THE GEMNET PROJECT - GNSS THREAT QUANTIFICATION IN THE UNITED KINGDOM

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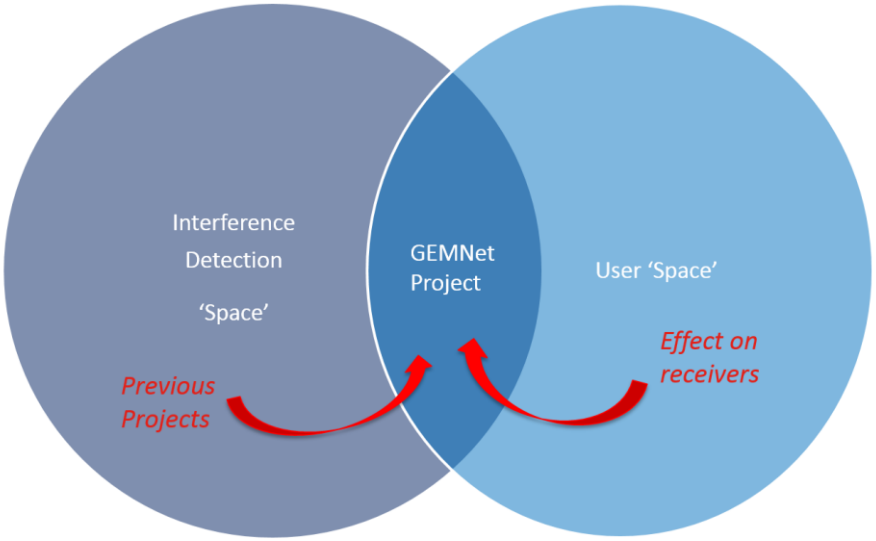
INTRODUCTION

- GEMNet was a collaborative project between Ordnance Survey the Satellite Applications Catapult.
- The Catapult is a not-for-profit, independent technology and innovation centre that connects businesses with the UK's research and academic communities
- There are many catapults for different areas of science, all of them overseen by Innovate UK which is the UK Government's agency for innovation.



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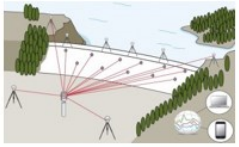
AREAS THAT COULD BE IMPACTED BY GNSS VULNERABILITY



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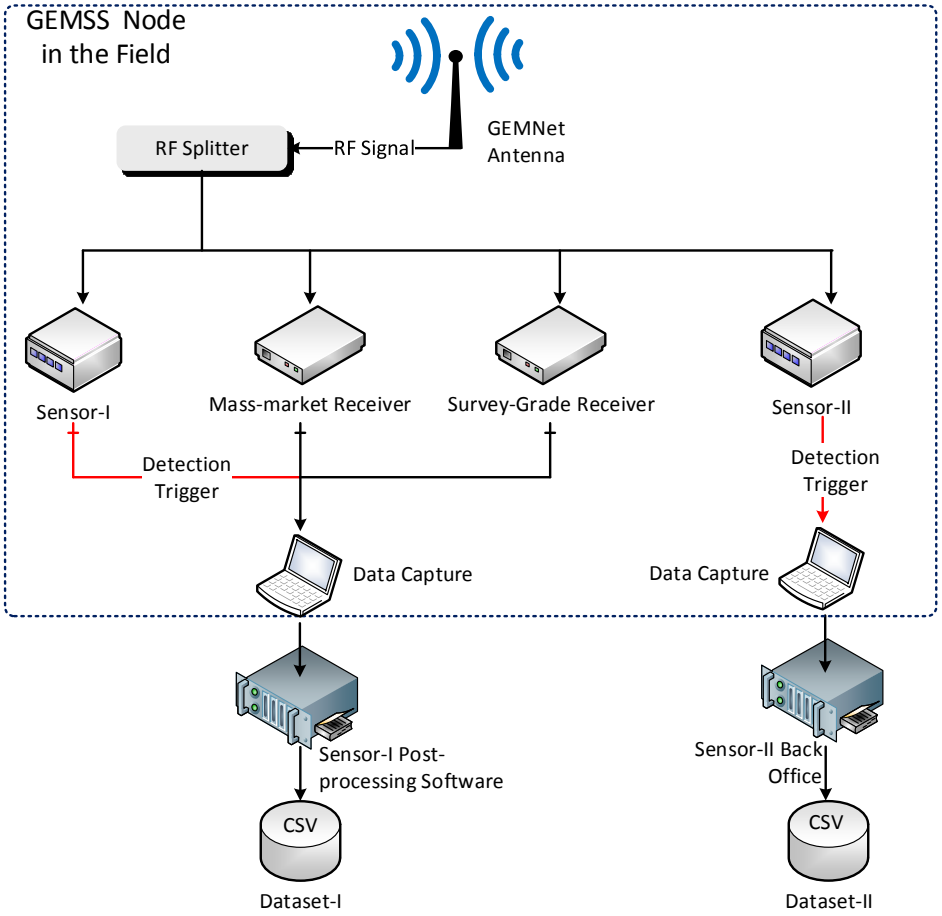
GEMNET SYSTEM DESIGN

