



5G Initiative – “5G Roadmap” Working Group

“5G roadmap for V2X services”

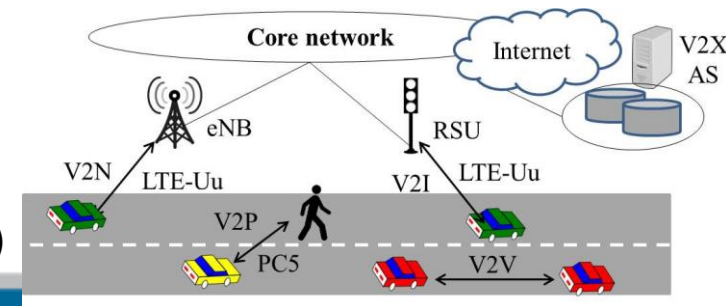
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Contribution “5G for V2X”

- **5G for vehicle-to-everything communications** has to support a variety of multi-tenant use cases/services (scope: device, wireless, core, application)
 - E.g., Autonomous driving, tele-operated driving via tactile Internet, infotainment, remote diagnostics, interactive gaming, AR/VR, road safety/traffic efficiency, fleet management, collaborative robots/drones on wheels
- **Relation to SDOs and other**
 - 3GPP Rel. 14 and beyond: use cases and technology enablers definition
 - NGMN Alliance, 5G-PPP: use cases definition
 - 5G Automotive Association: interoperability solutions
 - ETSI NFV/MANO: RAN/core network function virtualization and orchestration
 - ETSI MEC: edge-placement of services for latency-critical V2X services
 - IEEE 802.11/WAVE, ETSI ITS, SAE: access technologies, message sets
 - IETF WGs: mobility support, next-generation internet protocols (e.g., 5gangip)

- **Impact Horizon**

- IEEE/3GPP V2X std. ready (~3 years)
- First test-beds, std. harmonization (~5 years)
- Large-scale deployment&evaluation (>10 years)



Specific contribution n.1 - "5G for V2X"

■ 5G network slicing for V2X services

- V2X specific challenges, e.g.: (1) not easy mapping of reference slices/use cases (i.e., eMBB, URLLC, mMTC); (2) vehicles are *multi-slice devices*; (3) *diversity of UEs* (e.g., OBU, VRU's UE); (4) *e2e slicing including end device*
- **RAN** slicing, e.g.
 - Novel schemes for RAT selection/joint use (also non-3GPP access tech.)
 - New/improved scheduling schemes, e.g., adaptive HARQ and TTI; evolving PC5 and LTE-Uu interfaces (e.g., scheduled/autonomous mode, in-coverage, out-of-coverage spectrum management)
- **Core network** slicing, e.g.
 - eMBMS extension for geocasting; V2X application server placement
 - Network function placement through SDN/NFV
- **Device** slicing, e.g.
 - CP/UP customization to the UE type
 - Enable local decisions (e.g., HARQ, link adaptation, resource pool selection, slice selection/activation)
- **End-to-end orchestration (e.g., service chain composition)**
- New **business models** and **security** mechanisms definition

Specific contribution n.2- “5G for V2X”

- **Investigating novel media technologies in the 5G and beyond ecosystem (e.g., mmWave, VLC)**
 - Pros: increased bandwidth, strong directionality/low interference
 - To be investigated
 - Benefits for bandwidth-hungry V2I (e.g. cloud apps, tele-operated driving)
 - Potential for V2V automated multi-platoons and convoys
 - Channel models and numerology
 - Harmonization with other technologies
- **Sophisticated RF transceiver design like full-duplex for IEEE/3GPP**
 - Pros: simultaneous transmission and reception on the same channel and collision detection while transmitting
 - To be investigated
 - Self-interference cancellation techniques for highly varying vehicular channels
 - MAC-layer solutions exploiting full-duplex PHYs for V2X safety broadcasting, platooning, relaying, etc.

Specific contribution n.3 - “5G for V2X”

- **SDN/MEC/ICN to enhance V2X performance and to define new value-added services in the 5G-and-beyond ecosystem**
 - **Phase 1: enable MEC/ICN/SDN to enhance V2X service**
 - **MEC-assisted V2X** enables e.g., low-latency autonomous driving, high-bandwidth infotainment
 - **ICN native features in 5G** like *in-network caching, multipath delivery, named content*, enhance V2X performance (e.g., lower latency, bandwidth save in backhaul/core)
 - **SDN-enabled RSU/eNB** beyond simple flow forwarding (e.g., interference and congestion management) to improve V2X perf. (e.g., throughput)
 - **Phase 2: pushing MEC/ICN/SDN principles to the extreme edge**
 - **Vehicles as a “composite resource” platform on the move** equipped with sensing, processing, storage and multi-face capabilities. This allows:
 - **Pushing the MEC/cloud** to the further edge, i.e., to **the vehicle**
 - **Exploring new roles of ICN**; e.g., to enable VM migration between vehicles
 - **Make vehicles software-defined controllable units**