ION GNSS+ 2018

Strap-down Multiconstellation GNSS+Sensors Navigation in Smart Devices

September 28TH , 2018

Session A5: GNSS Chipset Manufacturer Showcase

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gmv INNOVATING SOLUTIONS

OUTLINE

GNSS & Smartphones

magicGNSS Evolutions

Experimentation

Conclusions and Way-Forward

GNSS & SMARTPHONES

GMV IN PRECISE POINT POSITIONING

Algorithms

Services

Products

PPP Algorithms:

- Gap bridging
- Integrity bounds
- Hybridization

PPP Services:

- Real-Time PPP via NTRIP
- Regional Corrections
- Australian & New Zealand Testbed

magic PPP

2011
- Real Time GPS+Glonass PPP

2013
- On-line multiGNSS PPP (GPS, Glonass, Galileo, Beidou, QZSS)

2015
- Real-time Galileo PPP
- Real-time Multi-GNSS PPP
- SF PPP

2016
- PPP low-cost
- magicFAST

2017
- PPP for Smart devices and IMUs

2018
- DF PPP for Smart devices

Low-Cost PPP Enhanced by IMU Sensors

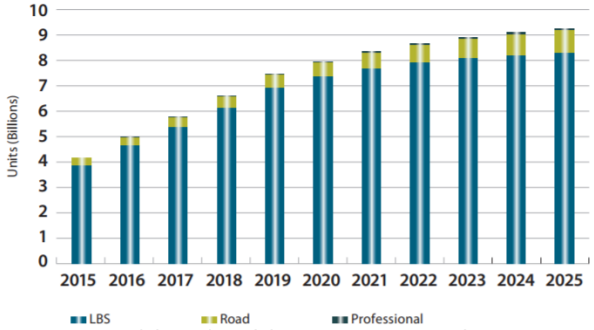
GNSS CHIPS FOR SMARTPHONES

- Low-cost GNSS in our daily lives:
  - Gmaps, Waze, Car Navigation, SportTracking…
  - Currently 6B devices and growing!
  - Smart-devices market is a huge pie
  - Renewal of devices allows to introduce new capabilities

- Smartphone GNSS chips are evolving:
  - Multi-constellation
  - Multi-frequency receivers is a reality
  - Reduced power consumption
  - Carrier-phase tracking
  - Fusion with other sensors (IMU, Compass)
  - Raw measurements provision

- Market Opportunity → Accurate positioning is possible for low-cost users.

