WILKINSON) BARKER) KNAUER) LLP

1800 M STREET, NW
SUITE 800N
WASHINGTON, DC 20036
TEL 202.783.4141
FAX 202.783.5851
WWW.WBKLAW.COM
SEAN T. CONWAY
202.383.3412
SCONWAY@WBKLAW.COM

April 5, 2019

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th St. SW, Room TW-B204
Washington, DC 20554

Re: *5GAA Petition for Waiver to Allow Deployment of Cellular Vehicle-to-Everything (C-V2X) Technology in the 5.9 GHz Band; GN Docket No. 18-357*

Revision of Part 15 of the Commission's Rules; ET Docket No. 13-49

Dear Ms. Dortch:

Representatives of the 5G Automotive Association ("5GAA") met with Patrick Forster, Howard Griboff, Syed Hasan, Aspa Paroutsas, Jamison Prime, all of the Office of Engineering and Technology ("OET"), and Aleks Yankelevich of the Office of Economics and Analytics ("OEA") on April 3, 2019. Separately, the 5GAA representatives met with Aaron Goldberger, Legal Advisor to Chairman Ajit Pai, on that same day. The following representatives attended on behalf of 5GAA:

- John Branding, BMW Group
- Nick Baracos, Ford Motor Company
- Ivan Vukovic, Ford Motor Company
- Kirby Howard, Continental AG
- Nancy Bell, Intel
- John Roman, Intel[1]
- Dave Horne, Intel[2]
- Doug Hohulin, Nokia[3]
- Jeff Marks, Nokia
- Dean Brenner, Qualcomm Incorporated
- John Kuzin, Qualcomm Incorporated

[1] John Roman joined by phone and participated in the meeting with OET and OEA staff.
[2] Dave Horne joined by phone and participated in the meeting with Aaron Goldberger.
[3] Doug Hohulin joined by phone and participated in the meeting with OET and OEA staff.

- Vincent Park, Qualcomm Incorporated
- Robert Kubik, Samsung
- Jim Harlan, InterDigital[4]

These representatives were joined by Mark Settle and the undersigned, both of Wilkinson Barker Knauer, LLP and both representing 5GAA.

During each meeting, we discussed how Cellular Vehicle-to-Everything ("C-V2X") operations in the 5.9 GHz band can make American roadway travel safer, smarter, and more efficient through the use of 5G technology. We also discussed Ford Motor Company's recent commitment to deploy C-V2X in all of its new vehicle models in the United States beginning in 2022. We further urged the Commission to seek comment on a forward-looking approach in the 5.9 GHz band to facilitate C-V2X's evolution path to 5G, consistent with the letter 5GAA filed on April 3, 2019. A copy of that letter is attached here.

Pursuant to the Commission's rules, this notice is being filed in the above-referenced dockets for inclusion in the public record. Please contact me should you have any questions.

Sincerely,

/s/ Sean T. Conway
Sean T. Conway

Counsel to the 5G Automotive Association

cc: Aaron Goldberger, Advisor to Chairman Ajit Pai
Julius Knapp, Office of Engineering and Technology
Ira Keltz, Office of Engineering and Technology
Aspa Paroutsas, Office of Engineering and Technology
Jamison Prime, Office of Engineering and Technology
Patrick Forster, Office of Engineering and Technology
Howard Griboff, Office of Engineering and Technology
Syed Hasan, Office of Engineering and Technology
Aleks Yankelevich, Office of Economics and Analytics

[4] Jim Harlan joined by phone and participated in the meeting with OET and OEA staff.

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April 3, 2019

Marlene H. Dortch
Secretary
Federal Communications Commission
445 12th St. SW
Room TW-B204
Washington, DC 20554

Re: *5GAA Petition for Waiver to Allow Deployment of Cellular Vehicle-to-Everything (C-V2X) Technology in the 5.9 GHz Band; GN Docket No. 18-357*

Revision of Part 15 of the Commission's Rules; ET Docket No. 13-49

Dear Ms. Dortch:

The 5G Automotive Association ("5GAA")[1] understands the Federal Communications Commission ("Commission") may be considering changes to the rules governing the 5.9 GHz band. 5GAA thus respectfully submits this letter encouraging the Commission to pursue a forward-looking approach in this band to facilitate the evolution path of Cellular Vehicle-to-Everything ("C-V2X") to 5G.

Ford Motor Company recently announced it will deploy C-V2X in all of its new vehicle models in the United States by 2022. And just last month, the Third Generation Partnership Project ("3GPP") adopted a work item description to ensure that C-V2X features are included in the next 5G standard.[2] By adopting forward-looking rules allowing for C-V2X operations in the

[1] 5GAA is a global cross-industry association of companies working to develop end-to-end connectivity solutions for intelligent transportation, future mobility systems, and smart cities. Created in 2016 by eight founding members, 5GAA's membership continues to expand rapidly. Today, over 100 companies – including many of the world's major automotive, technology, and telecommunications companies – count themselves as members of 5GAA. *See* Appendix A for a complete list of 5GAA members.

[2] *See* 3GPP, *3GPP Features and Study Items*, http://www.3gpp.org/DynaReport/FeatureListFrameSet.htm (last visited Apr. 1, 2019), (identifying a study on 5G NR Vehicle-to-Everything as part of the feature and study item list for Release 16). 3GPP is the world's preeminent standards body for cellular technologies. 3GPP develops specifications that are codified as accredited standards by the Alliance for Telecommunications Industry Solutions (ATIS) in the United States and by other "Organizational Partners" in different geographical regions. *See* 3GPP, About 3GPP, Partners, http://www.3gpp.org/about-3gpp/partners (last visited Apr. 1, 2019) for a complete list of the

5.9 GHz band, the Commission will pave the way for automobile manufacturers and other stakeholders to make American roadway travel safer, smarter, and more efficient through the use of 5G technology. Thus, 5GAA urges the Commission to solicit public comment on rule changes that will facilitate the deployment of C-V2X in the 5.9 GHz band.

I. Introduction

Intelligent Transportation System ("ITS") services hold the potential to revolutionize travel on America's roads. These services, which utilize communications technology incorporated into vehicles, transportation infrastructure, and other devices, can enable important safety, mobility, traffic efficiency, and environmental benefits. With hundreds of Americans losing their lives every day on our nation's roads, the need for ITS is greater than ever before.[3]

C-V2X has emerged as the best opportunity to further the vision of ITS. Built upon earlier efforts to develop ITS services and recent advancements in cellular technologies, C-V2X represents an evolution in connected vehicle technology and the first step towards leveraging 5G to make America's roads safer, smarter, and more efficient. The technology empowers direct communications between vehicles, between vehicles and pedestrians, cyclists and other vulnerable persons, and between vehicles and transportation infrastructure, as well as communications between vehicles and mobile cellular networks.

The momentum for C-V2X is growing at an unprecedented rate. Most notably, Ford Motor Company recently announced plans to deploy C-V2X in the United States beginning in 2022.[4] This announcement represents a watershed moment in the history of ITS: Ford is the first automaker to commit to deploy C-V2X technology that leverages the 5.9 GHz band in all of its new vehicle models sold in America. And Ford is not alone in its interest in C-V2X. BMW and Jaguar Land Rover have asked the Commission to allow C-V2X deployments as soon as

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accredited Standards Defining Organizations (SDOs) around the world. In this document, 3GPP will be used by reference to indicate any relevant 3GPP specification adopted as a standard by the Organizational Partners.

[3] *See, e.g.*, National Safety Council, *Vehicle Deaths Estimated at 40,000 for Third Straight Year*, https://www.-nsc.org/road-safety/safety-topics/fatality-estimates (last visited Apr. 1, 2019) ("For the first time since the Great Recession, the U.S. has experienced three straight years of at least 40,000 roadway deaths, according to preliminary estimates released Feb. 13[, 2019] by the National Safety Council.").

[4] Don Butler, *How 'Talking' and 'Listening' Vehicles Could Make Roads Safer, Cities Better*, Medium (Jan. 7, 2019), https://medium.com/@ford/how-talking-and-listening-vehicles-could-make-roads-safer-cities-better-f215c68f376f. ("Back in 1868, English engineer John Peake Knight invented the world's first traffic light to help people move through a congested London intersection that had become dangerous for pedestrians due to the popularity of horse-drawn carriages. At Ford, 150 years later, we are excited to continue advancing this type of thinking by committing to deploy cellular vehicle-to-everything technology—or C-V2X—in all of our new vehicle models in the United States beginning in 2022.").

possible,[5] and Daimler also has said it is excited by and is actively assessing C-V2X technology.[6]

Yet, unfortunately, Commission rules presently prevent widespread deployment of C-V2X technology. The current rules for the 5.9 GHz ITS band – adopted well before the development of C-V2X – restrict operations in the band to those that use the Dedicated Short Range Communications ("DSRC") standard. These rules pose the most significant regulatory roadblock that stands in the way of Ford and other stakeholders deploying C-V2X.

To expedite the availability of C-V2X on America's roads, 5GAA recently sought a blanket waiver of the Commission's rules to allow for initial deployments of C-V2X in the 5.905-5.925 GHz portion of the 5.9 GHz band.[7] While 5GAA previously signaled its intention to file a complementary petition for rulemaking requesting the Commission modify its rules for the 5.9 GHz band to accommodate C-V2X, we understand Commission staff already may be taking a broader look at its rules for the band.

5GAA thus urges the Commission through this letter to pursue a forward-looking approach in the 5.9 GHz band that facilitates C-V2X's evolution path to 5G. In addition, during the pendency of this rulemaking, the Commission should grant 5GAA's waiver request to allow initial deployments of this potentially life-saving technology as soon as possible.

II. Amending the Rules to Allow C-V2X at 5.9 GHz Will Advance the Objectives Congress, the U.S. Department of Transportation, and the Commission Share in Promoting ITS on America's Roads

For decades, Congress, the U.S. Department of Transportation ("DOT"), and the Commission have acknowledged the life-saving and societal benefits of connected vehicle technologies. ITS traces its modern day origins to the mid-1980s, when the DOT, in partnership with state departments of transportation, academia, and industry, began evaluating how to incorporate communications technology into transportation infrastructure to improve safety,

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[5] *See* Letter from Roberto Rossetti, Vice President Engineering, BMW of North America, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-357 (dated Jan. 18, 2019); Letter from Desi Ujkashevic, Global Director, Ford Motor Company, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-357 (dated Jan. 24, 2019); Letter from Colin Lee, V2X Global V2X owner, Jaguar Land Rover, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-357 (dated Jan. 18, 2019).

[6] *See* Letter from Jessica Nigro, General Manager, Technology and Innovation Policy, Daimler North America Corporation, to Marlene H. Dortch, Secretary, FCC, GN Docket No. 18-357 (dated Jan. 18, 2019).

[7] Petition of 5G Automotive Association for Waiver, GN Docket No. 18-357 (dated Nov. 21, 2018).

mobility, and emissions.[8] Shortly thereafter, Congress passed ITS provisions in the Intermodal Surface Transportation Efficiency Act of 1991 ("ISTEA") in an effort to improve traveler safety, decrease traffic congestion, facilitate the reduction of air pollution, and conserve vital fossil fuels.[9]

The passage of ISTEA represented the first in a sequence of collective actions by Congress,[10] the DOT,[11] and the Commission that ultimately led to the allocation of the 5.9 GHz band for the ITS Radio Service.[12] Throughout the allocation proceeding, the Commission repeatedly expressed the importance of "increas[ing] the [safety and] efficiency of the nation's transportation infrastructure," noting that "their future development could potentially increase traveler safety, reduce fuel consumption and pollution, and continue to advance the country's

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[8] *See* Federal Motor Vehicle Safety Standards; V2V Communications, 82 Fed. Reg. 3854, 3867 (Jan. 12, 2017) ("Federal Motor Vehicle Safety Standards") (discussing the history of ITS research).

