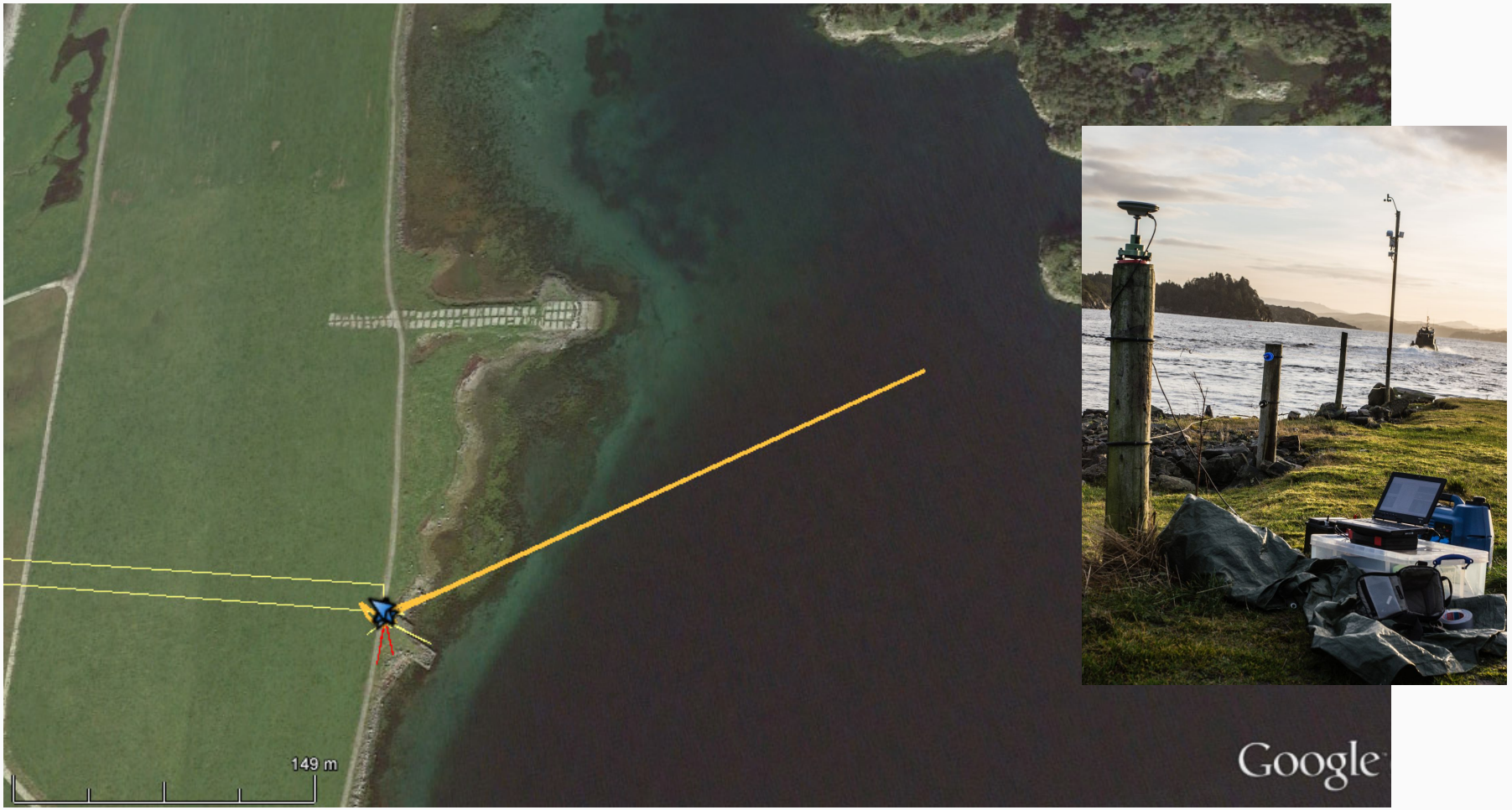
Jamming



Glomsvoll and Bonenberg, 2016

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Review of RAW GNSS Measurements

58th Meeting of the Civil GPS Service Interface Committee

Dr Lukasz K Bonenberg

24th September 2018

Nottingham Geospatial Institute, University of Nottingham
GSA RAW Measurements Task Force

