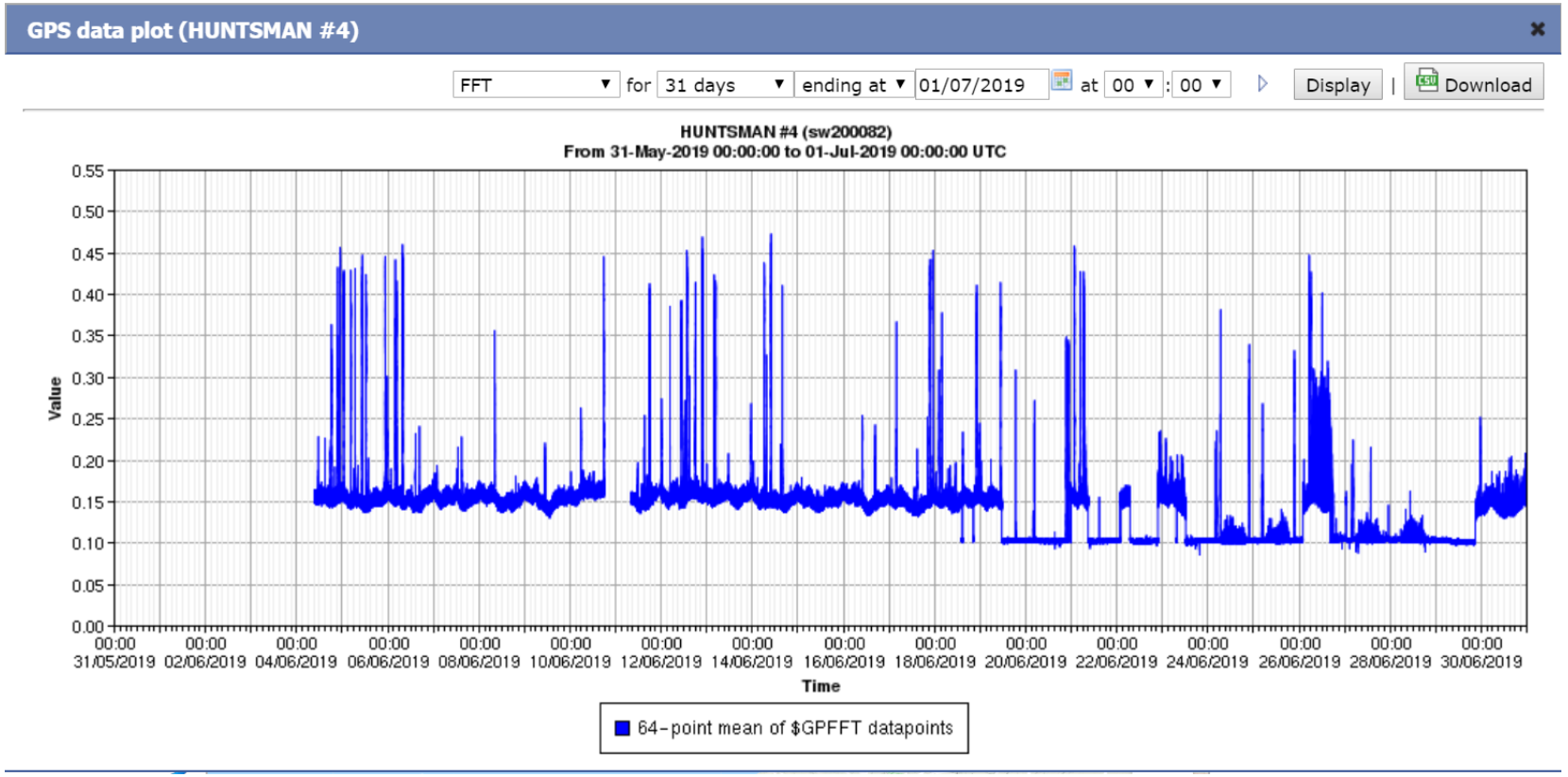
Long term monitoring - London

- FFT Power view is more interesting though.
  - Anything above 0.3 (an arbitrary linear scale) is probably a drive past jammer.



