

Latency Assessment for CAM services over 5G

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5GMOBIX



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- Introduction
- UDP protocol testing
- CAM/DENM messages through MQTT broker
- Latency results
- Conclusions

Introduction

- Wireless vehicular communications applications to provide efficient, safe and secure CAM services.
- Cellular communications (C-V2X): Preferred technology.
- Standard protocol stack: BTP and GeoNetworking transport protocols.
- Study on alternative MQTT broker using TCP/UDP transport protocols.
 - Becoming the facto standard for vehicle to cloud communications
 - Publish /Subscribe paradigm
 - Persistent session between MQTT client and MQTT broker

Introduction

- Assessment on *Latency*:
 - Key Performance Indicator to enable CAM applications.
- 2 Methods for evaluation
 - UDP protocol to evaluate the latency of the cellular network.
 - CAM/DENM messages transmitted through MQTT broker

Method 1: UDP protocol testing

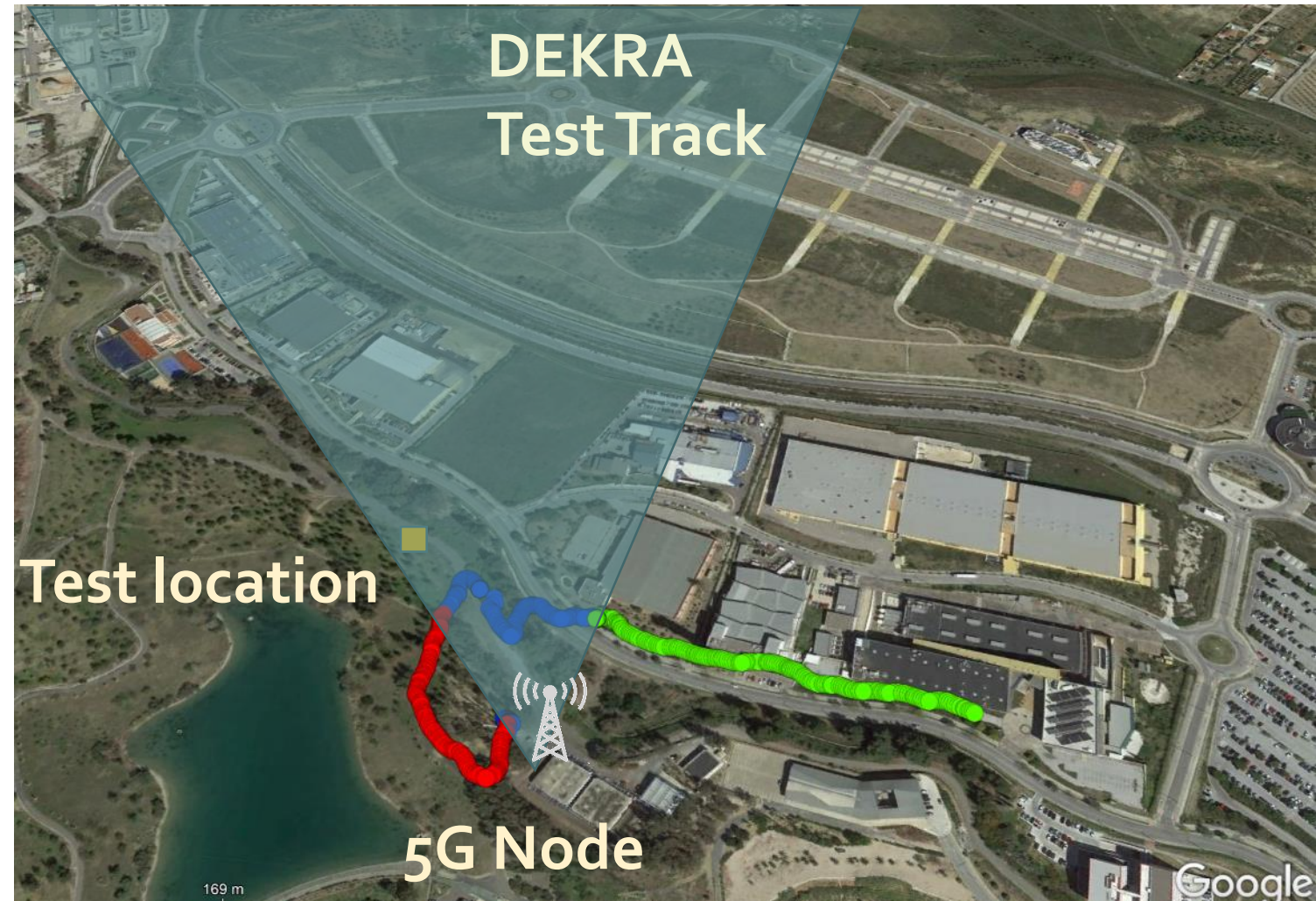
- Measure network performance: latency
- UDP protocol for latency measurements
- Synthetic traffic generated by measurement tool
- Tests performed at several speed rates
- DL and UL directions
- Static measurements as first step
- 10 minutes tests
- Good coverage area, close to 5G network node
- Measurement tool: TACS₄ Performance testing platform

UDP protocol Testing area Málaga TechPark

- Commercial network
- Movistar network operator
- NSA Option 3x

Latency assessment

- LTE FDD 7 (2600 MHz)
- NR TDD 78 (3500 MHz)



UDP protocol testing Test Setup

TACS₄-Web



Internet



TACS₄-Agent

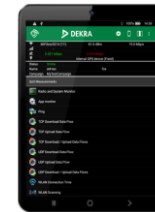
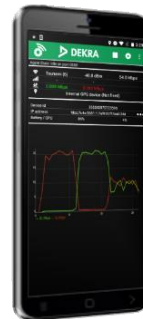
ITS Centre



