CUTTING-EDGE TECHNICAL SOLUTIONS FOR THE NEXT GENERATION OF AUTONOMOUS VEHICLE

ION GNSS+ 2019, Miami, Florida

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INNOVATING SOLUTIONS

PRESENTATION OUTLINE

OUTLINE

- PPP for autonomous driving: the challenge
- Performance testing strategy
- Performance testing results
  - Accuracy
  - Cold Convergence
  - Hot Convergence
- Conclusions

PPP AUTOMOTIVE

THE CHALLENGE

THE CHALLENGE

Classical PPP

- Open Environment

  Agriculture, Off-Shore, Mining...
- Human Supervised
- Low risk for human lives

Automotive PPP

- Harsh Environment

  Buildings, tree canopies, tunnels, underpasses..
- Fast Convergence in hot and cold start
- High Availability
- Safety Critical

ALGORITHMIC ENHANCEMENTS

Server Side

Positioning Engine

Accuracy

- Integer Ambiguity Fixing at satellite orbit and clock determination
- Phase biases estimation
- Zero-Difference Ambiguity Fixing

ALGORITHMIC ENHANCEMENTS

Server Side

Positioning Engine

Accuracy + Fast Convergence

- Integer Ambiguity Fixing at satellite orbit and clock determination
- Phase biases estimation
- Regional Ionosphere Estimation
- Zero-Difference Ambiguity Fixing
- Ionosphere correction

ALGORITHMIC ENHANCEMENTS

Server Side

Positioning Engine

Accuracy + Fast Convergence + Dead Reckoning

- Integer Ambiguity Fixing at satellite orbit and clock determination
- Phase biases estimation
- Regional Ionosphere Estimation
- Zero-Difference Ambiguity Fixing
- Ionosphere correction
- IMU Tight Coupling

ALGORITHMIC ENHANCEMENTS

Server Side

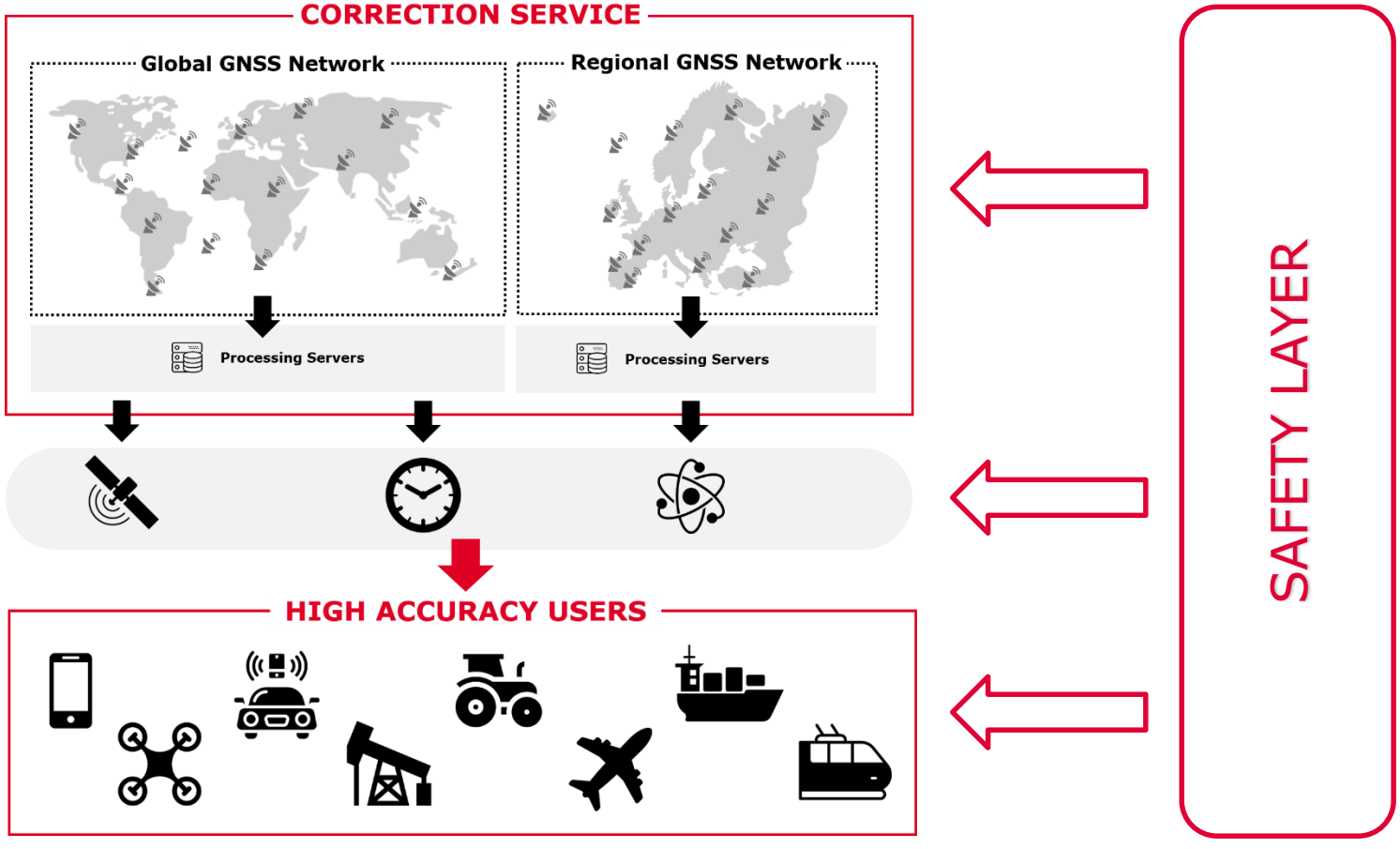
Positioning Engine

Accuracy + Fast Convergence + Dead Reckoning + Integrity

- Integer Ambiguity Fixing at Orbit Determination
- Phase biases estimation
- Regional Ionosphere Estimation
- Safety Processor

- Zero-Difference Ambiguity Fixing
- Ionosphere correction
- IMU Tight Coupling
- Threat Monitors
- KIPL Bounding