Standing on the shoulders of the Giants

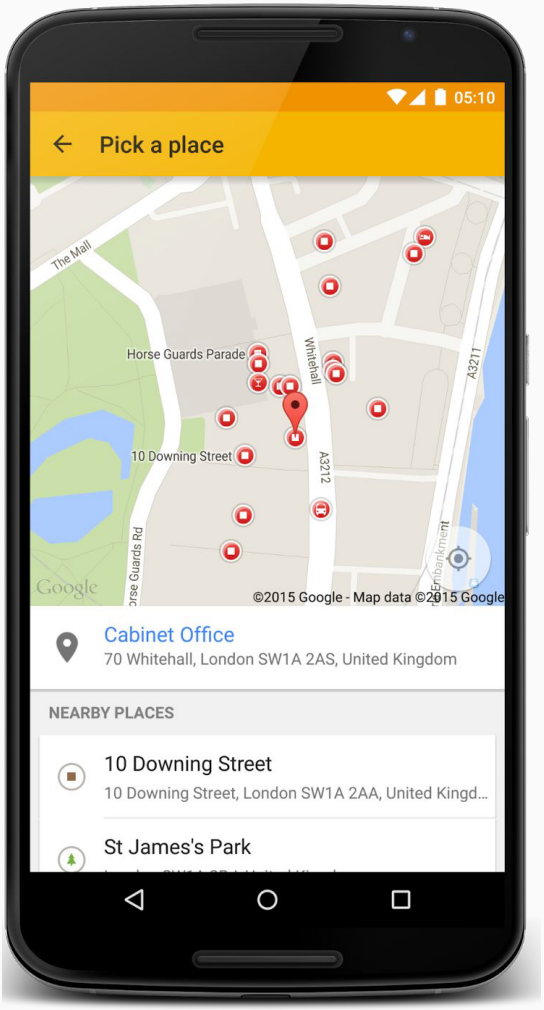
GRACE

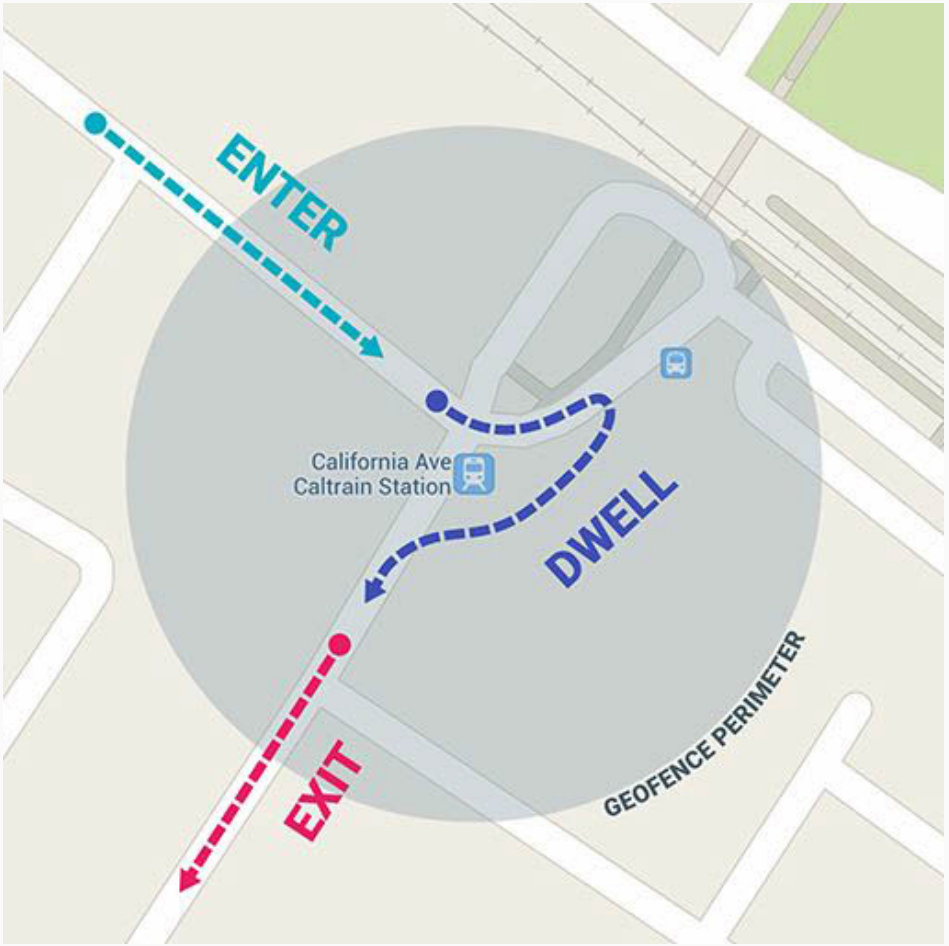
The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

- University of Nottingham
  - Simon Roberts
  - Oluropo Ogundipe
- GSA Task Force
  - Moises Navarro-Gallardo (Airbus)
  - Paolo Crosta (ESA)
  - Justyna Redelkiewicz-Musial (GSA)
- The Royal Norwegian Naval Academy
  - Oeystein Glomsvoll

Introduction to RAW GNSS

Google Play Services (android.gsm.location)





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android.location in Android 7.0+