Smartphones account for almost 80% of the global installed base of GNSS devices



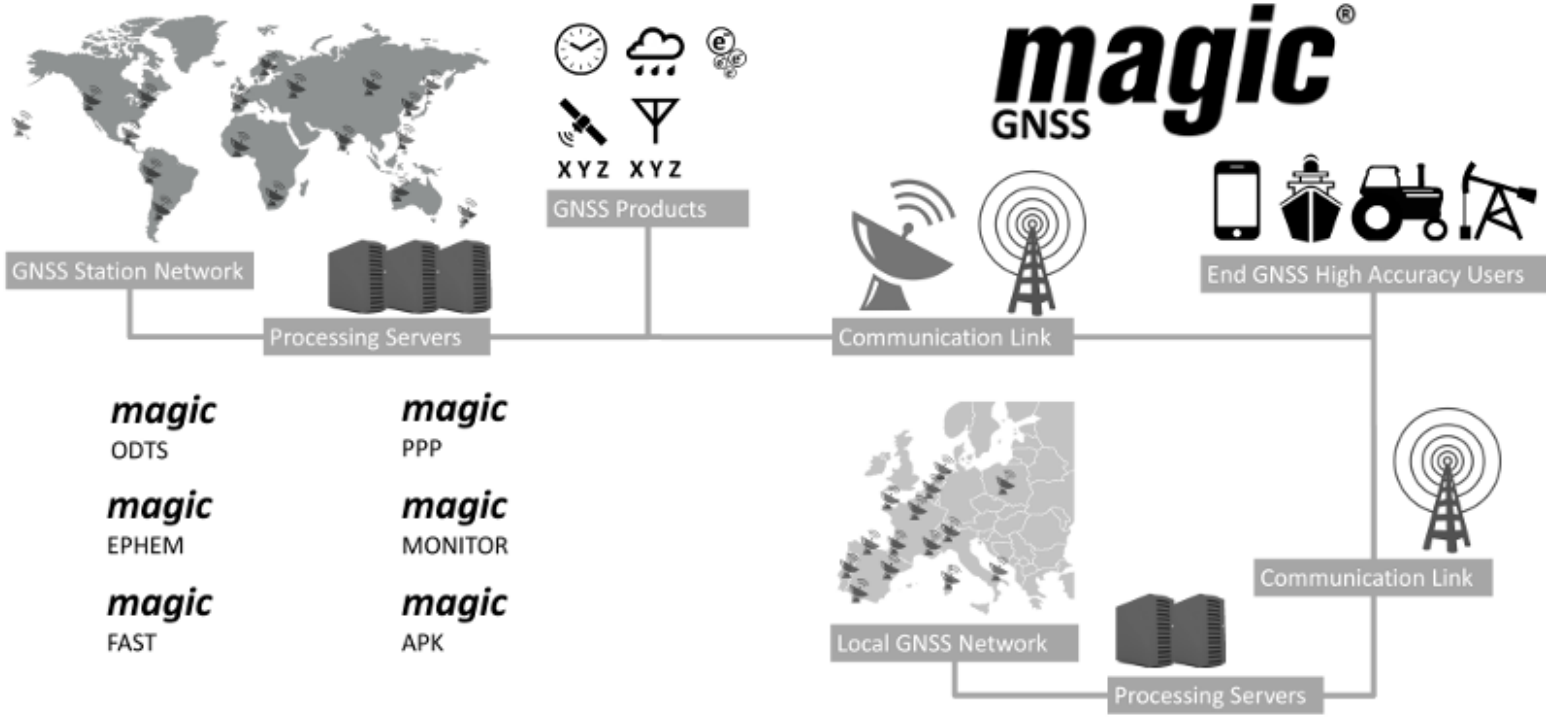
SOURCE: GSA MARKET REPORT

Low-Cost PPP Enhanced by IMU Sensors

magicGNSS EVOLUTIONS

magicGNSS' REAL TIME INFRASTRUCTURE

END-TO-END PPP SERVICE



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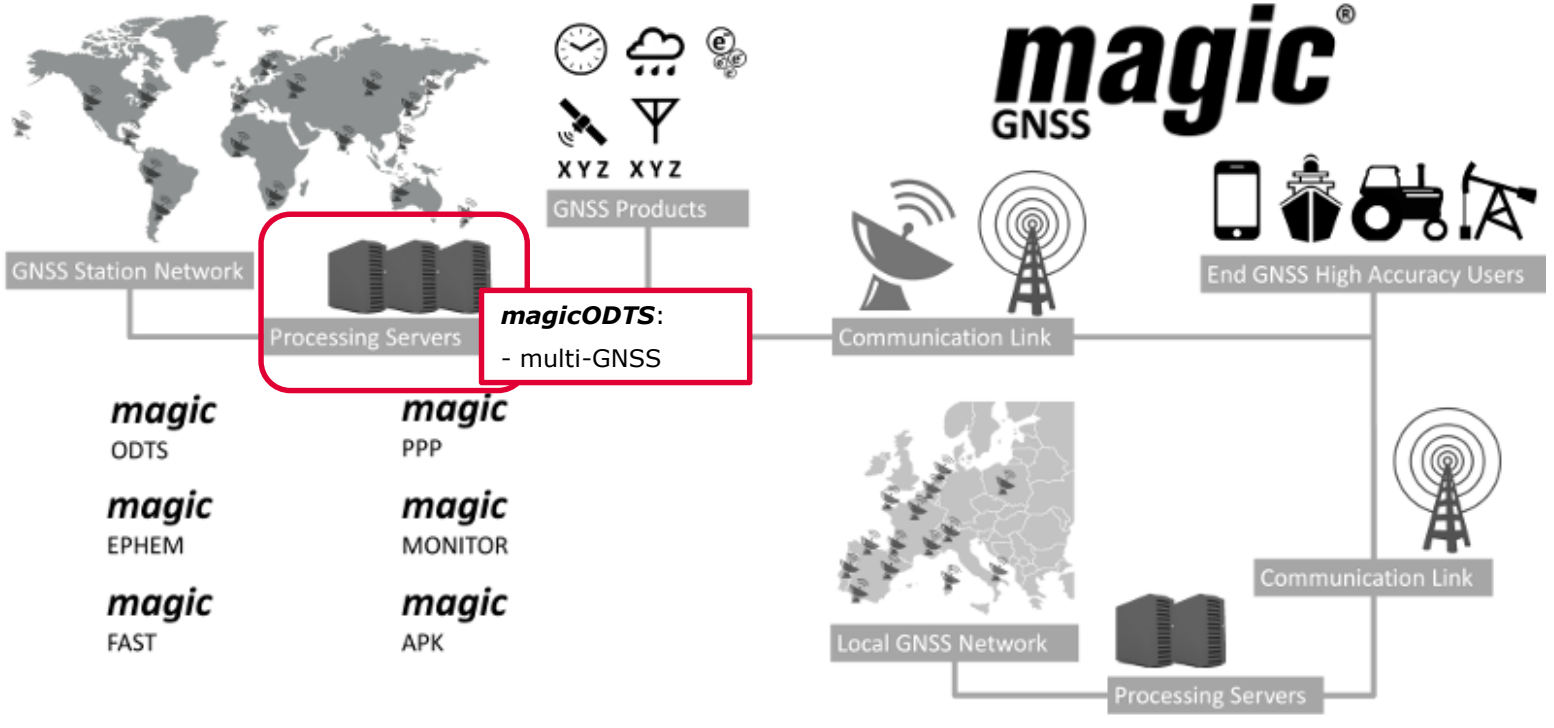
magicGNSS' REAL TIME INFRASTRUCTURE

UPGRADES FOR LOW-COST PPP



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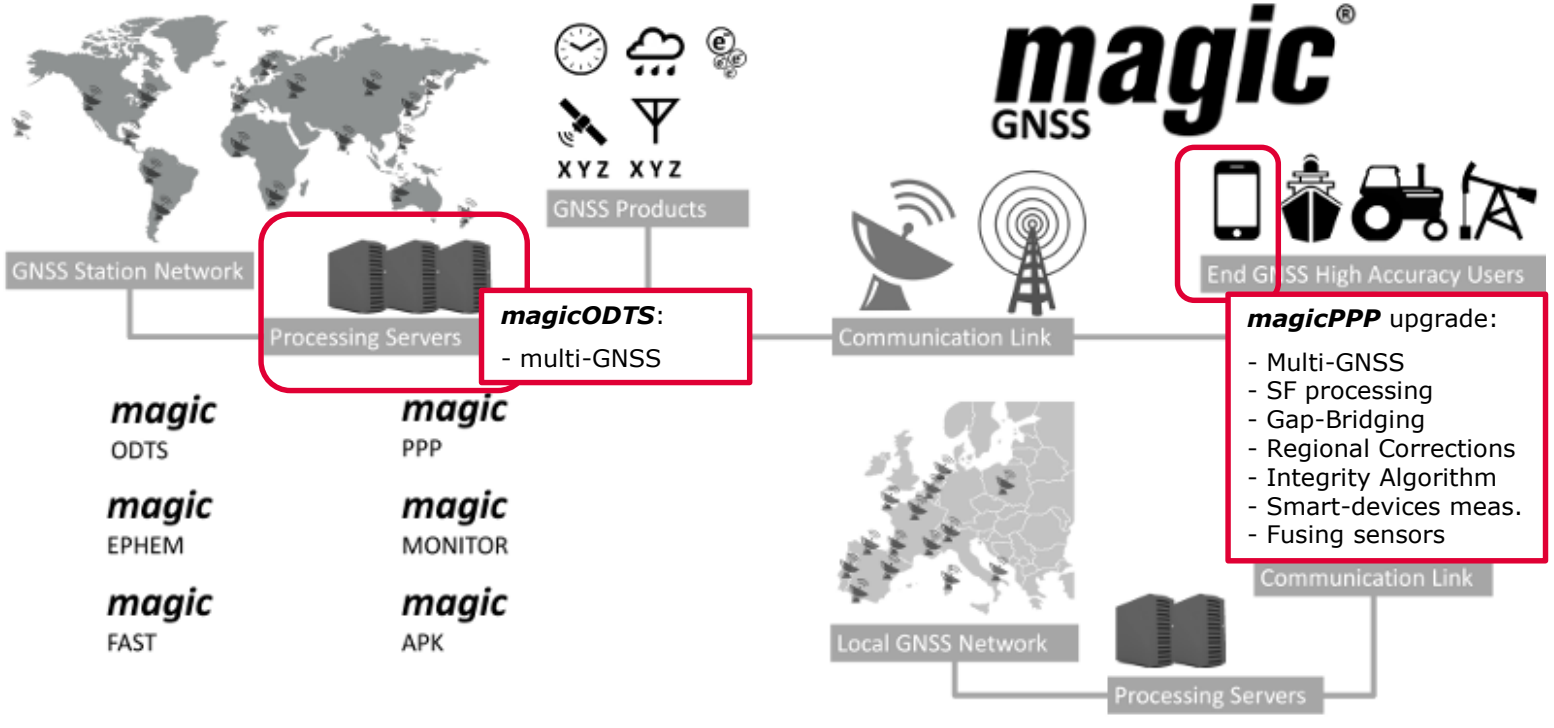

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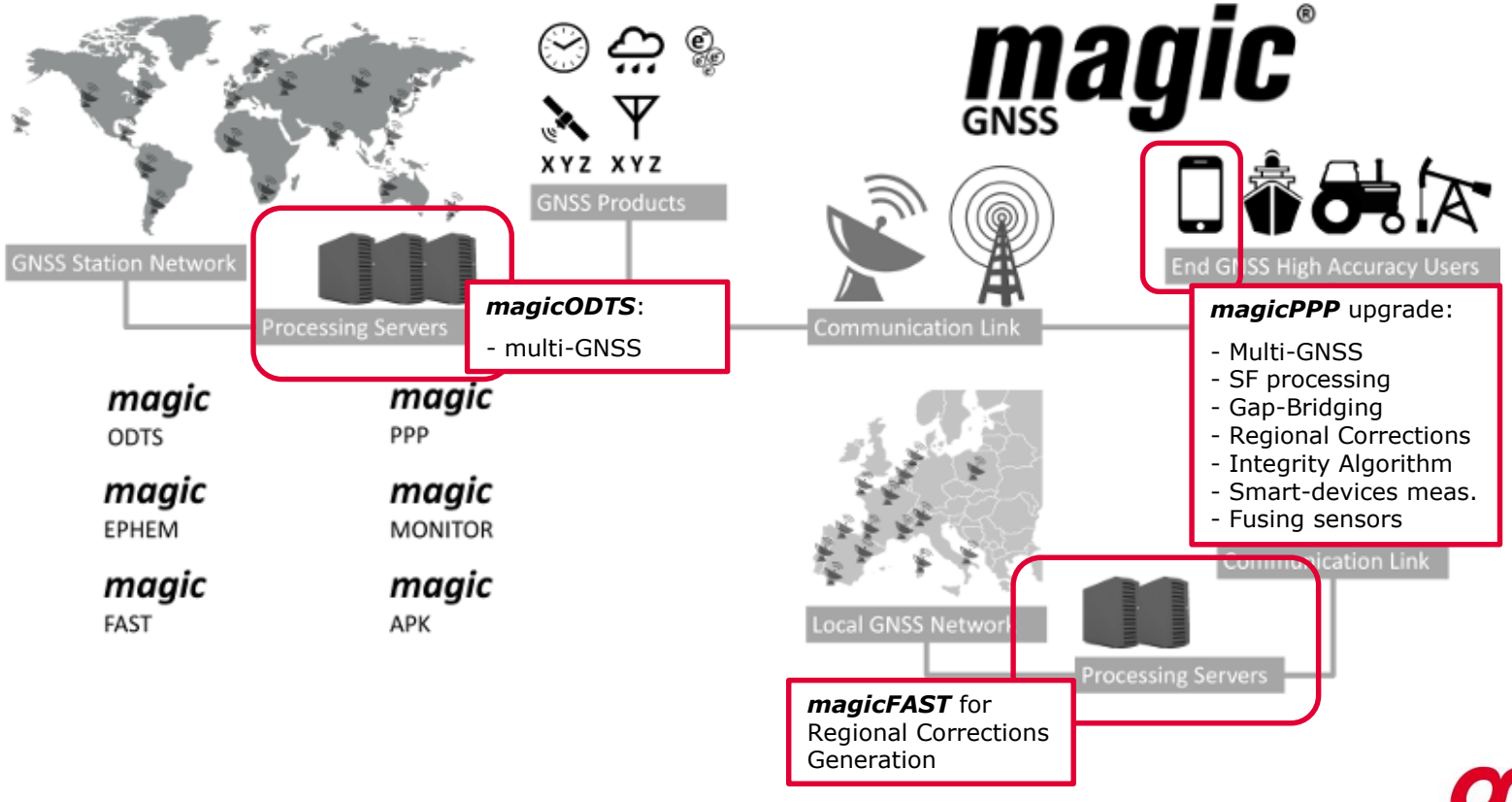