SERVICE CONCEPT



PERFORMANCE TESTING STRATEGY

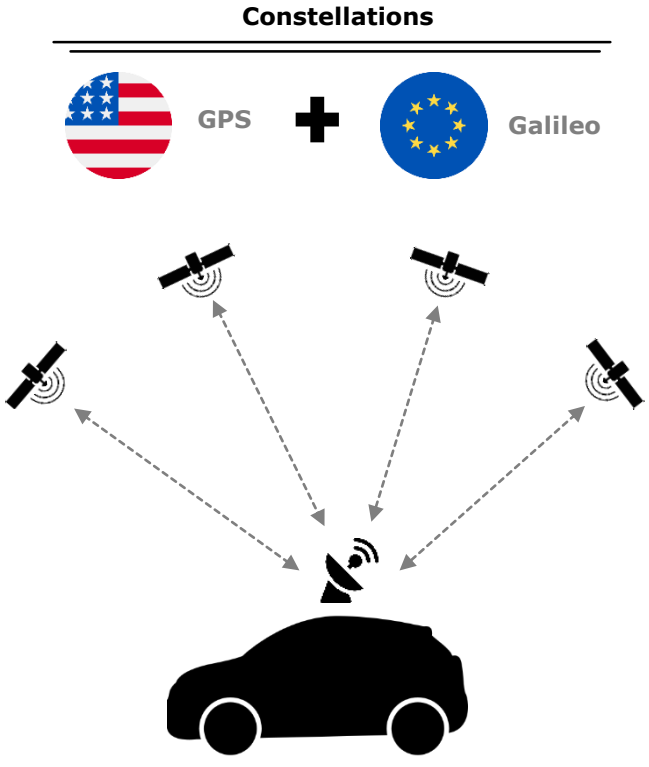
PERFORMANCE TESTING – SET-UP

Vehicle Equipment

Amotech AGA556022

uBlox ZED-F9P

Xsens Mti-10



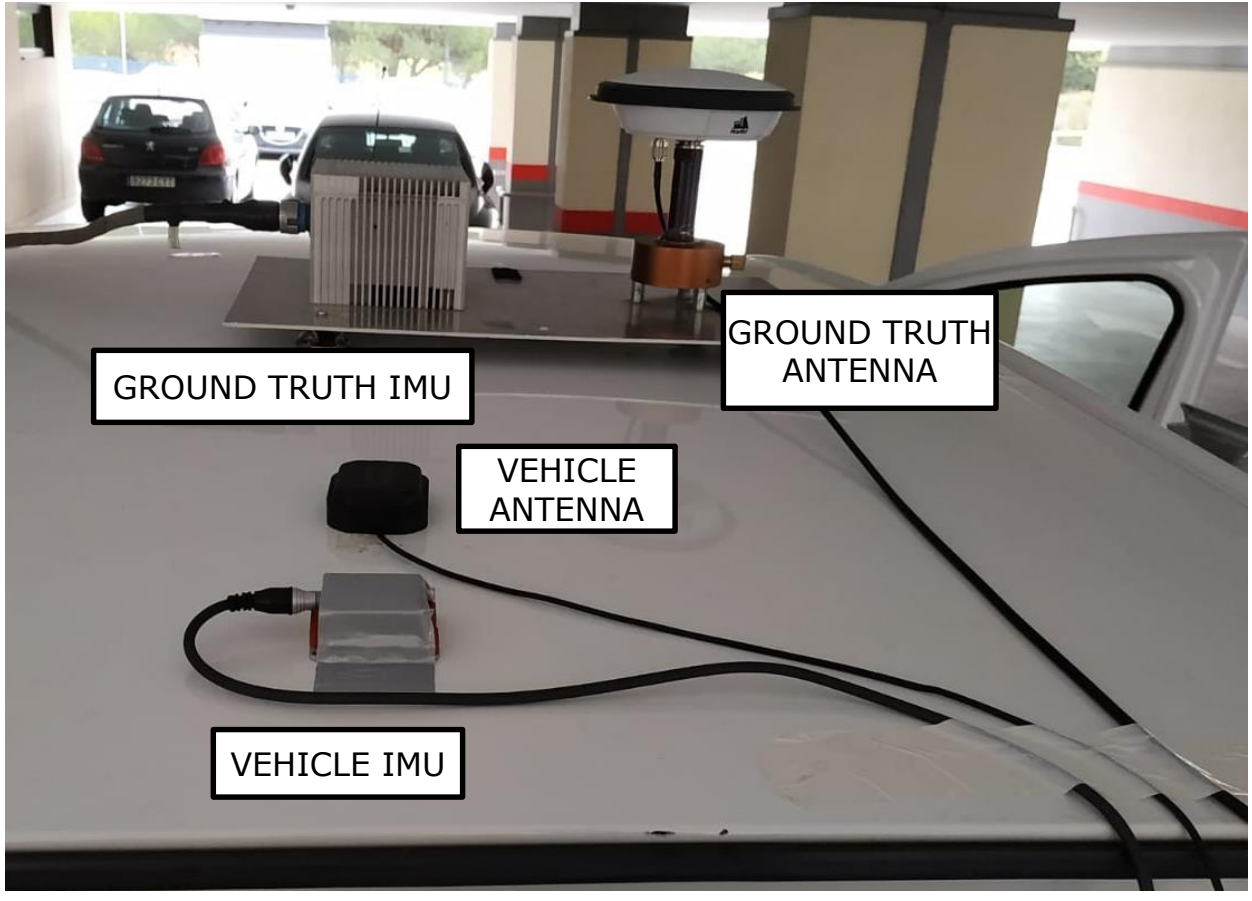
Ground Truth

Novatel GNSS 850

Novatel OEMV

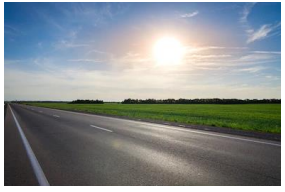
Imar FSAS

PERFORMANCE TESTING – SET-UP



PERFORMANCE TESTING – SCENARIOS

- Open Sky Recordings

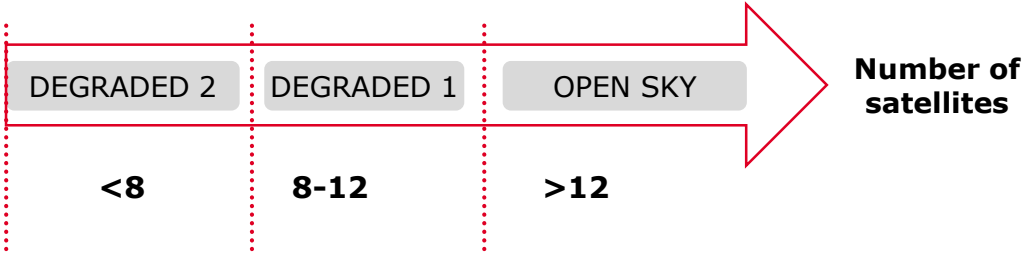


  - Degraded conditions simulated removing satellites
  - Cold convergence testing in consecutive restarts