Android Stack

Google Maps, Google Fit, GnssLogger

GOOGLE PLAY SERVICES

Places, Nearby
Activity Recognition,
Geofencing, FLP,

Sensors,
GNSS Raw Measurements

Abstraction to the physical Hardware

Physical Drivers

RAW GNSS Measurements are found here

GNSS, WiFi, BLE, and Sensor chips live down here

Google

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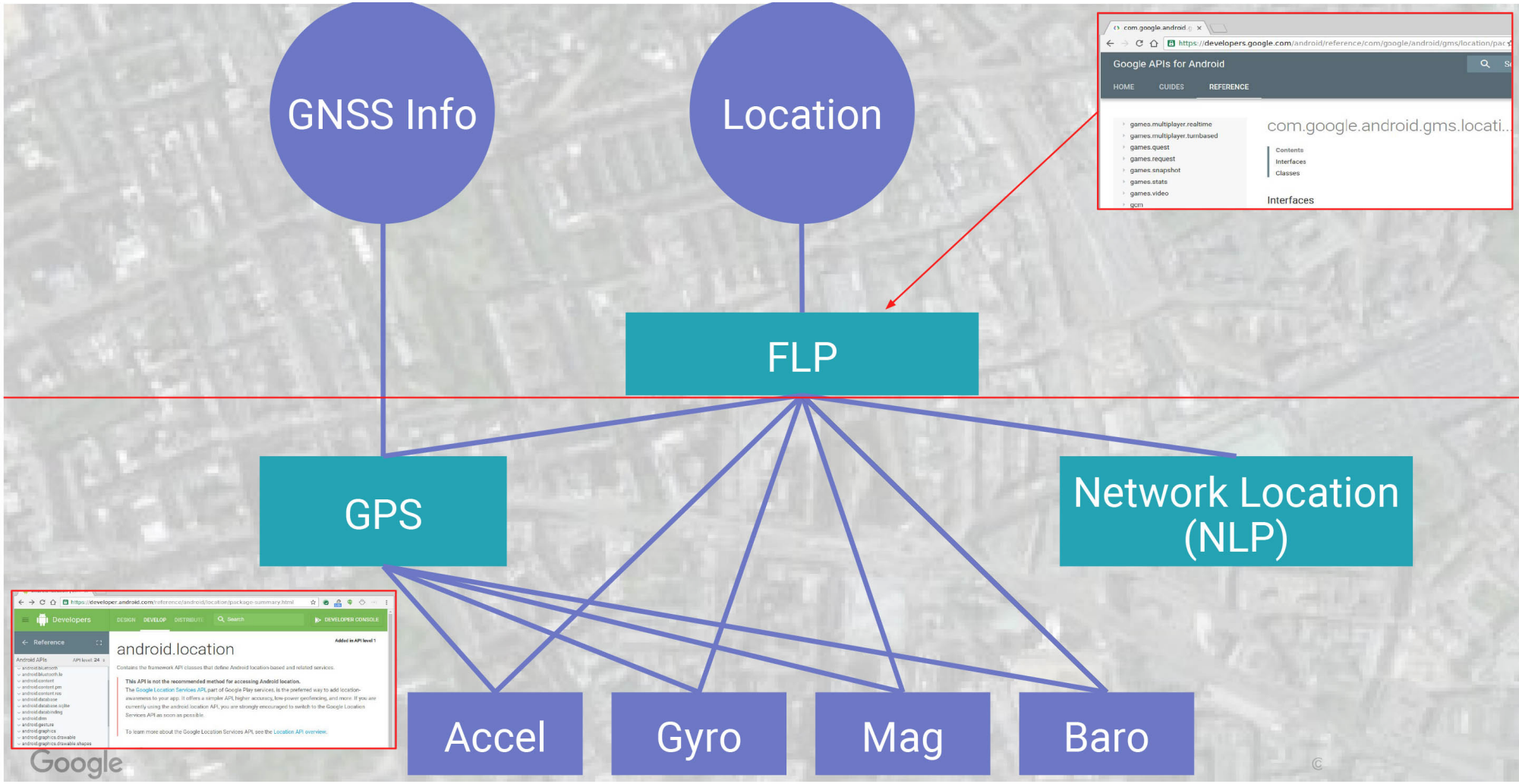
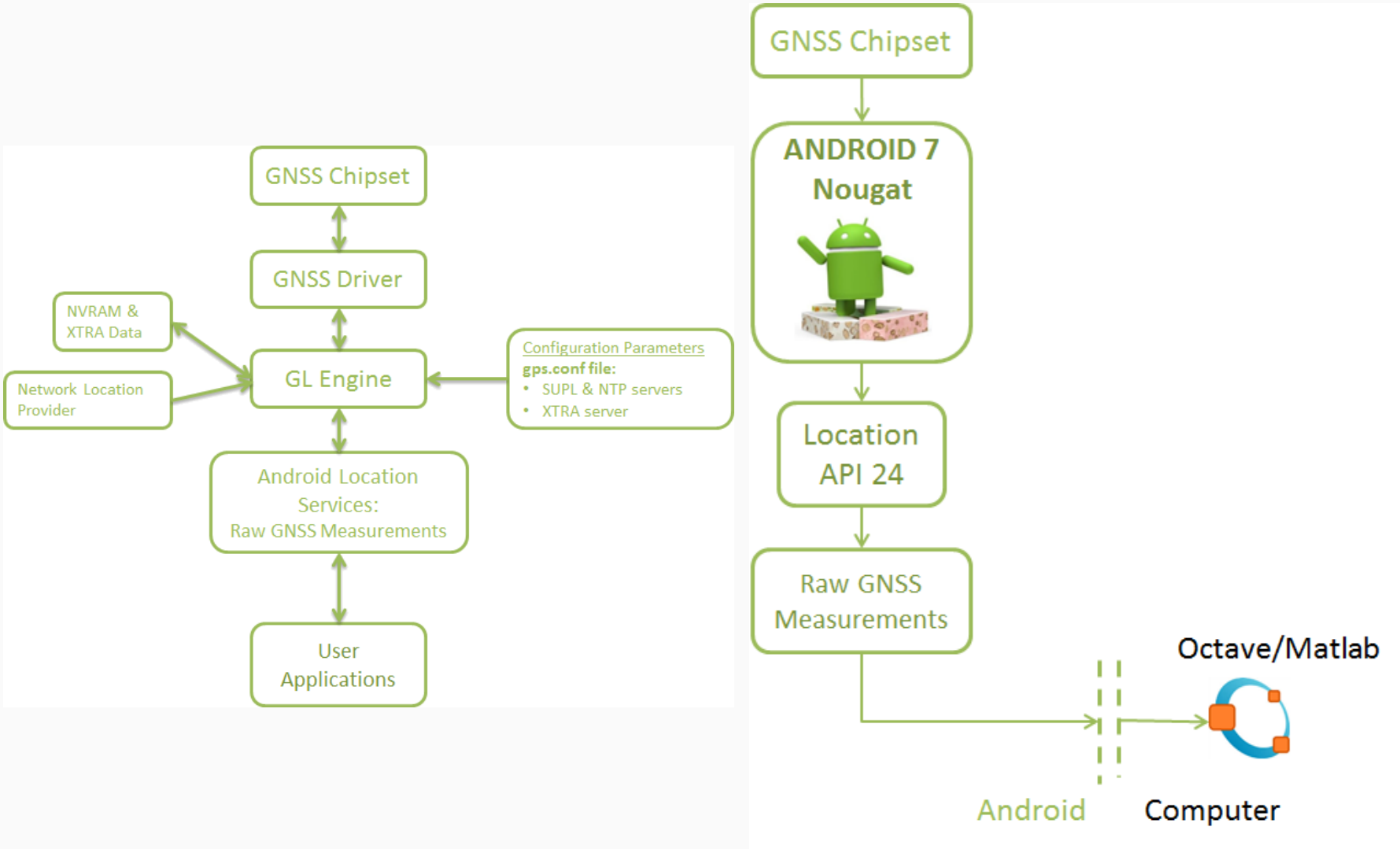
Fused location provider



