FIG WORKING WEEK 2019
22–26 April, Hanoi, Vietnam
"Geospatial Information for a Smarter Life and Environmental Resilience"

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Emerging Applications Exploiting GNSS Receiver Networks (10166)

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BELS+ Special Session: Galileo - Status and Innovative Solutions for Precise Positioning

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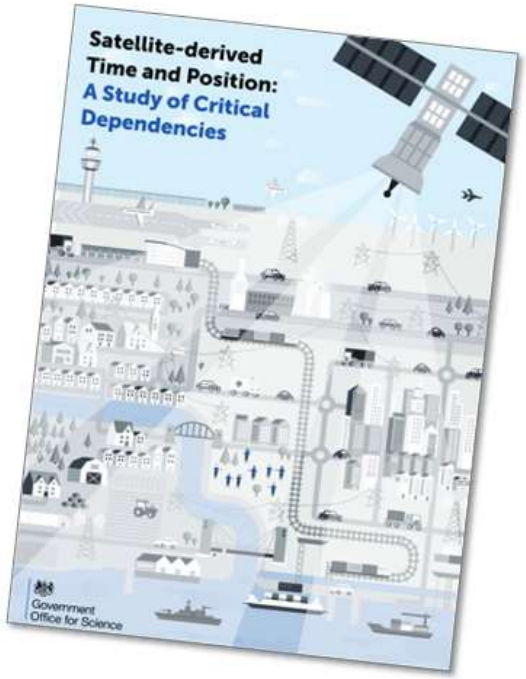
GNSS is critical to global economies...

Value at risk of loss of GNSS in UK is £5B over 5 days



The purpose of this report is to lay out the breadth, scale and implications of our reliance on GNSS

COLOSSUS

- Crowd-sourced platform for GNSS anomaly identification, isolation and attribution analysis

- Project sponsored by ESA under the Navigation Innovation and Support Programme (NAVISP)

esa
European Space Agency

- Start date: October 2017
- End date: March 2020.

Governments are using GNSS to support policy

Slovakia has experienced the largest extension of road tolling networks worldwide so far.

In addition to Slovakia, Germany, Switzerland and Hungary have successfully implemented GNSS-based tolling. Other countries are also leveraging the benefits:

- Belgium and Russia have launched similar projects implementing GNSS-based schemes.
- France, Finland, Bulgaria, Denmark, The Netherlands and Lithuania have all declared their interest in GNSS-based schemes.

Call

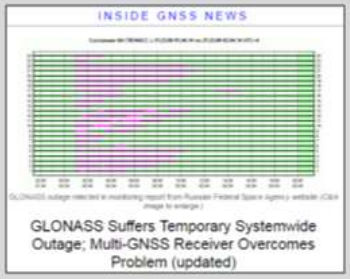
GNSS based road user charging

GNSS based Truck tolling

Offender monitoring

Fisheries Policy

Governments trust that GNSS works all of the time...



1. GNSS system issues

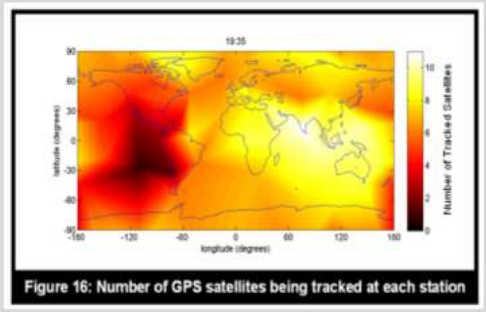
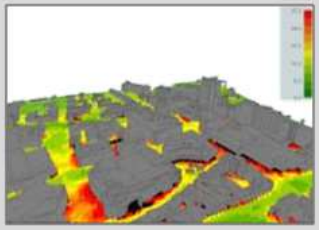