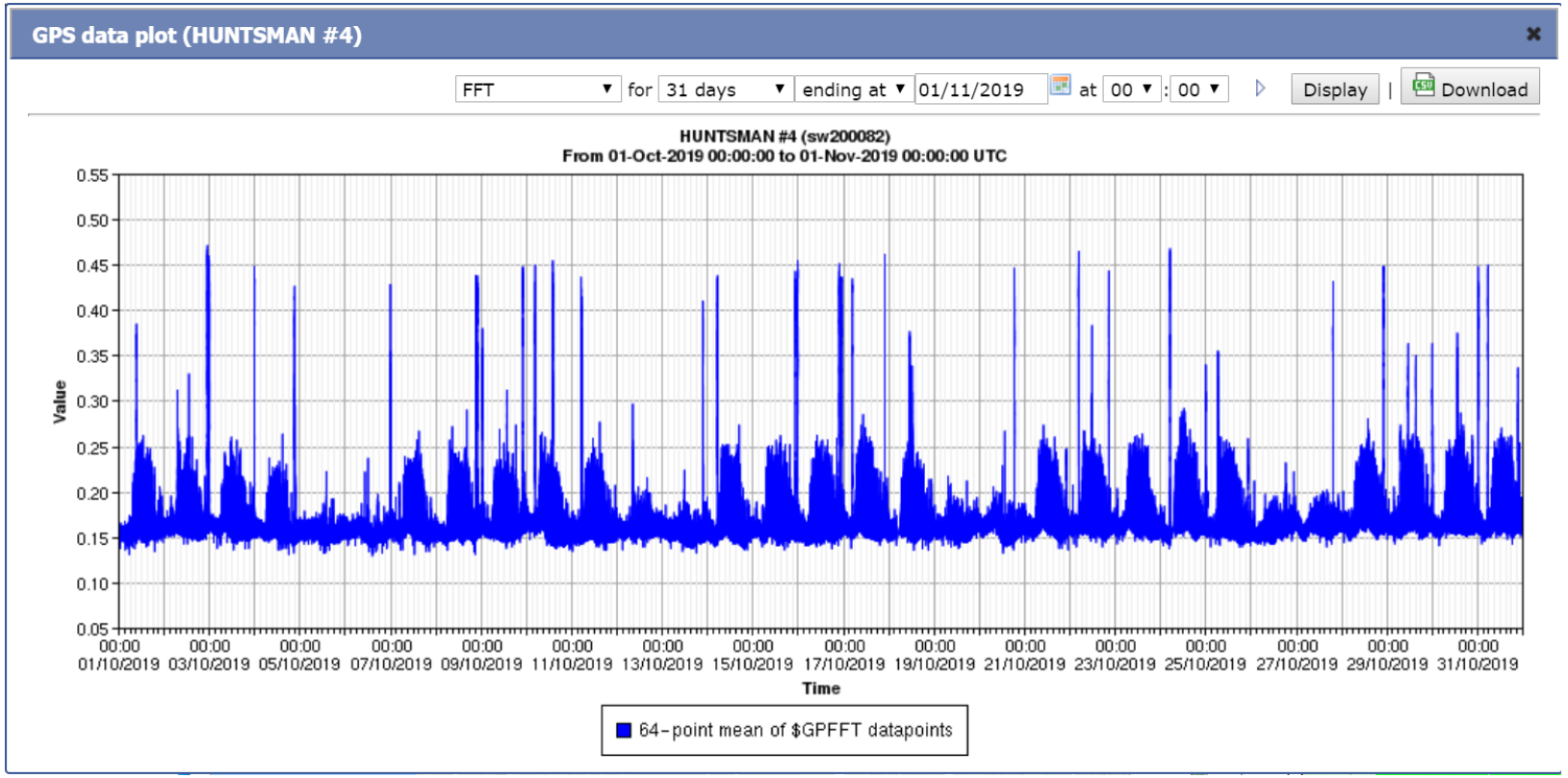
Long term monitoring - London

- FFT Power view is more interesting though.
  - June is confusing though
  - State visit by Donald Trump at the start



Long term monitoring - London

- Post June is more interesting.
  - Clear weekday disturbances
  - If anybody has seen similar increases in L1 band noise, I would be interested.