Processing data



Hardware Limitations

- Simple linearly polarised antenna[1];
- Duty cycle affects carrier phase[2];
- Galileo constellation not fully implemented;
- Background application and UX issue, leading to large battery drain devices and overheating;
- Non-dedicated hardware[3], poor clock, self-interference and performance differences even between same models;
- Difference with internal PVT solution.

[1] T. Humphrey et al (2016) On the Feasibility of cm-Accurate Positioning via a Smartphone's Antenna and GNSS Chip.

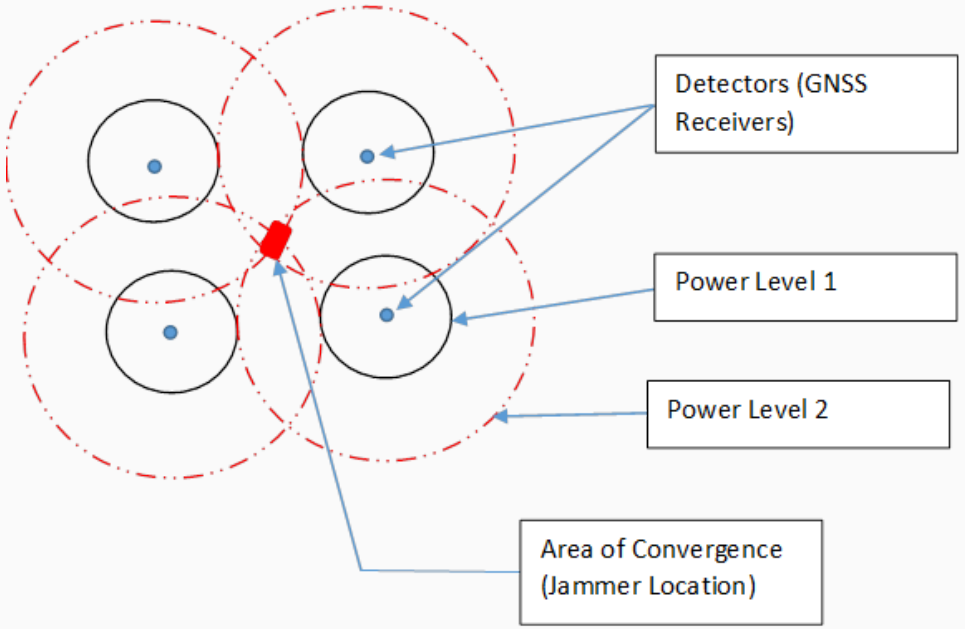
[2] Controllable in Android P developer options.