TACS₄-Agent

MEC

5G network



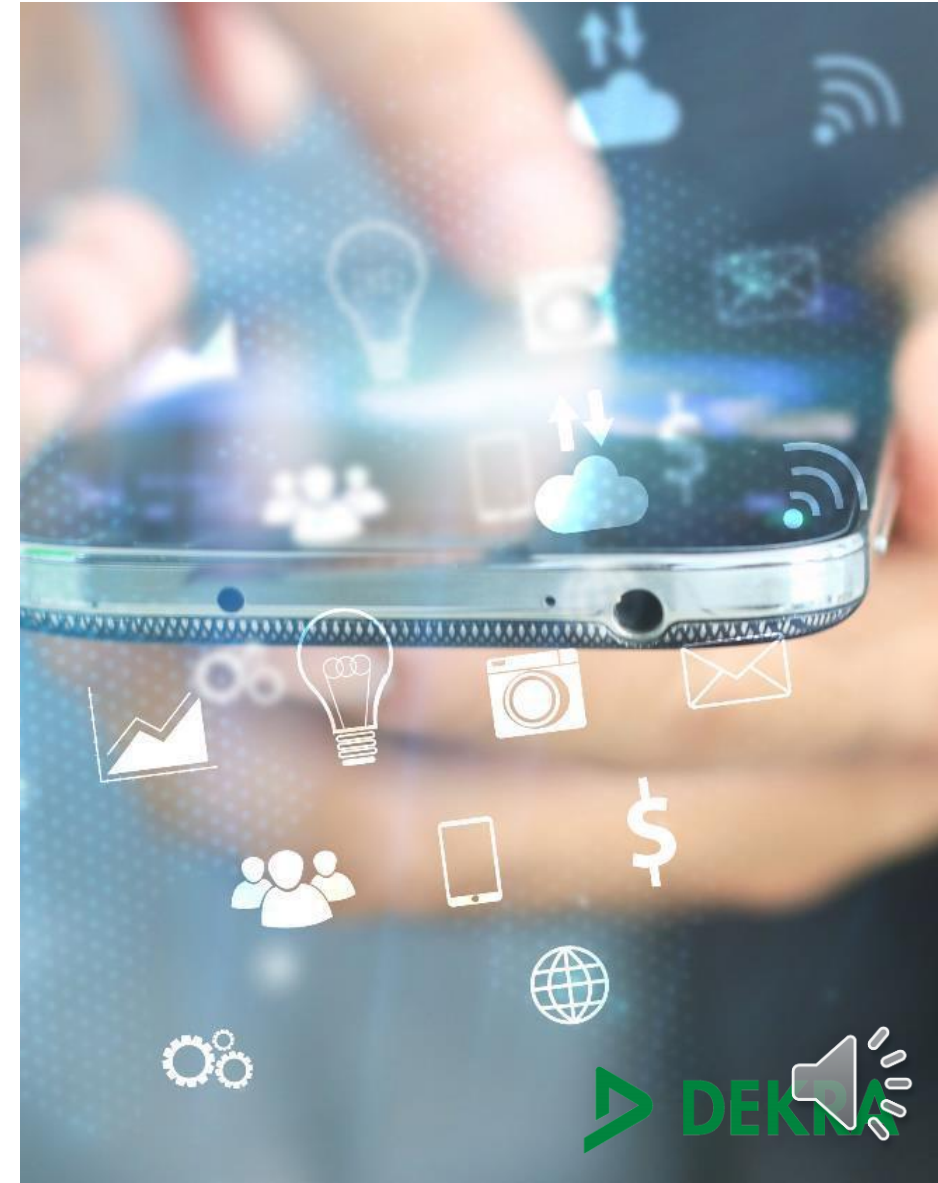
TACS₄-Mobile app running on mobile devices

TACS₄ Performance Testing Platform

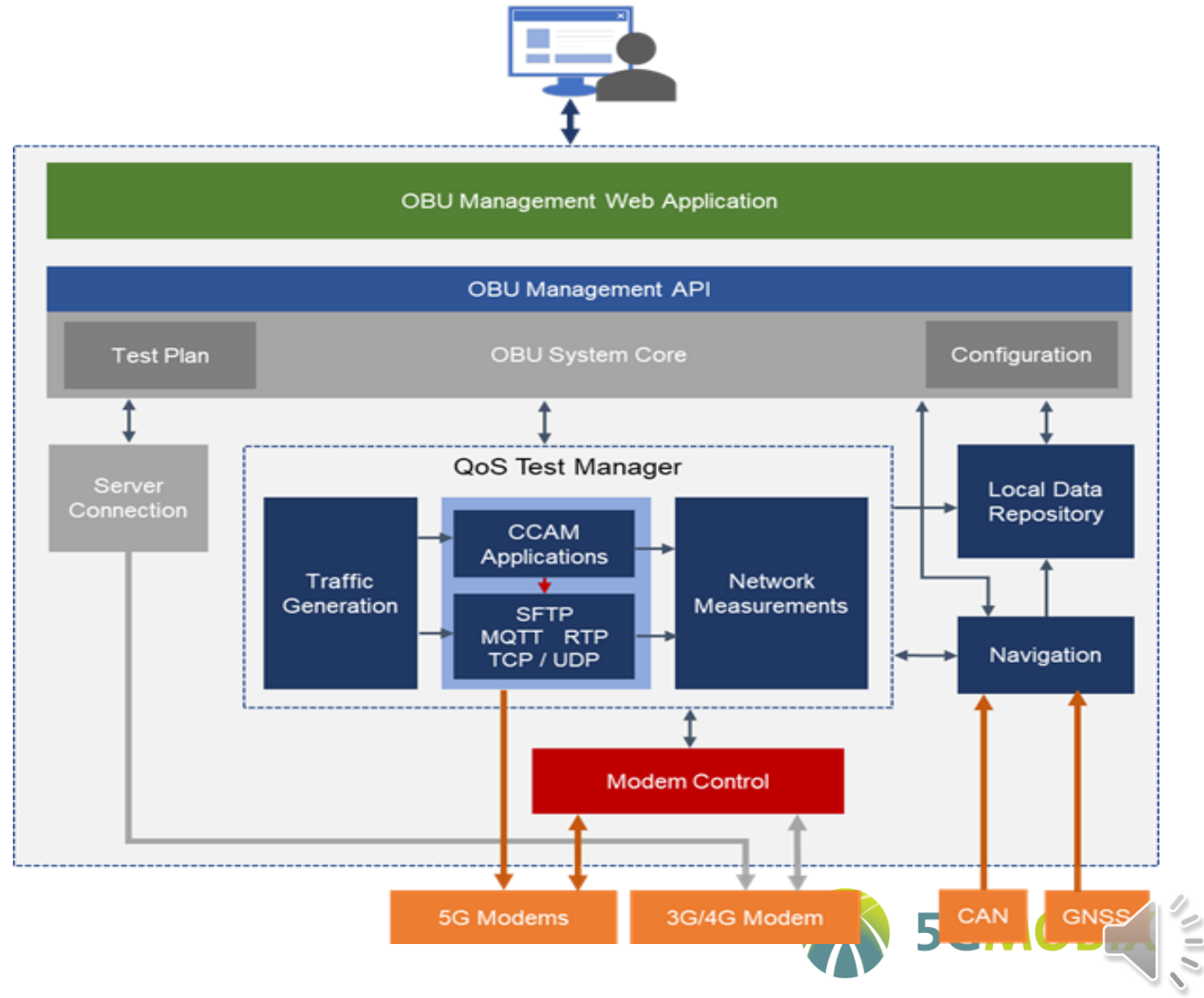
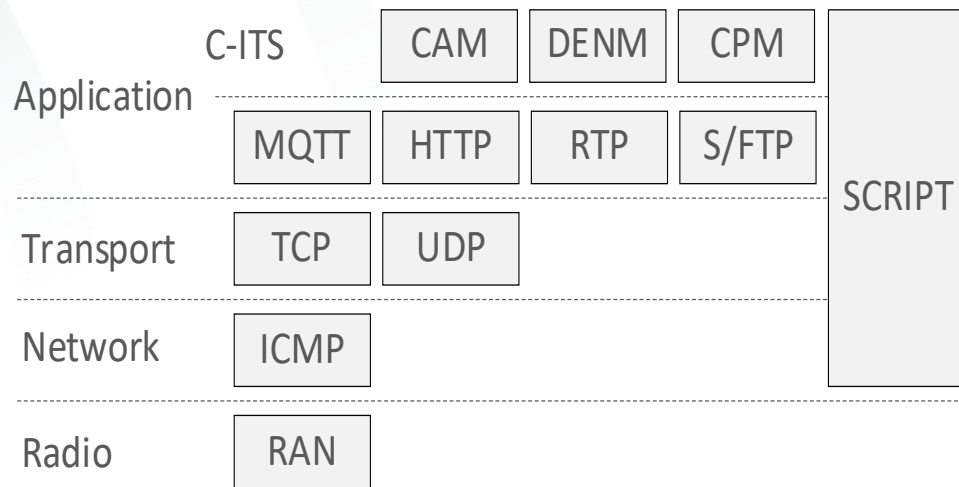
Delivers concurrent performance testing and user experience analytics of mobile communication networks for data and voice services.

