ION GNSS+ 2018

Facing the challenges of PPP: Convergence Time, Integrity and Improved Robustness

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Session C4: Precise Point Positioning (PPP) and L-Band Services

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gmv INNOVATING SOLUTIONS

OUTLINE

PPP Service Provision Infrastructure

Positioning Performance

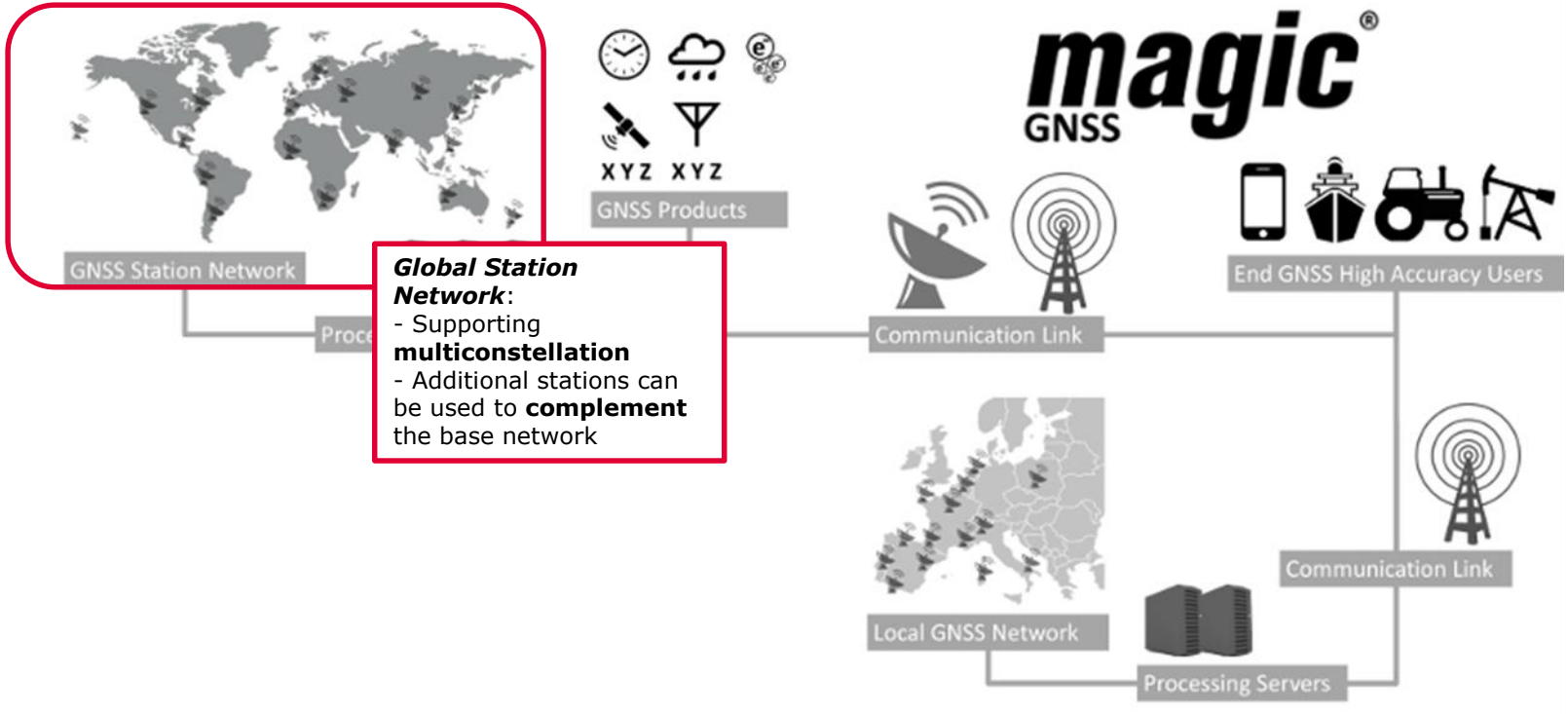
PPP Integrity

Conclusions

PPP Service Provision Infrastructure

PPP CORRECTION INFRASTRUCTURE

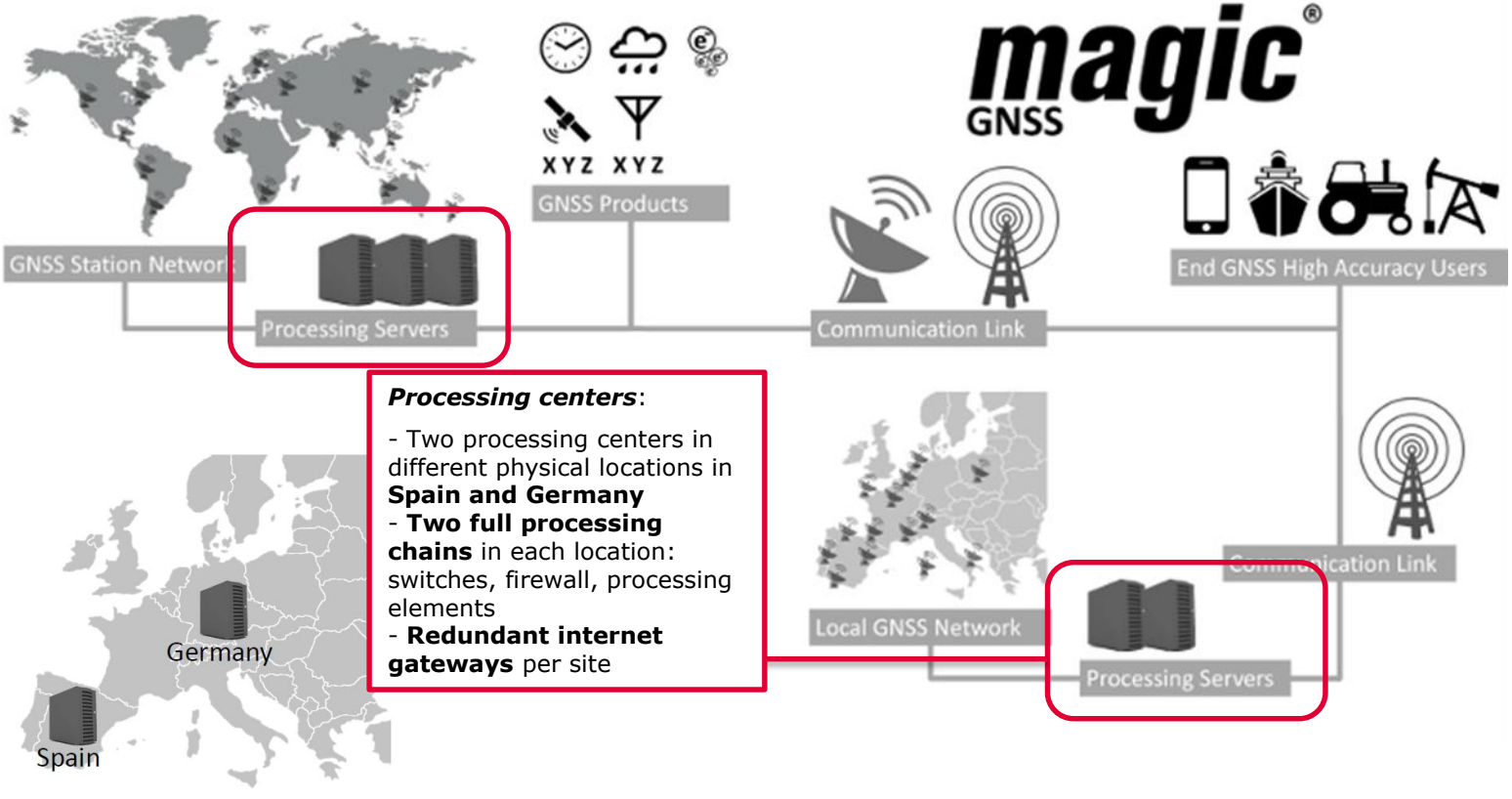
GLOBAL STATION NETWORK



Global Station Network:
- Supporting **multiconstellation**
- Additional stations can be used to **complement** the base network

