Accelerating C-V2X toward 5G for autonomous driving

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The race to deliver self-driving vehicles is underway and multiple technologies will be needed to get us to the finish line. Expect to see a multitude of partnerships and many technologies working together to enable autonomous vehicles – leading to a safer, greener and more efficient driving experience.

Qualcomm is paving the way to tomorrow’s autonomous vehicle by not only working with technology partners and automobile OEMs, but also by developing and refining a number of technological breakthroughs in wireless connectivity (Wi-Fi, BT and 4G/5G), vehicle-to-everything (V2X) communications (802.11p and C-V2X), precise positioning, and 3D High Definition (HD) mapping. And with our Qualcomm Snapdragon automotive platform, we’re providing the computing performance required for infotainment, sensor fusion and embedded machine learning – all of which will be needed for the more connected, automated vehicle of tomorrow.

Most recently at CES 2017, we demonstrated the capabilities of our Qualcomm Drive Data Platform that brings together our innovations in precise positioning, embedded machine learning and heterogeneous connectivity. We also announced the formation of Connected Vehicle to Everything of Tomorrow (ConVeX) – a consortium planning to carry out the first announced Cellular-V2X (C-V2X) trial based on 3rd Generation Partnership Project’s (3GPP) Release 14 specification.

C-V2X is paving the road to tomorrow’s autonomous driving

While advancements in radar, LIDAR (Light Detection and Ranging) and camera systems are encouraging, these sensors are limited by their line of sight. Direct V2X communication complements the capabilities of these sensors by providing 360-degree non-line-of-sight awareness, extending a vehicle’s ability to “see” further down the road – even at blind intersections or in bad weather conditions. By complementing other sensors, V2X provides higher level of predictability and determinism by conveying location, speed, direction and even intent, all of which all other sensors need to essentially estimate.

With initial specifications completed in September 2016, this release of C-V2X supports direct communications operating in the ITS 5.9 GHz band without network assistance, making it ideal for vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communications. Vehicles can connect with each other and roadside infrastructure without requiring a Subscriber Identity Module (SIM), cellular subscription or network assistance.

While 802.11p (the radio layer used in DSRC and ITS-G5) established the foundation for basic safety services, such as forward collision warning, C-V2X Rel-14 supports enhanced safety use cases at higher vehicle speeds and challenging road conditions with its improved reliability, extended range, low latency and non-line-of-sight (NLOS) capabilities. At Mobile World Congress (MWC) 2017, Qualcomm Technologies is demonstrating C-V2X’s superior performance in supporting some of these enhanced safety use cases, such as disabled car after blind curve, do-not-pass and road hazard warnings in varying road conditions.

By leveraging existing cellular infrastructure for network communications (V2N), C-V2X can combine the capabilities of roadside units (RSUs) and the cellular network to help improve safety and support autonomy
(e.g. providing local- and wide-area road condition information and real-time map updates). Combined RSU and cellular infrastructure can reduce deployment cost, providing economic benefits. Cellular players’ extensive experience in deploying, managing, and maintaining complex communication systems will not only provide cost savings, but can also enable new business models and service opportunities.

C-V2X evolution toward 5G will offer new capabilities with backward compatibility

C-V2X Rel-14 has a strong evolution path to future releases (i.e., Rel-15+ staring in March 2017) and will augment Rel-14 with complementary and new capabilities, while maintaining backward compatibility. C-V2X Rel-16 will incorporate 5G NR features, providing high throughput, wideband carrier support, ultra-low latency and high reliability for advanced use cases for increased driver awareness, cooperative driving/collision avoidance and fully autonomous driving featuring:

- **Accurate positioning and ranging:** Besides relying on GNSS and Visual Inertial Odometry (VIO) technologies, C-V2X’s active ranging and positioning will increase the confidence and accuracy of vehicle’s position estimate, thus enabling sub-meter positioning. C-V2X evolution will leverage wideband carrier support for vehicles to measure their relative distances by bouncing signals off each other for cooperated and automated driving use cases.

