Cellular V2X Discussion

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5G is important for the automotive vision

Providing a unifying connectivity fabric for the autonomous vehicle of the future

Enhanced mobile broadband

Mission-critical services

Massive Internet of Things

Unifying connectivity platform for future innovation
Starting today with Gigabit LTE, C-V2X Rel-14, and massive IoT deeper coverage
5G will bring new capabilities for autonomous vehicles

While maintaining backward compatibility
5G unified connectivity

Intelligently connecting the car to cloud and surroundings

Vehicle-to-vehicle

Vehicle-to-infrastructure
3D HD live map updates

Vehicle - to - pedestrian

Teleoperation
AR / VR
HD video

Vehicle-to-network
C-V2X defines two complementary transmission modes

**Network communications**

V2N on “Uu” interface operates in traditional mobile broadband licensed spectrum

V2N (Uu)  
Uu interface  
e.g. accident 2 kilometer ahead  
eNodeB

**Direct communications**

V2V, V2I, and V2P on “PC5” interface\(^1\), operating in ITS bands (e.g. ITS 5.9 GHz) independent of cellular network

PC5 interface  
e.g. location, speed

1. PC5 operates on 5.9GHz; whereas, Uu operates on commercial cellular licensed spectrum 2. RSU stands for roadside unit.
Network communications for latency tolerant use cases
Suitable for telematics, infotainment and informational safety use case

Discover parking and charging

Cloud-based sensor sharing

Traffic flow control/Queue warning

Road hazard warning 1 km ahead
C-V2X reuses upper layers defined by transportation stakeholders

Reuse established service and app layers
- Already defined by automotive and standards communities, e.g. ETSI, SAE
- Developing abstraction layer to interface with 3GPP lower layers

Reuse existing security and transport layers
- Defined by ISO, ETSI, and IEEE 1609 family

Continuous enhancements to the radio/lower layers
- Supports the ever-evolving V2X use cases

Note: Also enhancements to the LTE Direct network architecture / system design to support V2X
C-V2X reduces cost of infrastructure deployment

Combined RSUs and 4G/5G small cell, benefiting from cellular network densification

- 4G/5G small cells with Uu interface
- RSUs with direct link/PC5 interface
C-V2X offers new business models and economic benefits
Leveraging existing, ubiquitous cellular networks and mobile ecosystem support

More integrated solution
C-V2X functionality can be integrated in vehicle’s modem to enable most optimal platform

Reduced deployment cost
Combined RSU and eNodeB infrastructure synergies provide economic benefits

Mobile ecosystem expertise
Benefits from cellular player’s extensive experience in deploying, managing, and maintaining complex communication systems

New services and business opportunities
Leverages unified C-V2X / telematics offerings and addresses new services for shared mobility and autonomous driving
Advanced services further enabled by V2V+V2I+V2P+V2N

Offering new business models and enhancing most use cases

Most use cases use a combination of interfaces

V2N provides over-the-top cloud services

V2P enhances safety for vulnerable road-users

RSUs combined with eNodeBs or standalone roadside devices

RSUs can connect to network for cloud services

V2I allows RSU’s to monitor traffic, e.g. traffic signals, tolls

V2V mostly for safety and ADAS services