[9] Intelligent Vehicle-Highway Systems Act, Pub. L. No. 102-240 § 6052 (b), 105 Stat. 1914, 2189-90 (1991), https://www.gpo.gov/fdsys/pkg/STATUTE-105/pdf/STATUTE-105-Pg1914.pdf. The DOT embraced Congress' approach:

> Surface transportation systems – the networks of highways, local streets, bus routes, and rail lines – are the ties that bind communities and facilitate commerce, connecting businesses and residents to work, homes, schools, services, and each other. During the past 20 years, however, transportation systems have struggled to keep pace with Americans' growing and changing travel needs …. Rather than continuing to rely simply upon quantitative additions to the existing transportation infrastructure, Congress has chosen to also emphasize the use of technology to improve the performance of that infrastructure.

Comments of the U.S. Department of Transportation, ET Docket No. 98-95, at 2 (filed July 28, 1997),https://ecfsapi.fcc.gov/file/1879770001.pdf.

[10] *See, e.g.*, Transportation Equity Act for the 21st Century, Pub. L. No. 105-178, 112 Stat. 107 (1998), https://www.congress.gov/105/plaws/publ178/PLAW-105publ178.pdf.

[11] For example, in 1994, the DOT established the ITS Joint Program Office to oversee and manage a national ITS program. *See* Ashley Auer, Shelley Feese, and Stephen Lockwood, *History of Intelligent Transportation Systems*, at 15, U.S. Department of Transportation, ITS Joint Program Office (May 2016), https://www.its.dot.gov/history/-index.html. In 1999, the DOT established a Commercial Vehicle Information Systems and Networks Grant Program to support states in the deployment of advanced technologies in safety information exchange, electronic credentialing, and electronic screening. *Id*. at 16.

[12] *See Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, Report and Order, 14 FCC Rcd 18221 (1999) ("*Allocation Report and Order*").

economy."[13] It also acknowledged that, to achieve the goals of ITS services, dedicated spectrum was necessary:

> Communications are an essential component of the backbone of all ITS applications, which rely heavily on swift and accurate flow of information. [While] [m]any ITS communications requirements are being met within the framework of existing telecommunications systems… [there is] a need for spectrum for reliable short-range wireless communications links between vehicles traveling at highway speeds and roadside systems.[14]

The Commission found the 5.9 GHz band best suited for this allocation based on the band's propagation characteristics and the benefits of international harmonization.[15]

Today, the need for ITS services is greater than ever. Hundreds of Americans lose their lives each day on our nation's roadways, and millions more are injured annually in motor vehicle accidents.[16] More and more road use has contributed significantly to increased traffic congestion, higher energy consumption, and worsening pollution.[17] Further, millions of elderly and disabled Americans continue to struggle to find reliable and affordable mobility options.[18]

ITS services in the 5.9 GHz band can help address these challenges. With respect to safety in particular, the National Highway Traffic Safety Administration ("NHTSA") – the nation's expert agency in traffic safety – concluded that ITS communications in the 5.9 GHz

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[13] *See Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services*, Notice of Proposed Rule Making, 13 FCC Rcd 14321, 14324-25 ¶ 7 (1998).

[14] *See id.* at 14322 ¶ 2.

[15] *See Allocation Report and Order*, *supra* note 12, at 18227 ¶ 12.

[16] *See, e.g.*, National Safety Council, *supra* note 3.

[17] *See* Martin Knopp, *America's Drivers Continue to Spend More Time Stuck in Traffic, 2016 Data Shows*, Connections – U.S. Department of Transportation Blog (June 12, 2017), https://www.transportation.gov/-connections/america%E2%80%99s-drivers-continue-spend-more-time-stuck-traffic-2016-data-shows, ("[D]rivers are spending more time stuck in rush-hour traffic than ever. … Congestion got worse [from 2016 to 2017] during peak hours in 2016, as represented by the Travel Time Index which compares peak hour or commuter travel times to free flow travel times."); U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks (1990-2016)*, at 2-11 (Apr. 12, 2018), https://www.epa.gov/sites/production/files/2018-01/documents-/2018_complete_report.pdf, ("Emissions from petroleum consumption for transportation have increased by 21.7 percent since 1990 ….").

[18] National Aging and Disability Transportation Center, *Travel Patterns of American Adults with Disabilities*, (Nov. 8, 2018), https://www.nadtc.org/news/blog/travel-patterns-of-american-adults-with-disabilities, (showing that there are over 25 million Americans who have self-reported travel-limiting disabilities).

band can "revolutionize motor vehicle safety."[19] This is due in part to the ability of these communications to address crashes that cannot be prevented by vehicle-resident technologies.[20] For example, ITS communications offer non-line-of-sight capabilities (i.e., the ability to "see" around corners and through other vehicles) that vehicle-resident sensors and cameras cannot match.[21] NHTSA also expects the fusion of ITS with vehicle-resident technologies to enhance the reliability and accuracy of sensor-based information in the short term and, in the longer term, advance the continued development of autonomous vehicle systems.[22] Consistent with the importance of these services, the DOT recently issued guidance "encourag[ing] the automotive industry, wireless technology companies, [infrastructure owners and operators], and other stakeholders to continue developing technologies that leverage the 5.9 GHz spectrum for transportation safety benefits."[23]

Thanks to advancements in cellular technologies, C-V2X has emerged as today's best opportunity to further the vision of ITS in the 5.9 GHz band and respond to the societal needs that Congress, the Commission, the DOT, and NHTSA repeatedly have identified. C-V2X can meet the immediate needs ITS was originally intended to address, while also supporting the vast number of additional use cases that are emerging as the 5G revolution begins to take hold.

III. C-V2X Will Make America's Roads Safer and Smarter

C-V2X standards development began in 2015 when 3GPP specified C-V2X features based on the 4G LTE-Pro system in 3GPP Release 14.[24] The Release 14 version of 4G LTE-Pro, which was finalized in 2017, was the first cellular standard to incorporate C-V2X features.[25]

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[19] *See, e.g.*, Federal Motor Vehicle Safety Standards, 82 Fed. Reg. at 3855.

[20] *See id*. Vehicle-resident technologies include in-vehicle camera and sensor-based technologies.

[21] In addition to increased non-line-of-sight capabilities, ITS offers a number of additional benefits. For example, ITS basic safety messages contain additional information, such as path predictions and driver actions, not available from traditional sensors. Moreover, ITS offers an operational range that far exceeds that of vehicle-resident systems, and ITS technology is not subject to the same system limitations as vehicle-resident sensors, which may be affected by weather, sunlight, shadows, or cleanliness.

[22] *See* Federal Motor Vehicle Safety Standards, 82 Fed. Reg. at 3855.

[23] *See* U.S. Department of Transportation, *Automated Vehicles 3.0, Preparing For the Future of Transportation*, at 16 (Oct. 4, 2018), https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf.

[24] Dino Flore, *Initial Cellular V2X standard completed*, 3GPP (Sept. 26, 2016), http://www.3gpp.org/news-events/3gpp-news/1798-v2x_r14ietf%20ipwave.

[25] 3GPP, *Release 14*, http://www.3gpp.org/release-14 (last visited Apr. 1, 2019).

3GPP Release 15 incorporated C-V2X enhancements,[26] and work already is underway to develop 5G New Radio (NR) C-V2X features in 3GPP Release 16, which is expected to be completed in the near future.[27]

C-V2X's unique advantages will help make American roadway travel safer, smarter, and more efficient. Chief among these advantages are (1) a superior radio performance that enables new and improved ITS safety and other applications, (2) an evolutionary path to 5G that will unlock advanced ITS services supporting autonomous driving, and (3) an accelerated timeline for deployment.

A. C-V2X's Radio Performance Can Enable New and Improved Roadway Safety and Other Vehicle Applications

The radio performance advantages of C-V2X peer-to-peer mode can help unlock improvements in a variety of ITS applications and in a variety of different scenarios (e.g., varying road/traffic conditions and vehicle speeds).[28] With C-V2X, drivers and vehicles will have access to a more complete and accurate picture of the surrounding road environment. For example:

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[26] Release 15's enhancements increase reliability of communication and enable higher data rates. *See* 5G Automotive Association White Paper, *Timeline for deployment of C-V2X – Update*, at 7 (Jan. 22, 2019), http://5gaa.org/wp-content/uploads/-2019/01/5GAA_White-Paper-CV2X-Roadmap.pdf.

[27] *See 3GPP Features and Study Items*, *supra* note 2 (identifying a study on NR Vehicle-to-Everything as part of the feature and study item list for Release 16).

[28] C-V2X is comprised of two complementary communications modes for vehicular operations: peer-to-peer (called PC5 in 3GPP specifications) and network (called Uu in the specifications) communications. Peer-to-peer mode communications, which can operate independently of cellular networks and without a network subscription, include: (1) vehicle-to-vehicle ("V2V") communications, which are expected to be used to communicate safety information between nearby vehicles to prevent collisions; (2) vehicle-to-roadside infrastructure ("V2I") communications (e.g., traffic signals, variable message signs, etc.), which are expected to communicate safety and traffic information, to prevent accidents associated with roadway conditions and improve traffic efficiency, and (3) vehicle-to-pedestrian communications, which are expected to be used to communicate safety information between vehicles and other road users such as pedestrians, bicyclists, motorcyclists, etc. to prevent accidents. To augment these peer-to-peer mode communications, C-V2X's network ("V2N") mode capabilities allow vehicles to communicate with the rest of the world through cellular networks. These V2N mode communications enable key supporting functions for the peer-to-peer mode communications uses and expand the universe of applications enabled by C-V2X services.

- ***C-V2X's improved non-line-of-sight performance*** allows vehicles and drivers to "see" more clearly through obstructions and further around corners, providing an expanded and more useful view of the surroundings;[29]
- ***C-V2X's enhanced reliability*** and ***superior resiliency*** provides more certainty that critical safety messages reach their intended destination at a much greater communications range;[30]
- ***C-V2X's increased capacity*** to transmit greater amounts of data, a feature expected in future versions of C-V2X, will allow higher quality information to reach the driver and vehicle; and
- ***C-V2X's communications congestion control*** in traffic jams and other scenarios in which there is a high volume of vehicles in the same vicinity helps to ensure more consistent performance.[31]

These unique characteristics will enable new and improved ITS applications that will yield benefits on America's roads. For example, C-V2X's increased reliability provides better support for intersection movement applications. Left Turn Assist (LTA) and Intersection Movement Assist (IMA) – both of which NHTSA has identified as particularly important for improving traffic safety – benefit from C-V2X's ability to reliably deliver safety messages in intersection scenarios where line-of-sight is limited or obstructed.[32]

Similarly, C-V2X's ability to reliably deliver communications over extended ranges enables enhanced support for highway passing applications. In particular, Do Not Pass Warning (DNPW) – which provides warnings when it is not safe to pass slower moving vehicles – requires communications over long distances to ensure warnings are delivered in a manner that provides drivers with sufficient time to react. C-V2X offers an unrivaled ability to deliver messages over extended ranges in both line-of-sight and non-line-of-sight scenarios.[33]

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[29] *See* 5G Americas White Paper, *Cellular V2X Communications Towards 5G*, at 21-22 (Mar. 2018) ("5G Americas White Paper"), http://www.5gamericas.org/files/9615/2096/4441/2018_5G_Americas_White_Paper_Cellular_V2X-_Communications_Towards_5G__Final_for_Distribution.pdf.

[30] *See id*.

[31] *See id.* at 22.

[32] *See* Federal Motor Vehicle Safety Standards, 82 Fed. Reg. at 3859.