PPP CORRECTION INFRASTRUCTURE

PROCESSING CENTERS

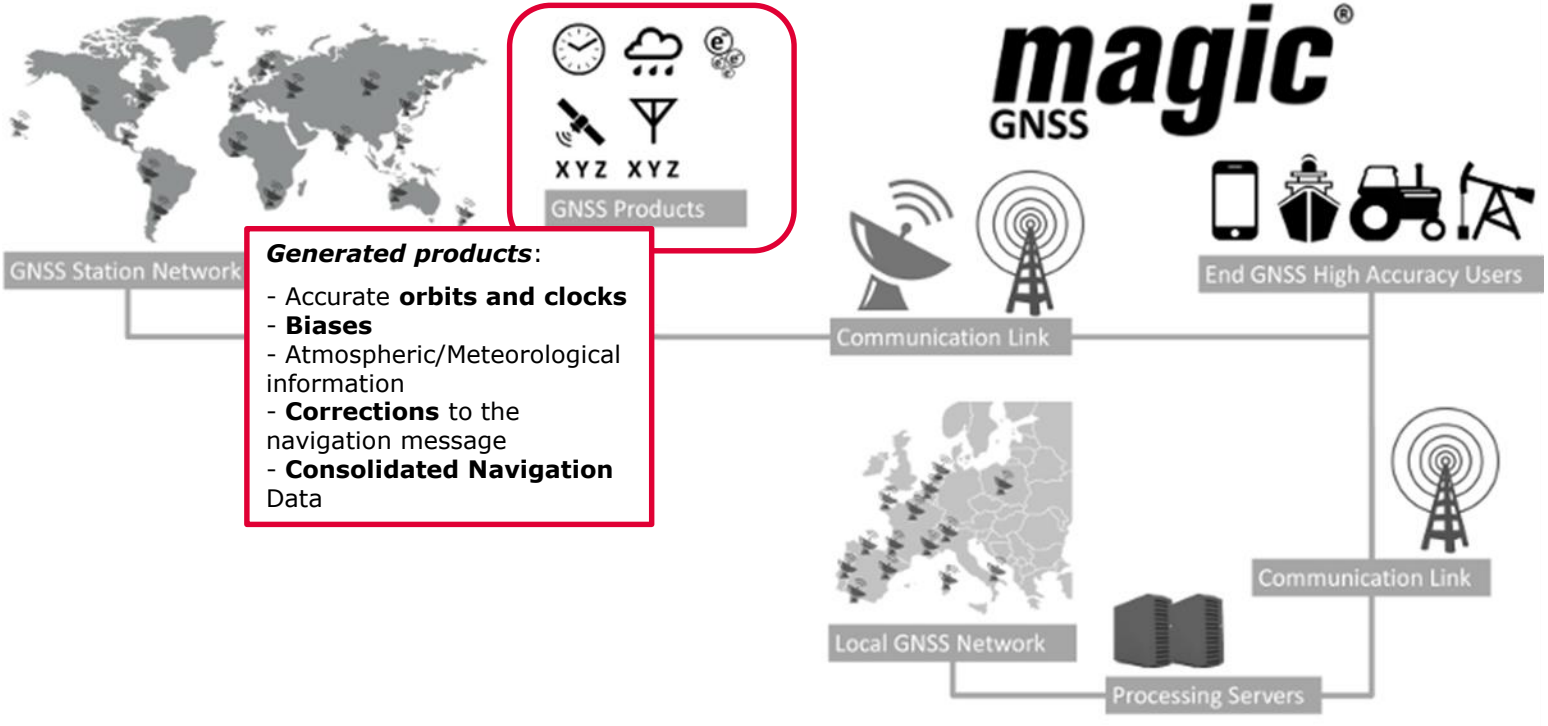


Processing centers:

- Two processing centers in different physical locations in **Spain and Germany**
- **Two full processing chains** in each location: switches, firewall, processing elements
- **Redundant internet gateways** per site