- Monitor the GNSS radio spectrum at a number of UK locations in order to quantify the occurrence of jammers in operational environments;
- Capture “RF signatures” of jammers (both to understand the characteristics of threats, and to support aim 4 below);
- Assess the impact of jammers and other interference on operational GNSS receivers;
- Assess the impact that closer or more powerful jammers could have on GNSS receivers, i.e. different operational environments.



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DATA OUTPUTS

Device	Outputs to GEMNet Database
Sensor-1	12-bit In-phase (I) and Quadrature (Q) samples from the A/D Converter, Jammer-to-Noise (J/N) ratio estimation, Received Signal Strength Indicator (RSSI), Plots of the signal spectrum, spectrogram and histogram.
Sensor-2	Interference event reports, Interference classification, Normalised signal power, Plots of signal spectrum and spectrogram.
Survey-Grade Receiver	Carrier-phase positioning solution (L1/L2), Number of visible satellites, Cycle Slips, Geometric Dilution of Precision (GDOP).
Mass-Market Receiver	Code-phase positioning solution (L1 only), Number of visible satellites, Automatic Gain Control (AGC) voltage level, Jamming strength indicator.

SENSOR 1 RESULTS

Event Statistics		Impact on normal Receiver output parameters				
J/N Ratio [dB], Sensor 1	Number of Events [%]	Average Change (compared to 90 seconds before the event)				
		C/N_0 [dB-Hz]	Visible Satellites [%]		Horizontal Accuracy [cm]	
			Mass-market Rx	Survey-Grade Rx	Mass-market Rx	Survey-Grade Rx
≥5	10 [2 %]	↓1.3	↓ 1.9	↓ 8.1	↓ 3.0	↔
2 to 5	169 [29 %]	↔	↔	↓ 1.1	↑ 1.1	↔
1.76 to 2	406 [69 %]	↔	↔	↔	↑ 1.9	↔
Total	585					