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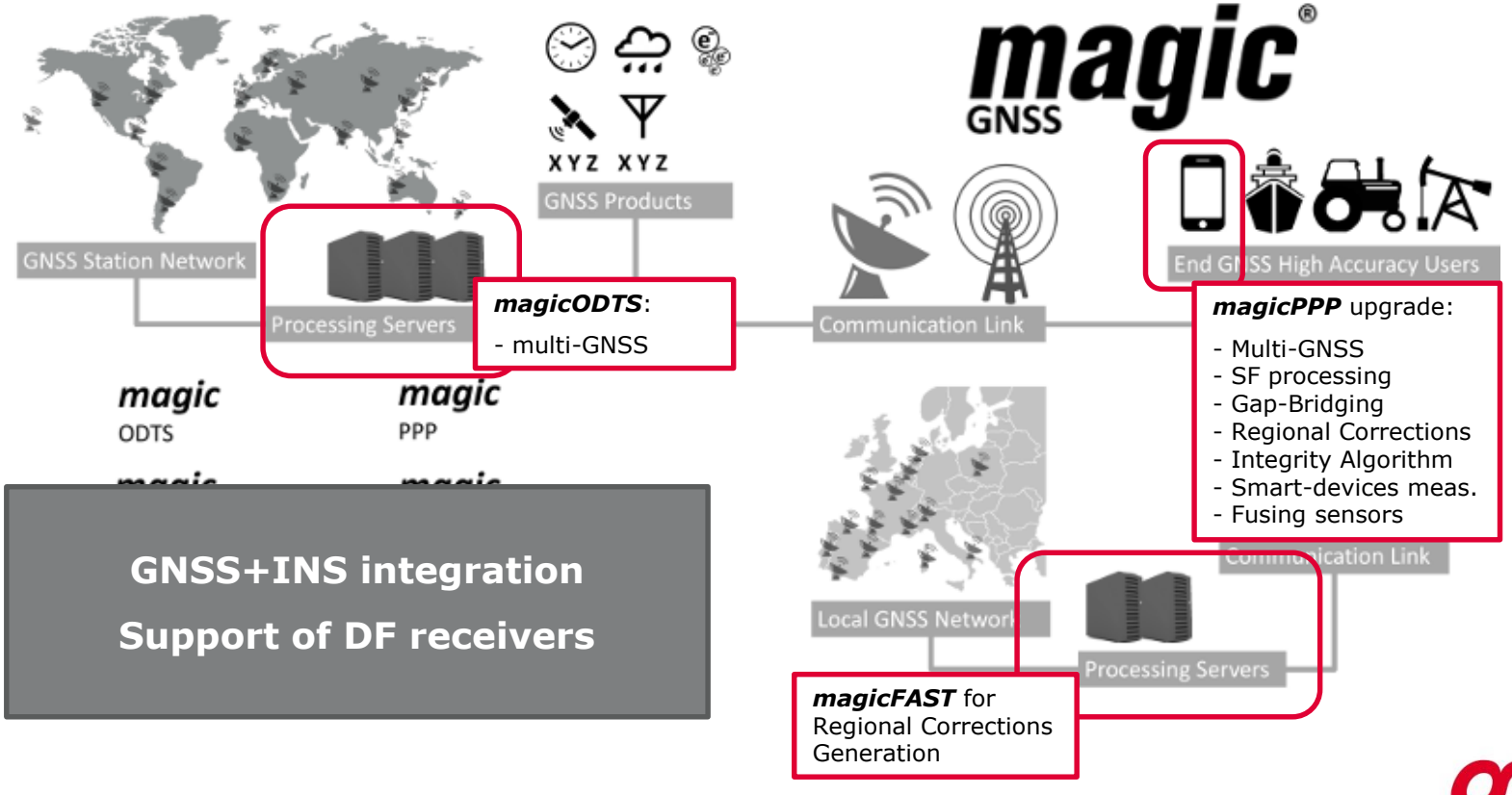
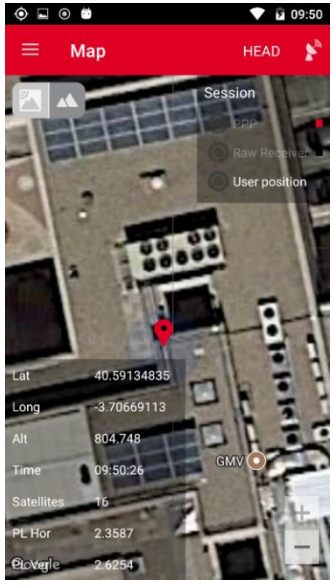
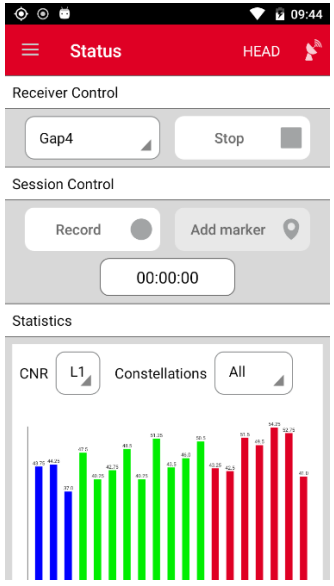


