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Next-generation communications for V2X applications

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Introduction

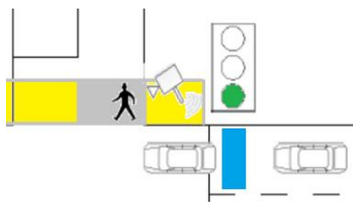
The paper targets Internet of Vehicles (IoV) based on Long Term Evolution Vehicle-to-Everything (LTE-V2X) using the 5.9 GHz band for Vehicle-to-Vehicle (V2V) and the 3.5 GHz band for Vehicle-to-Network (V2N).

Main objectives

- To test and demonstrate the latest 5G key technologies in pre-commercial 5G networks
- To study key innovations in network slicing, network virtualisation, 5G transport network, edge computing and 5G NR features
- To stimulate EU-China 5G collaboration
- To investigate the robustness of the 5G technology considering automated vehicles

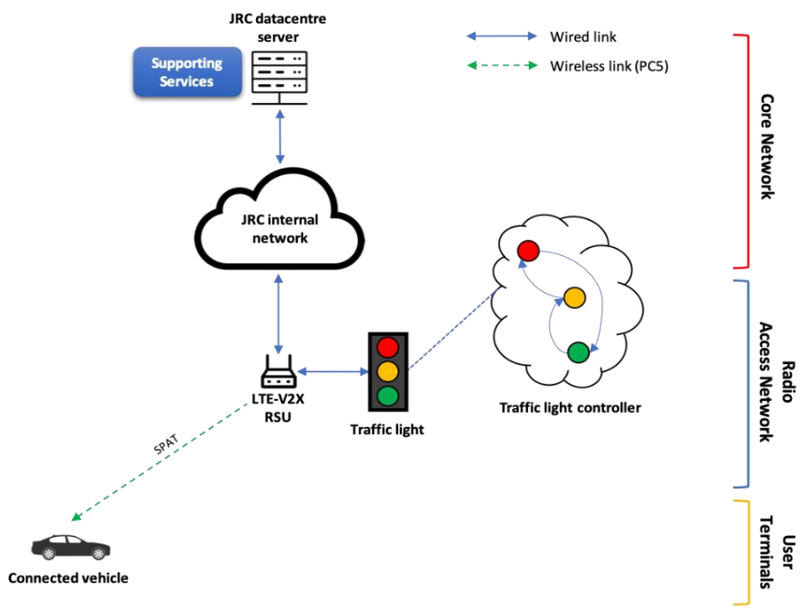
V2X use cases and KPIs

- GLOSA KPIs: 1) Packet Error Rate (PER): ratio of unsuccessfully received packets in the OBU vs. total number of packets sent by the RSU (%); 2) Latency: the radio access network contribution to the total elapsed time, measured from the instant the RSU sends a packet to the moment when the OBU receives it (ms).

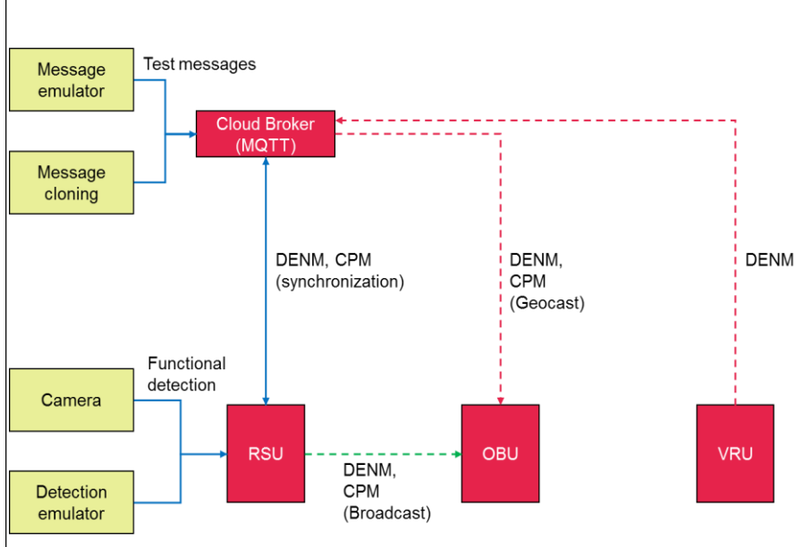


- Intelligent Intersection KPIs: 1) PER (see above); 2) Latency (see above); 3) Total active stations: this KPI tracks how many other stations were active at the same time while in communication range of the test subject; 4) Total channel load in MB/s: The total load of the channel is an important contextual variable to determine how much interference can be expected; 5) Total messages/s on channel: One other client using a load of 1MB/s has much less chance of packet collisions than a hundred clients transmitting at 10 KB/s.

Architectures and Trials



GLOSA physical architecture at the JRC Ispra site



Functional architecture of the intelligent intersection use case

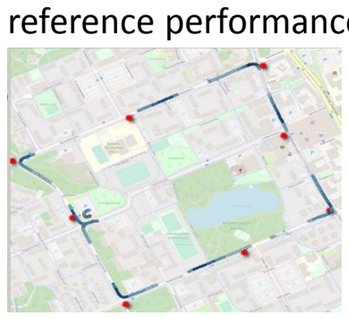
Joint Trials

Trial	Environment	KPI targets
DENM V2I	5/10/15/20 DENM stations 50/100/150/200 CAM stations	PER < 1% Latency < 10 ms
GLOSA V2N	100/200/300/400/500 CAM stations	PER < 10% Latency: MAP < 5s, SPaT < 2s
CPM V2X	80/100/120/140 CAM and CPM station	PER < 10% Latency < 100ms Bandwidth > 1.6 Mbyte/s
MCM V2X	100/200/300/400/500 active CAM and MCM stations	PER < 10% Latency < 100ms Active stations >=300

CAM - Cooperative Awareness Message
CPM - Collective Perception Message
DENM - Decentralized Environmental Notification Message
MCM - Manoeuvre Coordination Message
PER - Packet Error Rate
SPAT - Signal Phase and Timing

Preliminary results

The network is LTE based, operating in BAND 38 (2575 - 2615 MHz). The site is also equip with ITS G5 devices for capturing reference performance indicators.



LTE 2.6 GHz network signal coverage measurements

Discussion and Conclusion

When the signal level is -90 dB basically, the network becomes useless for transport and automated driving needs where coverage and low latencies are critical to guarantee safe and remotely supervised real-time driving. LTE-V2X has inherent limitations n bandwidth, latency and reliability to support new features, particularly automated driving in V2X applications. Communication requirements for automated driving will be substantially more challenging.

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