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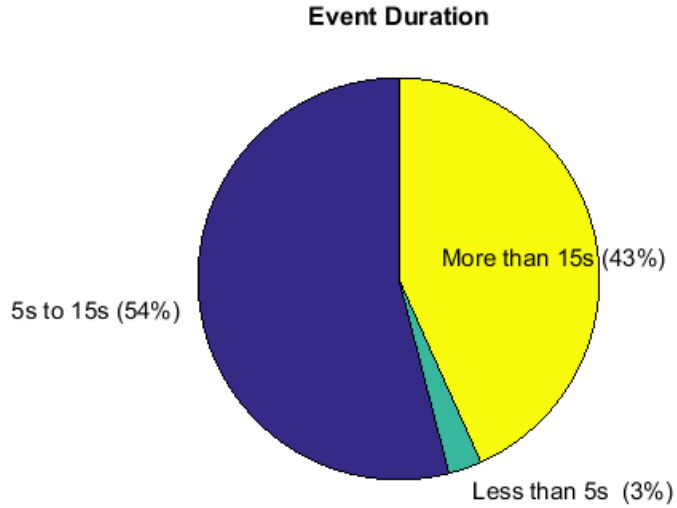
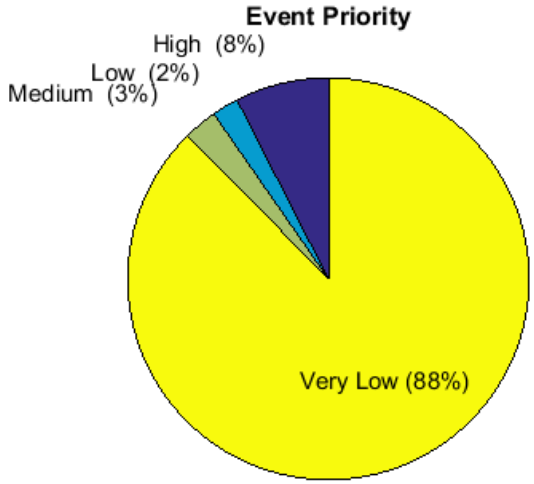
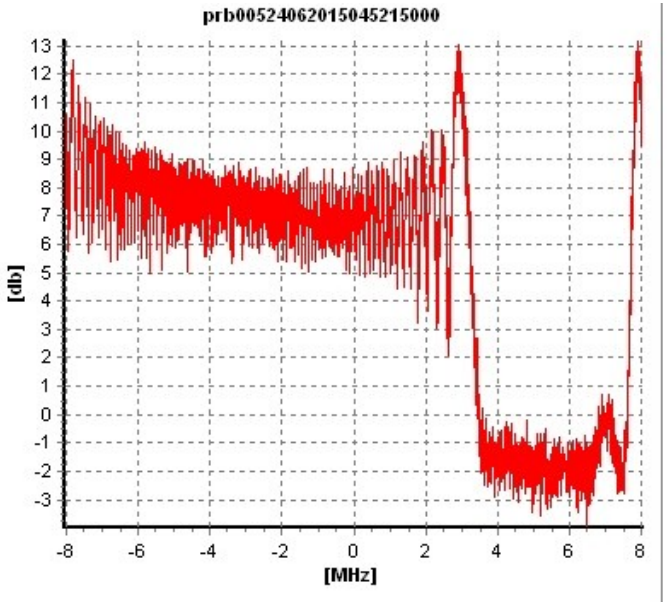
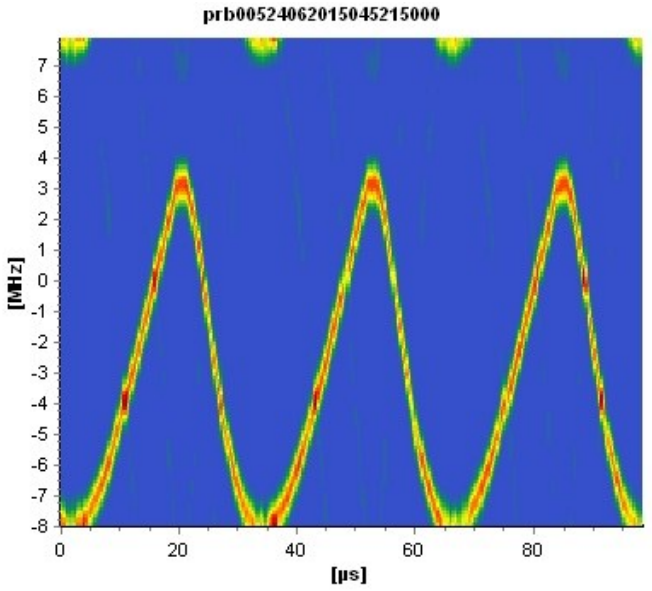
SENSOR 2 RESULTS