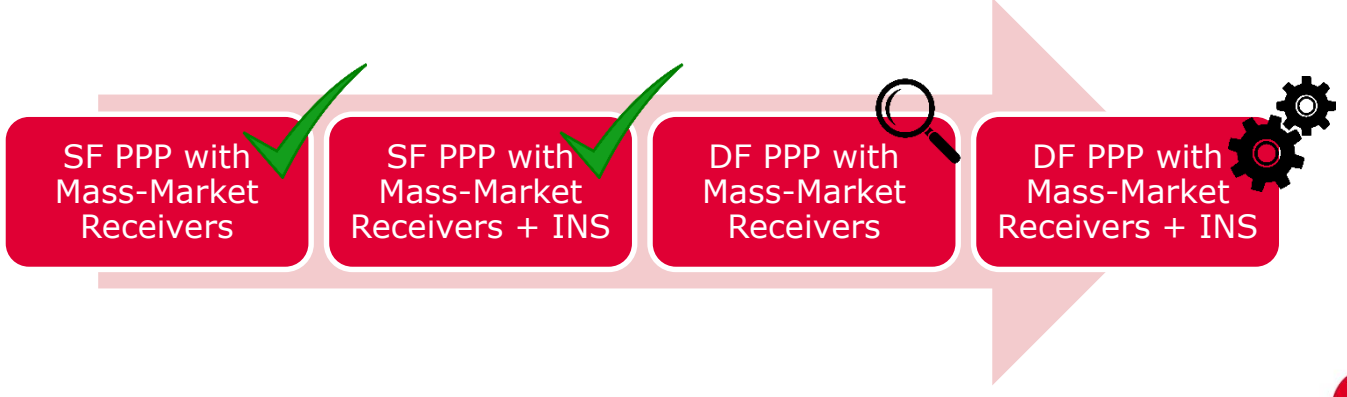
Low-Cost PPP Enhanced by IMU Sensors

magicPPP EVOLUTION

- Android Application continuously evolving
- Mass-market oriented Features:
  - Support the retrieval of raw measurements provided by the internal GNSS chip and antenna through the LocationServices API (1Hz)
  - Obtain the accelerometers and gyroscope information through the Sensors API (high frequency >> 1Hz)
  - Support of Dual-frequency Mass-market receivers





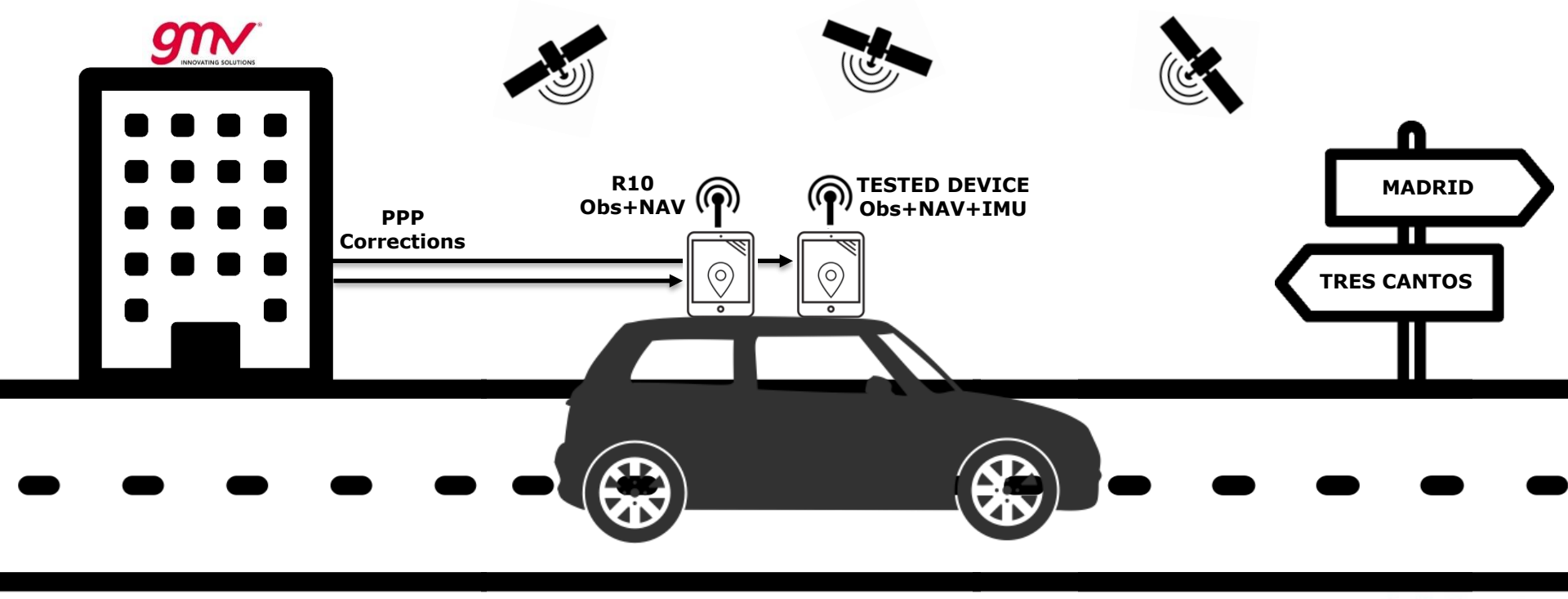


Low-Cost PPP Enhanced by IMU Sensors

EXPERIMENTATION

DEVICES UNDER TESTING - APPROACH

- Device #1 (Reference): Trimble R10 + PPP Android Application
- Device #2 (Tested): Nexus 9+ PPP Android Application
- Device #3 (Tested): Recently released Xiaomi Mi8 + PPP Android Application



DEVICES UNDER TESTING – SET UP

DEVICES UNDER TESTING - SCENARIOS

- Three kinematic scenarios:
  - Nexus 9: Two Open sky + suburban conditions. Duration ~ 40 minutes
  - Mi8: One walking. Duration ~ 15 minutes

- Reference trajectory obtained with Trimble R10 + RTKLib when possible. Applied correction between antenna positions.

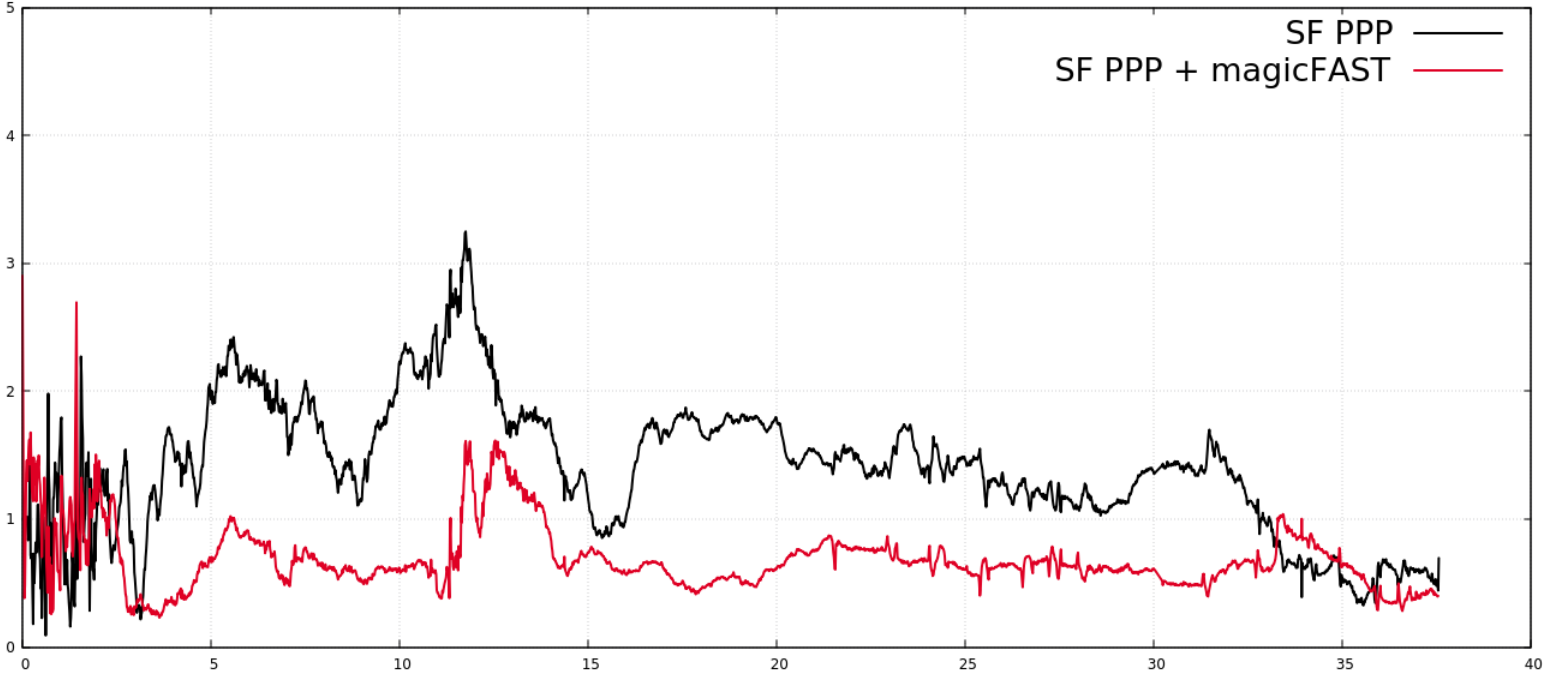
- Devices setup:
  - Nexus 9 Tablet Internal antenna and Trimble R10 placed on top of a car. Processing GPS+GLO L1.
  - Mi8. Walking scenarios held in the hands. Processing GPS+GAL L1/L5 GLO L1

