INTRODUCTION TO 5GCAR, AND THE ROLE OF 5G IN AUTOMOTIVE INDUSTRY

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5G Communication
Automotive Research and
innovation

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5GCAR

- From June 2017 to May 2019
- 30 full-time equivalents

https://5gcar.eu/

5G PPP Phase 2 Projects

https://5g-ppp.eu/5g-ppp-phase-2-projects/
Objectives

- Develop an overall 5G V2X system architecture
- Interworking of multiple Radio Access Technologies
- Develop an efficient, secure and scalable sidelink interface
- Objectives

- Identify innovative business models
- Demonstrate and validate the developed V2X concepts
- Contribute to 5G Standardization and regulation
- Integrate of the 5GCAR concepts in the 5G PPP

Methodology

- A. Definition of V2X scenarios, requirements and KPIs
- B. Design and validation of innovative technical solutions
- C. Proof-of-concept and demonstration

R&I Activities

- Business models for 5G V2X
- Spectrum for 5G V2X
- Infrastructure-based communication for 5G V2X
- Sidelink-based communications for 5G V2X
- Positioning for 5G V2X
- 5G Architecture for V2X
- Demonstrations for 5G V2X

Ambitions

- 1. End-to-end latencies, below 5 ms
- 2. Ultra-high reliability, close to $10^{-5}$
- 3. Very large density of connected vehicles
- 4. Positioning accuracy (VRUs: 10 cm, Vehicles: 30 cm)
The 5GCAR Use Cases

- Lane merge
- Network assisted vulnerable pedestrian protection
- See-through
- Remote driving for automated parking
- High definition local map acquisition

For more details, see D2.1 in [https://5gcar.eu/](https://5gcar.eu/)
On the 5GCAR Use Cases

— **Cooperative maneuver:** sharing local awareness and driving intentions and negotiating the planned trajectories
  — Lane merge

— **Cooperative perception:** perception extension is built on the basis of exchanging data from different sources, e.g., radars, laser sensors, stereo-vision sensors from on-board cameras
  — See-through

— **Cooperative safety:** achieved by exchanging the information about detection of the presence of road users
  — Network assisted vulnerable pedestrian protection
On the 5GCAR Use Cases

— **Autonomous navigation**: construction and distribution of real-time intelligent HD map
  — High definition local map acquisition

— **Remote driving**: control the different actuators of the car (steering wheel, brake and throttle) from outside the vehicle through wireless communication
  — Remote driving for automated parking
On 5GCAR Requirements

— **Automotive requirements**
  — Localization, minimum car distance, mobility, relevance area, etc.

— **Network requirements**
  — Availability, communication range, data rate, latency, reliability, service data unit size
  — Latency may be considered from different perspectives (for different use cases)
    — (Layer-based) latency: similar with user plane latency in 3GPP
    — End-to-end latency: the time it takes to transmit an application message from the application layer of the source node to the application layer of the destination node

— **Qualitative requirements**
  — Cost, power consumption, security

For more details, see D2.1 in [https://5gcar.eu/](https://5gcar.eu/)
On the 5GCAR Use Case Requirements

For more details, see https://5gcar.eu/
Intermediate 5GCAR Results

- Intermediate Report on V2X Business Models and Spectrum
- Intermediate 5G V2X Radio
- Initial Design of the 5G V2X System Level Architecture and Security Framework
- Demonstration Guidelines
- Intermediate Report on Standardization Dissemination and Exploitation Activities
- 5GCAR Mid-Project Report
Business

VALUE CHAINS

Telecom sector
- TVE (Telecom Equipment Vendor) → MNO (Mobile Network Operator) → EU (End User)
- Connectivity Infrastructure Suppliers
- Connectivity Provisioning

Automotive sector
- AS (Automotive Supplier) → OEM (Original Equipment Manufacturer) → EU
- Vehicle Component Suppliers
- Vehicle Makers/Sellers

POSSIBLE ECOSYSTEMS

TRANSITION

AS: Automotive Supplier
OEM: Original Equipment Manufacturer
TEV: Telecom Equipment Vendor
MNO: Mobile Network Operator
OTT: Over-The-Top Service Providers
EU: End User
5GCAR use cases analyzed:

Better spectrum bands are medium or low frequencies with lower propagation loss and better range

Coverage has precedence over bandwidth for V2X use cases so far
5G V2X Radio Interface

Scope

— **Efficient** and scalable 5G air interface to enable **low-latency, high-reliability** V2X communications

— **Infrastructure-based** communication (between vehicles and network)

— **Sidelink** communication (direct data exchange among vehicles without routing data traffic through the network infrastructure)

- **Evaluate** the individual enabling technologies with theoretical analysis, simulations and overall system performance evaluation

- Propose 5G radio-assisted **positioning** techniques for both VRU and vehicles
V2X System Level Architecture

- Support of multi-operator
- Security and privacy
- Smart Zoning
- Dynamic use of Multi-RAT and Multi-Links
- Use of advance context information
Lane Merge Coordination

— Connected vehicles make room for an entering vehicle
  — Coordinated by a central entity
  — Camera system for detection of unconnected vehicles
Cooperative Perception for Maneuvers of Connected Vehicles

— Camera-equipped vehicle streams region of interest from video (and other sensor data) to a rear vehicle
— The rear vehicle displays the received information as overlay over the occluded area
Vulnerable Road User Protection

- Pedestrian-UEs and CAR V-UE send out specific waveforms to infrastructure
- Base stations receive it, and the location server triangulates the positions
- Positions are sent via Infrastructure to Car (optional to Pedestrians, app required)
- Potentially triggering warnings via Alert message to Car (optional to pedestrian)
Role of 5G in Automotive Industry

- **New 5G radio technology** for more advanced automotive services of infotainment and a continuously safer system, while leverage on existing infrastructure and device support.
- **Cost-effective** coverage, e.g. in rural areas.
- **Coverage** is key for Automated Driving (AD) since if e.g. an (Original Equipment Manufacturer) OEM or transport company are liable than one would need to control if in AD or not.
- **Cellular** can accommodate both long range and short range communication, e.g. on licensed spectrum.
- **Reliability and low latency** connectivity in high mobility.
- **QoS** can be used to e.g. prioritise OEM traffic over MBB.
- **To be secured** from potential attacks and ensure privacy (e.g. how much personal location information is stored and possible to access for others).