- Mobile solution suitable for field and lab testing
- High scalability
- QoS measurements and one-way data KPIs
- QoE evaluation for several popular applications
- Tailored test scenarios thanks to the visual testing script language for Android devices
- Advanced data analytics : Maps, graphs, and grids
- Tests can be scheduled for periodic execution
- Remote control of commercial mobile devices from the TACS₄-Web
- Tests can run on multiple devices simultaneously

<https://performance.tacs4.com>

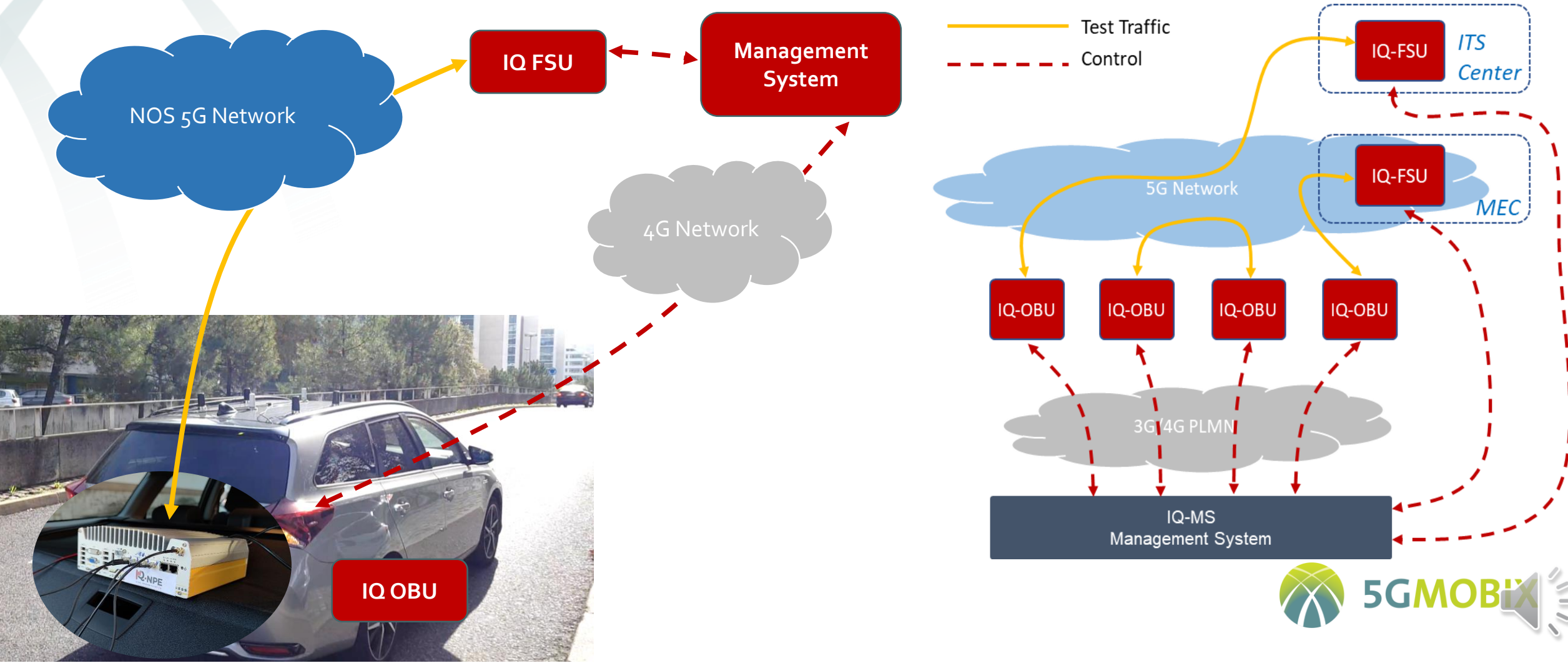


Method 2: MQTT Broker. OBU Architecture- a 5G QoS Probe

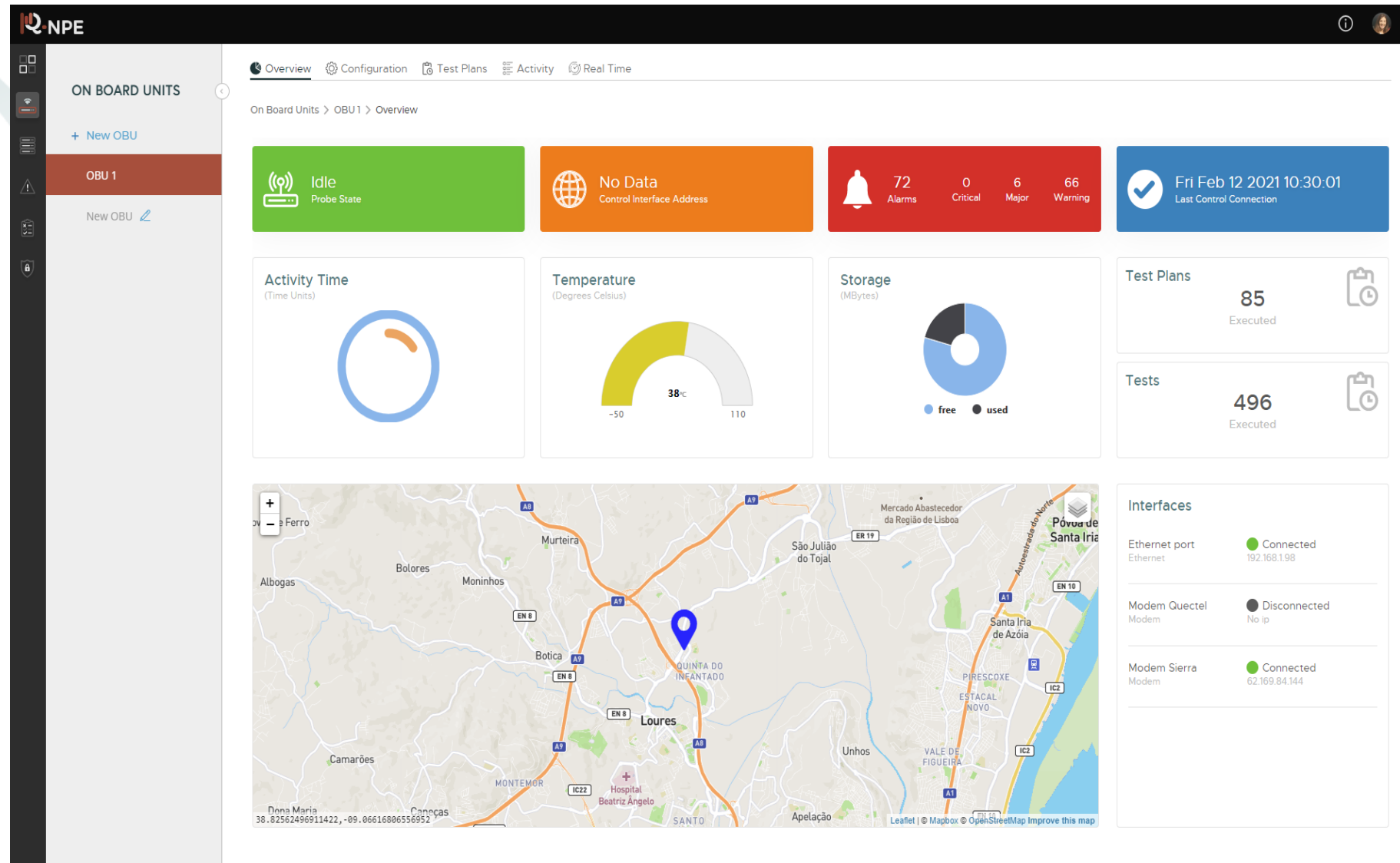


CBC Measurements Architecture

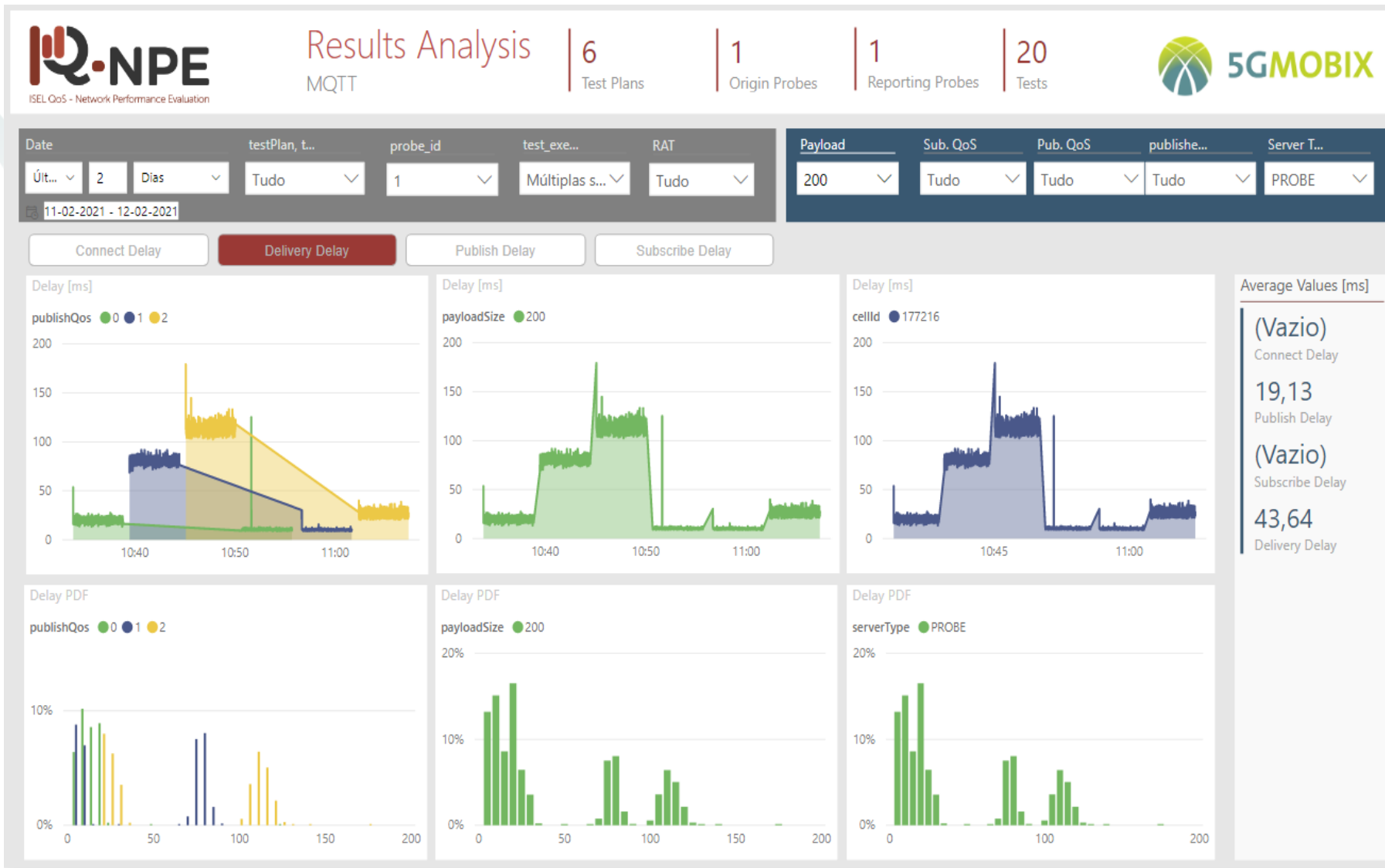
- 5G Radio Interface Performance Tests over NOS Network