- Regional corrections: *magicFAST* for enhanced convergence

NEXUS 9 TEST#1

- Kinematic scenario:
  - Open sky + suburban conditions
  - Duration ~ 40 minutes
  - During the first 21 minutes the car is at rest
- Data from tablet's IMU too sparse to be useful
- Frequent cycle slips found in carrier-phase measurements

NEXUS 9 TEST#1



2D RMS SF PPP: 1.51m
2D RMS SF PPP+magicFast: 0.76m

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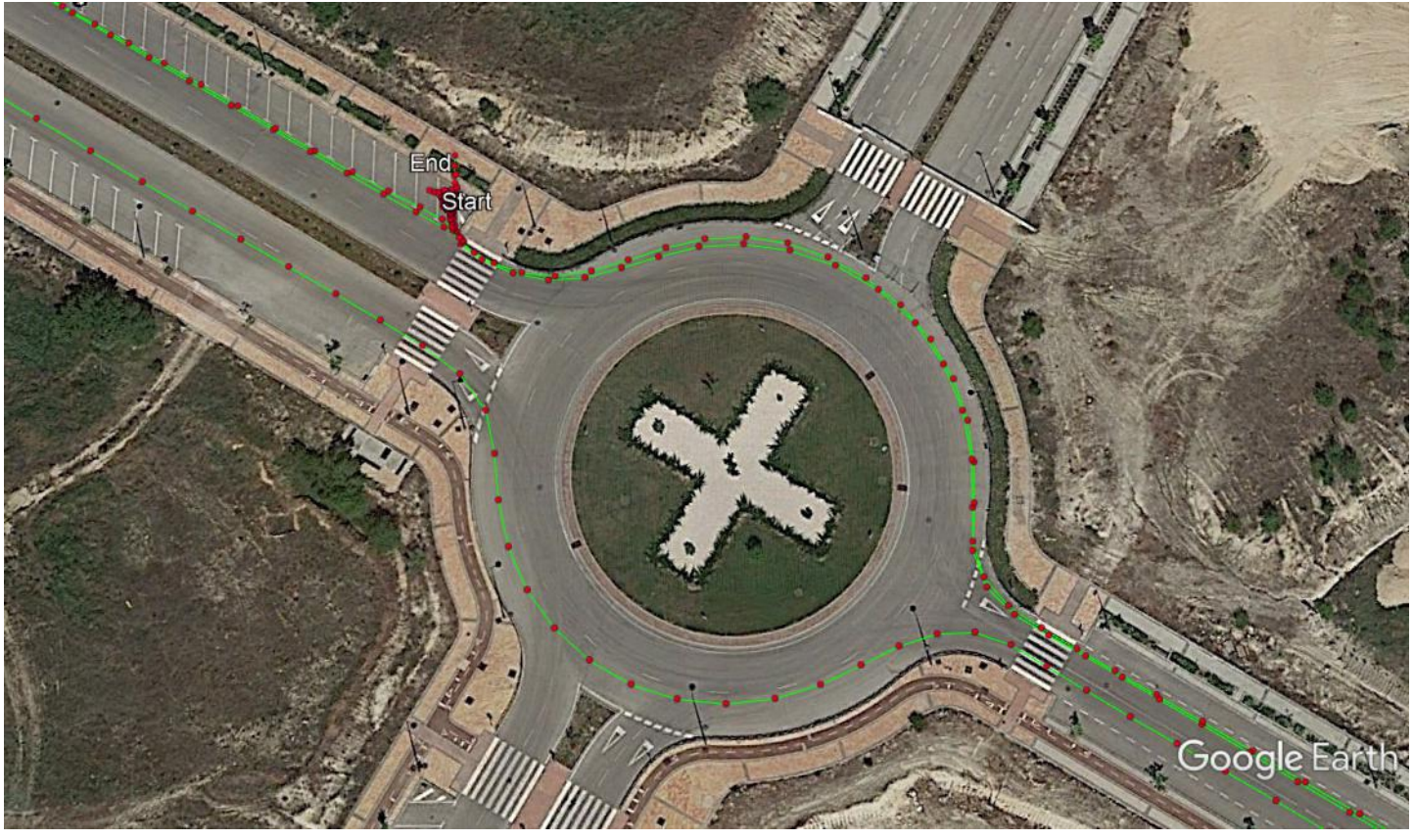
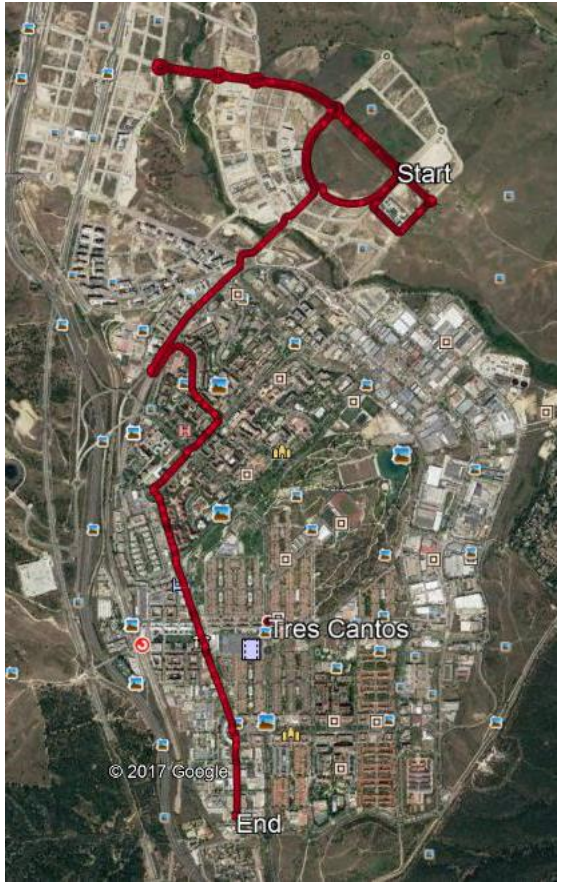