[33] In October 2018, 5GAA published a report summarizing benchmark-testing results comparing the radio performance of C-V2X peer-to-peer radios against DSRC radios. *See* 5G Automotive Association, *V2X Functional and Performance Test Report; Test Procedures and Results*, (Oct. 2018) http://5gaa.org/wp-content/uploads/-2018/11/P-180106-V2X-Functional-and-Performance-Test-Report_Final_051118.pdf. While the report indicated

B. C-V2X's Evolutionary Path to 5G and Subsequent Wireless Generations Will Enable Advanced ITS Services that Can Provide Support for Autonomous Driving

C-V2X is the only ITS technology designed with a clear path to 5G and subsequent mobile wireless generations. This evolution path ensures that vehicles using 5G C-V2X will be able to communicate with older vehicles that only have 4G LTE C-V2X.[34] Consequently, when future versions of 5G C-V2X are introduced, new vehicles equipped with the latest version of the technology will continue to seamlessly communicate with older versions of C-V2X-enabled vehicles, infrastructure, and networks, effectively future-proofing the technology.[35]

C-V2X thus will unlock the power of 5G technology, driving further improvements in performance, introducing new capabilities to connected vehicles, and extending the number of use cases for C-V2X. 5G C-V2X peer-to-peer mode communications, for example, will use advanced radio technologies to achieve ultra-low latency and ultra-high capacity capabilities.[36] With respect to 5G-enabled V2N and V2I, the combination of high-bandwidth operations and edge computing capabilities will allow for the movement of larger amounts of data, over shorter distances, in smaller amounts of time, maximizing the safety benefits of C-V2X.[37]

While the applications enabled by 5G C-V2X likely will expand in ways that are difficult to predict, 5GAA is aggressively exploring 5G C-V2X's role in advanced driving and extended sensor applications that support autonomous driving. For example, 5G C-V2X can complement and augment advanced driving applications that enhance semi-automated or fully-automated driving features by coordinating the behaviors of vehicles. These advanced driving applications

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that the DSRC devices used in testing had employed receive antenna diversity, 5GAA members recently discovered that this was not the case. As a result, 5GAA is expanding its testing to collect DSRC data that reflects the use of receive antenna diversity. 5GAA plans to file a fulsome set of expanded testing results in near term; however, attached in Appendix B is a presentation summarizing initial results of this expanded testing. As expected, the initial results confirm that C-V2X technology substantially outperforms DSRC technology.

[34] *See* Tom Rebbeck et al., *Socio-Economic Benefits of Cellular V2X*, at 1, Analysys Mason (Dec. 2017), http://5gaa.org/wp-content/uploads/2017/12/Final-report-for-5GAA-on-cellular-V2X-socio-economic-benefits-051217_FINAL.pdf ("The evolution path from C-V2X towards 5G is established as part of the 3GPP specification, which will enable C-V2X communications to progress seamlessly into the 5G era (while offering backward compatibility with earlier C-V2X solutions).").

[35] *See id.* at 30.

[36] *See* 5G Americas White Paper at 14.

[37] *See* 5G Automotive Association White Paper, *Toward fully connected vehicles: Edge computing for advanced automotive communications*, at 6 (Dec. 2017), http://5gaa.org/wp-content/uploads/2017/12/5GAA_T-170219-whitepaper-EdgeComputing_-5GAA.pdf.

allow a vehicle to share the trajectory data obtained from its local sensors with vehicles in its proximity.

5G C-V2X also will enable vehicles to use extended sensor applications to share their future intentions (i.e., lane changes, etc.) and engage in persistent information exchanges with vehicles in their proximity. These extended sensor applications allow vehicles to obtain information about objects around them located beyond the view of their own onboard sensors by sharing sensor data (for example, data obtained from cameras, radar, and LIDAR) with nearby vehicles, providing a more complete picture of road and traffic conditions.

Successful implementation of these advanced driving and extended sensor applications will require the type of ultra-low latency and ultra-high data rate communications supported by 5G capabilities.[38]

C. C-V2X's Accelerated Deployment Timeline Will Expedite the Realization of the Benefits of ITS Services

C-V2X also offers a unique cost efficiency that supports deployment on a timeline that exceeds the expected timeline for wide-spread deployment of DSRC. C-V2X technology can be economically integrated into vehicles, leverage today's 4G cellular networks and tomorrow's 5G networks to reduce infrastructure costs, and take advantage of economies of scale made possible by the growing momentum towards the adoption of C-V2X internationally. In addition, C-V2X's evolutionary path to 5G will help accelerate the development and improvement of a market for C-V2X equipment and applications, creating additional economies of scale and further driving down deployment costs.

IV. The Commission Should Pursue a Forward-Looking Approach in the 5.9 GHz Band That Facilitates C-V2X's Evolution Path to 5G

The applications enabled by C-V2X today – and the future applications enabled by 5G C-V2X – will help to improve safety, productivity, mobility, and energy efficiency on America's highways. These realities are already driving investment in the development of 5G C-V2X by automotive, technology, and telecommunications companies around the world. For the United States to capitalize on this investment and realize the benefits of C-V2X services, the Commission must revise its rules for the 5.9 GHz band as proposed in Appendix C.

The Commission should propose service rules that would enable the deployment of both today's C-V2X and future versions of C-V2X in the 5.9 GHz band. To help to expedite the

[38] *See* 5G Americas White Paper at 24-25.

promulgation of such rules, 5GAA took great care in considering the interests at play in this band, including the large-bandwidth requirements for advanced 5G C-V2X services and plans announced by certain automotive manufacturers to deploy DSRC. The proposal takes each set of needs into account. Specifically, 5GAA respectfully requests that the Commission consider a forward-looking approach that would:

- Grant permission for C-V2X operations in the 5.865-5.925 GHz band, allowing for C-V2X to achieve its evolution path to 5G; and

- Maintain the 5.855-5.865 GHz frequencies for continued operations of the limited number of DSRC radios that have been deployed and any future DSRC radios that may be deployed.

Such an approach will accommodate continued operations of DSRC-equipped vehicles and infrastructure, allow for the near term deployment of C-V2X, and facilitate future evolutions of 5G C-V2X.[39] Moreover, such an approach is consistent with the repeated findings over the past three decades by Congress, the DOT, NHTSA, and the Commission regarding the safety benefits of ITS services in the 5.9 GHz band.[40]

A. The Proposal Will Enable 5G-Powered C-V2X Services – Improving Safety and Delivering Other Benefits on America's Highways

The proposed band plan for C-V2X services is informed by the spectrum requirements of both LTE C-V2X and 5G C-V2X. While 20 MHz is the ideal channel size for LTE C-V2X, the bandwidth requirements to support more intensive 5G-enabled road safety applications will be much higher. This should come as no surprise. It is a simple matter of physics that 5G technology requires access to large swaths of spectrum to meet the speed and latency requirements of advanced applications. 5G C-V2X is no different.

The proposed rules therefore identify two C-V2X channels: (1) the Basic C-V2X channel in the 5.905-5.925 GHz frequency range and (2) the Advanced C-V2X channel in the 5.865-5.905 GHz frequency range. The Basic C-V2X channel will support V2V and V2I messages such as the Basic Safety Message (BSM), Signal Phase and Timing (SPaT), Emergency Vehicle Alert (EVA), Probe Data Management (PDM), Probe Vehicle Data (PVD), Signal Request

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[39] 5GAA members are in the process of completing testing demonstrating the ability of C-V2X and DSRC to co-exist in adjacent channels in the 5.9 GHz band. 5GAA plans to publish this data in a report that will be made public in the near future, and 5GAA intends to file that report in this docket.

[40] *See supra* notes 9-15, 19 (discussing the numerous acknowledgements of the safety benefits of ITS services by Congress, the DOT, and the Commission).

Message (SRM), Signal Status Message (SSM), Geometric Intersection Description (GID/MAP), Traveler Information Message (TIM), and others encompassed by the Road Safety Message. Messages transmitted over the Basic C-V2X channel will enable many important safety applications, such as red light warnings and intersection movement applications, to enhance traffic systems and operations.[41]

The Advanced C-V2X channel will support the delivery of 5G and future generations of C-V2X applications to support autonomous driving. To unleash advanced features, 5G C-V2X will need to access as much contiguous spectrum as possible in the 5.9 GHz band. Advanced applications may require transmit rates of 50 messages per second, latency as low as 5 milliseconds, message lengths of up to 6500 bytes, data rates up to 1 Gbps, reliability up to 99.999%, and ranges up to 1000 meters.[42] Accordingly, 5GAA proposes rules that would enable C-V2X operations in the 5865-5905 MHz band for these types of advanced capabilities.[43]

Significant investment in 5G C-V2X already is occurring. For example, C-V2X recently reached a major industry milestone when 3GPP approved a work item for the specification for 5G C-V2X, which will be included in the next phase of the 5G standard in 3GPP Release 16.[44] The adoption of the 5GAA's rules will unleash an avalanche of additional private sector investment in the development of 5G C-V2X, leading to enhanced functionality, increased use cases and applications, and an accelerated timeline for deployment.

In sum, the Basic C-V2X channel and the Advanced C-V2X channel will accommodate both current versions of C-V2X technology and C-V2X's evolution path to 5G and future

[41] A 20 MHz Basic Safety channel will enhance C-V2X's ability to implement congestion control, should help improve its resiliency to out-of-band interference, and will enable capacity to adjust dynamically between V2V and V2I applications in any given location, depending on usage. A 20 MHz channel allows for soft multiplexing of the various peer-to-peer mode communications supported by C-V2X. The communications system therefore will dynamically adjust to the capacity demands, ensuring a high reliability for message delivery. 5GAA members have validated C-V2X operation in a 20 MHz channel in laboratory tests and are performing additional field tests using a 20 MHz channel. Congestion control test results are expected to improve when utilizing a 20 MHz channel because a wider channel naturally accommodates more simultaneous users. In addition, resiliency test results using 20 MHz may similarly improve due to C-V2X's channel sensing, which will choose less polluted parts of the channel for message transmission.

[42] *See* 5G Americas White Paper at 24-26.

[43] To the extent that the market abandons DSRC services, the Commission should extend the bottom of the Advanced C-V2X channel down to 5.85 GHz. Providing advanced C-V2X services with access to an additional 15 MHz of spectrum will further enhance the capabilities of these services.

[44] 3GPP, *5G V2X with NR Sideline*, RP-190766, 3GPP TSG RAN Meeting #83 (Mar. 18-21, 2019); *see also* Shailesh Patil, *5G NR C-V2X Moves Toward Realization With a New Paradigm of Communication Design for Tomorrow's Vehicles*, QUALCOMM (Mar. 22, 2019), https://www.qualcomm.com/news/onq/2019/03/22/5g-nr-c-v2x-moves-toward-realization-new-paradigm-communication-design-tomorrows.

generations of cellular technology. Alternatively, if access to sufficiently large, contiguous, internationally-harmonized ITS spectrum is not granted, America may lose its chance to capitalize on the benefits of 5G-enabled traffic safety applications.

B. The Proposal Will Accommodate Continued Operations by DSRC-Equipped Vehicles and Infrastructure

The proposed band plan accommodates continued operations by DSRC-equipped vehicles and infrastructure by maintaining channel 172 for DSRC communications. While there has been some limited commercial deployment of DSRC-equipped vehicles, the vast majority – if not all – of these vehicles are equipped with radios whose operations exclusively occur on channel 172. The proposed band plan therefore would not interrupt these continued uses.[45] DSRC radios thus can continue to operate to the extent the market demands support for such operations, while at the same time opening the ITS band for an advanced technology that promises to bring substantial benefits to the public today and even greater benefits tomorrow through the evolution to 5G.

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[45] While those commercially-available vehicles equipped with DSRC operate on channel 172, there are some V2I pilots and tests that use other channels in the 5.9 GHz band. One of the major nationwide focuses of those V2I pilots and tests has been with SPaT broadcasts, which was the subject of a nationwide challenge by DOT. SPaT can be deployed on channel 172 using DSRC or on the Basic C-V2X channel using C-V2X. Similarly, another focus of V2I, principally in Michigan, has been on using DSRC for Data Use Analysis and Processing ("DUAP"). DUAP also can be deployed on channel 172 or on the Basic C-V2X channel using C-V2X. Using a channel other than 172 for DSRC-based V2I would require a multi-channel DSRC radio, and 5GAA is not aware of any commercially-available vehicles being sold with such a radio.