MQTT broker. Measurements execution

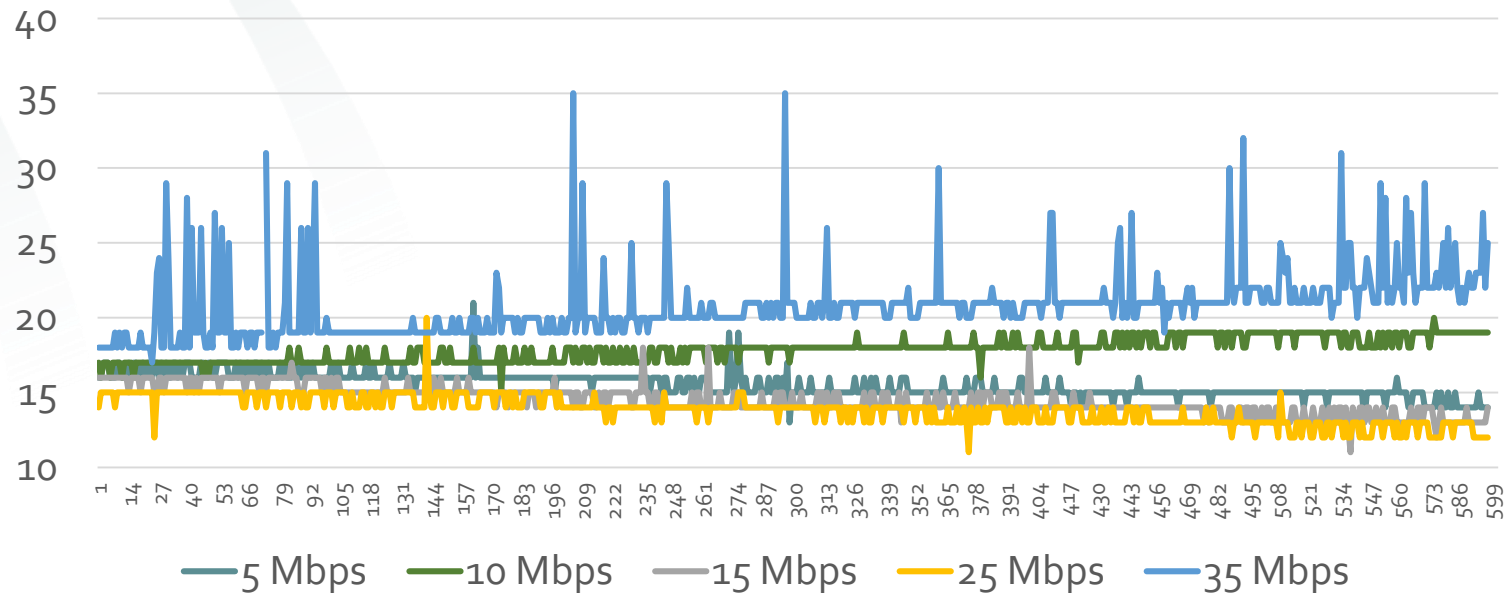


MQTT broker. Results Analysis Using BI Tools

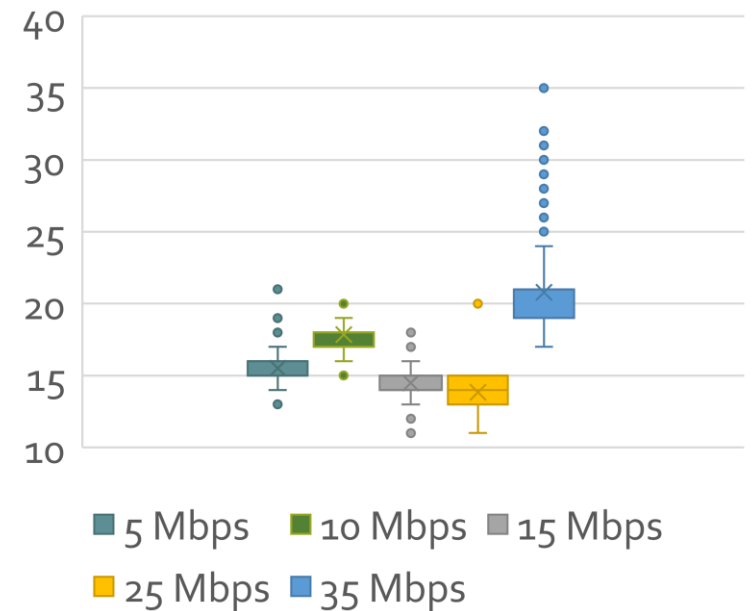


UDP Protocol testing. DL

UDP DL. One-Way-Delay (ms)