- Suburban Highway Recordings

  - Frequent underpasses
  - Tunnels
  - Moderate multipath

Environment catalogue



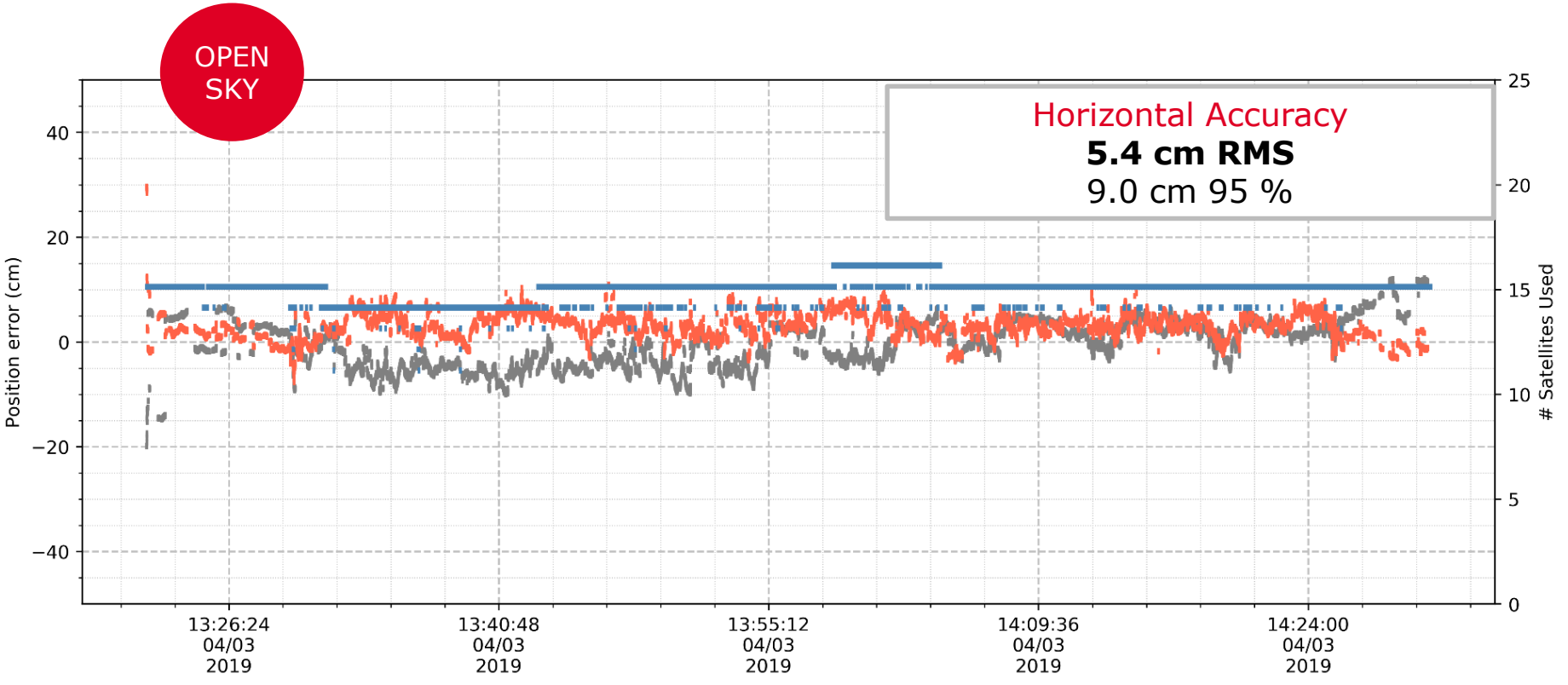
PERFORMANCE TESTING

RESULTS

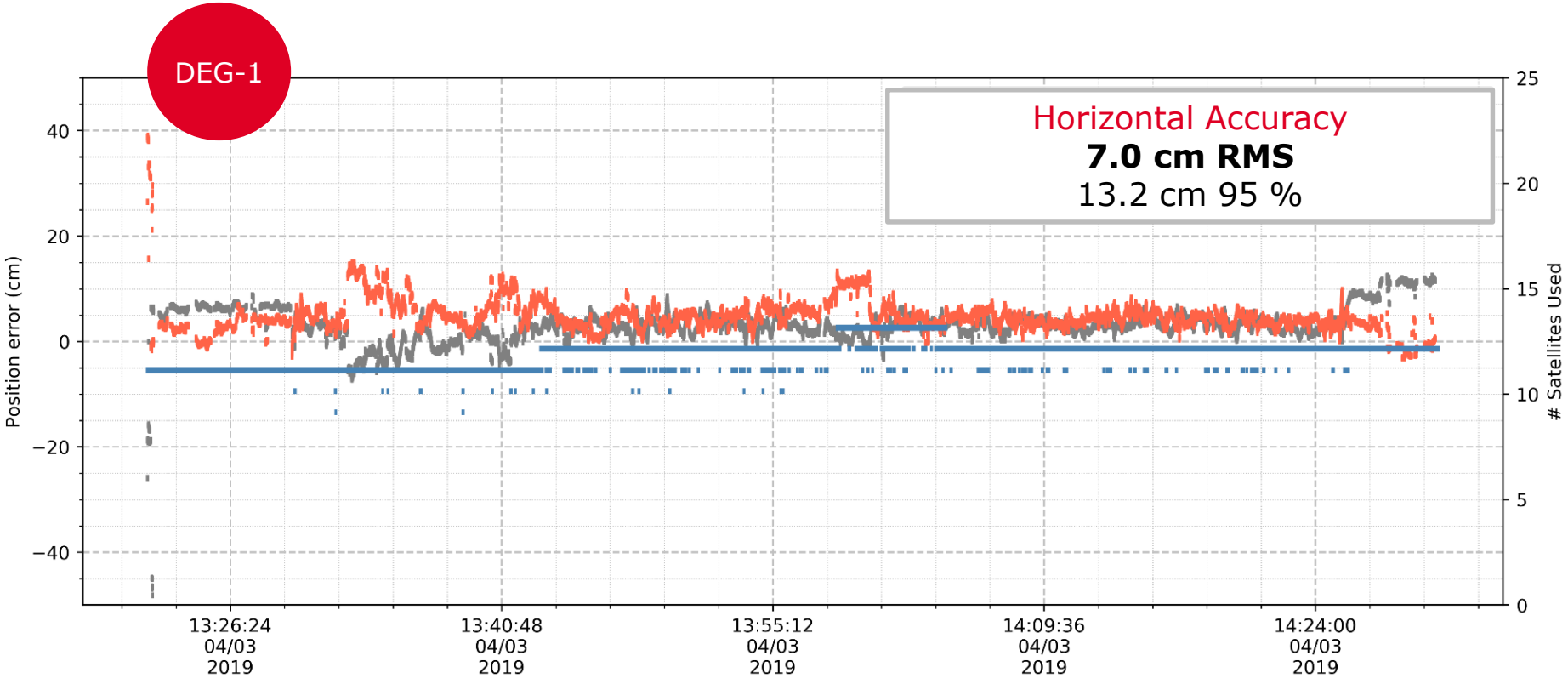