[3] Hardware 2016+ and APIv24+.

Jamming detection

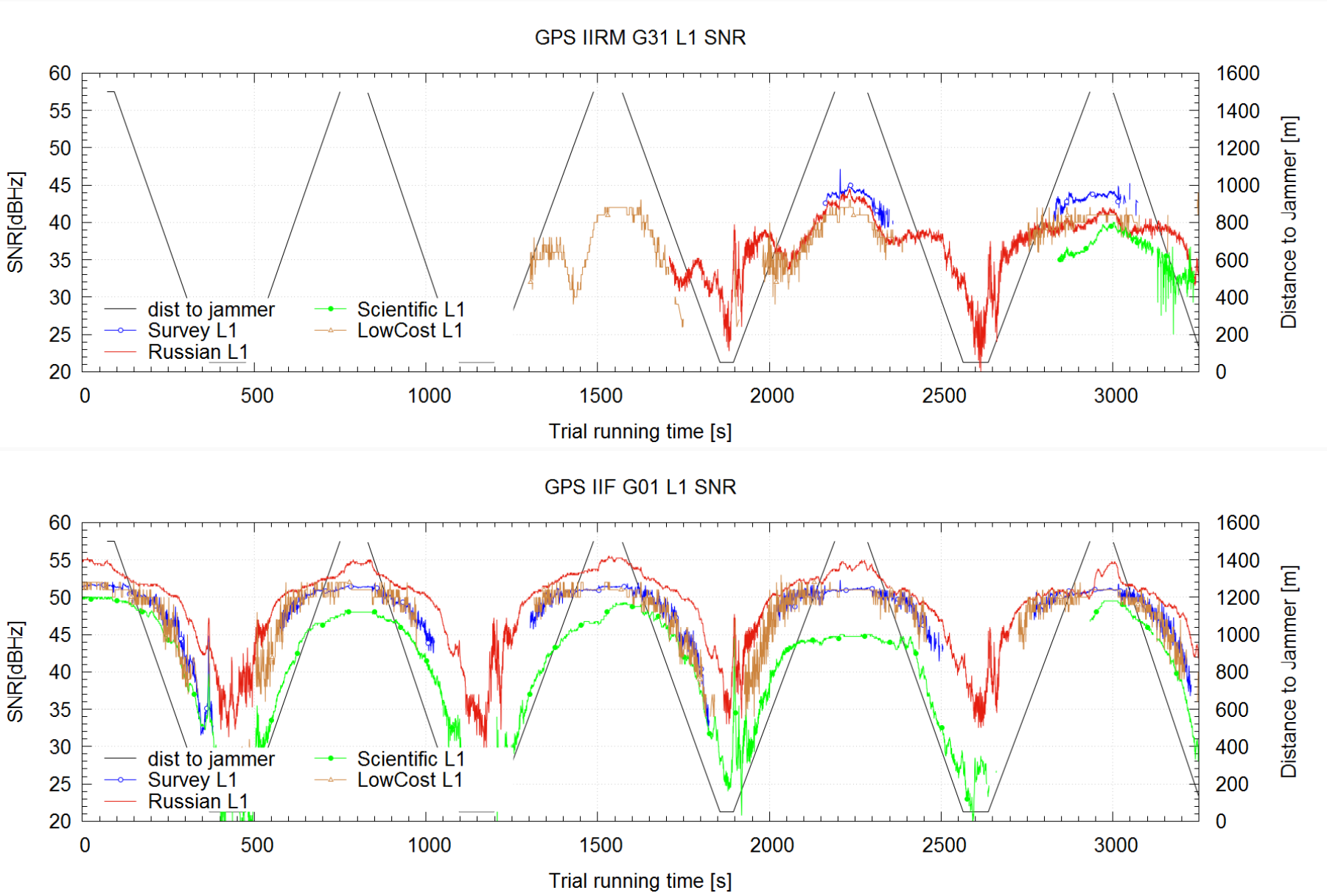
Factors influencing detection

- Jammer signal characteristics and power;
- Probe hardware and front end design, antenna;
- Differences between sensors;
- Terrain characteristics;
- Proper identification of the event;
- Probes distribution and known positions' accuracy.