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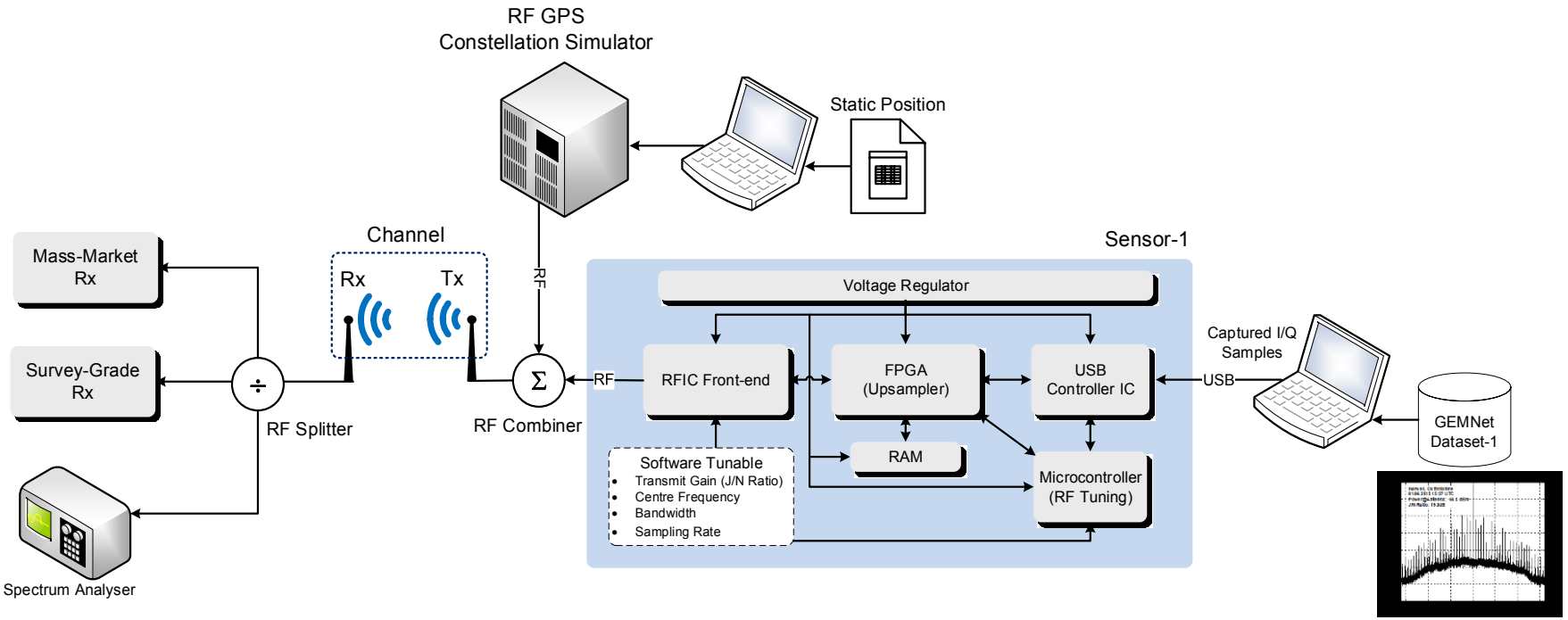
IMPACT OF HIGHER POWER INTERFERENCE ON GNSS RECEIVERS