V. Conclusion

C-V2X has emerged as the best opportunity to further the vision of ITS in the 5.9 GHz band and respond to the societal needs that Congress, the Commission, and the DOT repeatedly have identified over the better part of the past three decades. As the Commission takes a broader look at the 5.9 GHz band, it should pursue a forward-looking approach for licensed ITS operations in the 5.9 GHz band as proposed herein that facilitates C-V2X's evolution path to 5G. Moreover, during the pendency of this rulemaking, the Commission should grant 5GAA's waiver request to enable initial deployments of this potentially life-saving technology as soon as possible.

Sincerely,

/s/ Sean T. Conway
Sean T. Conway

Counsel to the 5G Automotive Association

Attachments

Appendix A –5GAA Membership

- Airbus
- Airgain, Inc.
- Alpine Electronics Inc.
- American Tower Corp
- Analog Devices Inc.
- Anritsu A/S
- Applied Information
- AT&T
- Audi AG
- BAIC Group (Beijing Automotive Group Co., Ltd.)
- Baidu
- Baoneng
- Beijing University of Technology
- Bell Mobility
- BlackBerry UK Limited
- BMW Group (Bayerische Motoren Werke AG)
- Bosch (Robert Bosch GmbH)
- CATT (China Academy of Telecommunication Technology)
- CETECOM GmbH
- China Mobile
- China Transinfo
- China Unicom (China United Network Communications Group Co., Ltd)
- China Mobile Research Institute
- Clarion Co. Ltd
- Cohda Wireless
- Commsignia Inc.
- Continental Teves AG & Co. oHG
- Daimler AG
- Danlaw Inc.
- Dekra
- DENSO AUTOMOTIVE Deutschland GmbH
- Deutsche Telekom AG
- Dt&C
- Equinix
- Ericsson AB
- Faraday Future
- FarEasTone
- FEV Group GmbH
- Ford
- Fraunhofer Institute
- Geely Auto

- Gemalto SA
- General Motors
- Hirschmann Car Communication GmbH
- Hitachi
- Honda
- Huawei
- Hyundai America Technical Center
- Hyundai Mobis
- iDirect
- Infineon Technologies AG
- Intel
- InterDigital Communications, Inc.
- Jaguar Land Rover Ltd.
- Juniper Networks
- KDDI
- Keysight Technologies UK Limited
- KT R&D Center
- Laird Bochum GmbH
- Latvijas Mobilais Telefons
- Lear
- LG Electronics Inc.
- Magneti Marelli
- Mitsubishi Electronics
- Murata Manufacturing
- NavInfo
- Neusoft
- NIO China
- Nissan
- Nokia
- Noris Network AG
- NTT-DoCoMo
- OKI
- Orange SA
- P3 Group
- Panasonic
- Proximus B.V.
- PSA Groupe
- Qorvo
- Qualcomm Incorporated
- Quectel
- Renault
- Rohde & Schwarz GmbH & Co. KG
- Rohm Semiconductor
- SAIC Motor Corporation Limited

- Samsung Electronics Co., Ltd
- Savari Inc.
- SGS
- Shanghai Gotell Communication Technology Holdings Co., Ltd.
- SIAC (Shanghai Int. Automobile City)
- SK Telecom
- Skyworks
- Smart Mobile Labs
- Softbank Corp.
- Sumitomo Electric
- Swift Navigation
- Telefónica Digital España S.L.
- Telekom Austria Aktiengesellschaft
- Telstra
- TELUS
- Tencent
- Terranet, SE
- TÜV Rheinland AG
- Valeo (peiker acustic GmbH & Co.KG)
- Veniam Inc.
- Verizon
- Viavi
- Vodafone Group Services Ltd
- Volkswagen AG
- Volvo Cars
- VT Direct
- Wistron NeWeb Corp.
- ZF
- ZTE Corporation

Appendix B

5GAA Updates to V2X Technology Benchmark Study

Updates to V2X Technology Benchmark Study

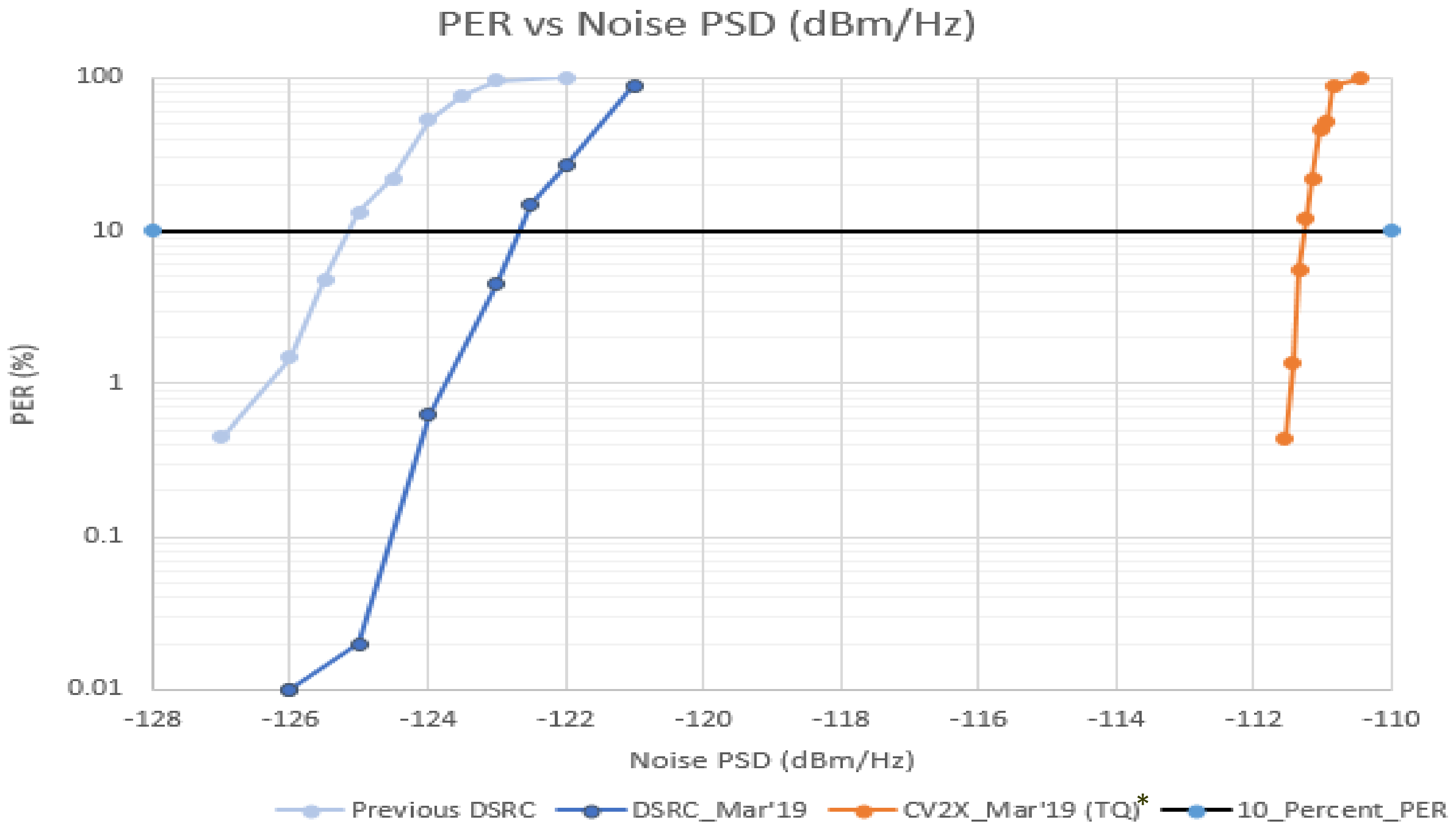
April 2019

5GAA Test Results with Corrected DSRC Configuration

- Ford and Qualcomm repeated the technology agnostic capability assessment procedures documented in the 5GAA test report with the corrected DSRC configuration
- Bench and Field tests were conducted in San Diego and Michigan during March 2019
- Testing was conducted with scrupulous control of factors influencing radio wave propagation to ensure fair comparison
- Field conditions at the time of the recent testing seemed to have had a positive effect on both C-V2X and DSRC, with both technologies showing improved performance
- While performance improvement was seen with DSRC due to the revised configuration, C-V2X was still found to be better in all test scenarios
- Trial quality C-V2X software was used for this repeat testing of C-V2X
  - Same software that used for C-V2X testing published in the originally published 5GAA test report
  - Commercial quality software will enable better C-V2X performance

Cabled Radio Lab Test Results

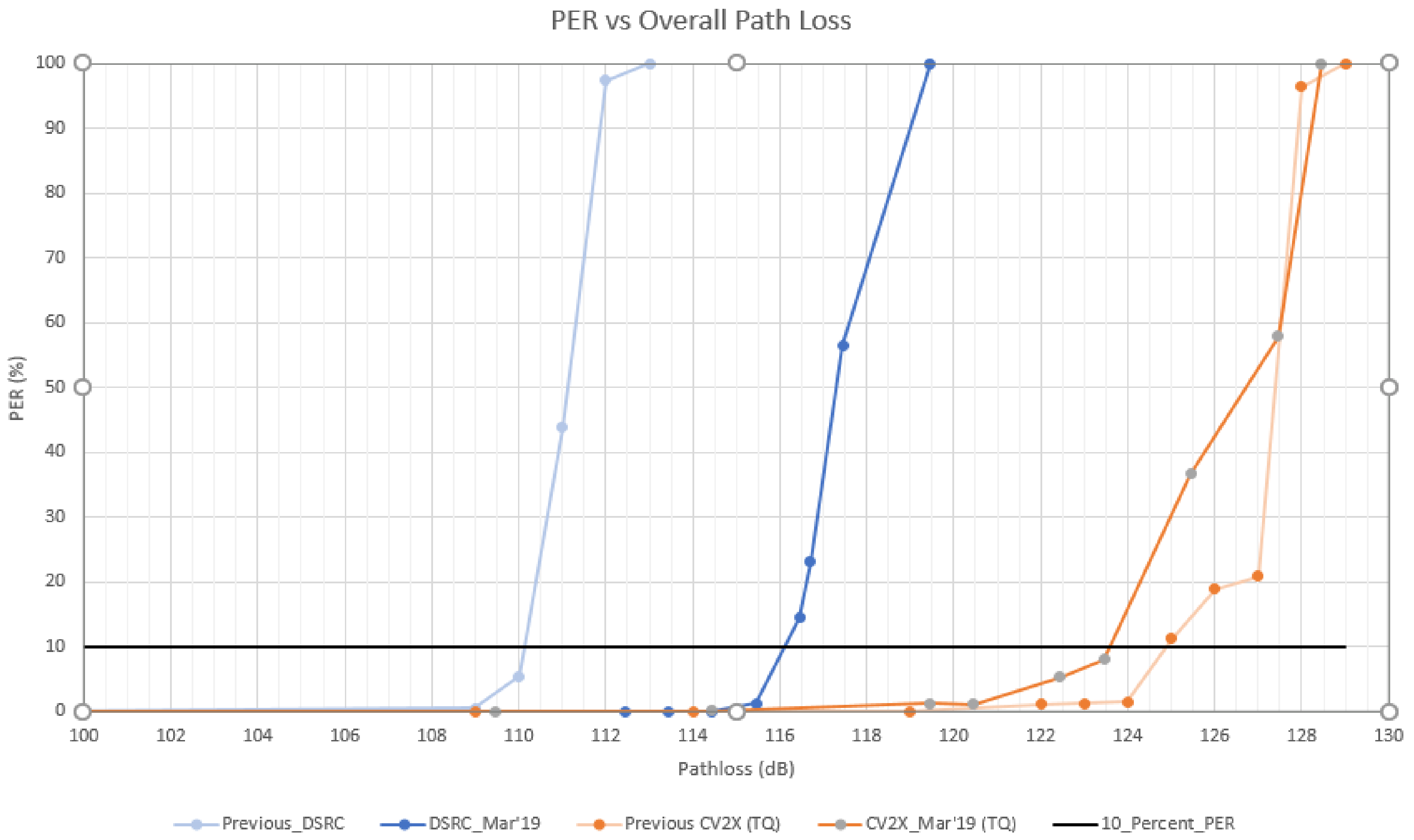
Purpose: Measure radio performance with added channel impairment



**Previous C-V2X results overlap C-V2X Mar'19 results*

Cabled Radio Lab Test Results

Purpose: Measure radio performance under varying receive power conditions



Transmit Power = 20dBm

Test track and configurations

Track: Fowlerville Proving Ground, Road A (straight-away 1350m long)

Parameter[1]	DSRC	CV2X
Vehicle	Fusion (w/o moon roof)	Fusion (w/o moon roof)
Modulation and coding	QPSK, ½	MCS5 (QPSK)
HARQ	Not available	Yes
Channel	CH184 (5,920 MHz)[2]	CH184 (5,920 MHz)
Bandwidth (message)	10 MHz	10 MHz
Packet size	193B	193B
Message frequency	10 Hz	10 Hz
Antenna[3]	ECOM6-5500 (6dBi)	ECOM6-5500 (6dBi)
Diversity	1Tx, 2Rx	1Tx, 2Rx
Equivalent Tx Power (with attenuation)[4]	5 & 11 dBm	5 & 11 dBm

[1] Selected parameters include **standard options**. Proprietary options were not considered.