Figure 16: Number of GPS satellites being tracked at each station

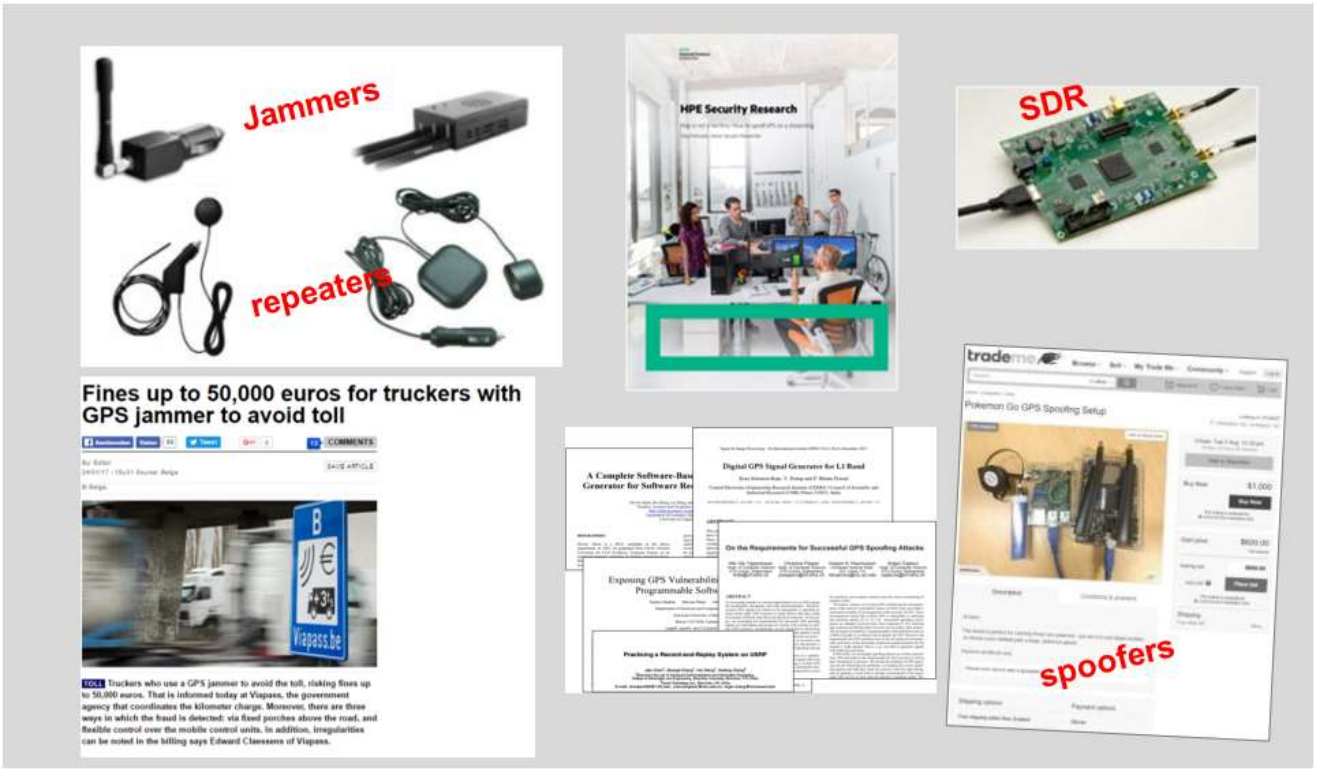
2. Solar Flare



3. Masking, obscurations and blockages

4. High ionospheric activity

There is an increasing awareness that GNSS in under threat...



COLOSSUS Concept

- COLOSSUS processes **crowd-sourced GNSS RINEX data** to identify, isolate and attribute GNSS faults and failures into causation groupings.

- COLOSSUS identifies common mode **GNSS** failures, **constellation** failures, **atmospheric** events and single satellite failures by persistent monitoring across all GNSS constellations and all GNSS frequencies throughout different geographical scales and receiver network densities.