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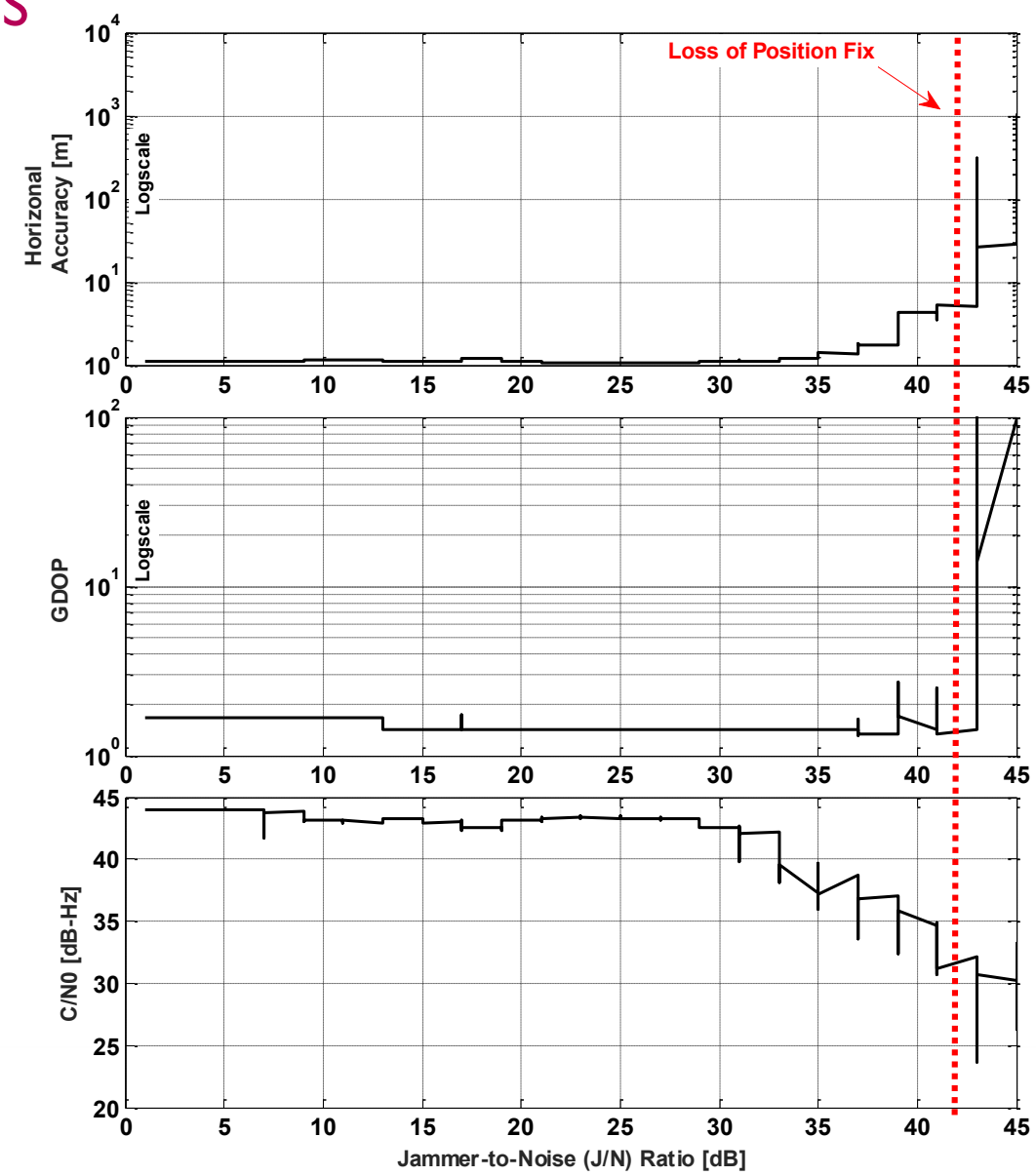
IMPACT OF HIGHER POWER INTERFERENCE ON GNSS RECEIVERS - RESULTS



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CONCLUSIONS

- Clear evidence of GNSS interference was collected
- Interference observed was of very low power
- Very occasional higher interference power
- Much of interference characteristic of deliberate low power jamming
- No discernible degradation in GNSS receivers
- HMI is possible
- Should operational jammers with 1000 times higher power than those operating today become common, then both mass market and survey grade GNSS receivers could often be compromised
- CNI sites may need better protection

RECOMMENDATIONS

- Strengthen and enforce legislation
- Standardise GNSS threat recording data parameters nationally and internationally, so that threat characteristics can be captured by platforms and detectors provided by multiple commercial vendors.
- Assess, and create a database of, the impact of identified interference threats on commercially available GNSS receivers

http://mycoordinates.org/gnss-threat-quantification-in-the-united-kingdom-in-2015/

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