Position Resilience

- Maintaining course and speed information is critical
  - Road vehicles already do this really well counting pulses from the braking ABS systems on each wheel
  - For Road vehicles, changes of direction can be correlated with cartography information. Good and up-to-date cartography essential
  - For Off Road this won't work due to lack of suitable mapping and wheel slippage on rough terrain
  - Other solutions required

Position Resilience (maritime)

- First you must realise that GNSS is under attack
  - For spoofing this may not be obvious as discussed earlier
  - Course and speed however should largely align with other navigation aids.
  - Ships are slow, so there is time to spoof
  - Recovery can take between 12 – 30 minutes depending on the receiver type
  - Spoofing during poor visibility is the greatest risk.
  - Jamming not such an issue as that is always apparent

Solutions

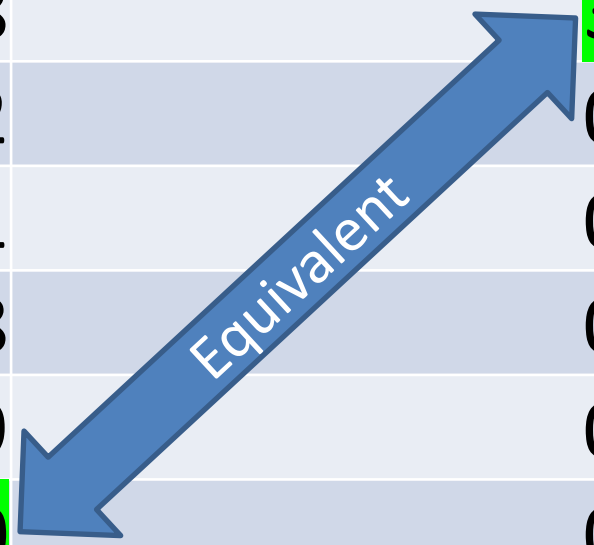
- For static timing it is relatively simple
  - Detect the GNSS event and switch to an alternative source or local oscillator
    - This could be rejecting a bad GNSS constellation in the case of system failure. Not that it ever happens!
    - Cost rapidly increases though the longer you wish to holdover for.
      - TCXO to OCXO to Rubidium to Caesium to ???
  - Detecting the event to allow switching to an alternative source is the hard part
    - Apparent motion is a good indicator
    - Assumes we know all of the available spoofing mechanisms
    - Look for GNSS subframe inconsistencies

Solutions

- A GNSS Firewall is now available with a programmable anomaly detector that validates the GPS subframes for spoofing incidents based on defined data validation rules. The Firewall detects suspicious time and position inconsistencies. As with traditional security firewalls, new validation rules are dynamically loaded into the GNSS Firewall as new threats are identified.
- Don’t forget to protect against equipment failure
  - GNSS Antenna can take a long time to fix!

Availability (Single or Dual system)

	Single system	Dual system
Availability	Minutes outage/year	Minutes outage/year
99.000%	3820	38.196
99.623%	One day - 1440	5.429
99.684%	1208	3.820
99.900%	382	0.382
99.950%	191	0.095
99.990%	38	0.004
99.995%	19	0.001
99.999%	3.820	0.000



Solutions

- For position it is relatively complex
  - The same detection problems occur, but can’t use motion without comparison to other sources
  - Need to be able to input other motion sensor inputs
  - Or assume constant vector and speed (Possible ok for Shipping)
- Whatever you do. It gets increasingly expensive
  - Normally an order of magnitude for level of improvement
  - Get this budgeted for. Coping with this as a surprise later is good for nobodies health!


Thank you for listening