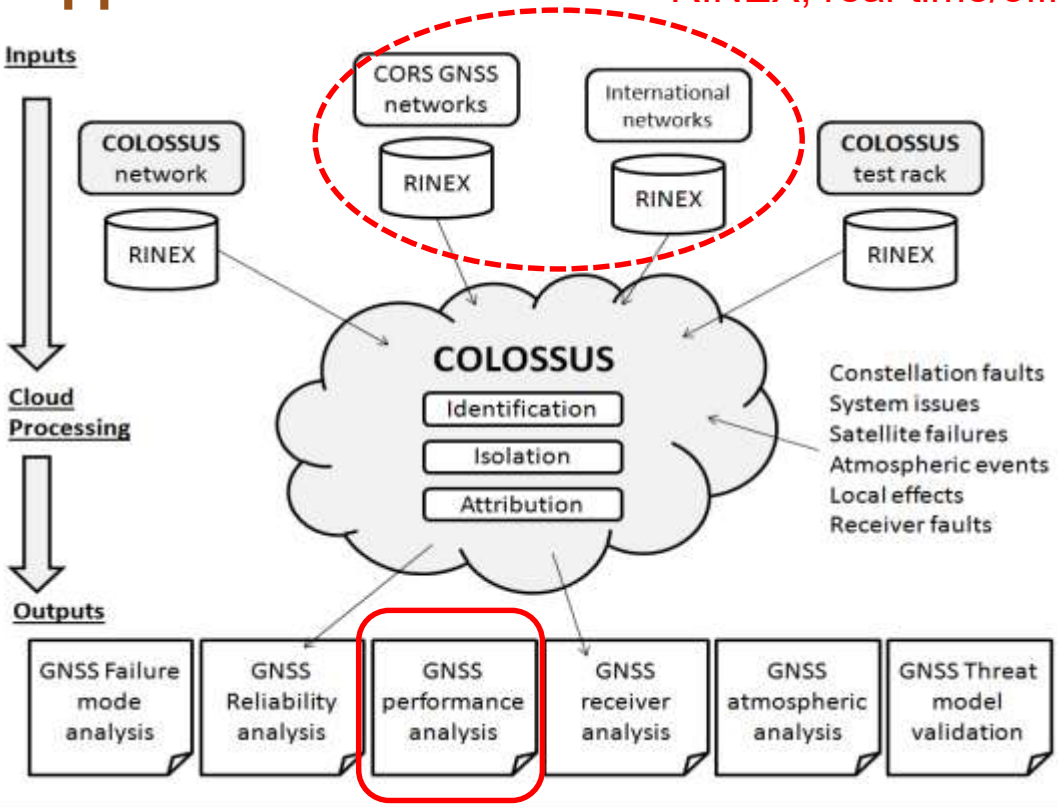
- COLOSSUS is able to identify inter-GNSS failures and inter-GNSS dependencies within GNSS receivers **by processing RINEX data from multiple GNSS receiver types**.

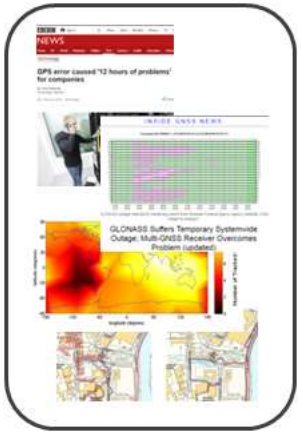
COLOSSUS Objectives

1. To be "scalable" to **any size of GNSS network**, any volume of GNSS data
2. To assemble and maintain a "**database**" of probabilities of occurrences of GNSS anomalies and the associated impact of faults, failures and events
3. To become **the "reference" for GNSS performance monitoring**, GNSS fault reporting, GNSS investigatory analysis and for the assembly and provision of GNSS incident reports, warnings/alerts and reliability statistics.
4. To understand **what "trust" to place in GNSS** and in doing so support the development of next generation GNSS applications