Courtesy of Oluropo Ogundipe

Detection


GPS IIRM G31 L1 SNR
SNR[dBHz]
Distance to Jammer [m]
Trial running time [s]
dist to jammer
Survey L1
Russian L1
Scientific L1
LowCost L1
GPS IIF G01 L1 SNR
SNR[dBHz]
Distance to Jammer [m]
Trial running time [s]
dist to jammer
Survey L1
Russian L1
Scientific L1
LowCost L1

Multipath and urban canyons

Unsplash/CC0 Courtesy of Ms Alina Wang

Positional accuracy

	Planar Accuracy [m]		
	SPS	**DGPS**	**RTK**
Open Area	2.3	0.4	1.5
Urban-like MP	48.5	44.2	36.6
MP corrected[a]	3.1	2.4	7.8
MP corrected (GPS only)	15.5	10.9	3.1

Table 1: *Three minutes average of GPS+GLO PVT in different conditions*

[a] S. Roberts et al, 2017

Courtesy of Ge Shi

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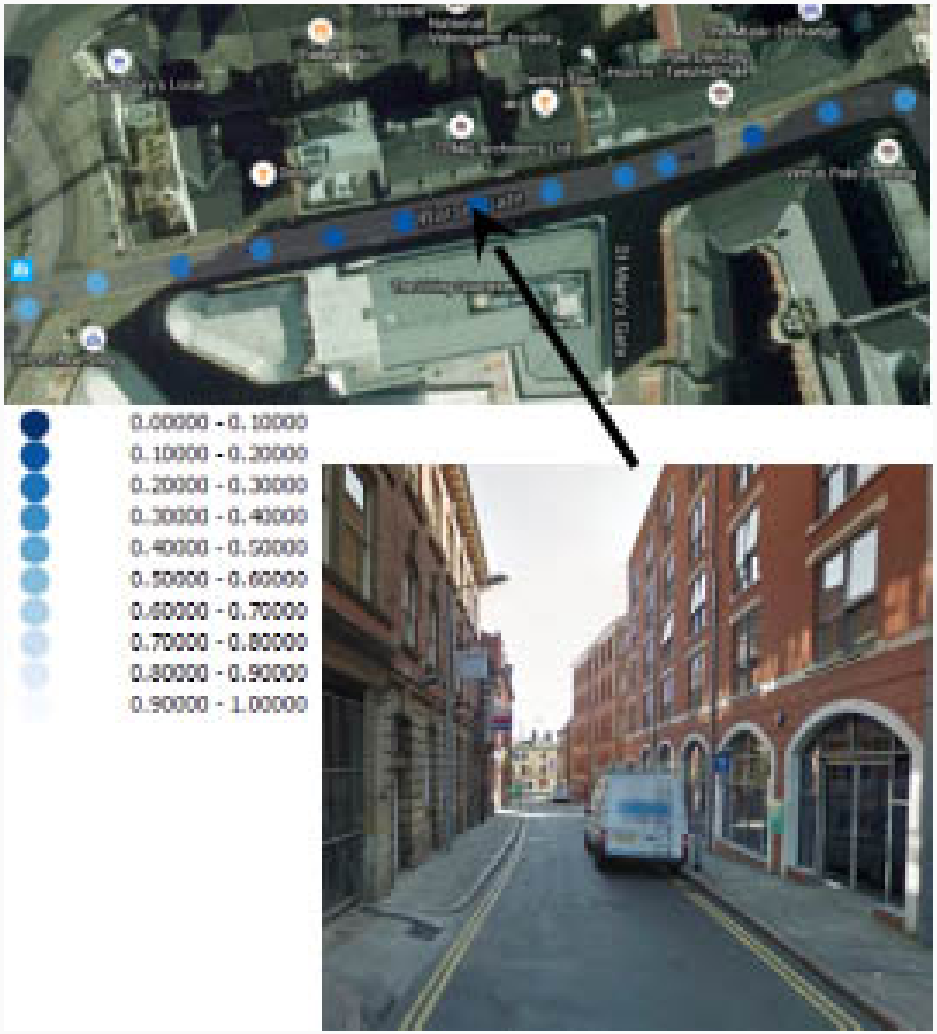
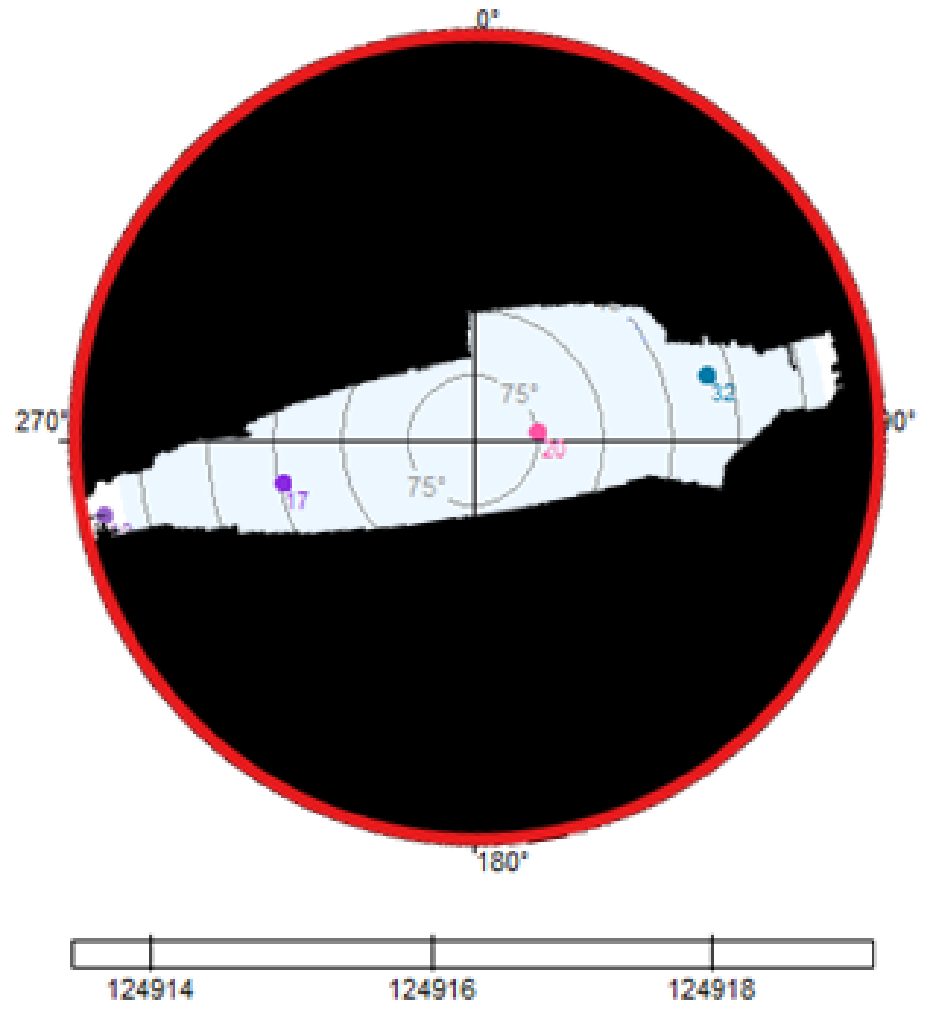
Predictive intelligence