OPEN SKY TRAJECTORY

Tres Cantos, Madrid

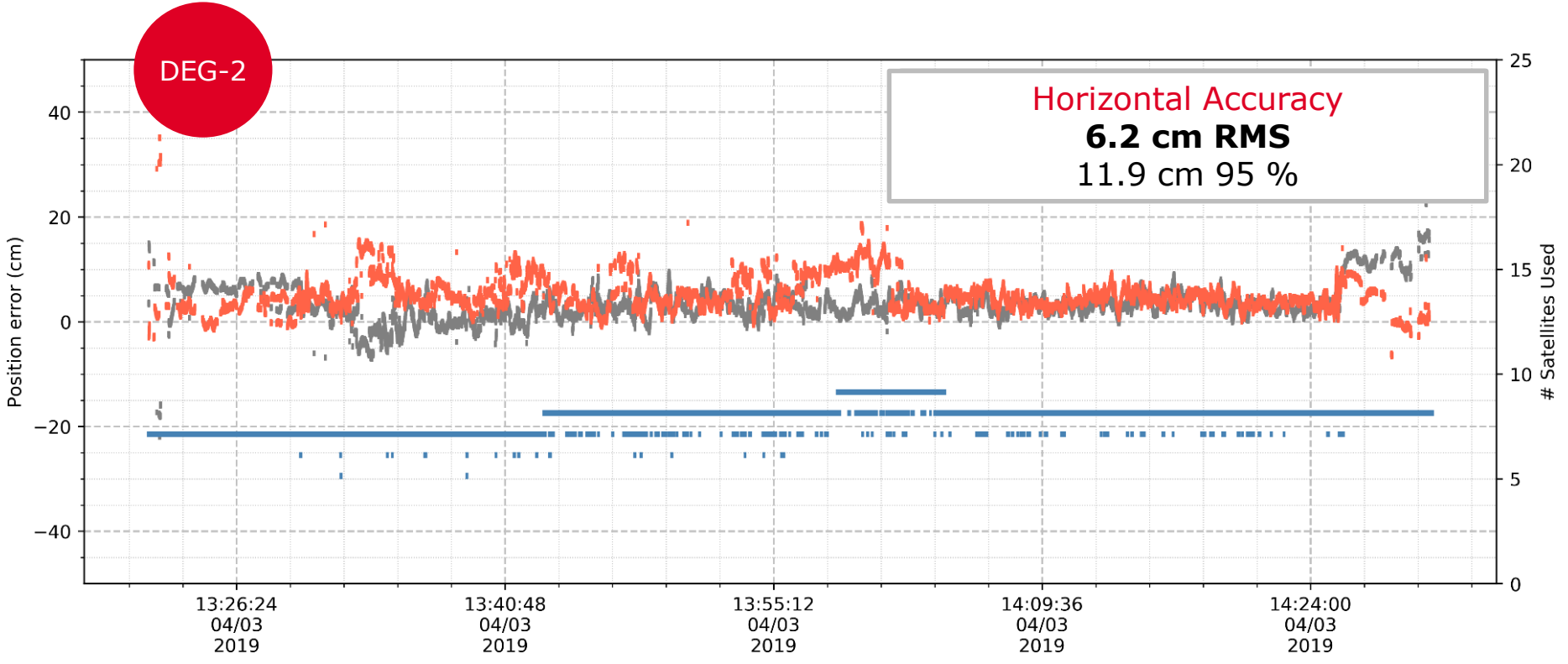
OPEN SKY ACCURACY



DEGRADED-1 ACCURACY

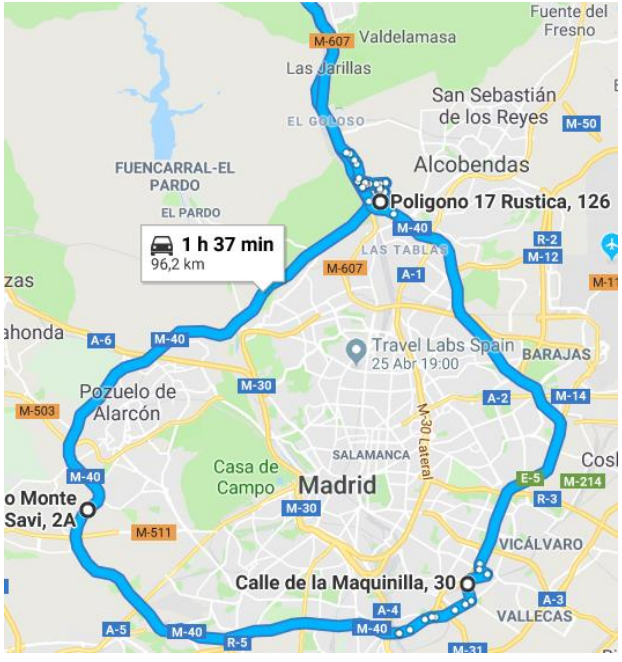


DEGRADED-2 ACCURACY



SUBURBAN TRAJECTORY