- **See-through / High throughput sensor sharing:** As the number of ADAS sensors increase in complexity and proliferate in autonomous cars, high throughput and low-latency of C-V2X Rel-16 will enable real-time exchange of live video images and high throughput sensor data from surround cameras, RADAR, LIDAR and other car sensors.

- **Real-time HD map update / bird’s eye view of an intersection:** The roadside units will use the high throughput connection with other cars on the road to build local, dynamic HD maps based on camera and sensor data, and distribute them at street intersections. For example, the road side infrastructure can share the detailed 3D map/bird’s eye view of the intersection with approaching vehicles.
C-V2X Rel-15+ will also support direct communications, operating in the same ITS 5.9GHz band. Since advanced safety services require wide spectrum bands, careful technology and spectrum planning are needed to wisely leverage the scarce ITS 5.9 GHz spectrum band for basic and enhanced safety services along with these advanced services enabled by C-V2X Rel-15+.

**Driving C-V2X momentum**

We are pleased to see C-V2X gaining momentum and broad ecosystem support from automotive and telecom leaders, paving the path for safer autonomous driving. To accelerate its adoption, Qualcomm is taking a critical role in driving the development of C-V2X:

- In September 2016, Qualcomm co-founded the 5G Automotive Association (5GAA) and resides on the board along with AUDI AG, BMW Group, Daimler AG, Ericsson, Ford Motor Company, Huawei, Intel and Nokia. Since then, 5GAA has been growing rapidly, adding other global automobile OEMs, automotive suppliers, network operators and telecom players.
- At MWC 2017, Qualcomm Technologies is demonstrating the capabilities of our C-V2X trial platform based upon 3GPP Release 14.
- In 2017, Qualcomm Technologies is further accelerating the C-V2X adoption by participating in a number of important trials including the ConVeX trial in Germany with Audi, Ericsson, SWARCO and the University of Kaiserslautern; and the newly announced “Toward 5G trial” in France with PSA, Orange and Ericsson. Other trials are planned globally throughout 2018.
- To further accelerate the availability of C-V2X commercial solutions, we are working closely with key automotive suppliers to bring C-V2X technology into vehicles. For example, we announced coordinated efforts with LG to facilitate testing and adoption of 5G and C-V2X communications into vehicles. Qualcomm Technologies and LG expect to showcase these next-generation wireless technologies through trials during the first half of 2018.
Accelerating the future of autonomous vehicles

Again, successfully paving the way to tomorrow’s autonomous vehicles will rely on numerous innovations, including but not limited to C-V2X. As a leading inventor, Qualcomm is driving several technological innovations into the connected car and autonomous driving, including:

- **Unified connectivity platform** - our [Connected Car Reference Platform](#) is using the flagship Gigabit Class Qualcomm Snapdragon™ X16 LTE modem to deliver the high-speed, high-quality and reliable connectivity required for advanced telematics and connected vehicle services today. Complemented with 5G NR’s elevated broadband, we will provide the required reliability, low latency and throughput for next generation, autonomous vehicle application, including, remote control services, 3D high-definition map updates, and Augmented Reality (AR) Heads Up Displays (HUDs).
- **Vehicle-to-everything (V2X) communications** – providing 802.11p and C-V2X solutions for safety use cases and automated driving
- **Qualcomm Drive Data Platform** – bringing together innovations in precise positioning/3D HD mapping, embedded machine learning and heterogeneous connectivity – all of which will be needed for shared mobility and automated vehicle of tomorrow.
- **Qualcomm Snapdragon Automotive solutions** - Volkswagen AG and PSA Group elected Qualcomm Snapdragon for their next generation Infotainment systems. Beyond infotainment, Snapdragon solutions can offer the computing performance required for sensor fusion and embedded machine learning for automated driving.

To learn more, visit Qualcomm C-V2X [website](#) and listen to our recent [webinar](#)

Qualcomm Snapdragon and Qualcomm Drive Data platform are products of Qualcomm Technologies, Inc.