

## NETWORK & DIRECT POINT-TO-POINT COMMUNICATIONS

Network communications are wide area communications that provide a connection via the cloud to infrastructure systems and devices. This includes existing 4G LTE cellular communications used for personal mobile phones.

Direct point-to-point communications are low-latency communications that take place across short distances, allowing information to be transmitted directly between two vehicle on-board units (OBUs), or between an OBU and roadside infrastructure called roadside units (RSUs). Examples include Dedicated Short Range Communications (DSRC) and cellular vehicle-to-everything (C-V2X) direct communications.

# Comparing Direct Communications and Network Cellular Communications

## Connected Intersections Program Brief

### Direct Communications

Dedicated short range communications (DSRC) were developed to use the “dedicated” 5.9 GHz part of the radio spectrum and special “dedicated” radios in vehicles and roadside units (RSUs). The name alludes to the “short-range” line of sight distance, which is about 1000 feet, but reflects an intentional advantage of fast, low-latency, reliable point-to-point communication between vehicles and infrastructure in close proximity to reduce unneeded messages from faraway vehicles.

A second 5.9 GHz communication technology, Cellular Vehicle-to-Everything (C-V2X), was standardized at the radio level in 2017. C-V2X has two components; one of which, C-V2X Direct (also known as C-V2X (PC5) or LTE CV2X) is a short-range equivalent of DSRC and does not use traditional cellular network communications. Some agencies have started to deploy C-V2X Direct in lieu of DSRC. Both DSRC and C-V2X share the same 5.9 GHz spectrum, message applications, and goals, but the two technologies are not interoperable.

### 5G versus Cellular Vehicle-to-Everything (C-V2X)

5G is the next generation of network cellular communication, that uses closely spaced, “small cell” towers. 5G is NOT the same as C-V2X. C-V2X is a direct communication technology that has been standardized by the IEEE 1609 WG, is being standardized in SAE, and is based on 4G LTE technology (3rd Generation Partnership Project (3GPP) Release 14), but communicates directly, like DSRC, not through a cell tower. However, 4G and 5G wide area network specifications (that enable personal cellular phones) are paid-for commercial cellular services that are different than direct C-V2X communication operations in the 5.9 GHz band.

Additionally, a new version of direct C-V2X is under development, sometimes referred to as 5G New Radio sidelink or 5G V2X, that will eventually use 5G technology and still be direct communications. As currently envisioned, 5G V2X would require different spectrum not currently being used by 4G LTE-based C-V2X. Given the reduction in dedicated bandwidth within the 5.9 GHz spectrum that new bandwidth has not yet been identified. Both 4G LTE C-V2X and 5G V2X are designed to be used in ITS spectrum and not on commercial spectrum, as such they are not operated by a mobile network operator and are not subscription based.

### Network Cellular Communications

Network cellular communications provide an alternate communications mechanism for some transportation applications. Network cellular communications include existing 4G LTE networks and also future 5G networks. The terms 4G and 5G refer to the “Generation” of cellular technology, and 5G is expected to provide significantly faster data speeds and lower latency than 4G. One advantage of network cellular communications is being able to reach vulnerable road users like cyclists or pedestrians through their personal cellular devices. However, network cellular communications are not able to provide either unicast (i.e., targeted) transmissions to a specific vehicle or device, or broadcast to all users and devices within range like point-to-point communications can for safety and mobility applications.

## RELEVANT RESOURCES

“DSRC and C-V2X: Similarities, Differences, and the Future of Connected Vehicles” by Doug Gettman, Kimley Horn.

<https://www.kimley-horn.com/dsrc-cv2x-comparison-future-connected-vehicles>

NCHRP Web-Only Document 310: “Evaluation and Synthesis of Connected Vehicle Communication Technologies”.

[https://www.nap.edu/login.php?action=guest&record\\_id=26370](https://www.nap.edu/login.php?action=guest&record_id=26370)

“Practical Considerations for Deployers of V2X Roadside Equipment in Light of the Recent FCC Ruling” led by Blaine Leonard, Utah DOT.

<https://transportationtechnology.utah.gov/what-were-learning>

FCC “Use of the 5.850-5.925 GHz Band”, May 2021.

- Initial Rule & Order (R&O). <https://www.federalregister.gov/documents/2021/05/03/2021-08802/use-of-the-5850-5925-ghz-band>

- Further Notice of Proposed Rulemaking (FNPRM) (that will result in a second R&O).

<https://www.federalregister.gov/documents/2021/05/03/2021-08801/use-of-the-5850-5925-ghz-band>

## Current State of V2X Communication Options and Uncertainty for Agencies with DSRC

For IOOs who have deployed DSRC systems for CI deployments, recent FCC decisions raise questions about impacts to existing and proposed deployments. DSRC remains in a state of flux until lawsuits and FCC rulemaking efforts have concluded. In the meantime, agencies have three options, but should consider the process and time to have new technologies in place before FCC deadlines:

1. Keep DSRC for as long as is allowed with an eventual transition to C-V2X or other technologies. Current DSRC deployments that operate in multiple channels will need to be modified to use only the upper 30 MHz of spectrum within a year of the effective date of the first R&O (i.e., July 5, 2022). By then, some uncertainties that exist today about hardware and software market maturity and C-V2X licensing processes should be resolved.
2. Transition from DSRC to C-V2X. Agencies with deployments in multiple locations may choose to do this gradually (e.g., corridor-by-corridor). Agencies with smaller, more uniform deployments might do this all at once. The most direct substitute for DSRC capability is C-V2X Direct. C-V2X devices are available and being used by some agencies.
3. Transition some or all use cases to a network system (i.e. traditional telematics), using 4G or 5G cellular networks. This approach could be appropriate for applications that can tolerate higher latency and periodic interference, but would be inadequate for most low-latency safety applications as currently designed, including CI deployments. Reliability may also be negatively impacted in locations with limited cellular coverage or during events that have heavy cellular traffic. In addition, network systems may incur over-the-air charges.

Significant challenges for the industry remain in uncertainty and unknowns regarding real-world impacts of FCC changes. The impact of interference, how use of the spectrum will evolve in future years, and end-to-end security needs need to be considered and reassessed over time. Likewise, the specific impacts on applications remain uncertain, and will continue to be evaluated by industry experts with varying assumptions and outcome scenarios.

However, opportunities to save lives is sufficient motivation to proceed given understanding that IOO projects require time and resources to plan and execute, and any FCC actions will not be immediate. Engagement is cited as a best practice by agencies currently involved in pilot or deployment efforts. Staying up-to-date on the FCC’s actions is recognized as another.

*As currently envisioned, CIs require direct point-to-point communications, using either DSRC and C-V2X Direct, both of which use the 5.9 GHz Spectrum. However, the viability of DSRC for new CI deployments is likely to be determined in 2022 as a result of anticipated regulatory clarity.*

## RELEVANCE TO CV PFS MEMBERS

- Communications are a central component of Connected Intersections deployments.
- A multitude of options and fast-evolving landscape create challenges for understanding the differences and advantages of various alternatives.
- Many unknowns still exist regarding FCC rulings and the timing at which various communications options will be available for CI operations.