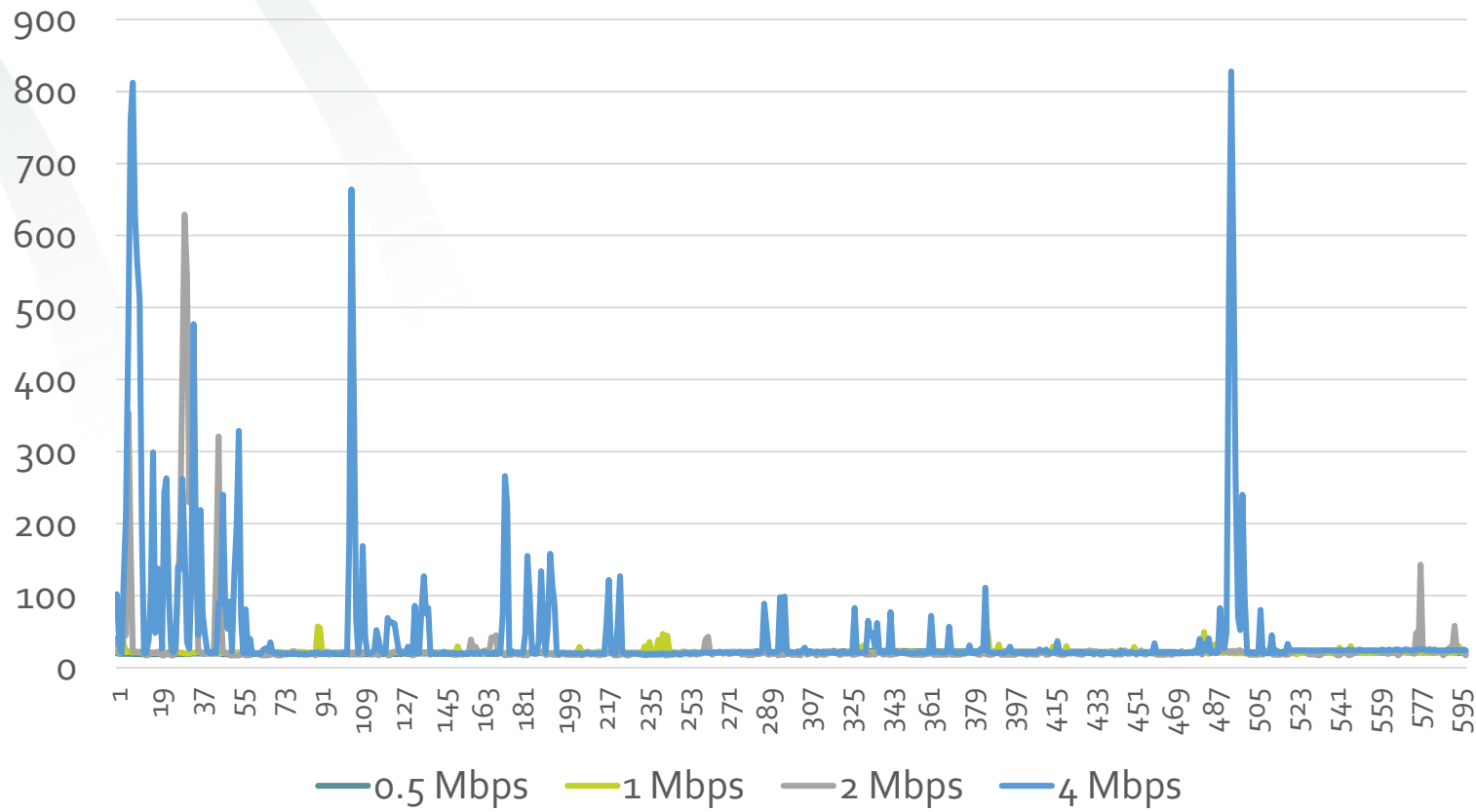


UDP DL. One-Way-Delay

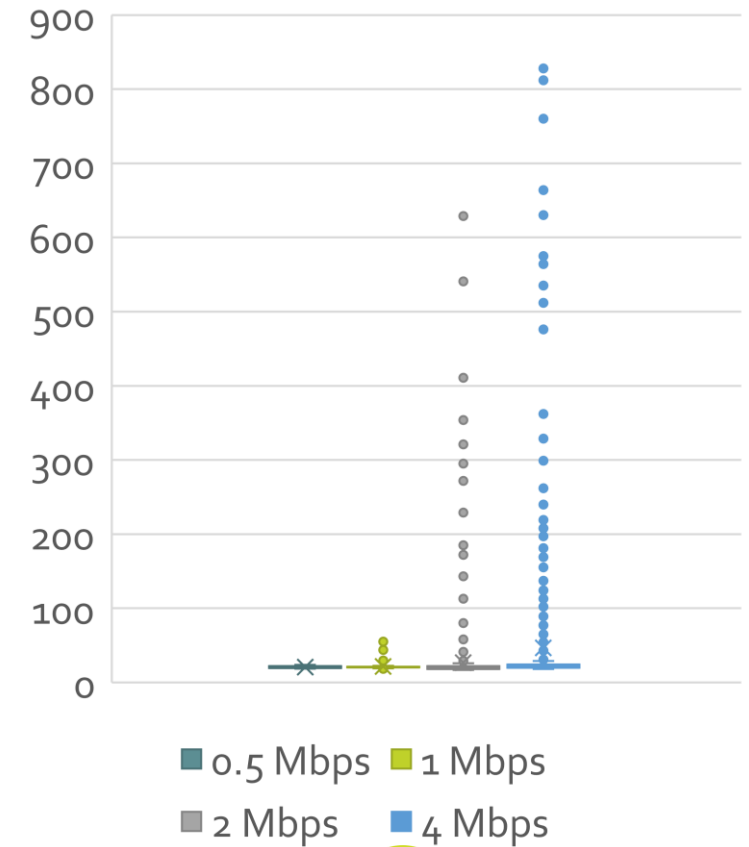


UDP Protocol testing. UL