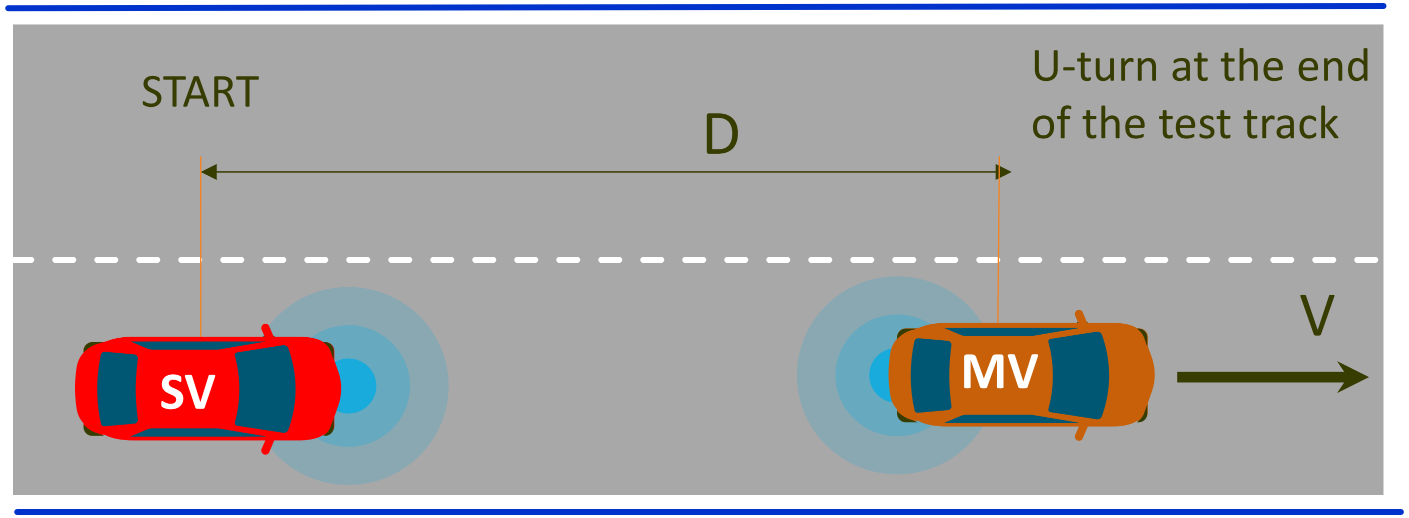
[2] We used CH184 to avoid any impact of the existing UNII-3 devices operating near the test track that we don't necessarily have control over.

[3] Antennas were mounted 24-in apart in the middle of the roof: driver side Primary (Tx), passenger side Secondary.

[4] Equivalent Tx power is the OBU total Tx power out minus attenuation on each RF antenna cable. Tx power was 21 dBm and the total attenuation was 10dB (on both Rx ends combined) resulting in 11dBm equivalent Tx power. *Equivalent transmit power was set at 11dBm for both DSRC and CV2X to fit measured range into the test track and to match the setting in previous tests by the industry.*

Line-of-Sight Field Test

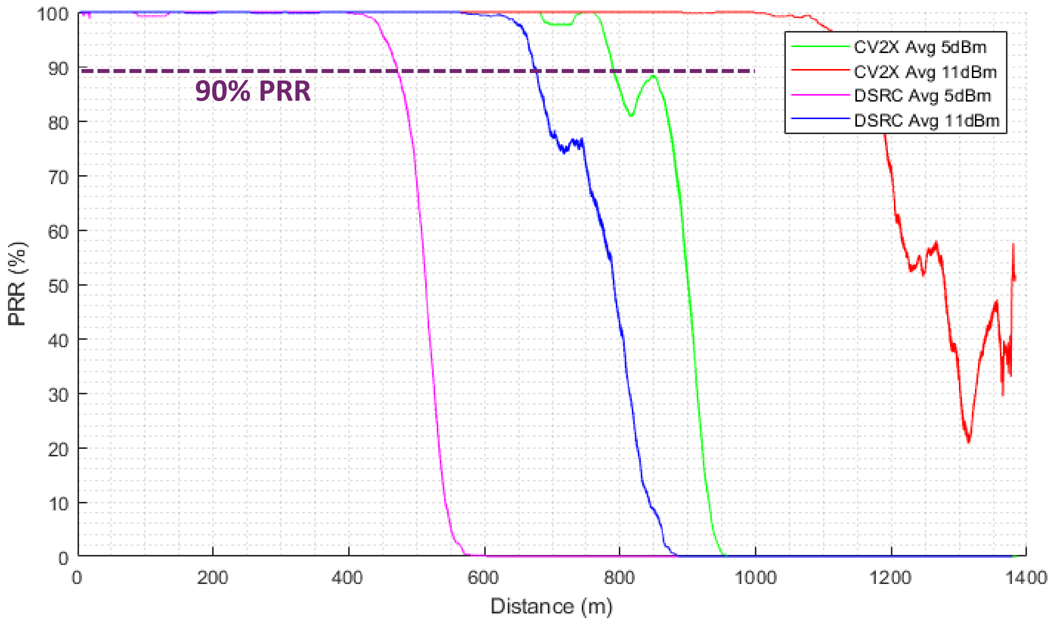
Purpose:
Assess baseline capability for V2V message exchange in line of sight (LOS).



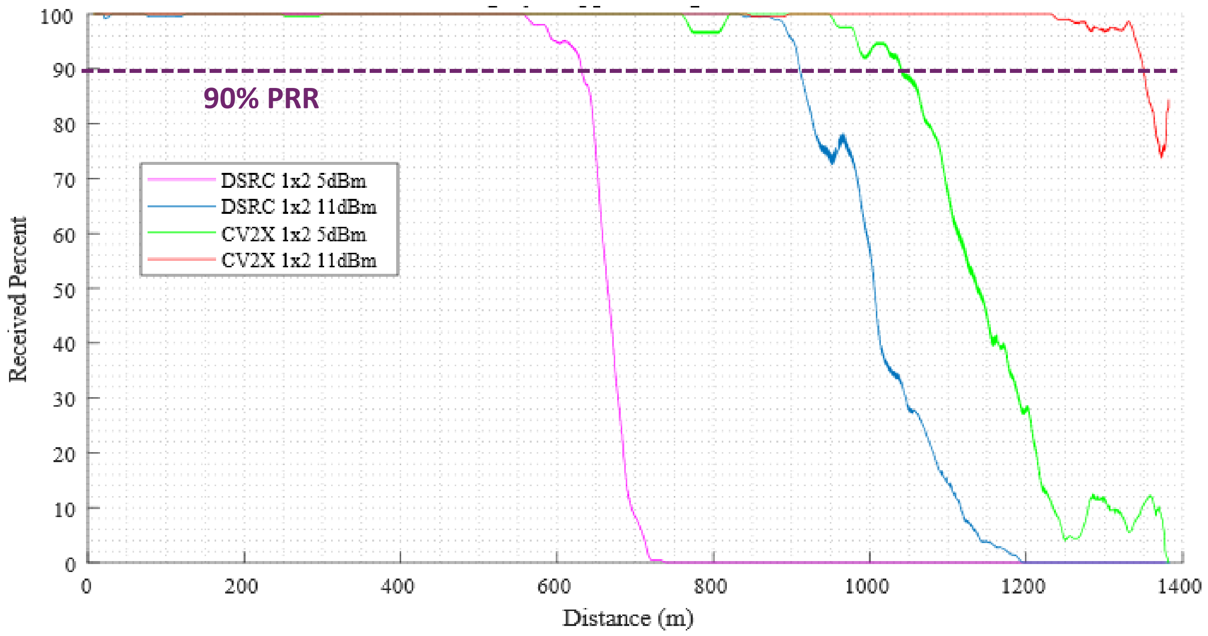
Note: Equivalent transmit power levels were set at 5dBm and 11dBm for both DSRC and CV2X to fit measured range into the test track (1350m long) and to match the setting in previous tests by the industry.

Line-of-Sight Field Test Results

Previously Published Results



March 2019 Results



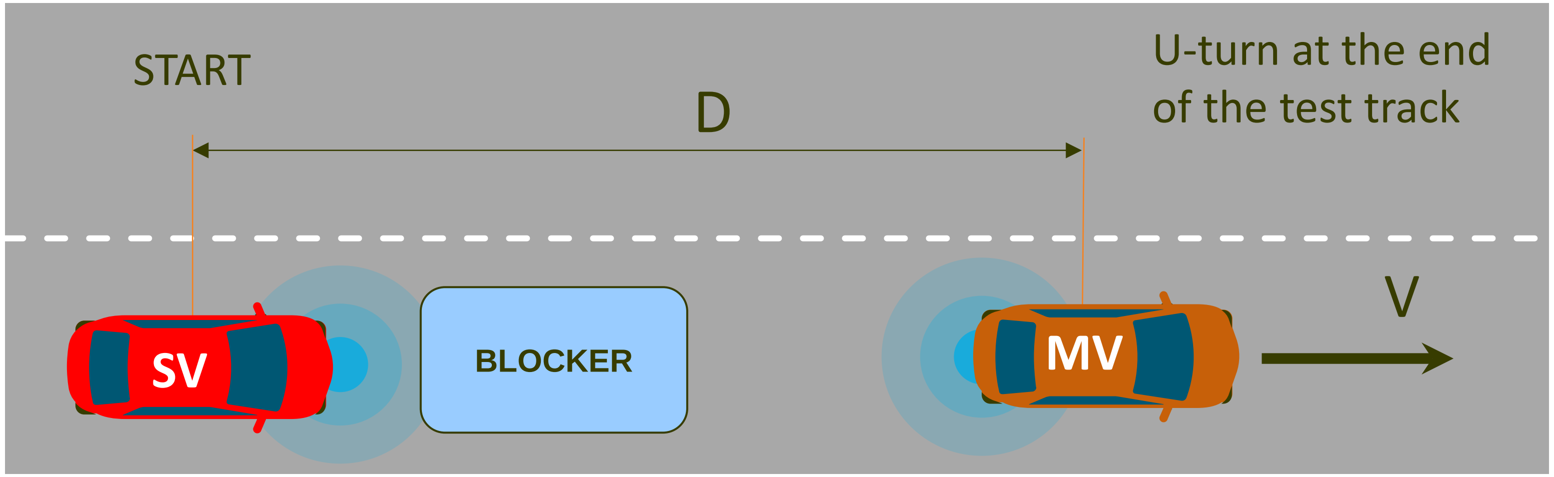
Stationary vehicle reception plots

HI	LO	Weather Conditions	Track Conditions
22°F	8°F	Snowy, Very windy	Track wet

5GAA Shadowing Test

Purpose:

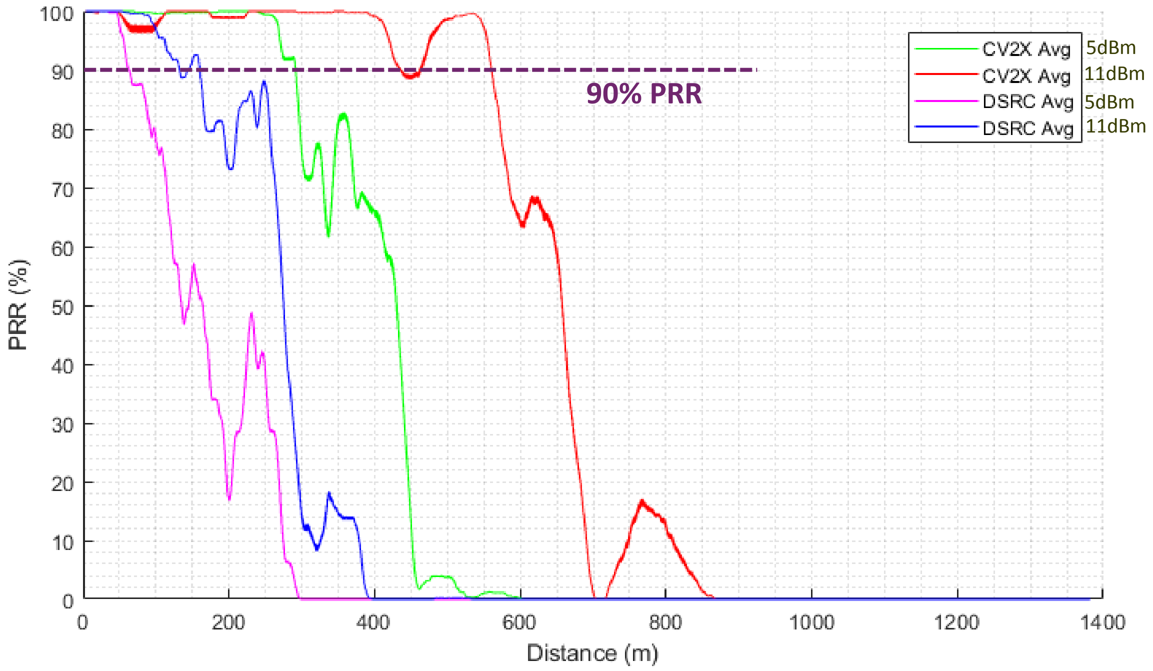
Assess capability for V2V message exchange in non-line of sight (NLOS) scenario with significant obstruction.



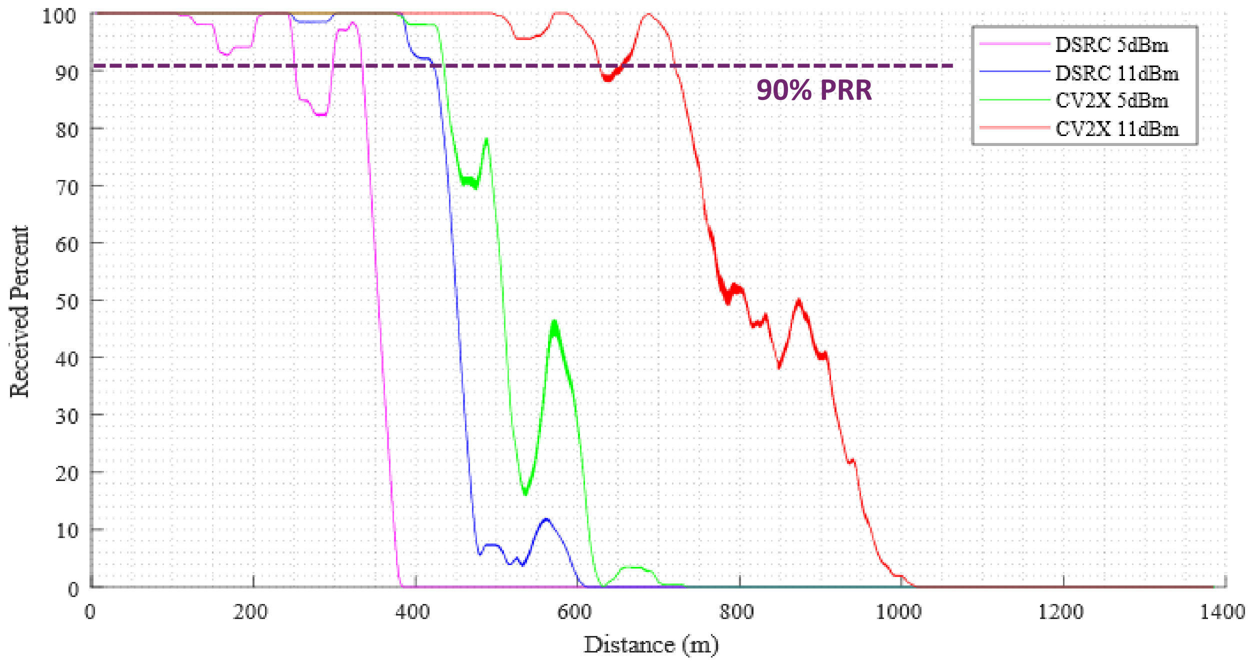
Note: The blocker is positioned in front of the stationary vehicle in order to create a significant (and constant) line of sight obstruction. **The Stationary Vehicle and Blocker remain motionless during the entire test**.

5GAA Shadowing Test Results

Previously Published Results



March 2019 Results



Stationary vehicle reception plots

HI	LO	Weather Conditions	Track Conditions
22°F	8°F	Snowy, Windy	Snow on Track

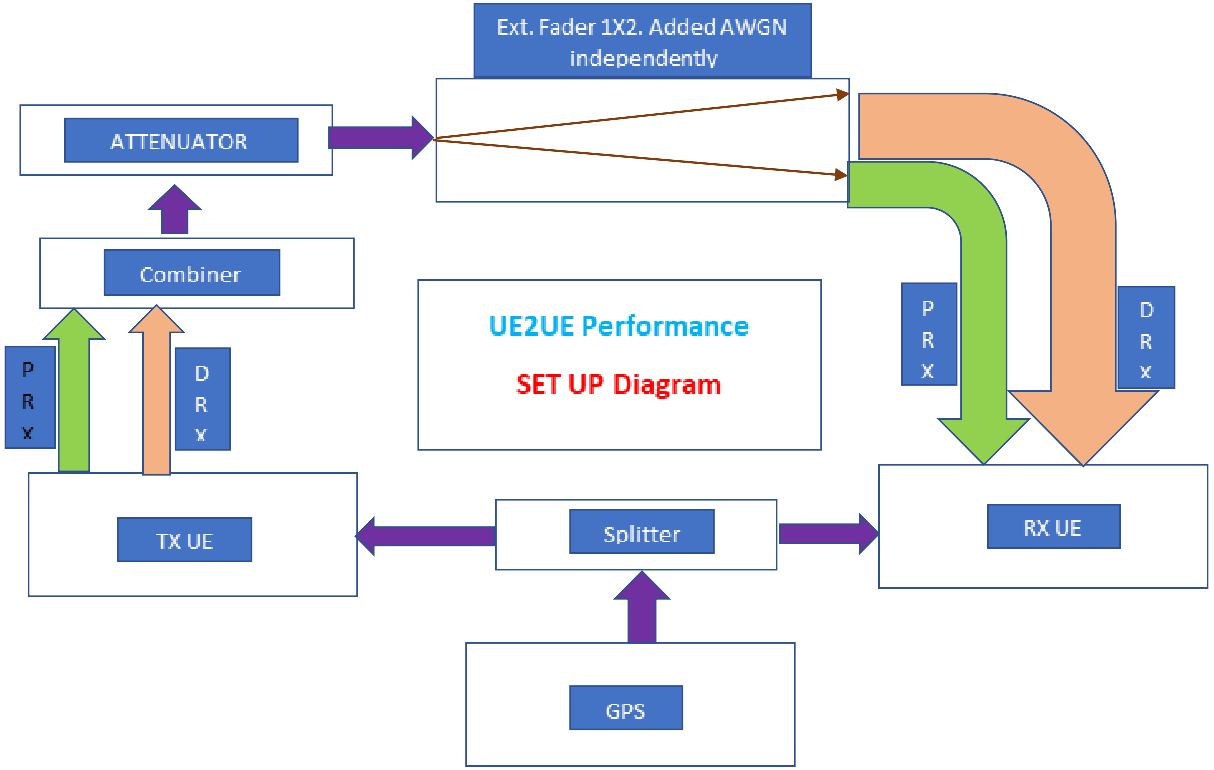
Technology benchmark summary

Congestion	**Lab** Cabled Congestion Control	Pass
Reliability	**Lab** Cabled Tx and Rx Tests	CV2X better
	Field Line-of-Sight (LOS) Range Tests	CV2X better
	Field Non-Line-of-Sight (NLOS) Range Tests	CV2X better
Interference	**Lab** Cabled Test with Simulated Co-channel Interference	CV2X better
	Lab Cabled Near-Far Test	Pass
	Field Co-existence with Wi-Fi 80 MHz Bandwidth in UNII-3	CV2X better
	Field Co-existing of V2X with Adjacent DSRC Carrier	Pass

CV2X radio technology consistently outperforms DSRC.

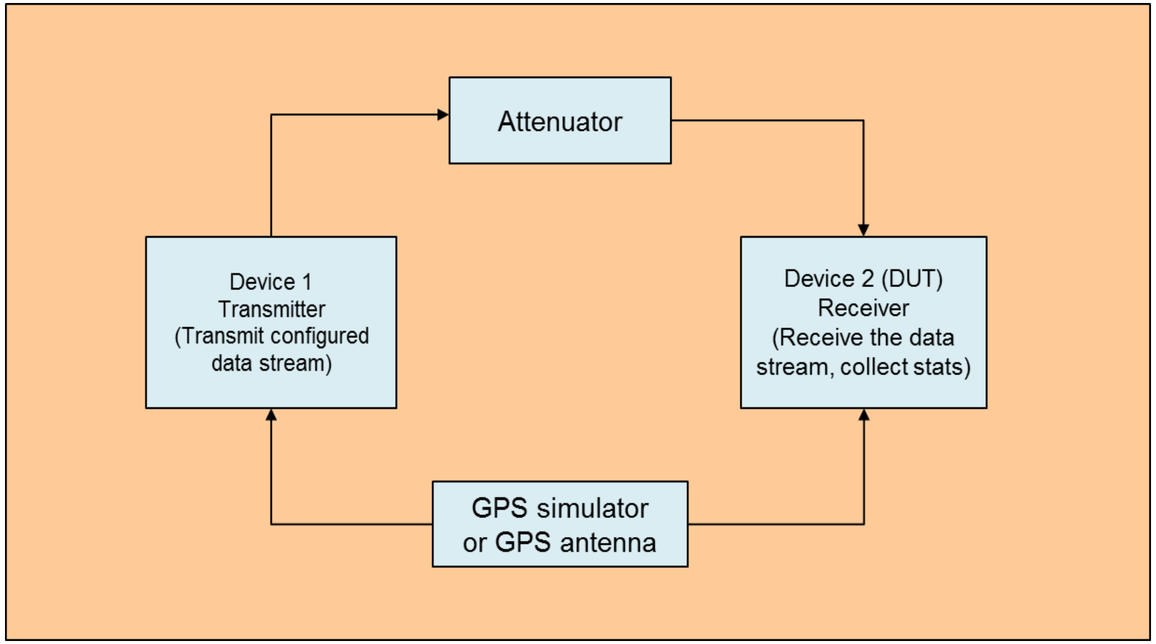
Backup

7.2.3 Cabled Transmission and Reception Test with added Channel Impairment (Setup)



Configuration	DSRC	C-V2X (PC5 Mode 4)
Channel	Channel 184	Channel 184
Bandwidth	10 MHz	10 MHz
Modulation	QPSK ½ (6 Mbps burst rate)	MCS5
Application Used	Savari	Savari
Tx/Rx Configuration	1 Tx 2 Rx	1 Tx 2 Rx
Device Details	Savari MW1000	Qualcomm Roadrunner platform
HARQ	NA	Enabled
Tx Power	20 dBm	20 dBm
Packet Size	193 Bytes	193 Bytes (5 Sub-Channels)*