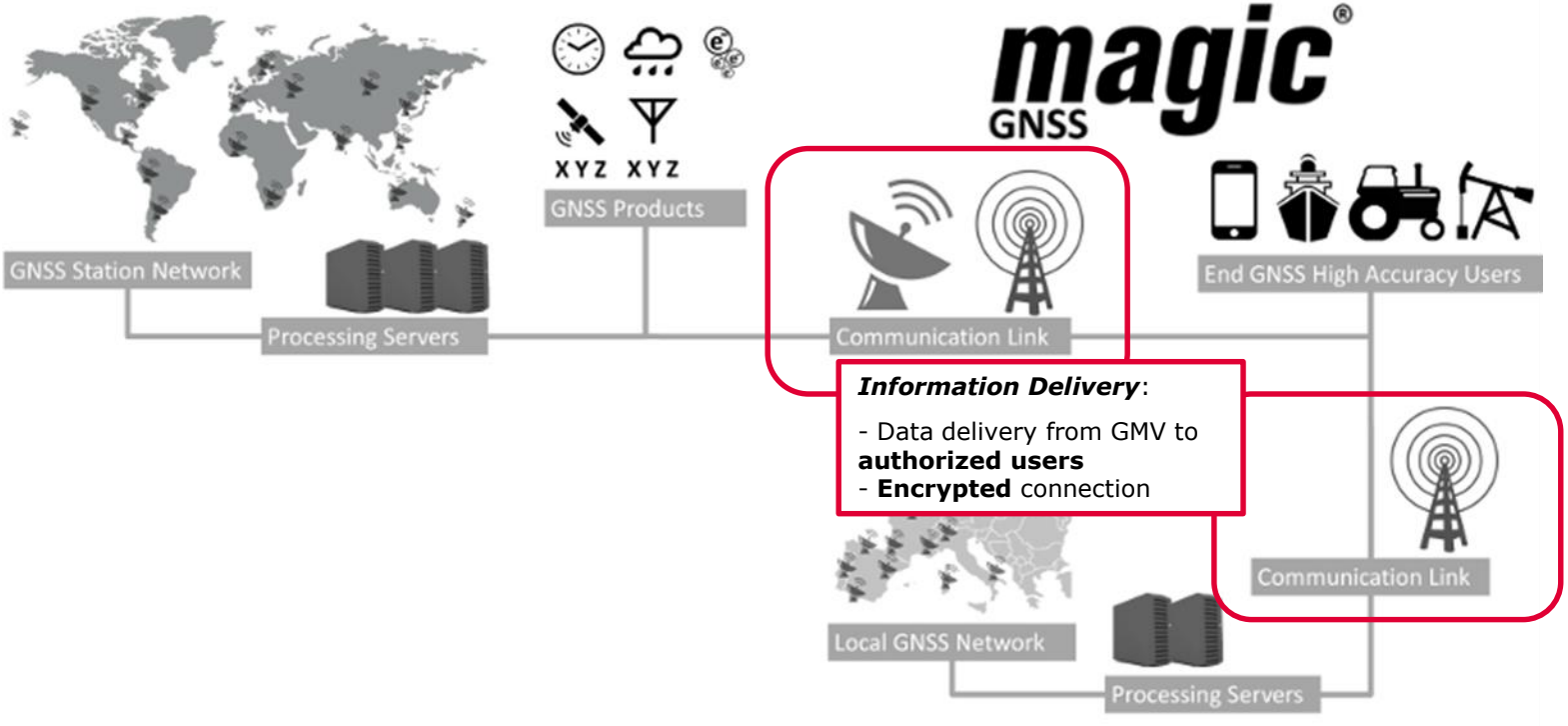
PPP CORRECTION INFRASTRUCTURE

PRODUCTS



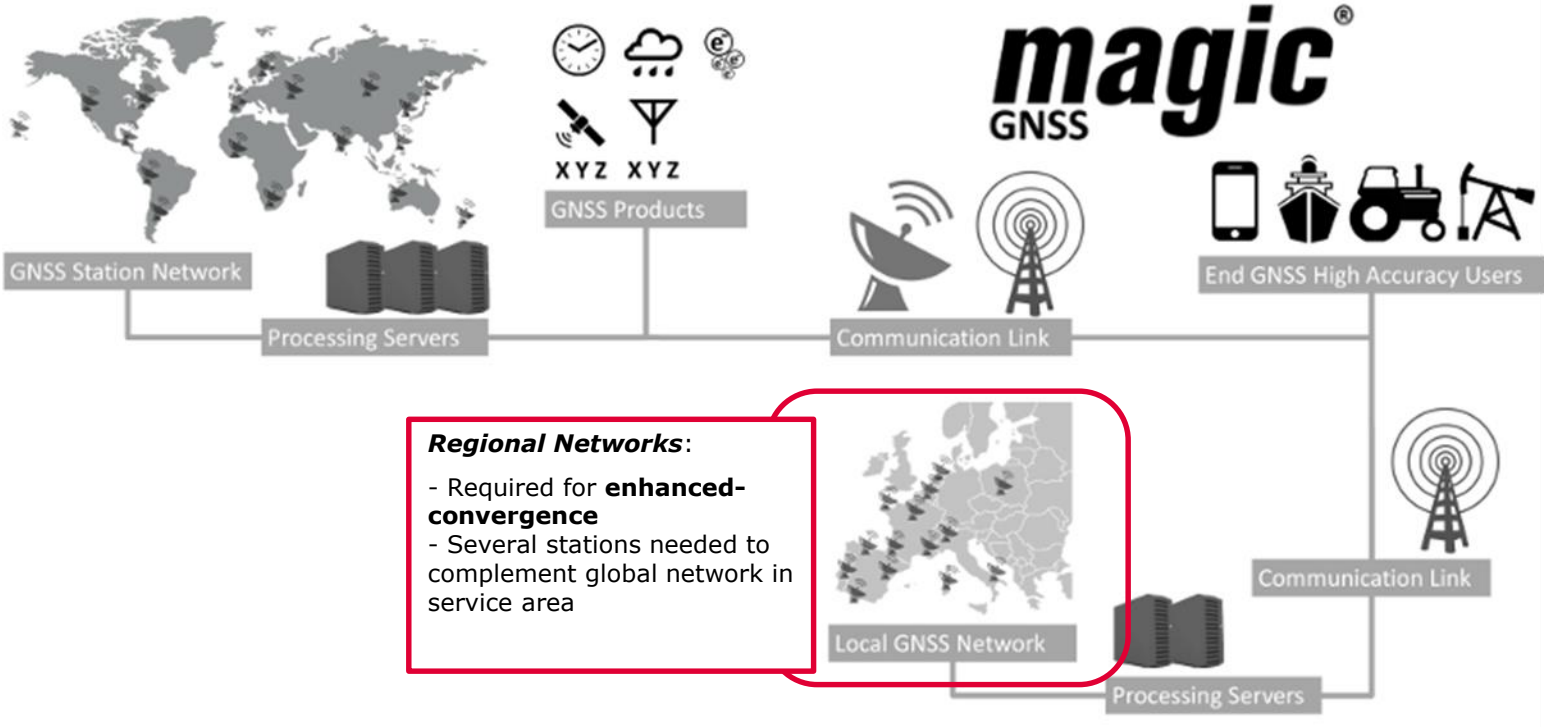
PPP CORRECTION INFRASTRUCTURE

COMMUNICATION LINK



PPP CORRECTION INFRASTRUCTURE

REGIONAL STATION NETWORK



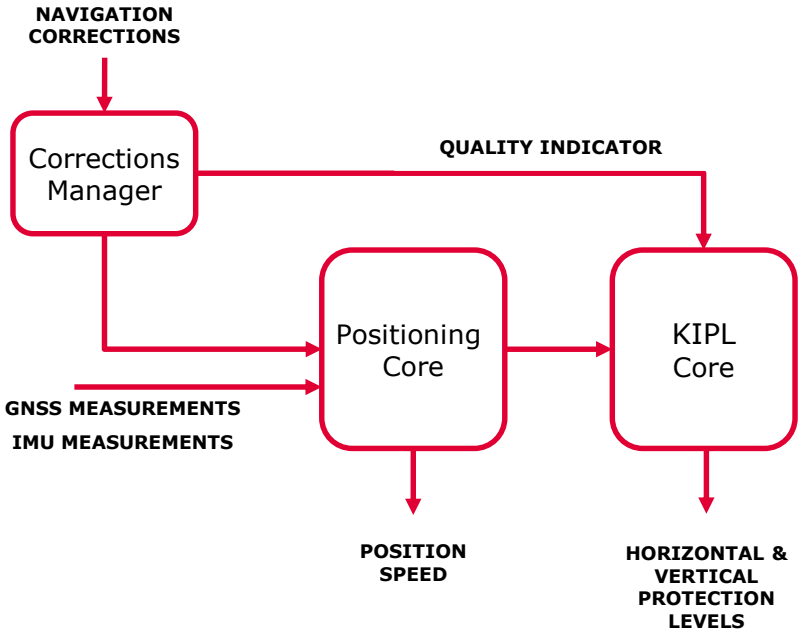
Regional Networks:

- Required for **enhanced-convergence**
- Several stations needed to complement global network in service area

PPP USER POSITIONING ALGORITHM

ALGORITHM SPECIFICATION

- **Multi-constellation/frequency** capable: GPS, GLONASS, Galileo, BeiDou, QZSS
- **IMU** data processing supported
- **Gap-bridging** solution for fast cycle slip repairing
- **Integrity algorithm (KIPL)** on all estimated parameters for configurable Confidence Levels
- Standard input **interfaces**:
  - GNSS Data RTCM supported (including MSM)
  - Corrections information compliant with RTCM Standard
- **Regional Information** Processing for Fast Convergence
- **Multiple barriers**, weighting strategies and data correlation monitoring for measurements fault detection and exclusion



PPP Positioning Performance

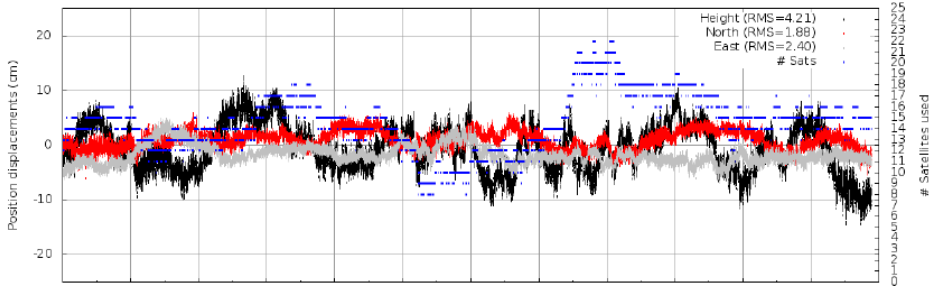
INNOVATING SOLUTIONS

POSITIONING PERFORMANCE

SERVICE SPECIFICATION

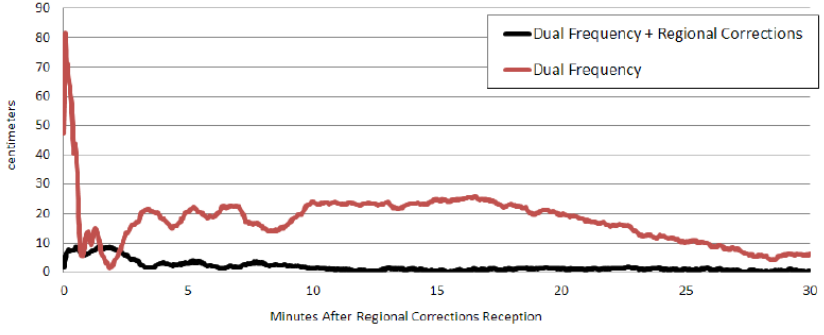
TECHNICAL SPECIFICATIONS	
Supported constellations	GPS, GLONASS, Galileo, BeiDou, QZSS
Corrections' format	RTCM
Corrections' rate	5 seconds
Corrections' Accuracy	< 3 cm 1-D RMS (orbits) < 0.06 ns Sigma (clocks)
Convergence time	20 minutes
Enhanced convergence time*	< 20 cm in 5 minutes < 50 cm instantaneous