UDP UL. One-Way-Delay (ms)



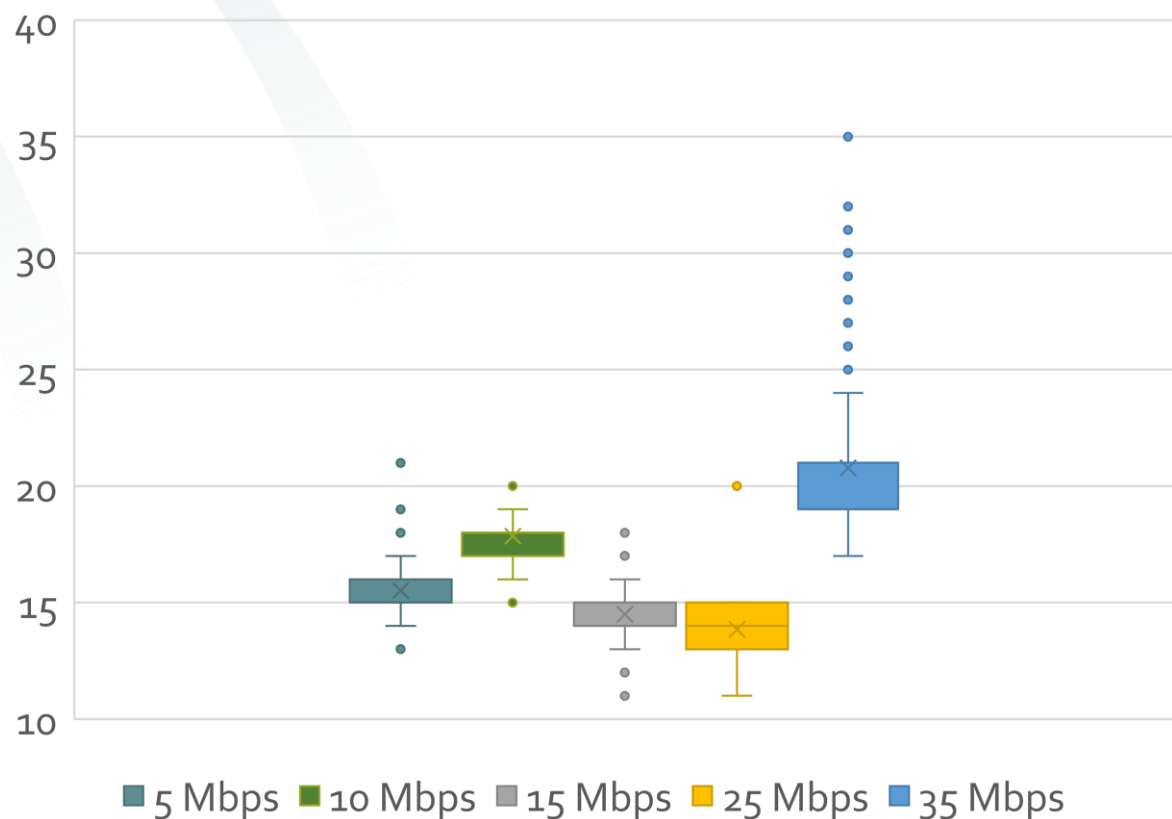
UDP UL. One-Way-Delay (ms)



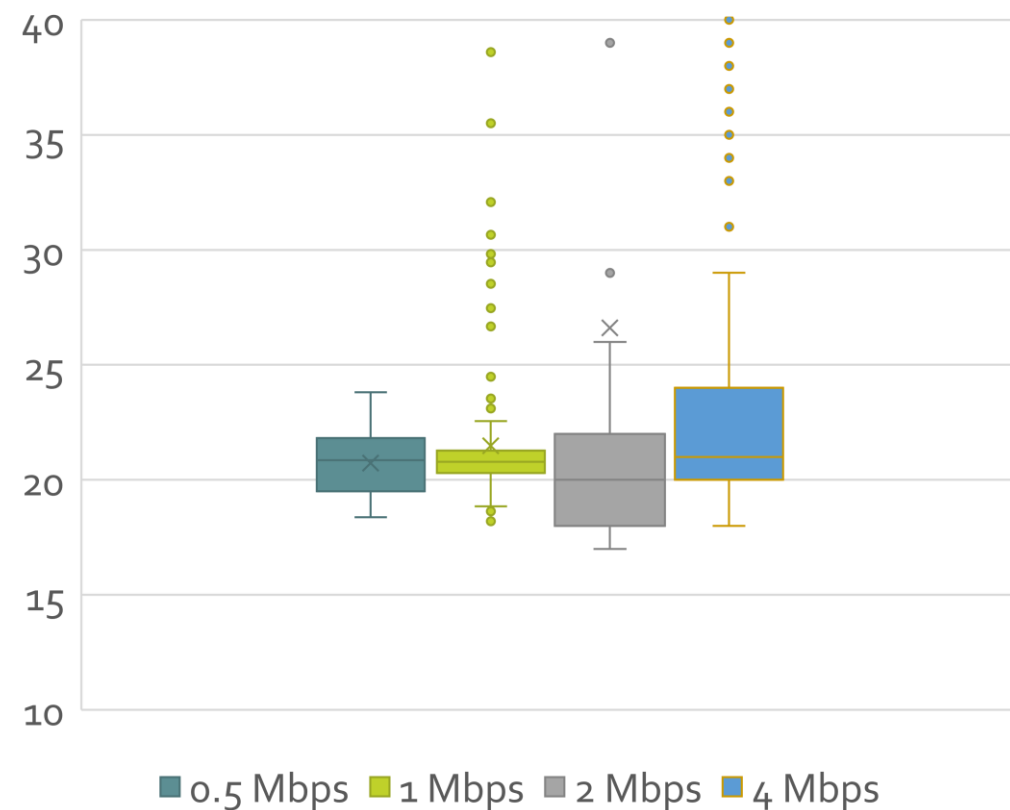
UDP Protocol testing.