EXPERIMENTATION

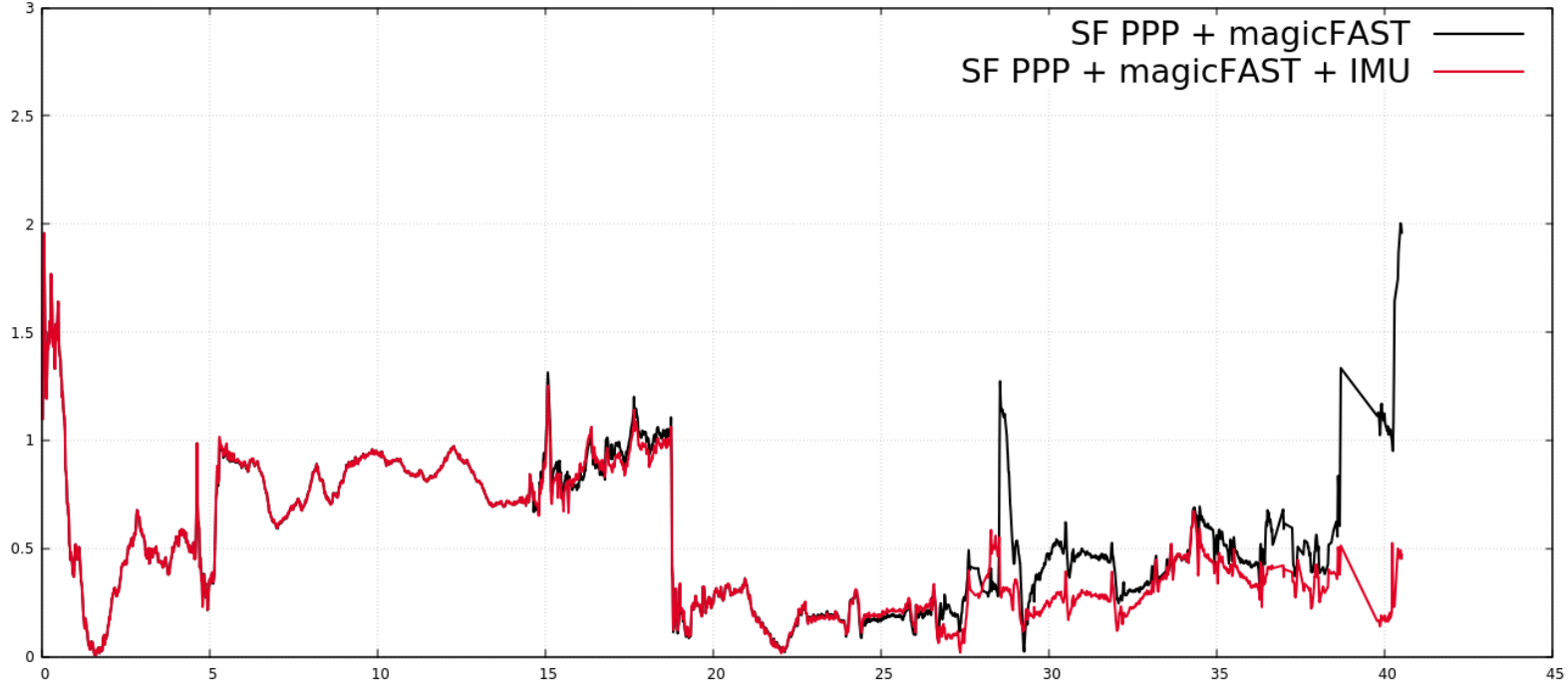
NEXUS 9 TEST#1

NEXUS 9 TEST#2



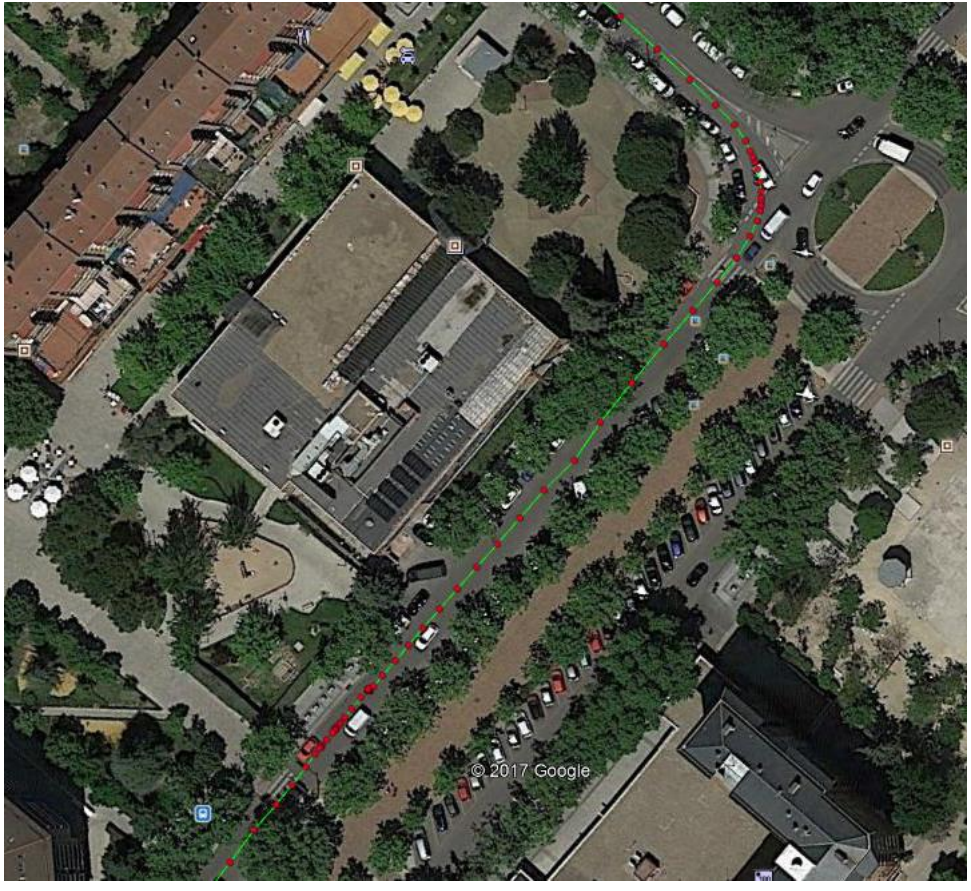
- Kinematic scenario:
  - Open sky + suburban conditions
  - Duration ~ 50 minutes
  - During the first 22 minutes the car is at rest
- IMU data from tablet (3-axis accelerometer and gyro) at 500Hz
- Tablet axes aligned with car
- Frequent cycle slips found in carrier-phase measurements

NEXUS 9 TEST#2



2D RMS SF PPP+magicFast: 0.65m
2D RMS SF PPP+magicFast+IMU: 0.61m

NEXUS 9 TEST#2



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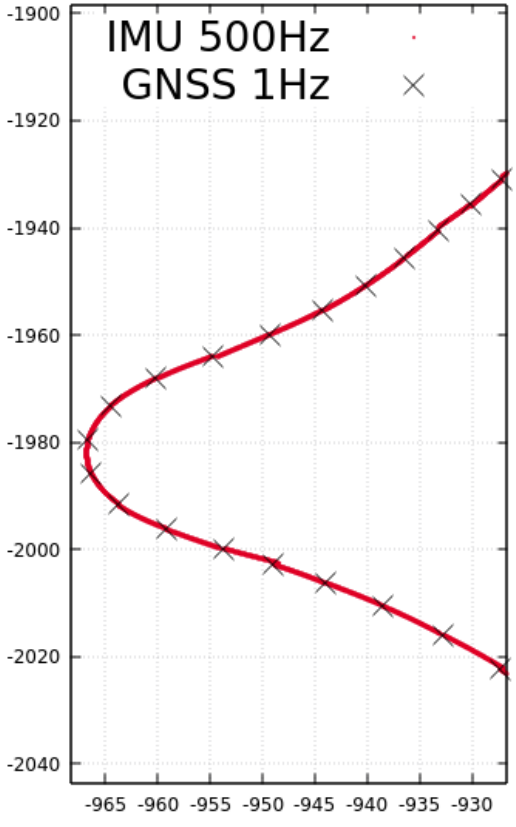