Typical accuracy for double-frequency PPP

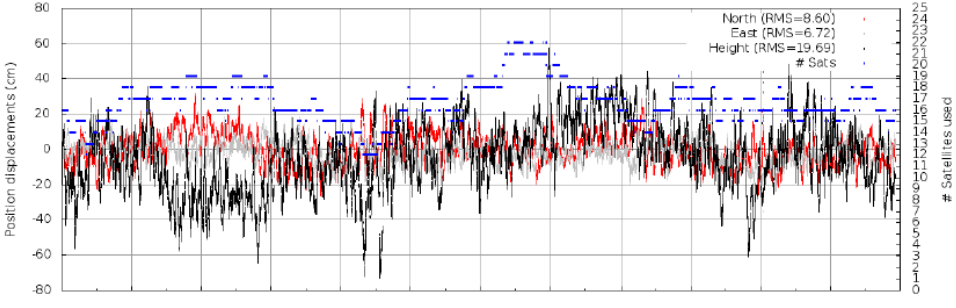


(*) Results obtained with a geodetic receiver and antenna

Typical PPP convergence time



Typical accuracy for single-frequency PPP



(*) Results obtained with a mass-market receiver and antenna

POSITIONING PERFORMANCES

DEMO ACCURACY

VIDEO LOGO

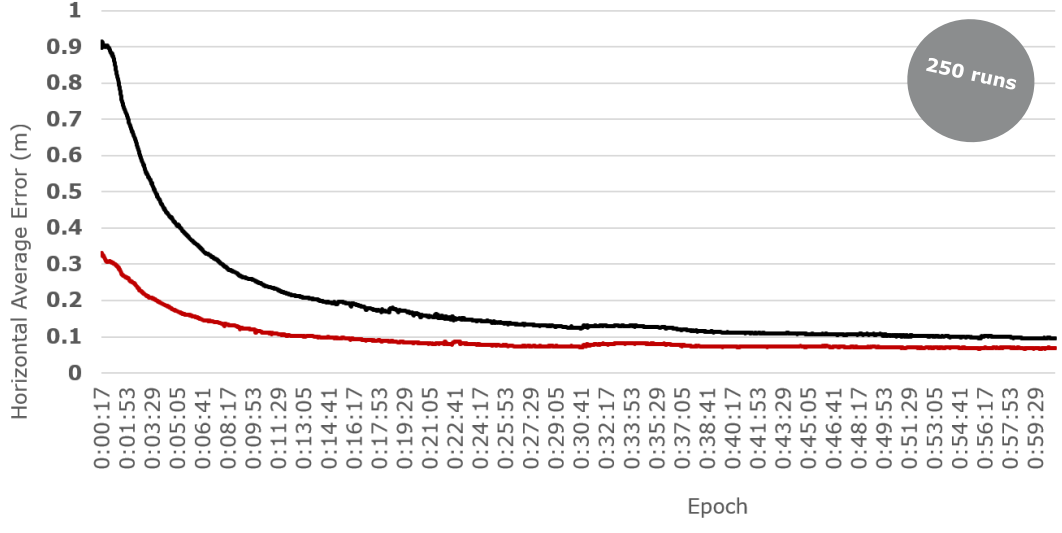
POSITIONING PERFORMANCES

CONVERGENCE TIME

- Approximately 3 months of data collected in real-time
- Static Receiver
- Open Sky
- Dual Frequency Combination
- GPS + GLONASS + GALILEO

TARGET ACCURACY	NOMINAL CONVERGENCE	ENHANCED CONVERGENCE
50 cm	3 min 36 sec	0 min 0 sec
40 cm	5 min 19 sec	0 min 00 sec
30 cm	7 min 57 sec	1 min 11 sec

CONVERGENCE ANALYSIS



Reference station separation 600 to 800 km

STANDARD PPP

ENHANCED CONVERGENCE PPP

PPP Integrity

INTEGRITY

INTEGRITY ALGORITHM OVERVIEW

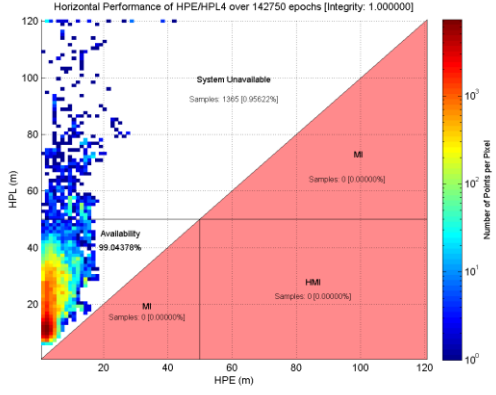
GMV has an extensive experience in **integrity for navigation** (EGNOS, Galileo, GSBAS, ESCAPE)

Integrity for non-aviation applications requires development of new tools

GMV's Integrity solution for PPP based on **three main concepts**:

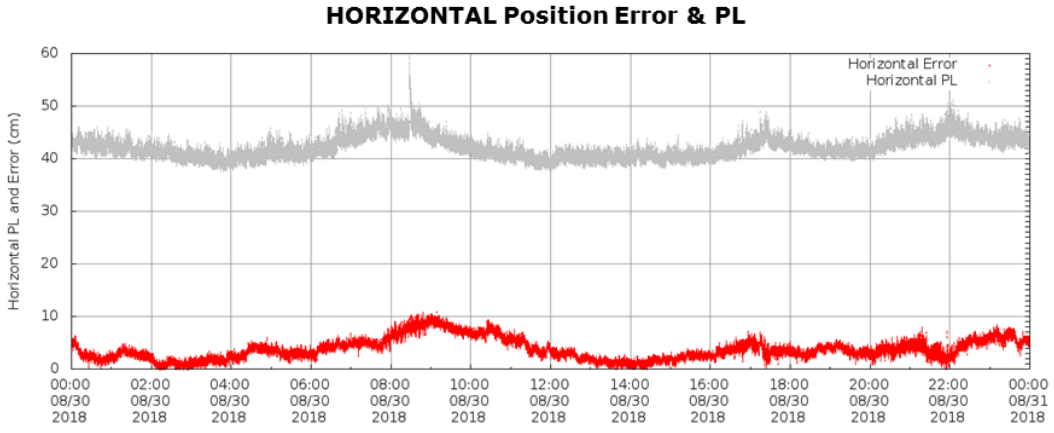
	Aviation	PPP
Estimation Technique	**Least-squares**	**Kalman**
Local Conditions Impact	**Low**	**High**
Size of PLs	**High**	**Small**

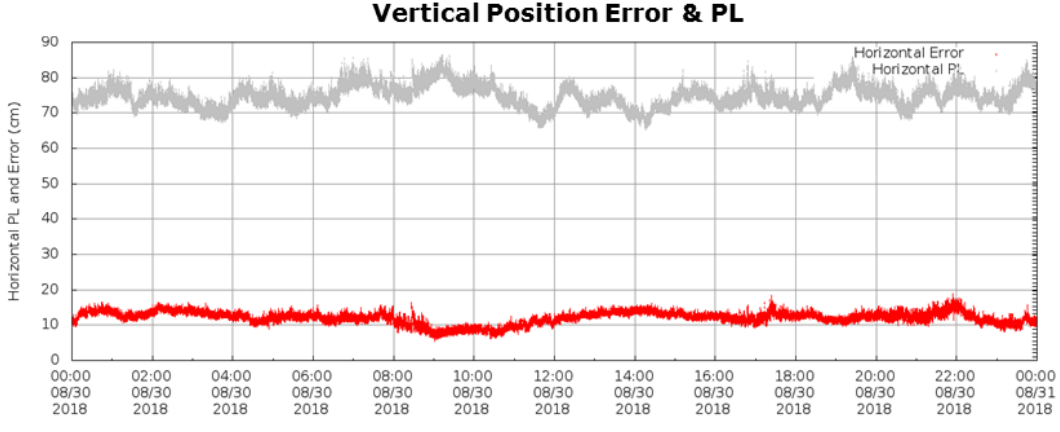
- **Multiple barriers** for faulty inputs detection and exclusion both at PPP server and user level
- **Correction data monitoring** for assured PPP augmentation data provision
- **KIPL algorithm at user** level to provide an integer error bound based on local effects and measurement correlation monitoring



INTEGRITY

STATIC INTEGRITY ALGORITHM PERFORMANCE



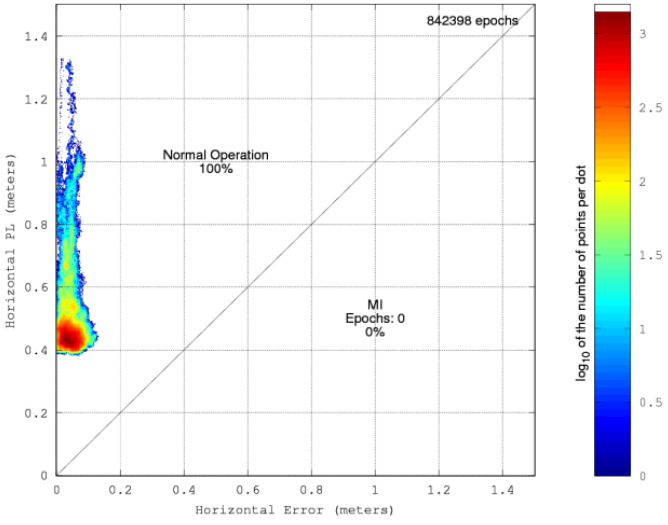


$$TIR = 10^{-7}$$

INTEGRITY

STATIC INTEGRITY ALGORITHM PERFORMANCE

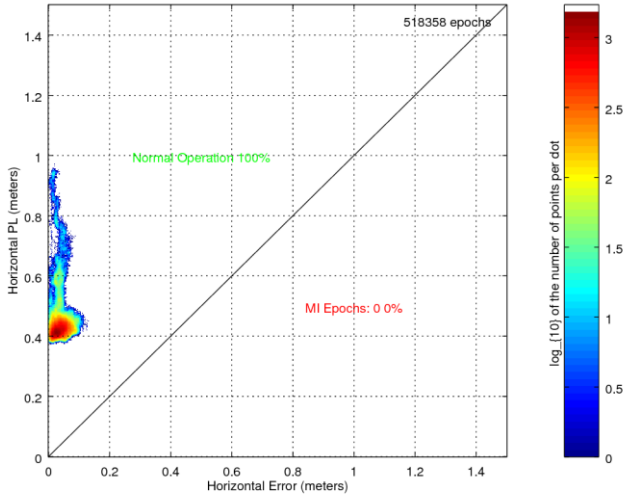
Stanford Diagram (TIR = 1e-07)