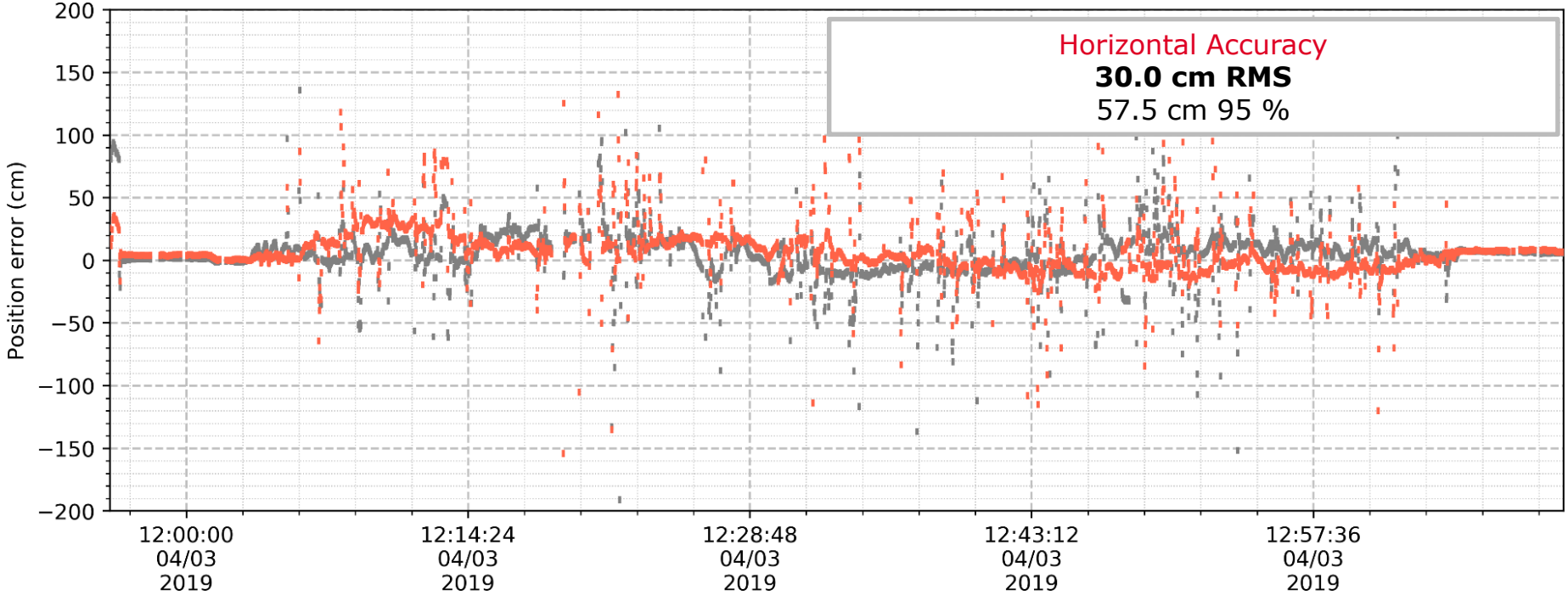
- Peripheral highway in Madrid (M40)
  - High multipath
  - Multiple overpasses
  - Max speed 100km/h
  - Medium-High level traffic during whole day
  - Considered worst use case