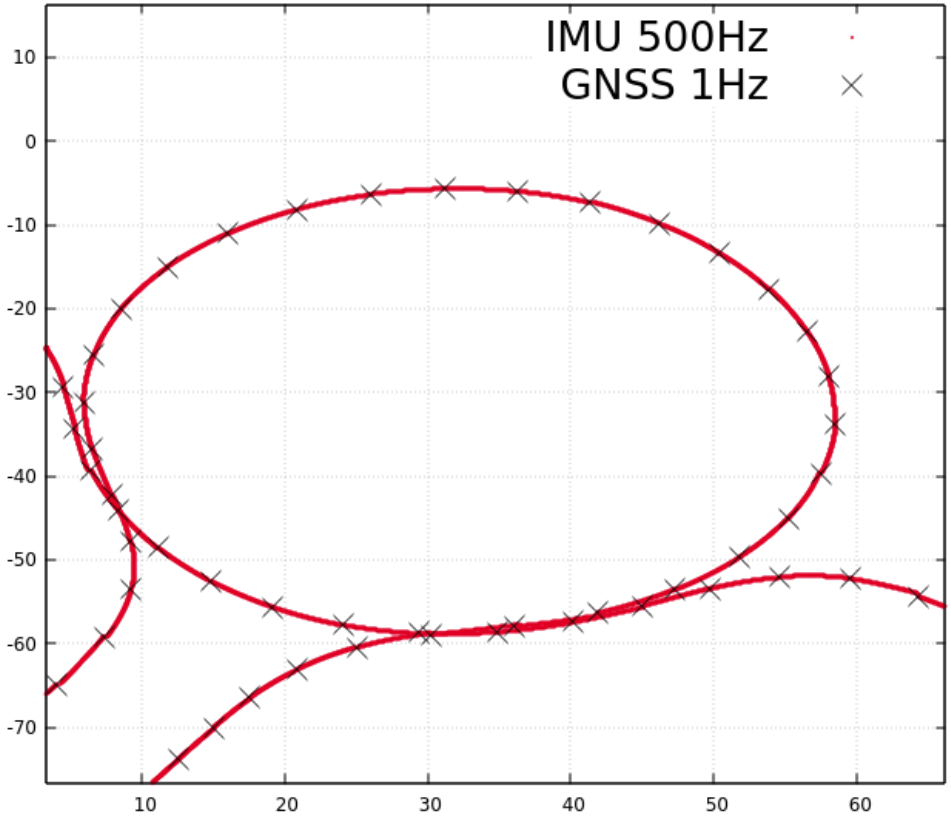

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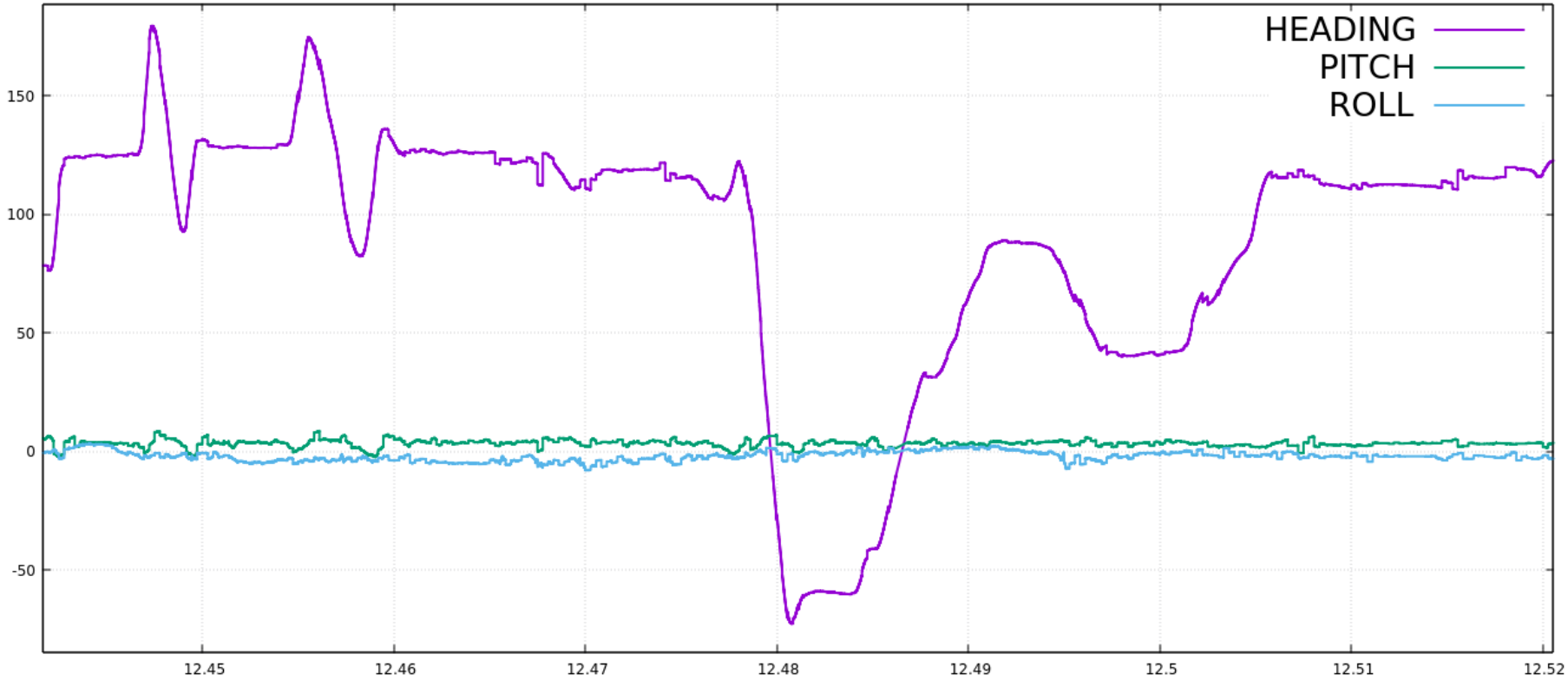

XIAOMI Mi8 TEST#1

- Kinematic scenario:
  - Open sky
  - Duration ~ 15 minutes
  - Walking dynamics

- Comparison of L1 vs L5 performances

- Frequent cycle slips found in carrier-phase measurements

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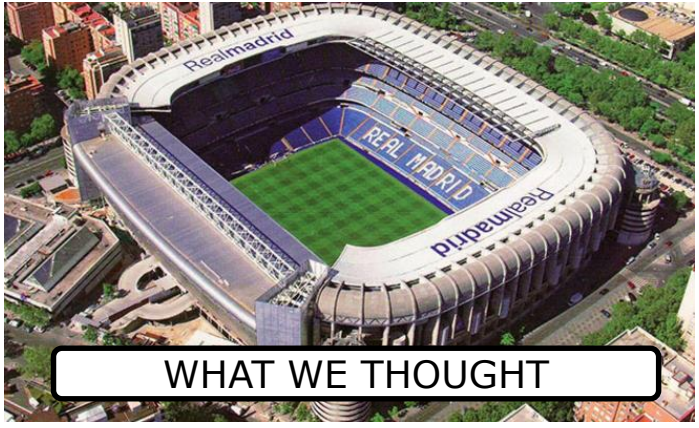
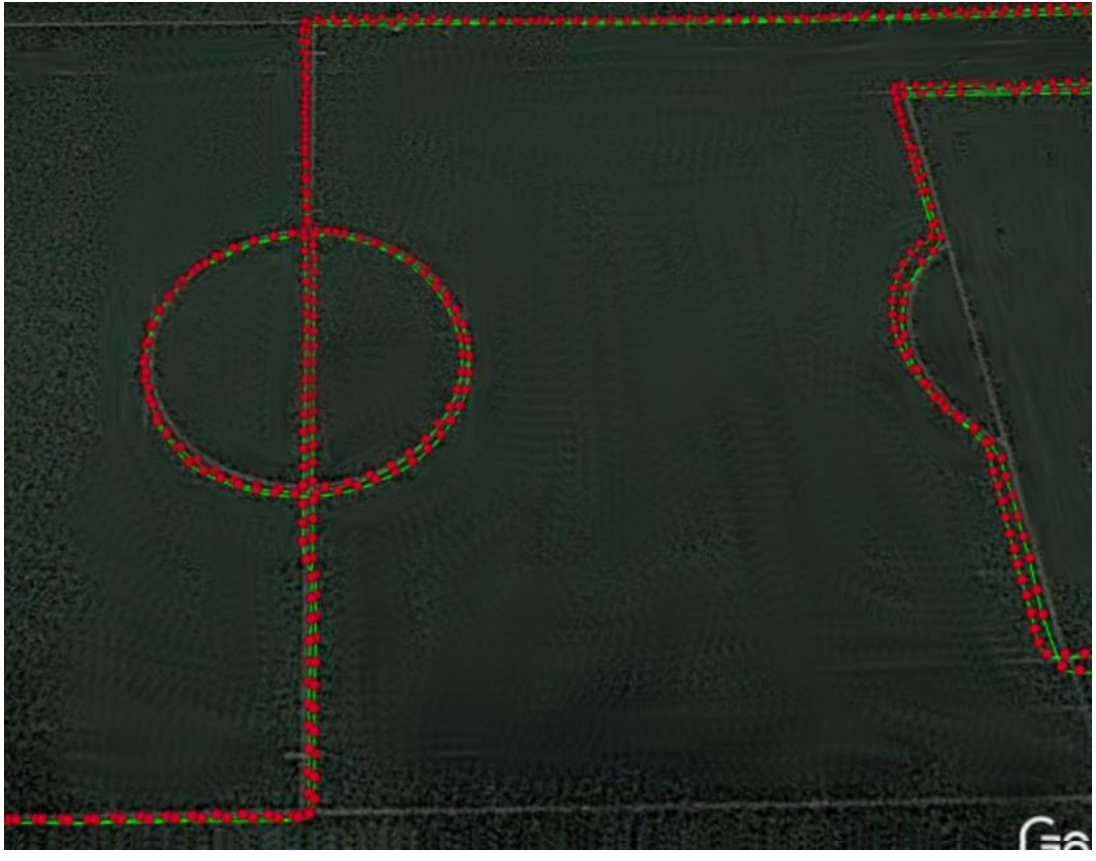