DL vs UL results

UDP DL. One-Way-Delay (ms)

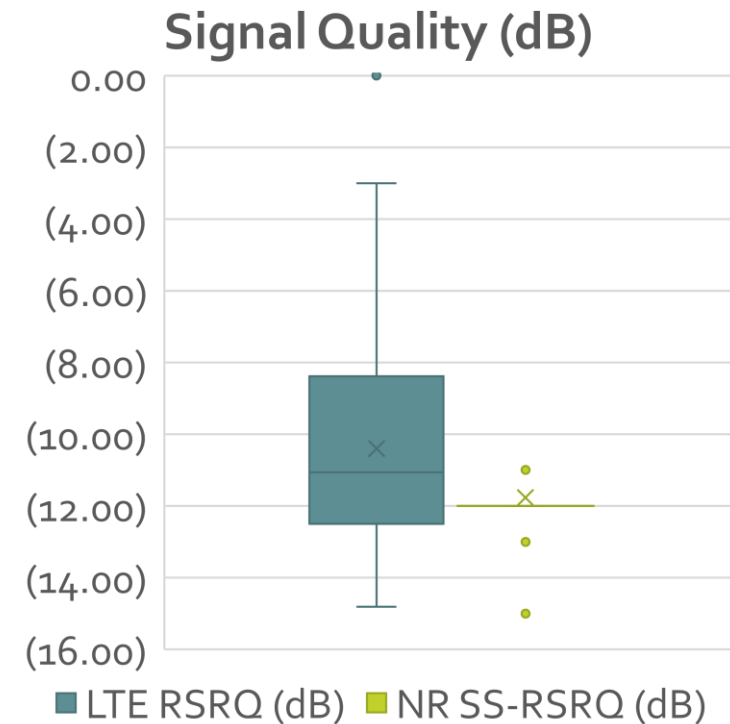
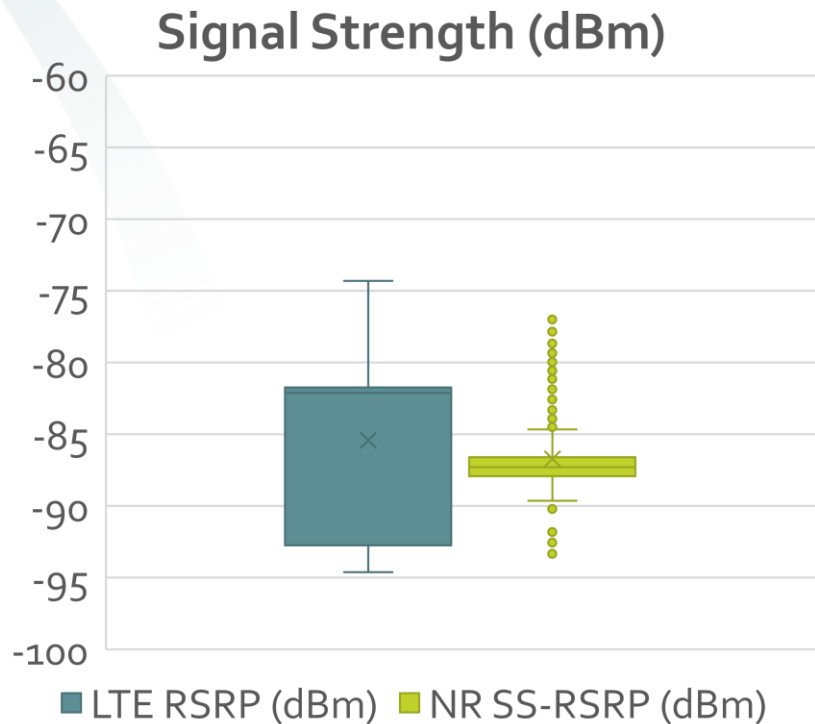


UDP UL. One-Way-Delay
Zoom (10-40 ms)



UDP Protocol testing.