SUBURBAN ACCURACY

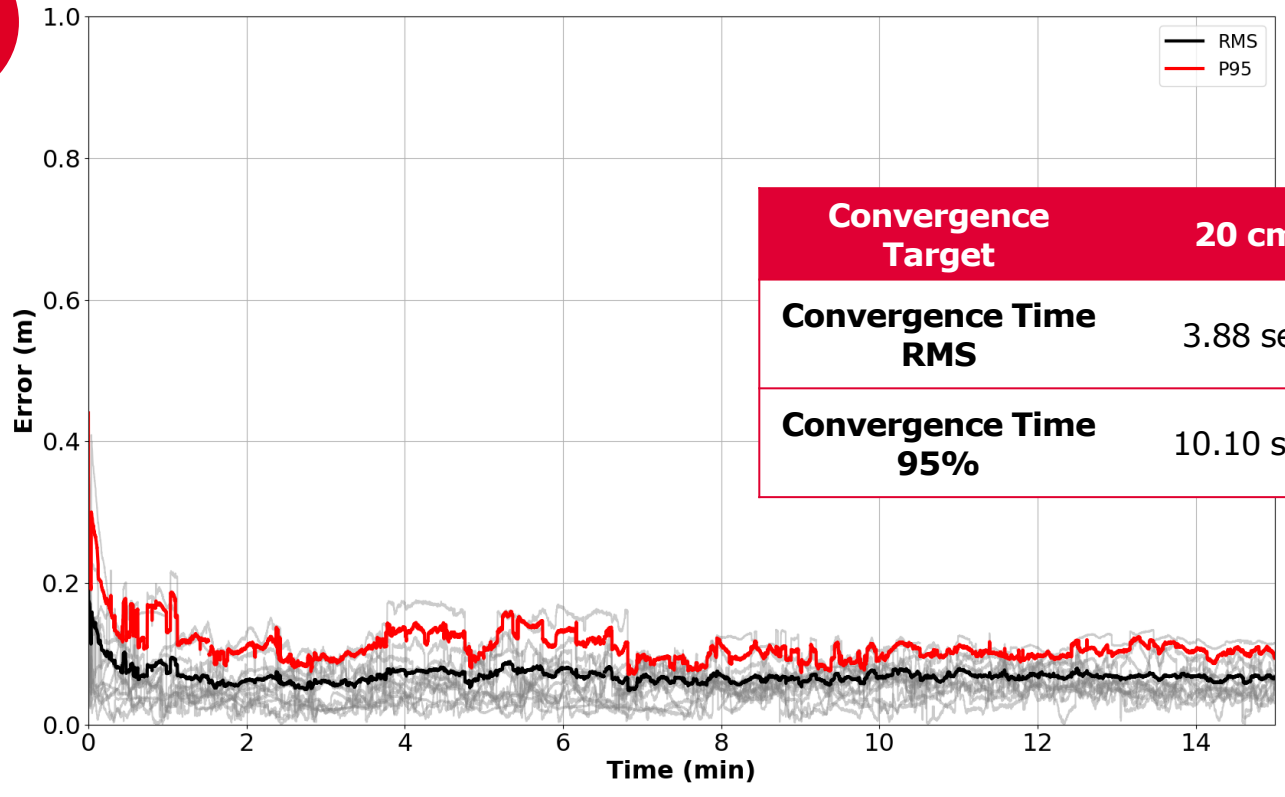
VIDEO

SUBURBAN ACCURACY



OPEN SKY COLD CONVERGENCE

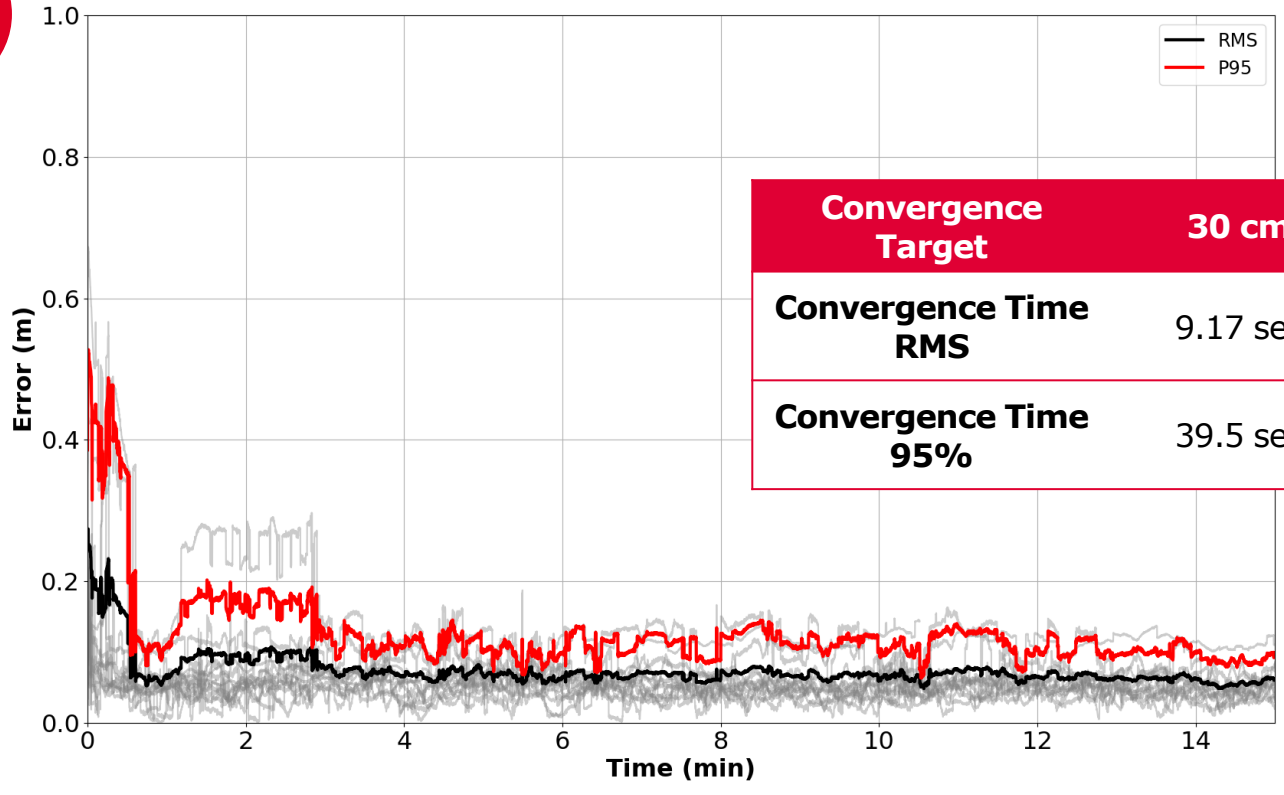
OPEN SKY



Convergence Target	20 cm
Convergence Time RMS	3.88 sec
Convergence Time 95%	10.10 sec