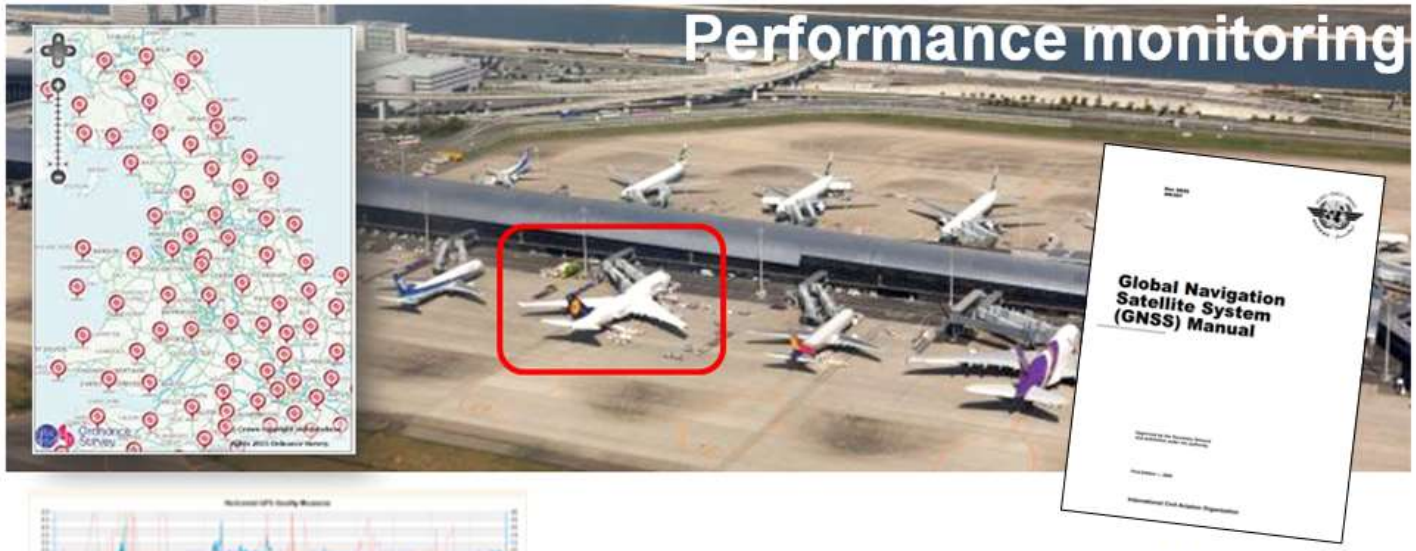
COLOSSUS Approach

10,000s receivers (local, regional, national)
multi-GNSS, multi-frequency, multi-receiver
RINEX, real-time/offline





COLOSSUS example: Civil Aviation



- Use of **Continuously Operating GNSS** networks
- Assessing performance of GNSS for airspace users
- Meeting International Standards (eg, ICAO)
- Accuracy, Integrity, Availability and continuity

FLAMINGO

Fulfilling enhanced Location Accuracy in the Mass-market through Initial GalileO services

What is FLAMINGO?

European Global Navigation Satellite Systems Agency

- FLAMINGO will be a high accuracy positioning service to be used by mass market applications
- Comprise architecture, services, positioning solutions and interfaces for easy integration
- 9-organisation collaborative venture with the best of European GNSS capabilities
  - PPP and RTK infrastructure, products, service provision and user solution
  - Use existing hardware
  - Expand precise services (RTK, PPP) to mass market
- We will demonstrate it's use and facilitate uptake
  - 3 city, long-duration demonstration events
  - Dedicated hackathon and participation in other hackathons
  - Supporting other initiatives, eg Task Force

NSL
TELESPAZIO a LEONARDO and THALES company
The University of Nottingham
ThalesAlenia Space
VVA ECONOMICS & POLICY
bq
ECLEXYS
BLUE DOT SOLUTIONS

3

Applications of FLAMINGO

- Comprehensive application analysis carried out within the project
- < 50cm accuracy was concluded as target for FLAMINGO

- Applications **enabled by FLAMINGO** (horizontal accuracy 10-50 cm)
- Applications **benefitting from FLAMINGO** (horizontal accuracy around 1m)
- Applications **with limited market size** (market size below 100,000)

How will it be implemented?