S. Roberts et al, 2017

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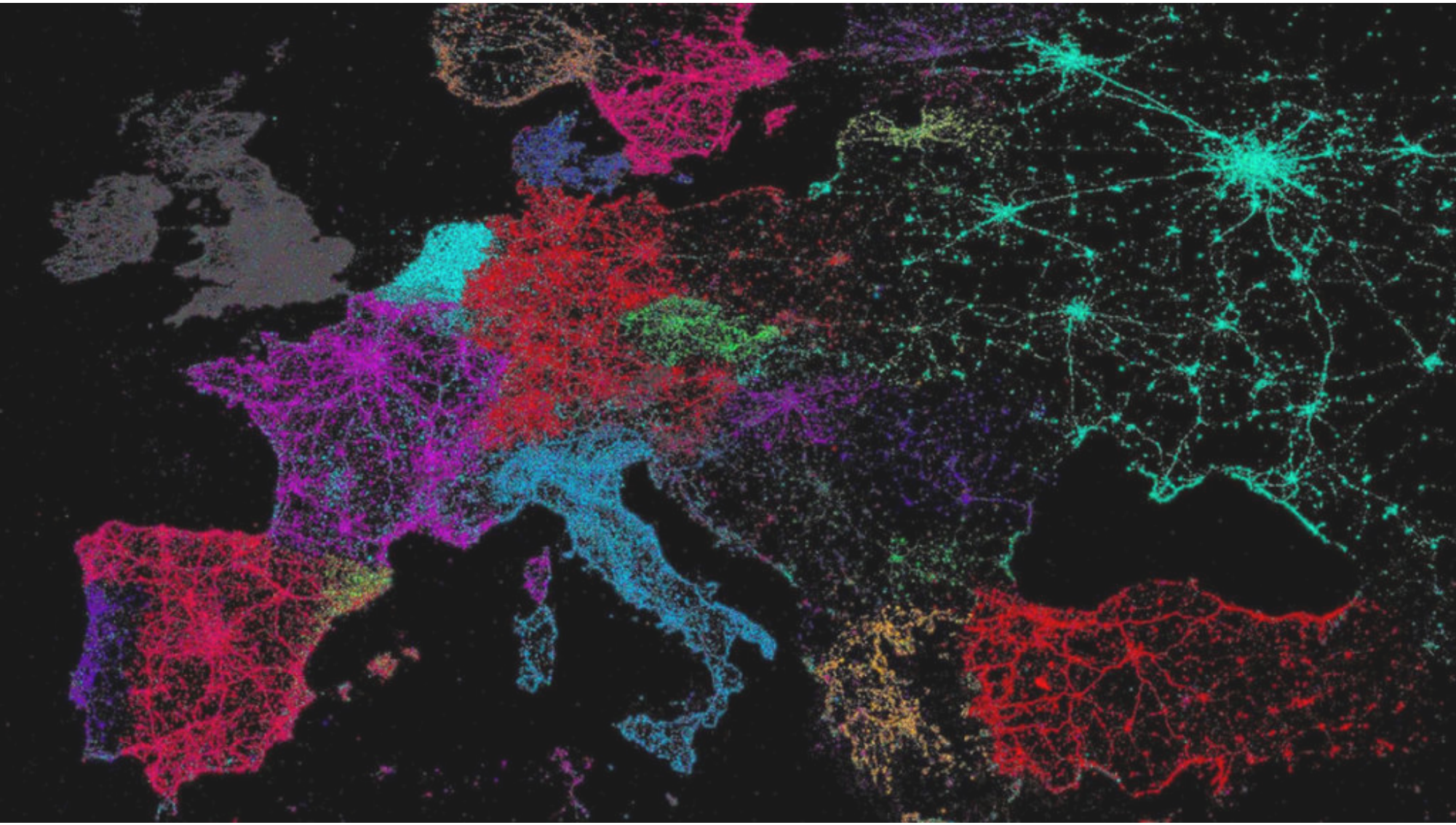
Sensors everywhere?