DEGRADED-1 COLD CONVERGENCE

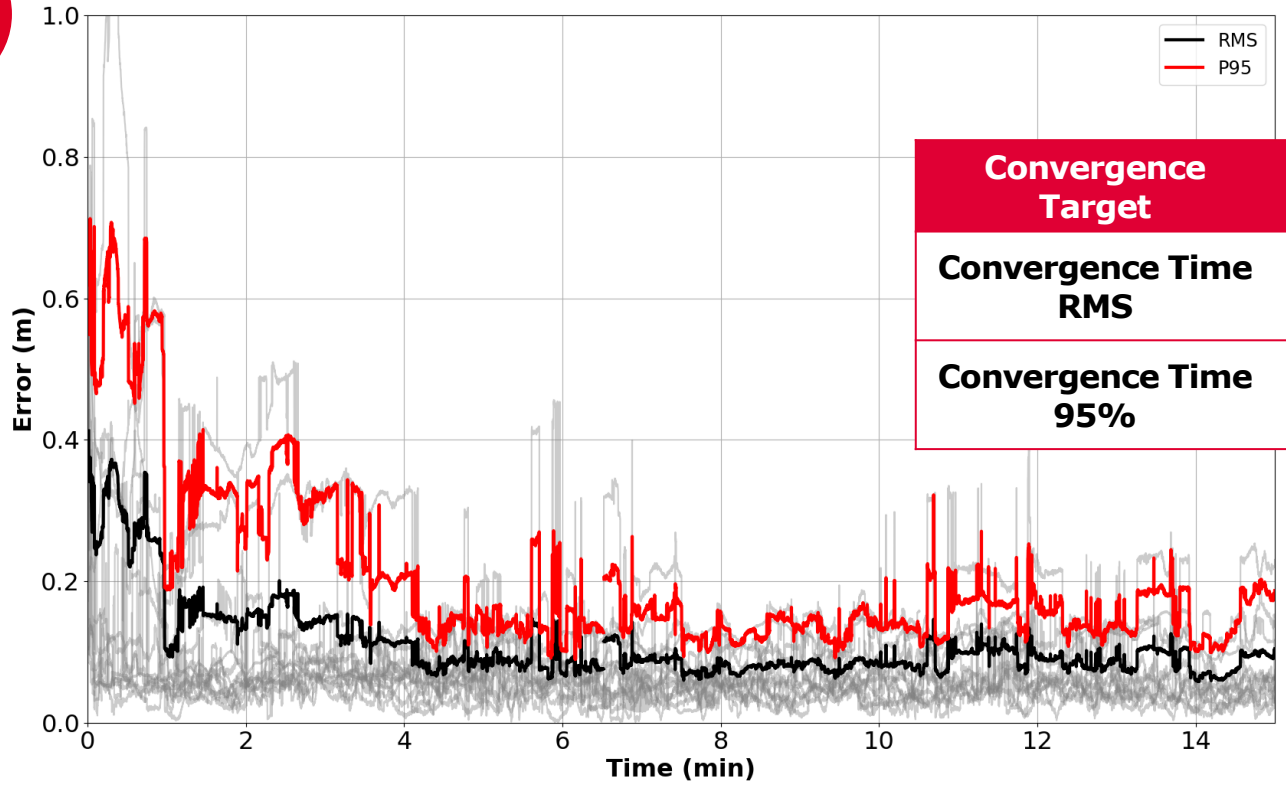
DEG-1



Convergence Target	30 cm
Convergence Time RMS	9.17 sec
Convergence Time 95%	39.5 sec

DEGRADED-2 COLD CONVERGENCE

DEG-2



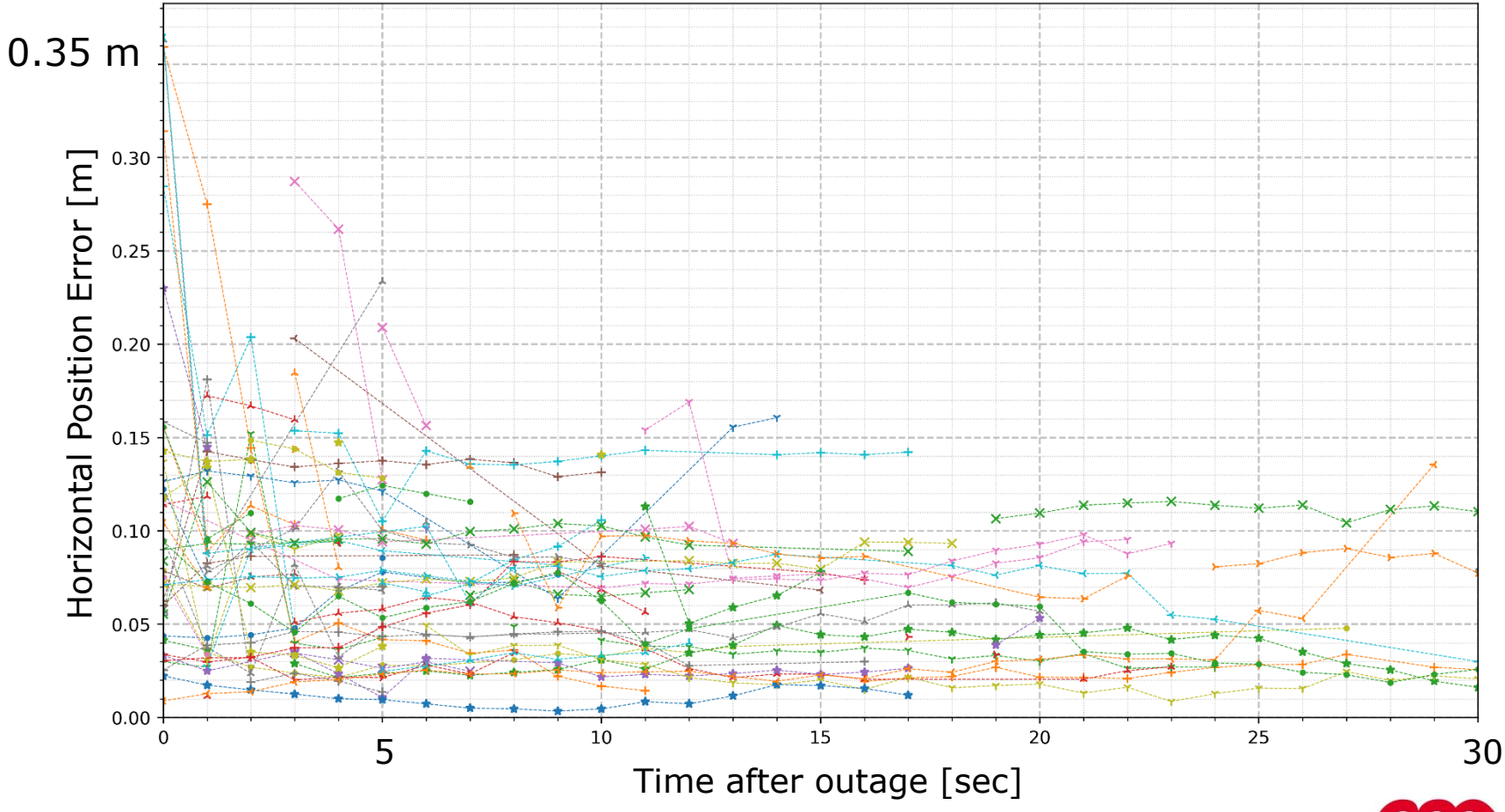
Convergence Target	90 cm
Convergence Time RMS	3.19 sec
Convergence Time 95%	9.75 sec