XIAOMI Mi8 TEST#1

- Pitch lines used as reference
- General consistency when comparing SF L1 vs DF L1-L5 (<50-60cms)



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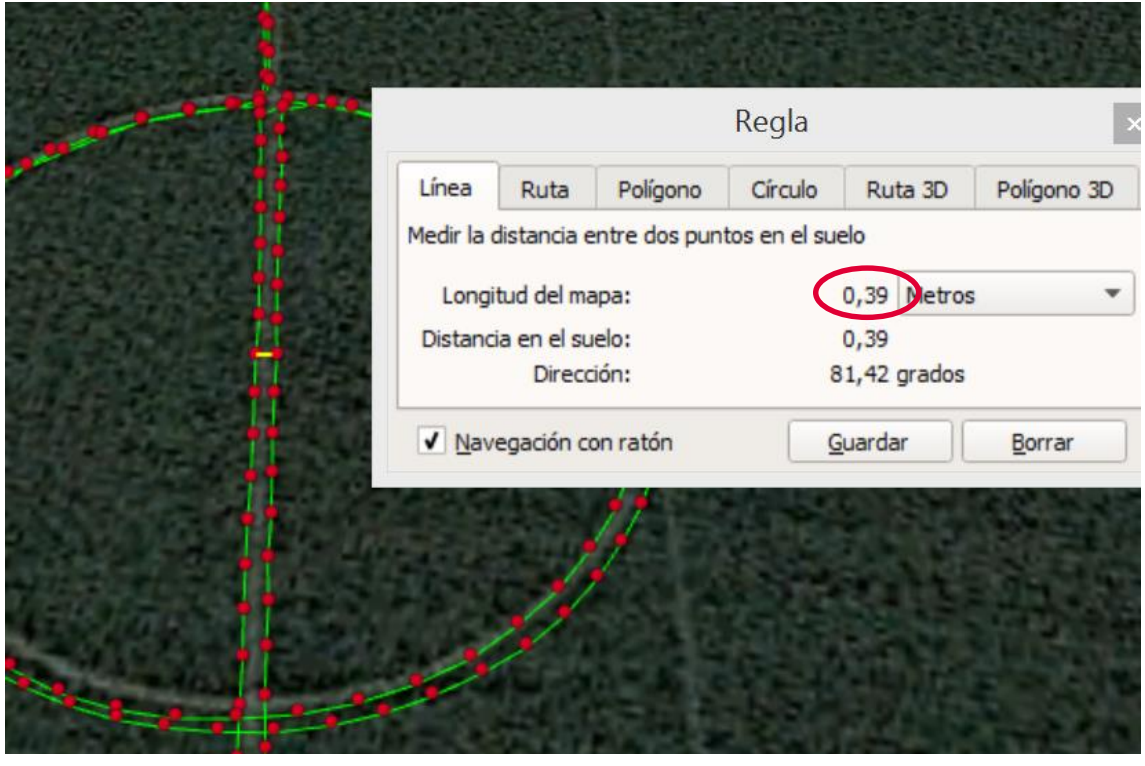

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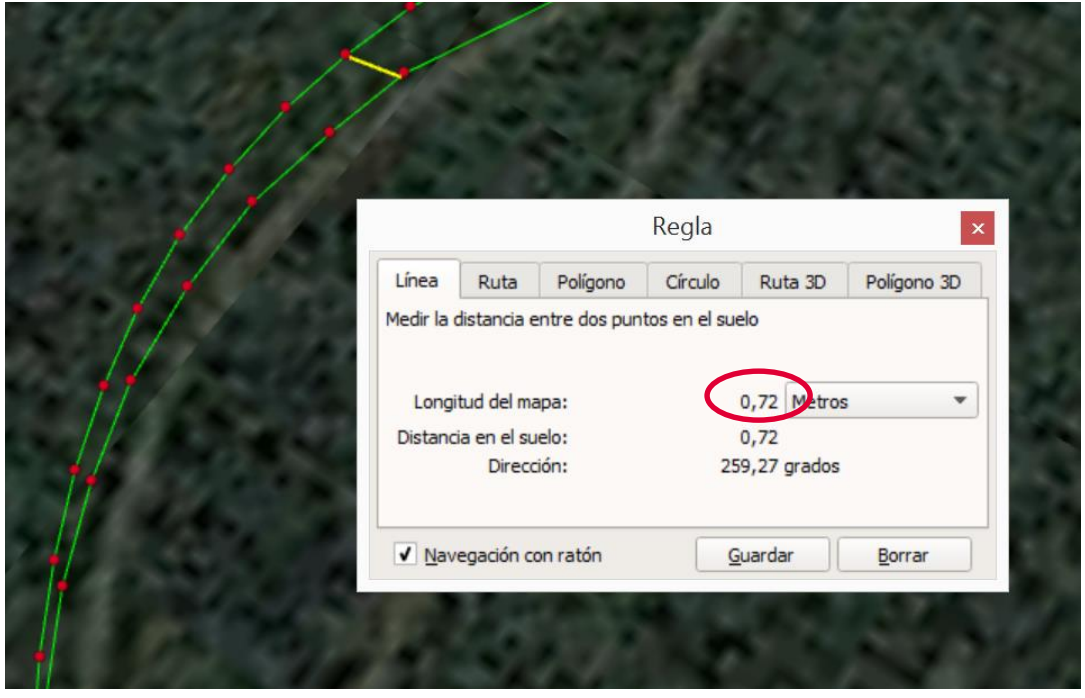

CONCLUSIONS

CONCLUSIONS AND WAY-FORWARD

- **Accurate GNSS navigation with smart devices** is becoming possible with current and future chips

- **magicPPP has a solution for smartphones/tablets**. IMU data can be used to improve both quality and rate of the navigation solution

- First results with Mass-market Dual Frequency receiver are presented:
  - Work to refine results still on-going
  - Preliminary results shows that L5/E5a contributes positively to the solution.
  - With upcoming Galileo, GPS IIF/III results may be improved.

- Reduction of number of cycle slips in receivers

- Next steps:
  - Continue the work with Mass-Market Dual-Frequency Receivers to **polish and consolidate results**.
  - Test **hybridation of Dual-frequency measurements + IMU**. IMU data quality is a driver.

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