7.2.2 Clean channel cabled transmission and reception test across power levels (Setup)



Configuration	DSRC	C-V2X (PC5 Mode 4)
Channel	Channel 184	Channel 184
Bandwidth	10 MHz	10 MHz
Modulation	QPSK ½ (6 Mbps burst rate)	MCS5
Application Used	Savari	Savari
Tx/Rx Configuration	1 Tx 2 Rx	1 Tx 2 Rx
Device Details	Savari MW1000	Qualcomm Roadrunner platform
HARQ	NA	Enabled
Tx Power	20 dBm	20 dBm
Packet Size	193 Bytes	193 Bytes (5 Sub-Channels)*

Appendix C –Proposed FCC Rule Revisions

PART 2—FREQUENCY ALLOCATIONS AND RADIO TREATY MATTERS; GENERAL RULES AND REGULATIONS

Subpart B—Allocation, Assignment, and Use of Radio Frequencies

Section 2.106 is amended by modifying footnote US160 to the Table of Frequency Allocations to read as follows:

§2.106 Table of Frequency Allocations.

NG160 In the band 5850-5925 MHz, the use of the non-Federal mobile service is limited to Dedicated Short Range Communications and Cellular Vehicle to Everything (C-V2X) Communications operating in the Intelligent Transportation System radio service.

NOTE: The modification to NG160 would permit C-V2X to operate as part of the Intelligent Transportation System service.

PART 90—PRIVATE LAND MOBILE RADIO SERVICES

Subpart A—GENERAL INFORMATION

Section 90.7 is amended by modifying or adding the following definitions:

§90.7 Definitions.

Cellular Vehicle to Everything (C-V2X) Communications Services. The use of cellular radio techniques defined by the 3rd Generation Partnership Program to transfer data between roadside and mobile units, between mobile units, and between portable and mobile units to perform operations related to the improvement of traffic flow, traffic safety, and other intelligent transportation service applications in a variety of environments. C-V2X systems may also transmit status and instructional messages related to the units involved.

On-Board unit (OBU). An On-Board Unit is a DSRCS or C-V2X transceiver that is normally mounted in or on a vehicle, or which in some instances may be a portable unit. An OBU can be operational while a vehicle or person is either mobile or stationary. The OBUs receive and transmit on one or more radio frequency (RF) channels. Except where specifically excluded, OBU operation is permitted wherever vehicle operation or human passage is permitted. The OBUs mounted in vehicles are licensed by rule under part 95 of this chapter and communicate with Roadside Units (RSUs) and other OBUs. Portable OBUs are also licensed by rule under part 95 of this chapter. OBU operations in the Unlicensed National Information Infrastructure (UNII) Bands follow the rules in those bands.

Roadside unit (RSU). A Roadside Unit is a DSRC or C-V2X transceiver that is mounted along a road or pedestrian passageway. An RSU may also be mounted on a vehicle or is hand carried, but it may only operate when the vehicle or hand-carried unit is stationary. Furthermore, an RSU operating under this part is restricted to the location where it is licensed to operate. However, portable or hand-held RSUs are permitted to operate where they do not interfere with a site-licensed operation. A RSU broadcasts data to or exchanges data with OBUs.

Roadway bed surface. For DSRCS or C-V2X, the road surface at ground level.

NOTE: The definition for C-V2X is added, while the definitions for OBU, RSU, and Roadway bed surface are modified to add C-V2X under the same conditions as DSRC.

Subpart G—APPLICATIONS AND AUTHORIZATIONS

Section 90.149 is amended to read as follows:

§90.149 License term.

(a) Except as provided in subpart R of this part, licenses for stations authorized under this part will be issued for a term not to exceed ten (10) years from the date of the original issuance or renewal.

(b) Non-exclusive geographic area licenses for DSRCS or C-V2X Roadside Units (RSUs) in the 5850-5925 MHz band will be issued for a term not to exceed ten years from the date of original issuance or renewal. The registration dates of individual RSUs (see §90.375) will not change the overall renewal period of the single license.

NOTE: §90.149(b) is modified to add C-V2X under the same conditions as DSRC.

Section 90.155 is amended to read as follows:

§90.155 Time in which station must be placed in operation.

*****

(i) DSRCS or C-V2X Roadside Units (RSUs) in the 5850-5925 MHz band must be placed in operation within 12 months from the date of registration (see §90.375) or the authority to operate the RSUs cancels automatically (see §1.955 of this chapter). Such registration date(s) do not change the overall renewal period of the single license. Licensees must notify the Commission in accordance with §1.946 of this chapter when registered units are placed in operation within their construction period.

NOTE: §90.155(i) is modified to add C-V2X under the same conditions as DSRC.

Subpart H—POLICIES GOVERNING THE ASSIGNMENT OF FREQUENCIES

Section 90.175 is amended to read as follows:

§90.175 Frequency coordinator requirements.

Except for applications listed in paragraph (j) of this section, each application for a new frequency assignment, for a change in existing facilities as listed in §90.135(a), or for operation at temporary locations in accordance with §90.137 must include a showing of frequency coordination as set forth further.

*****

(j) The following applications need not be accompanied by evidence of frequency coordination:

*****

(16) Applications for DSRCS or C-V2X licenses (as well as registrations for Roadside Units) in the 5850-5925 GHz band.

*****

NOTE: §90.175(j)(16) is modified to add C-V2X under the same conditions as DSRC.

Section 90.179 is amended to read as follows:

§90.179 Shared use of radio stations.

*****

(f) Above 800 MHz, shared use on a for-profit private carrier basis is permitted only by SMR, Private Carrier Paging, LMS, DSRCS, and C-V2X licensees. See subparts M, P, and S of this part.

NOTE: §90.179(f) is modified to add C-V2X under the same conditions as DSRC.

Subpart I—GENERAL TECHNICAL STANDARDS

Section 90.210 is amended to read as follows:

§90.210 Emission masks.

Except as indicated elsewhere in this part, transmitters used in the radio services governed by this part must comply with the emission masks outlined in this section. Unless otherwise stated, per paragraphs (d)(4), (e)(4), and (o) of this section, measurements of emission power can be expressed in either peak or average values provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth. Unless indicated elsewhere in this part, the table in this section specifies the emission masks for equipment operating under this part.

Applicable Emission Masks

Frequency band (MHz)	Mask for equipment with audio low pass filter	Mask for equipment without audio low pass filter
*****	*****	*****
5850-5925[4]		
*****	*****	*****

*****

[4]DSRCS and C-V2X Roadside Units equipment in the 5850-5925 MHz band is governed under subpart M of this part.

*****

NOTE: §90.210 is modified to add C-V2X under the same conditions as DSRC.

Section 90.213 is amended to read as follows:

§90.213 Frequency stability.

(a) Unless noted elsewhere, transmitters used in the services governed by this part must have a minimum frequency stability as specified in the following table.

*****

[10]Except for DSRCS and C-V2X equipment in the 5850-5925 MHz band, frequency stability is to be specified in the station authorization. Frequency stability for DSRCS and C-V2X equipment in the 5850-5925 MHz band is specified in subpart M of this part.

*****

NOTE: §90.213 is modified to add C-V2X under the same conditions as DSRC.

Subpart M—Intelligent Transportation Systems Radio Service

Section 90.350 is amended to read as follows:

§90.350 Scope.

The Intelligent Transportation Systems radio service is for the purpose of integrating radio-based technologies into the nation's transportation infrastructure and to develop and implement the nation's intelligent transportation systems. It includes the Location and Monitoring Service (LMS), the Dedicated Short Range Communications Service (DSRCS), and the Cellular Vehicle to Everything (C-V2X) Service. Rules as to eligibility for licensing, frequencies available, and any special requirements for services in the Intelligent Transportation Systems radio service are set forth in this subpart.

NOTE: §90.350 is modified to add C-V2X under the same conditions as DSRC.

The subtitle for DSRCS is modified to read as follows:

Regulations Governing the Licensing and Use of Frequencies in the 5850-5925 MHz Band for Dedicated Short-Range Communications Service (DSRCS) and Cellular Vehicle to Everything (C-V2X) Service.

Section 90.371 is amended to read as follows:

§90.371 Dedicated short range communications service and Cellular Vehicle to Everything Service.

(a) These provisions pertain to systems in the 5850-5925 MHz band for Dedicated Short-Range Communications Service (DSRCS) and Cellular Vehicle to Everything (C-V2X) Service. DSRCS and C-V2X systems use radio techniques to transfer data over short distances between roadside and mobile units, between mobile units, and between portable and mobile units to perform operations related to the improvement of traffic flow, traffic safety, and other intelligent transportation service applications in a variety of environments. DSRCS and C-V2X systems may also transmit status and instructional messages related to the units involved. DSRCS and C-V2X Roadside Units are authorized under this part. DSRCS and C-V2X On-Board Units are authorized under part 95 of this chapter.

(b) DSRCS and C-V2X Roadside Units (RSUs) operating in the band 5850-5925 MHz shall not receive protection from Government Radiolocation services in operation prior to the establishment of the DSRCS or C-V2X station. Operation of DSRCS or C-V2X RSU stations within 75 kilometers of the locations listed in the table below must be coordinated through the National Telecommunications and Information Administration.