HOT CONVERGENCE

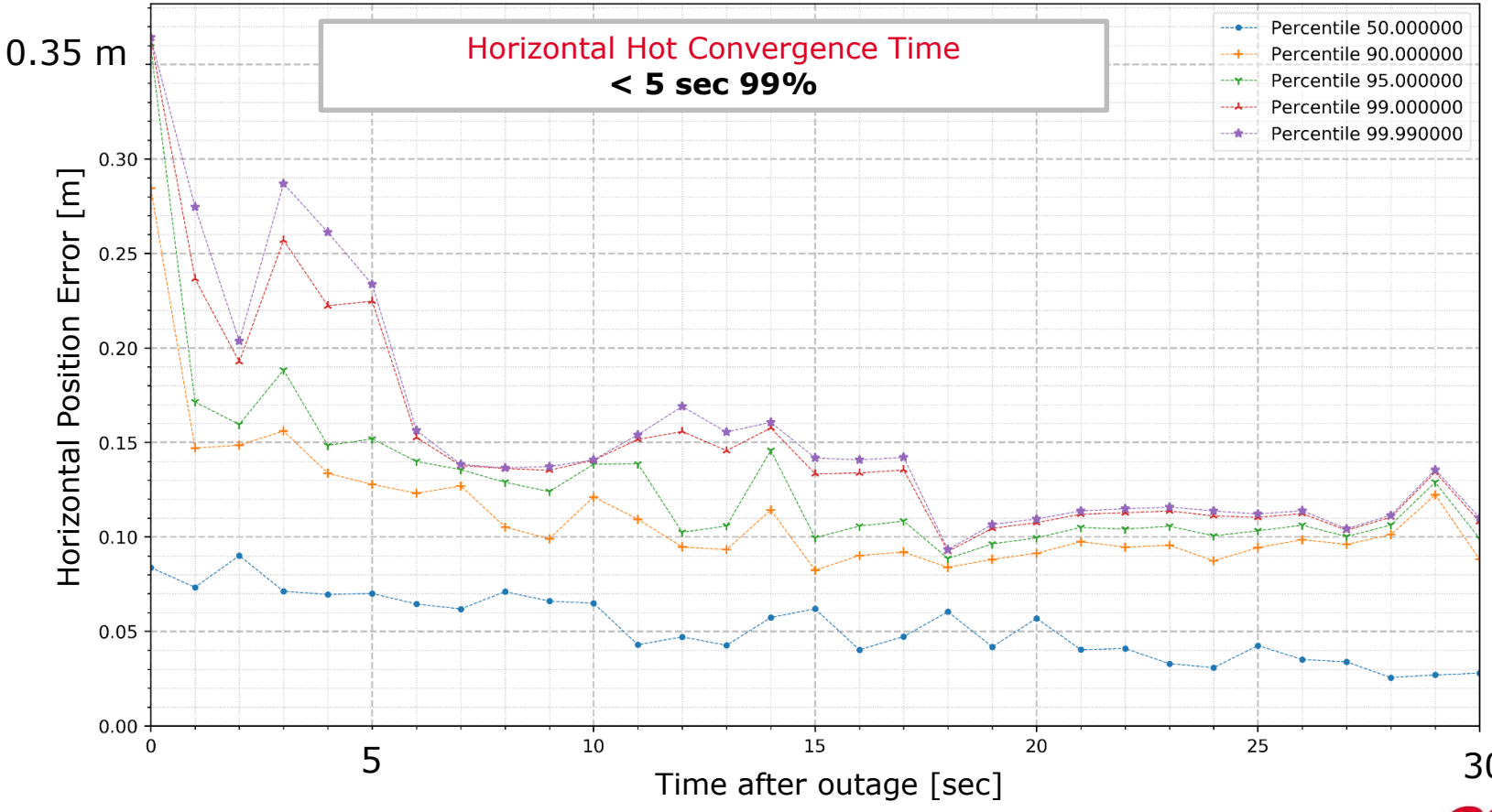
Performance Recovery Time after short signal outages

Bridges, Tunnels, Tree Canopies…

HOT CONVERGENCE TIME



HOT CONVERGENCE TIME



PRESENTATION

CONCLUSIONS

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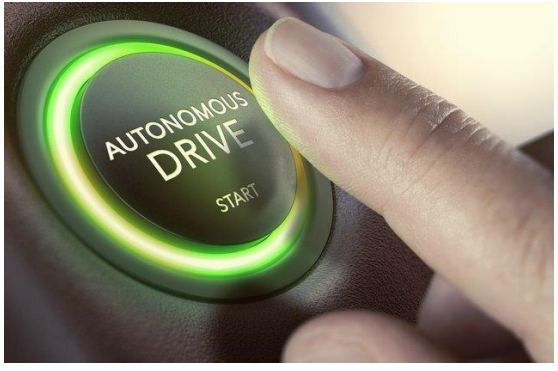
- The **needs** for GNSS-based positioning in autonomous driving have been clearly identified
- **Algorithms** have been deployed and tested
- **Performances** meet needs
- **GMV is ready** to provide GNSS-based positioning for autonomous driving



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THANK YOU

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