Interconnected



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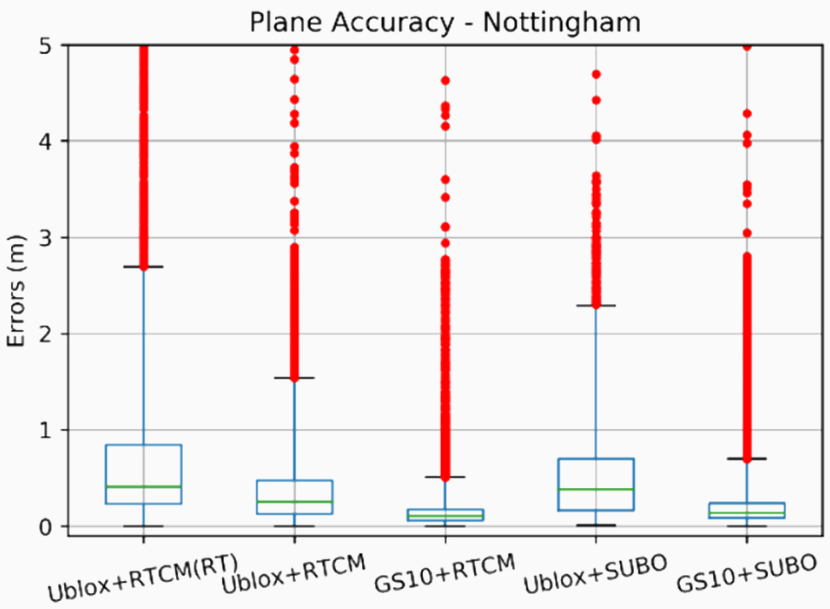
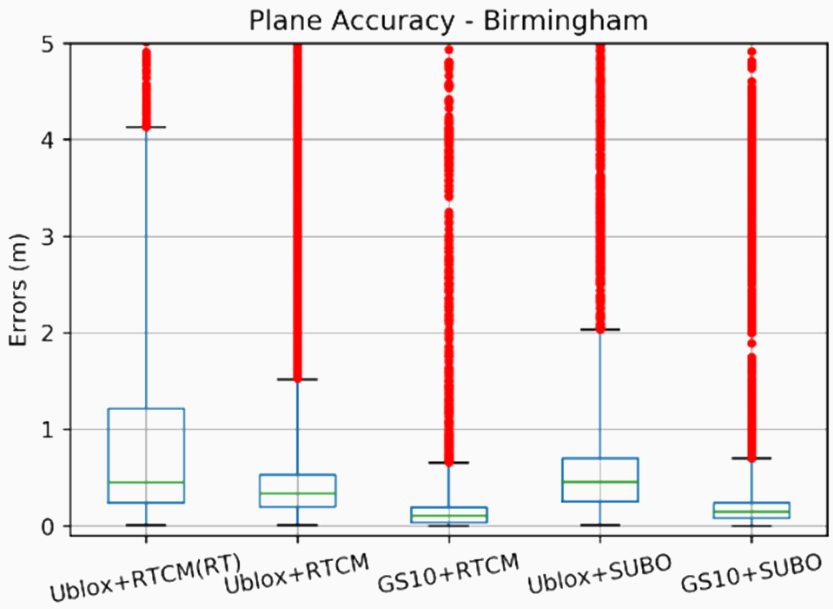
Differential correction





Communication channel effect on differential corrections in urban environment (planar accuracy)

Courtesy of Ms Alina Wang

Lukasz.Bonenberg@nottingham.ac.uk

Summary

What we discussed...

1. Introduction to RAW GNSS
2. Jamming detection
3. Summary

Take away

- Low cost hardware is limited in comparison with geodetic grade, and especially dedicated font ends;
- New developments are very promising, especially dual frequency and AGC. Let's start with proximity and then do distance and direction;
- Android offer an unique benefit of engaging and informing public as well as widening general community;
- Keep exchanging ideas, encouraging discussion with public.