Cellular–Vehicle to Everything (C-V2X) Connectivity

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C-V2X offers a cellular alternative to IEEE 802.11p/DSRC

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Cellular Vehicle-to-Everything (C-V2X) is a technology concept involving the use of developing cellular standards for a wide range of vehicle connectivity use cases and applications. Many of these use cases are safety-related, though there are also mobility- and environment-related use case opportunities as well, and the breadth of use cases is increasing. The vehicle connectivity and safety market is complex, and C-V2X competes against, and sometimes complements, other technologies, including dedicated short range radio (IEEE 802.11p/DSRC) and automaker telematics programs.

C-V2X overview

C-V2X is developing as part of the overall 3GPP process to advance cellular systems from 4G to 5G technologies. C-V2X will first be introduced in 3GPP Release 14. However, the basis for C-V2X technologies started as enhancements to LTE Broadcast (introduced with 3GPP Release 9) and LTE Direct (introduced with 3GPP Release 12). The enhancements to LTE Direct will enable direct communications, such as robust vehicle-to-vehicle (V2V) connectivity at distances up to hundreds of meters at very low alert latency (about one millisecond) and, crucially, both in-coverage and out-of-coverage (of standard cellular infrastructure.)

The enhancements to LTE Broadcast will facilitate vehicle-to-infrastructure (V2I) and vehicle-to-network (V2N) communications, leveraging traditional cellular infrastructure. Messages can be broadcast from V2X servers to a number of vehicles simultaneously, while individual vehicles can unicast messages back to the server. Enabling V2I and V2N communications is beneficial because that makes possible a wide range of applications, such as the vehicle receiving alerts about accidents a few miles ahead up the road, or connecting to smart parking systems to find open available parking spaces automatically.

IHS expects that full C-V2X technology implementation will be possible in 2017 with 3GPP Release 14. The future rollout of 5G technology should be fully backwards-compatible with C-V2X technology currently under development.

IEEE 802.11p/DSRC: long in development, still to be deployed

The primary competition to C-V2X from a technological perspective is IEEE 802.11p/DSRC. IEEE 802.11p/DSRC is a short range wireless technology that developed from standard Wi-Fi and is now its own standard (i.e. “IEEE 802.11p”). IEEE 802.11p/DSRC operates in dedicated 5.9 GHz “Intelligent Transportation System” bandwidth in the US, and similar spectrum in the EU, although it operates in the 5.8 GHz spectrum in Japan.

IEEE 802.11p/DSRC is primarily focused on V2V safety applications. IEEE 802.11p/DSRC offers the benefits of extended range and non-line of site awareness over and above current advanced driver assistance systems (ADAS). IEEE

802.11p/DSRC also offers a very fast 2 millisecond over the air latency. Furthermore, unlike standalone ADAS technology, IEEE 802.11p/DSRC offers the possibility for V2I and vehicle-to-pedestrian (V2P) connectivity. This provides for added situational awareness for the vehicle.

IEEE 802.11p/DSRC is likely to become mandated in the US for all light vehicles starting in the 2020 model year. However, based on research by IHS Technology's automotive analyst team, it appears unlikely that similar mandates will occur elsewhere, either in the EU, Japan, South Korea, or other important emerging car markets, such as China.

Comparing C-V2X to IEEE 802.11p/DSRC

The primary goal for developers of C-V2X technology is to enable every use case made possible by IEEE 802.11p/DSRC and then expand functionality even further from there. One important distinction between the two technologies lies in technology evolution roadmap that exists for C-V2X, but does not exist for the fifteen year old IEEE 802.11p/DSRC specification. The C-V2X roadmap will benefit enormously from the introduction of 5G technologies in the coming years, and from the mobile ecosystem as a whole.

One obvious area of enhancement over DSRC is in V2I and V2N communications. By leveraging traditional cellular infrastructure, C-V2X immediately offers a robust platform to provide the vehicle with enhanced situation awareness. In contrast, DSRC V2I capability will rely on deployment of new, dedicated DSRC-capable infrastructure along roadways.

In addition, C-V2X offers extended V2V range relative to IEEE 802.11p/DSRC, which enhances the safety capabilities of the technology. According to testing done by Qualcomm, a key developer of both C-V2X technology and IEEE 802.11p/DSRC technology, C-V2X enables up to a few additional seconds of alert time and twice the range of IEEE 802.11p/DSRC.

A crucial point to make regarding C-V2X technology is that it functions both "in-coverage" (of cellular network infrastructure) as well as "out-of-coverage" (i.e. in direct V2V communication mode). IEEE 802.11p/DSRC is de facto always an "out-of-coverage" technology. IEEE 802.11p/DSRC proponents have argued that "out-of-coverage" capability is crucial from both a technical standpoint and business/operational model standpoint. IHS agrees with this assessment on the technical front; true V2V capability requires two vehicles to be able to communicate directly and with ultra-low latency regardless of surrounding infrastructure. C-V2X offers such direct, out-of-coverage connectivity, however, so IHS views the added "in-coverage" capability as an enhancement over IEEE 802.11p/DSRC.

The C-V2X opportunity

IHS regards the opportunity for C-V2X principally as:

- **Offering enhanced V2V communications relative to IEEE 802.11p/DSRC.** C-V2X should nearly double the alert/reaction time relative to IEE802.11p/DSRC technology.
- **Facilitating more robust V2I and V2N communications relative to IEEE 802.11p/DSRC**. C-V2X will leverage existing cellular infrastructure, obviating the need for a build-out of new, fit-for-purpose IEEE 802.11p/DSRC infrastructure in roadways. This ability to leverage existing infrastructure reduces overall deployment costs.

- **Leveraging the investment made in cellular technology development and deployment by the mobile industry**. Cellular infrastructure is deployed for, and amortized across, the vast vase of smartphone and mobile broadband users.
- **Leveraging the potential for cellular operators to play a positive role in developing and promoting C-V2X services**. Cellular operators have extensive experience and capabilities in managing complex telecommunications services over wide areas.
- **Leveraging the potential for unified C-V2X/telematics offerings**. C-V2X safety technology could potentially be integrated into overall vehicle telematics systems, creating further efficiencies, cost reductions, and network-effect benefits.

Key considerations that still need to be addressed for widespread C-V2X market adoption include:

- **Stakeholder acceptance versus IEEE 802.11p/DSRC**. IEEE 802.11p/DSRC has over 15 years of developing and testing history in the market and will likely be mandated in the US. In contrast, C-V2X is a relatively recent introduction of technology.
- **Optimal role for operators to play in facilitating C-V2X applications**. Some stakeholders are leery of an operator role if this entails fees being paid to the operators.
- **Need for access to common spectrum for V2V use cases**. Out-of-coverage, direct V2V connectivity will require common spectrum. Enabling C-V2X connectivity in some portion of the 5.9 GHz ITS band (and its related bands internationally), would be an easy way to facilitate adoption, but is controversial in the industry, particularly among IEEE 802.11p/DSRC proponents.