FEATURES

- 10 days
- Static receiver
- Open Sky
- Dual Frequency Combination
- GPS + GLONASS

Stanford Diagram (TIR = 1e-07)



FEATURES

- 6 days
- Static receiver
- Open Sky
- Dual Frequency Combination
- GPS + GLONASS + GALILEO

INTEGRITY

KINEMATIC INTEGRITY ALGORITHM PERFORMANCE

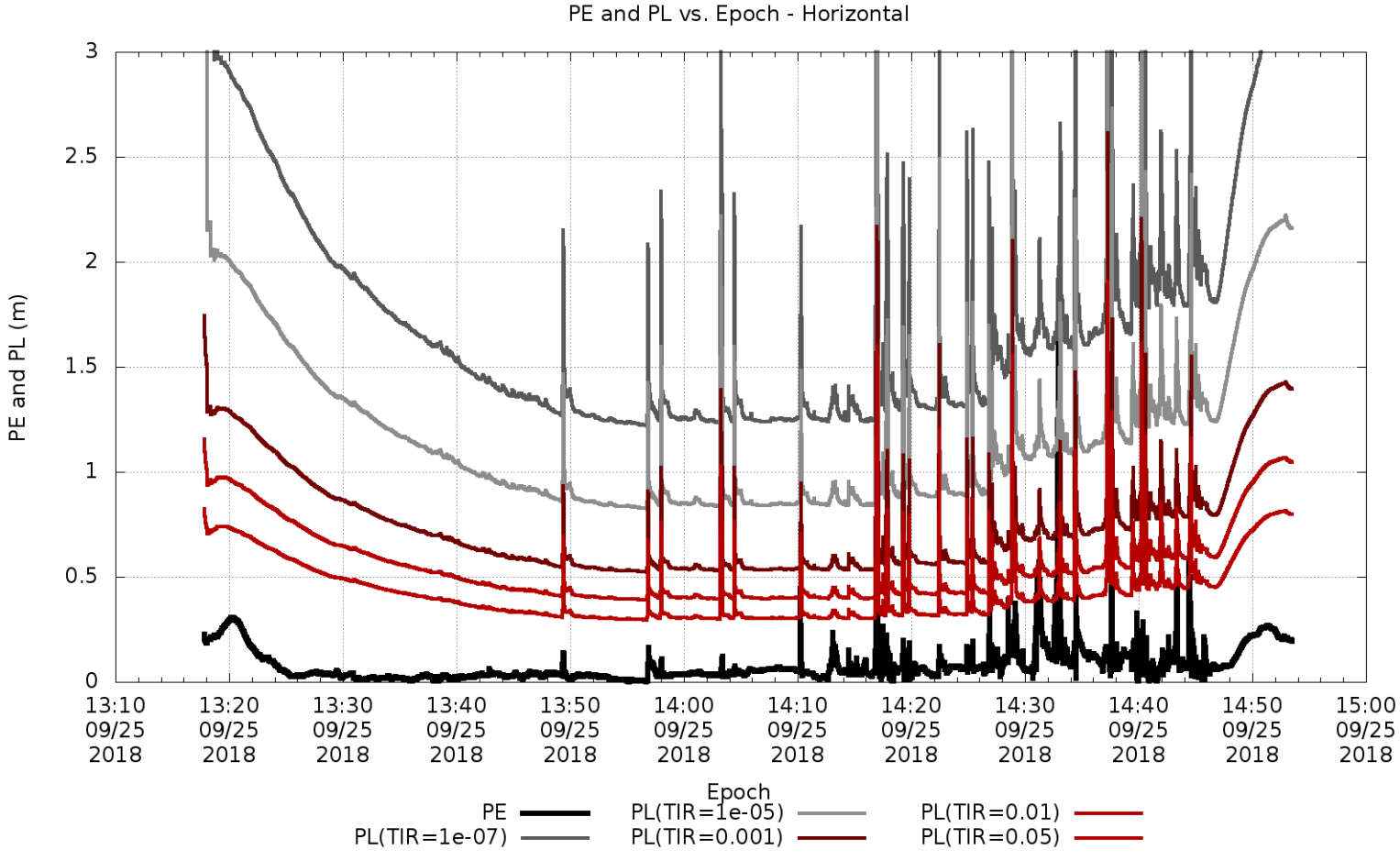
INTEGRITY

KINEMATIC INTEGRITY ALGORITHM PERFORMANCE

VIDEO CAR

INTEGRITY

KINEMATIC INTEGRITY ALGORITHM PERFORMANCE



Conclusions

INNOVATING SOLUTIONS

CONCLUSIONS

- GMV's magicGNSS suite is capable of delivering a state-of-the-art PPP service with a **high degree of integrity**
- Path firmly set towards Precise Positioning in **Safety-critical Applications**
- Extensively **tested** in real scenarios
- Already available through ***magicUT***

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THANK YOU

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