Client | Server

USER

High Accuracy User Position

SMARTPHONE
Raw meas

NMEA Position

RTCM Observations

SERVER POSITIONING ENGINE
PPP and RTK Processing
Hybridised Processing and Filtering
Real Time using RTCM

NMEA Position

RTCM Observations

RTCM Products

DEVICE POSITIONING ENGINE
PPP and RTK Processing
Hybridised Processing and Filtering
Real Time using RTCM

RTCM Products

FLAMINGO CASTER

RTCM Products

DATA PRODUCTS
FLAMINGO Reference Stations
FLAMINGO Correction Products
Other Reference Solutions

CORS

H2020-GALILEO-GSA-2017-1, FLAMINGO, Project 776436

9

Challenges of FLAMINGO

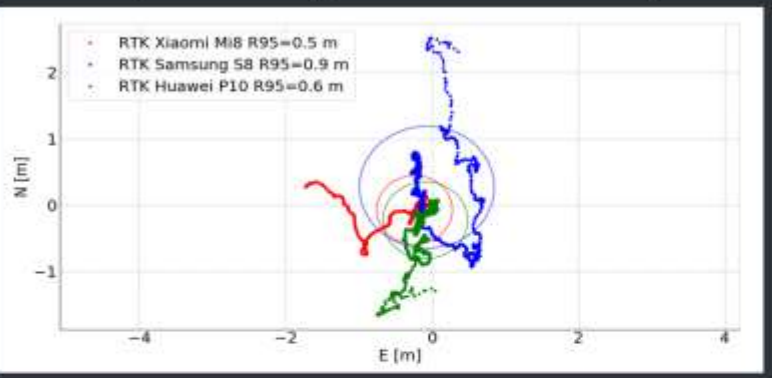
- Demonstrate these challenges with three smartphones using GPS, GLONASS and Galileo
- Xiaomi Mi 8 (DF)

Huawei P10 (SF)

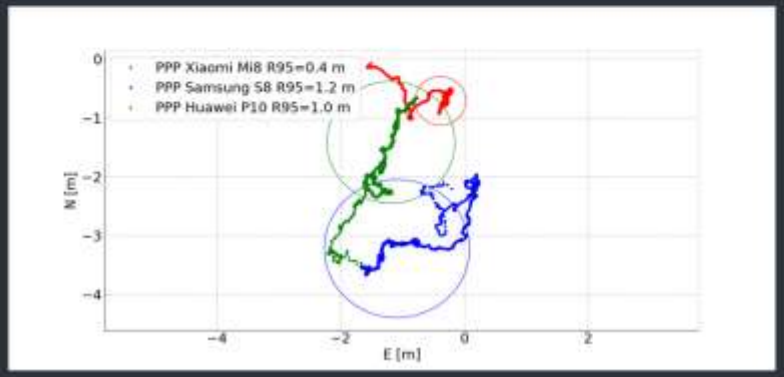
Samsung S8 (SF)

Comparative Single Frequency Solutions (RTK&PPP)

RTK



PPP



15

rinex ON

Enables users to access and records GNSS raw observables from enabled smartphones

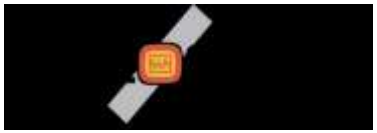
Available on **Playstore**

H2020-GALILEO-GSA-2017-1, FLAMINGO, Project 776436

FLAMINGO Conclusions

- FLAMINGO addresses the high accuracy need in the mass-market, inspiring a range of new applications.
- Challenges of FLAMINGO are identified in terms of hardware limitations and user control over the device.
- Demonstrated the potential to achieve high accuracy positioning using Smartphone hardware
- Substantial improvements are made to internal PVT solutions.
- Dual frequency produces very impressive results (lower multipath on all obs)
- Next steps are to implement a service and solution, to develop and demonstrate applications.

Conclusions



- GNSS is being used for a wide range of applications that require assurance of performance
- High precision GNSS is becoming available in low-end devices and smartphones
- Access to high precision GNSS is enabling new applications

- National mapping authorities who have invested in GNSS infrastructure (continuous operating receiver station networks) have new business opportunities to exploit their data and services.
  - Supporting **government agencies** in implementing GNSS applications
  - Supporting **emerging commercial applications**

thank you

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