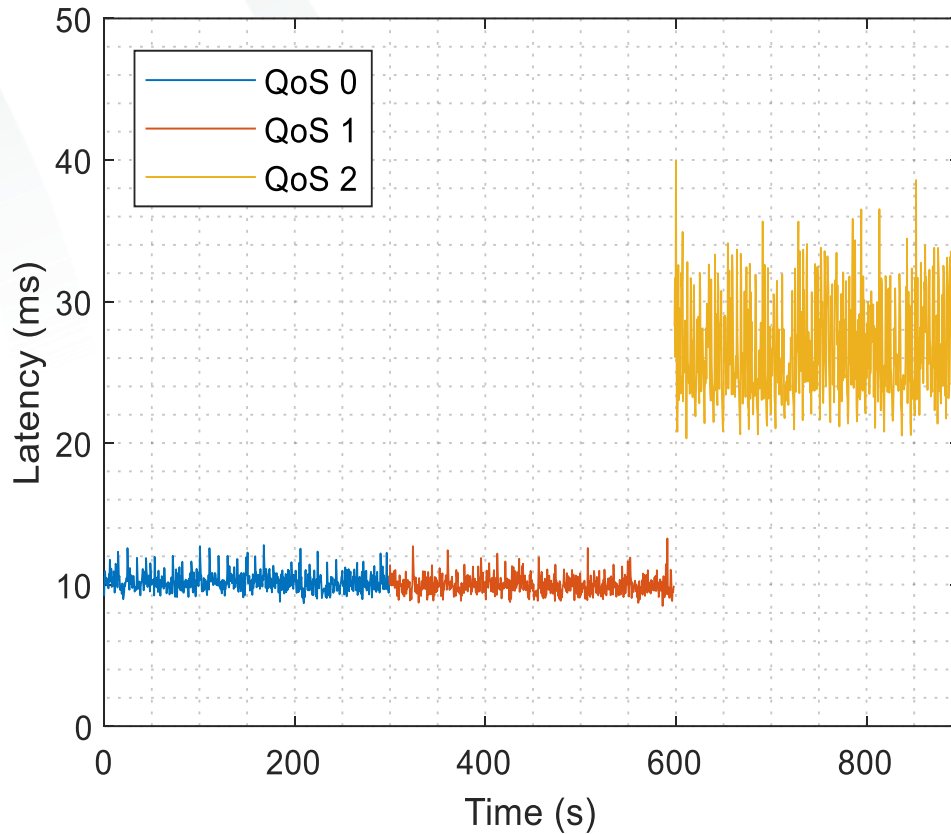
Network conditions



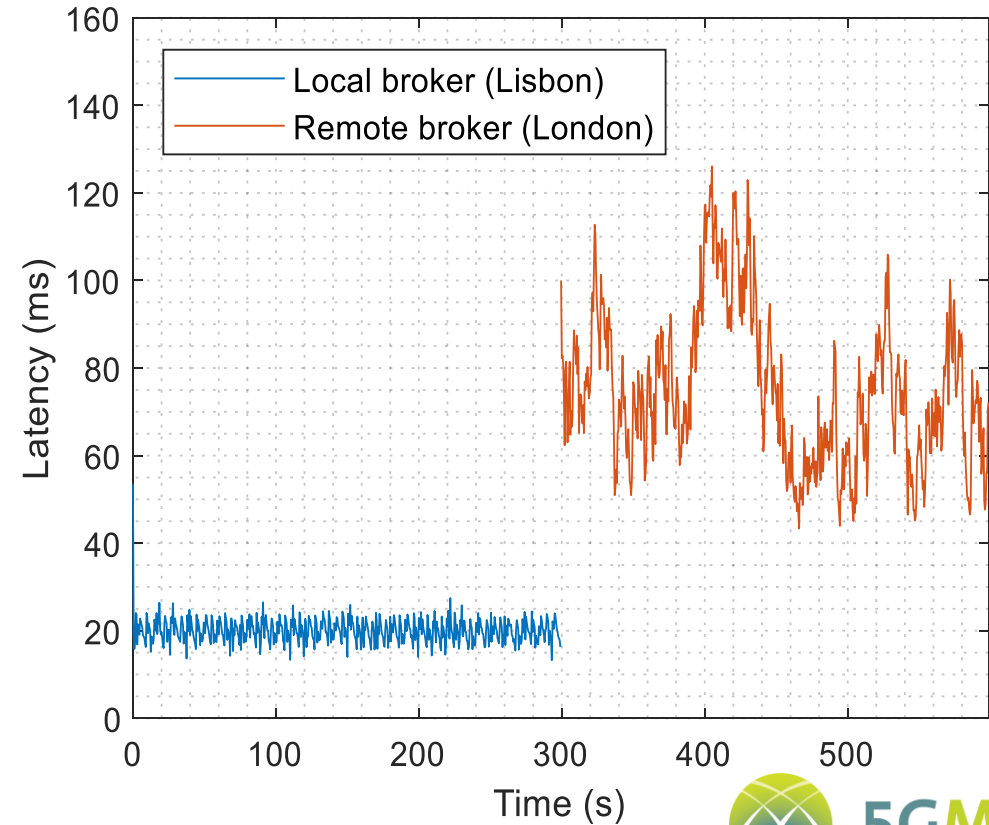
MQTT broker- Initial measurement results.

Latency

Downlink CAM/MQTT Latency
(different QoS Levels)

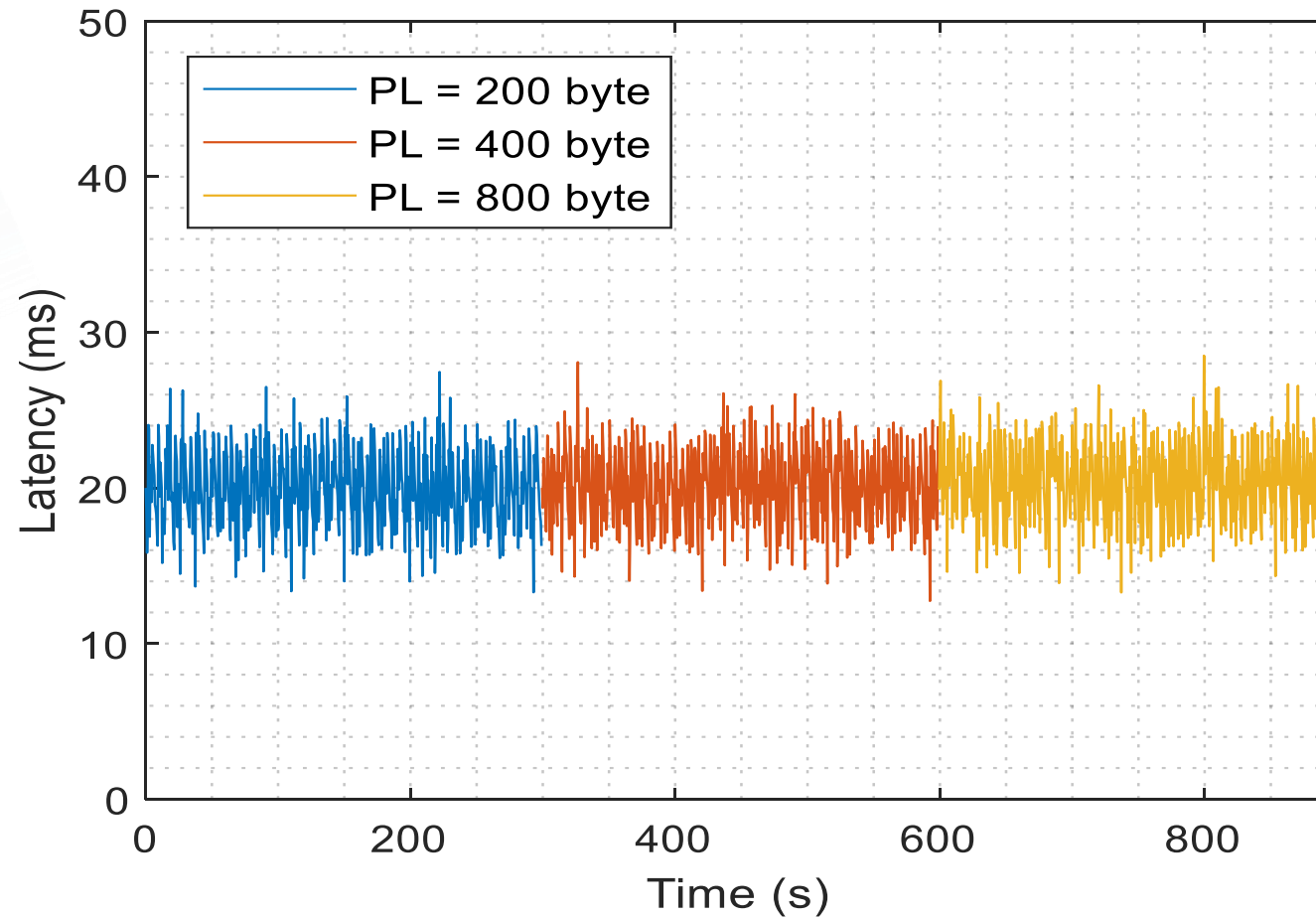


RTT CAM Latency
(different MQTT Servers Locations)



Initial Measurements Results - Latency

Assess different CAM payload sizes



Conclusions

- Two complementary methods for latency assessment
 - UDP protocol and synthetic CAM/DENM messages through MQTT broker
- Results on a commercial network using UDP protocol show that:
 - More stable results in DL, with several outliers in UL
 - Latencies around 15 ms in DL and over 20 ms in UL
 - Degradation of latency happens above certain speed rates (30 Mbps in DL and 2 Mbps in UL)
- Results on a commercial network using MQTT broker show that:
 - QoS 2 provides a poor latency response
 - Payload packet size does not seem to affect latency
 - Distance to remote MQTT broker increases latency
- Additional steps to be considered:
 - Characterisation of outliers, and their relevance in CAM applications
 - Network Traffic loads
 - Stability of results: Analysis on different runs.
- Network latencies vary significantly.
 - CAM applications must consider these changes for robust behaviour.

Thank you



www.5g-mobix.com



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