Future Networked Car Symposium @ Geneva Auto Show 2018

Accelerating 5G for autonomous driving

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All major automakers use Qualcomm Technologies

- Acura
- Audi
- BMW
- Buick
- BYD
- Cadillac
- Chevrolet
- Dodge
- FCA
- Ford
- Geely
- Honda
- Hyundai
- Infiniti
- Jaguar
- Jeep
- Kia
- Land Rover
- Lexus
- Lincoln
- Mercedes
- Mini
- Nissan
- Opel
- Porsche
- PSA
- Renault
- Rolls-Royce
- Smart
- Subaru
- Toyota
- Tesla
- Volvo
- VW

25
New Infotainment and Telematics design-wins in FY2017

$3B+
Design-win pipeline

Telematics / V2X

- 2G/3G
- 4G LTE
- 5G
- 5G NR based C-V2X
- C-V2X

Location

- Multi-Hz GNSS
- Dead Reckoning (DR)
- VIO*

Security

- Power mgmt
- Linux enabled

Connectivity

- 802.11ac
- 802.11ax
- 802.11ad
- 802.11p

- Bluetooth
- CAN
- Powerline
- Ethernet
- EV charging PLC
Superior in-car Infotainment experience

12+ automakers
Have selected Snapdragon Automotive for infotainment

Billion-dollar+ design pipeline
Focused on premium tier

Leading in premium
Next-gen premium infotainment design-wins

1 2018-2027 period. Source: Company data
2 for production vehicles starting 2019-2020
C-V2X complements other ADAS\(^1\) sensor technologies
Provides 360° NLOS\(^2\) sensing for higher levels of predictability and autonomy

Brain of the car to help automate the driving process by using:
Sensor fusion | Machine learning

1 Advanced Driver Assistance Systems; 2 Non-line of Sight
C-V2X
Intelligently connecting the car to surroundings and cloud

V2V
Vehicle-to-vehicle
  e.g. collision avoidance safety systems

V2P
Vehicle-to-pedestrian
  e.g. safety alerts to pedestrians, bicyclists

V2I
Vehicle-to-infrastructure
  e.g. traffic signal timing/priority

V2N
Vehicle-to-network
  e.g. real-time traffic / routing, cloud services

Commercial vehicle deployments coming soon...
C-V2X defines two complementary transmission modes

**Direct communications (PC5)**
V2V, V2I, and V2P operating in harmonized 5.9 GHz ITS bands independent of cellular network or cellular subscription

**Network communications (Uu)**
V2N operating in traditional mobile broadband licensed spectrum

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**Active safety**
Latency-sensitive use cases, e.g. collision avoidance

**Informational safety**
More latency tolerant use cases, e.g. accident 2 kilometers ahead
C-V2X direct communications offers key advantages

- Enhanced range and reliability
- Up to 500km/h relative speed support
- Synergistic with cellular modem already being embedded
- Leverages cellular ecosystem
- Reuse of SAE/ETSI upper layers
- More cost efficient than other technologies
- Forward compatible evolution path to 5G

5G NR
Driving C-V2X towards commercialization

Qualcomm Technologies, Inc.’s (QTI) first-announced C-V2X solution supports C-V2X PC5 Direct Communications (V2V, V2I and V2P) based on 3GPP Release-14

Qualcomm 9150 C-V2X chipset and Qualcomm C-V2X are products of Qualcomm Technologies, Inc. and/or its subsidiaries.
C-V2X direct communications is being validated globally
Many trials started in 2017, based upon 3GPP R14

Example of global trials

ConVeX trial in Germany
Qualcomm, Audi, Ericsson, SWARCO, U. of Kaiserslautern

Towards 5G trial in France
Qualcomm, PSA Group, Orange, Ericsson

Ford trials in US
Qualcomm, AT&T, Ford, Nokia and McCain with SANDAG, Caltrans and the City of Chula Vista

Nissan trials in Japan
Qualcomm, Continental, Ericsson, Nissan, NTT DOCOMO, INC., OKI

C-V2X specifications completed in 2017

Other trials announced, and some still unannounced in China, Korea, elsewhere
Ecosystem preparing for commercialization\(^1\) of 9150 C-V2X chipset

Tier-1 suppliers

- Continental
- LG
- gemalto
- LG Innotek
- Ficosa
- LEAR Corporation
- Quectel
- Sierra Wireless
- Telit
- Panasonic Automotive
- Valeo
- WNC
- ZTE

Cellular module manufacturers

- Cohda Wireless
- commsignia
- R&S (ROHDE & SCHWARZ)
- SAVARI
- MARBEN
- SASKEN
- ThunderSoft

ITS software solution providers

- Some Supporting Automakers

C-V2X has a strong evolution path towards 5G NR
While maintaining backward compatibility

Evolution to 5G NR, while being backward compatible
C-V2X R14/R15 is necessary and operates with R16

Basic and enhanced safety
C-V2X R14/R15 with enhanced range and reliability

Basic safety
IEEE 802.11p

Autonomous driving use cases
5G NR based C-V2X R16
Backward compatible with R14/R15 enabled vehicles
Higher throughput
Higher reliability
Wideband ranging/positioning
Lower latency
Thank you!

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