Location	Latitude	Longitude
Ft. Lewis, WA	470525N	1223510W
Yakima Firing Center, WA	464018N	1202135W
Ft. Carson, CO	383810N	1044750W
Ft. Riley, KS	385813N	0965139W
Ft. Shafter, HI	211800N	1574900W
Hunter Army Airfield, GA	320100N	0810800W
Ft. Gillem, GA	333600N	0841900W
Ft. Benning, GA	322130N	0845815W

Ft. Stewart, GA	315145N	0813655W
Ft. Rucker, AL	311947N	0854255W
Yuma Proving Grounds, AZ	330114N	1141855W
Ft. Hood, TX	310830N	0974550W
Ft. Knox, KY	375350N	0855655W
Ft. Bragg, NC	350805N	0790035W
Ft. Campbell, KY	363950N	0872820W
Ft. Polk, LA	310343N	0931226W
Ft. Leonard Wood, MO	374430N	0920737W
Ft. Irwin, CA	351536N	1164102W
Ft. Sill, OK	344024N	0982352W
Ft. Bliss, TX	314850N	1062533W
Ft. Leavenworth, KS	392115N	0945500W
Ft. Drum, NY	440115N	0754844W
Ft. Gordon, GA	332510N	0820910W
Ft. McCoy, WI	440636N	0904127W
Ft. Dix, NJ	400025N	0743713W
Parks Reserve Forces Training Area, CA	374254N	1214218W
Ft. Hunter Ligget, CA	355756N	1211404W
Pacific Missile Test Center, CA	340914N	1190524W
Naval Air Development Center, PA	401200N	0750500W
Mid-Atlantic Area Frequency Coordinator, MD	381710N	0762500W
Naval Research Laboratory, MD	383927N	0763143W
Naval Ocean Systems Center, CA	324500N	1171000W
Naval Research Laboratory, DC	385500N	0770000W
Naval Surface Weapons Center, MD	390205N	0765900W
Naval Electronic Systems Engineering Activity, MD	381000N	0762300W
Midway Research Center, VA	382640N	0772650W
Aberdeen Proving Ground, MD	392825N	0760655W
Ft. Huachuca, AZ	313500N	1102000W

Ft. Monmouth, NJ	401900N	0740215W
Picatinny Arsenal, NJ	405600N	0743400W
Redstone Arsenal, AL	343630N	0863610W
White Sands Missile Range, NM	322246N	1062813W
Army Research Laboratory, MD	390000N	0765800W
Space and Missile Systems Center, CA	335500N	1182200W
Edwards AFB, CA	345400N	1175200W
Patrick AFB, FL	281331N	0803607W
Eglin AFB, FL	302900N	0863200W
Holloman AFB, NM	322510N	1060601W
Kirtland AFB, NM	350230N	1063624W
Griffiss AFB, NY	431315N	0752431W
Wright-Patterson AFB, OH	394656N	0840539W
Hanscom AFB, MA	422816N	0711725W
Nellis AFB, NV	361410N	1150245W
Vandenberg AFB, CA	344348N	1203436W
U.S. Air Force Academy, CO	385800N	1044900W
Brooks AFB, TX	292000N	0982600W
Arnold AFB, TN	352250N	0860202W
Tyndall AFB, FL	300412N	0853436W
Charles E. Kelly Support Facility—Oakdale, PA	402357N	0800925W

(c) NTIA may authorize additional Government Radiolocation services. Once a new Federal assignment is made, the Commission's Universal Licensing System database will be updated, accordingly, to protect the new Federal assignment and the list in paragraph (b) of this section will be updated as soon as practicable.

NOTE: §90.371 is modified to add C-V2X under the same conditions as DSRC.

Section 90.373 is amended to read as follows:

§90.373 Eligibility in the DSRCS and C-V2X.

The following entities are eligible to hold an authorization to operate Roadside units in the DSRCS or C-V2X:

(a) Any territory, possession, state, city, county, town or similar governmental entity.

(b) Any entity meeting the eligibility requirements of §§90.33 or 90.35.

NOTE: §90.373 is modified to add C-V2X under the same conditions as DSRC.

Section 90.375 is amended to read as follows:

§90.375 RSU license areas, DSRC communication zones, C-V2X power levels and RSU registrations

(a) DSRCS and C-V2X Roadside Units (RSUs) in the 5850-5925 MHz band are licensed on the basis of non-exclusive geographic areas. Governmental applicants will be issued a geographic area license based on the geo-political area encompassing the legal jurisdiction of the entity. All other applicants will be issued a geographic area license for their proposed area of operation based on county(s), state(s) or nationwide.

(b) DSRC applicants who are approved in accordance with FCC Form 601 will be granted non-exclusive licenses for all non-reserved DSRCS frequencies (see §90.377).

(c) C-V2X applicants who are approved in accordance with FCC Form 601 will be granted non-exclusive licenses for all non-reserved C-V2X frequencies (see §90.377).

(d) Such licenses serve as a prerequisite of registering individual RSUs located within the licensed geographic area described in paragraph (a) of this section. Licensees must register each RSU in the Universal Licensing System (ULS) before operating such RSU. RSU registrations are subject, inter alia, to the requirements of §1.923 of this chapter as applicable (antenna structure registration, environmental concerns, international coordination, and quiet zones). Additionally, RSUs at locations subject to NTIA coordination (see §90.371(b)) may not begin operation until NTIA approval is received. Registrations are not effective until the Commission posts them on the ULS. It is the licensee's responsibility to delete from the registration database any RSUs that have been discontinued.

(e) DSRC licensees must operate each RSU in accordance with the Commission's Rules and the registration data posted on the ULS for such RSU. Licensees must register each RSU for the smallest communication zone needed (for the DSRC-based intelligent transportation systems application) using one of the following four communication zones:

RSU class	**Max. output power (dBm)[1]**	**Communications zone (meters)**
A	0	15
B	10	100

C	20	400
D	28.8	1000

[1]The ASTM-DSRC Standard is incorporated by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51 and approved by The Director of the Federal Register. Copies may be inspected at the Federal Communications Commission, 445 12th Street, SW., Washington, DC 20554 or National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.* Copies of the ASTM E2213-03 DSRC Standard[1] can be obtained from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. Copies may also be obtained from ASTM via the Internet at *http://www.astm.org.* The ASTM-DSRC Standard limits output power to 28.8 dBm but allows more power to overcome cable losses to the antenna as long as the antenna input power does not exceed 28.8 dBm and the EIRP does not exceed 44.8 dBm. However, specific channels and categories of uses have additional limitations under the ASTM-DSRC Standard.

(f) C-V2X licensees must operate each RSU in accordance with the Commission's Rules and the registration data posted on the ULS for such RSU. The maximum output power for each RSU is 20 dBm. This may be referenced to the antenna input, so cable losses are taken into account.

NOTE: §90.375 is modified to add C-V2X under the same conditions as DSRC, except §90.375 (f) is added to include the power limit for C-V2X stations.

Section 90.377 is amended to read as follows:

§90.377 Frequencies available; maximum EIRP and antenna height.

(a) DSRC Licensees shall transmit only the power (EIRP) needed to communicate with an On-Board Unit (OBU) within the communications zone and must take steps to limit the Roadside Unit (RSU) signal within the zone to the maximum extent practicable.

(b) Frequencies available for assignment to eligible applicants within the 5850-5925 MHz band for RSUs and the maximum EIRP permitted for an RSU with an antenna height not exceeding 8 meters above the roadway bed surface are specified in the table below.

Frequency range (MHz)	**Max. EIRP[1] (dBm)**	**Channel use**
5850-5855		Reserved.
5855-5865	33	DSRC Service Channel.[2]

[1] 5GAA notes that the ASTM E2213-03 DSRC Standard is obsolete. 5GAA is taking no position with regard to the DSRC rules, only proposing modifications to the rules to enable C-V2X operations in the 5.9 GHz ITS band.

5865-5905	33	C-V2X
5905-5925	33	C-V2X Service Channel.[3]

[1]An RSU may employ an antenna with a height exceeding 8 meters but not exceeding 15 meters provided the EIRP specified in the table above is reduced by a factor of 20 log(Ht/8) in dB where Ht is the height of the radiation center of the antenna in meters above the roadway bed surface. The EIRP is measured as the maximum EIRP toward the horizon or horizontal, whichever is greater, of the gain associated with the main or center of the transmission beam. The RSU antenna height shall not exceed 15 meters above the roadway bed surface.
[2]5855-5865 MHz is designated for DSRC public safety applications involving safety of life and property.
[3]5905-5925 MHz is designated for Basic C-V2X applications, which will support messages such as the Basic Safety Message, Signal Phase and Timing, Emergency Vehicle Alert, Probe Data Management, Probe Vehicle Data, Signal Request Message, Signal Status Message, Geometric Intersection Description, Traveler Information Message, & others encompassed by the Road Safety Message.

NOTE: §90.377 is modified to create a new band plan for the 5850-5925 MHz band that includes both DSRC and C-V2X operations. Both DSRC and C-V2X RSUs will be subject to the same antenna height limitations.

Section 90.379 is amended to read as follows:

§90.379 RSU technical standard

(a) DSRC Roadside Units operating in the 5850-5925 MHz band shall comply with the following technical standard, which is incorporated by reference: American Society for Testing and Materials (ASTM) E2213-03, "Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems—5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications" published September 2003 (ASTM E2213-03 DSRC Standard). The Director of the Federal Register approves this incorporation by reference in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies may be inspected at the Federal Communications Commission, 445 12th Street, SW., Washington, DC 20554 or National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html. Copies of the ASTM E2213-03 DSRC Standard can be obtained from ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959. Copies may also be obtained from ASTM via the Internet at http://www.astm.org.

(b) C-V2X Roadside Units operating in the 5850-5925 MHz band shall comply with the V2X sidelink service for this band as described in the ATIS transposed standards of the 3GPP specifications except where these rules and regulations take precedence. The published ATIS standards are available at: https://www.atis.org/docstore/default.aspx. The 3GPP specifications can be obtained at http://www.3gpp.org/specifications.

NOTE: §90.379 is modified to clarify that the ASTM E2213-03 standard applies only to DSRC stations, and that C-V2X stations will adhere to the ATIS standards.

Section 90.381 is added to read as follows:

§90.381 C-V2X emissions

C-V2X On-board Units must attenuate their emissions consistent with the limits shown below. Emission levels may be measured at the antenna input.

For use of the 20 MHz band from 5905 to 5925 MHz, C-V2X On-board Units shall not exceed:

Δf_{OOB} (MHz)	Frequency (MHz)	Emission Limit (dBm)	Measurement Bandwidth
-50	5855	-30	1 MHz
-40	5865	-53	100 kHz
-20	5885	-50	100 kHz
-10	5895	-40	100 kHz
-1	5904	-32	100 kHz
-0	5905	-29	100 kHz
0	5925	-29	100 kHz
1	5926	-32	100 kHz
10	5935	-40	100 kHz
20	5945	-50	100 kHz
40	5965	-53	100 kHz
50	5975	-30	1 MHz

For use of the 40 MHz band from 5865 to 5905 MHz, C-V2X On-board Units shall not exceed:

Δf_{OOB} (MHz)	Frequency (MHz)	Emission Limit (dBm)	Measurement Bandwidth
-100	5765	-30	1 MHz
-40	5825	-50	100 kHz
-20	5845	-43	100 kHz
-10	5855	-38	100 kHz
-2	5863	-36	100 kHz
-0	5865	-32	100 kHz
0	5905	-32	100 kHz
2	5907	-36	100 kHz
10	5915	-38	100 kHz

20	5925	-43	100 kHz
40	5945	-50	100 kHz
100	6105	-30	1 MHz

NOTE: §90.381 is added to provide C-V2X emission limits.

Section 90.383 is amended to read as follows:

§90.383 RSU sites near the U.S./Canada or U.S./Mexico border.

Until such time as agreements between the United States and Canada or the United States and Mexico, as applicable, become effective governing border area use of the 5850-5925 MHz band for DSRCS and C-V2X, authorizations to operate Roadside Units (RSUs) are granted subject to the following conditions:

(a) RSUs must not cause harmful interference to stations in Canada or Mexico that are licensed in accordance with the international table of frequency allocations for Region 2 (see §2.106 of this chapter) and must accept any interference that may be caused by such stations.

(b) Authority to operate DSRCS or C-V2X Roadside Units is subject to modifications and future agreements between the United States and Canada or the United States and Mexico, as applicable.

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NOTE: §90.383 is modified to add C-V2X under the same conditions as DSRC.

Subpart N—OPERATING REQUIREMENTS

Section 90.425 is amended to read as follows:

§90.425 Station identification.

Stations licensed under this part shall transmit identification in accordance with the following provisions:

*****

(d) General exemptions. A station need not transmit identification if:

*****

(10) It is a Roadside Unit in a DSRCS or a C-V2X system.

*****

NOTE: §90.425 is modified to add C-V2X under the same conditions as DSRC.

PART 95—PERSONAL RADIO SERVICES

The subtitle for DSRCS is modified to read as follows:

Subpart L—DSRCS and C-V2X On-Board Units

Section 95.3101 is amended to read as follows:

§95.3101 Scope.

This subpart contains rules that apply only to On-Board Units (OBUs) transmitting in the 5850-5925 MHz frequency band in the Dedicated Short-Range Communications Services (DSRCS) and the Cellular Vehicle to Everything (C-V2X) Service (see §90.371 of this chapter).

NOTE: §95.3101 is modified to add C-V2X under the same conditions as DSRC.

Section 95.3103 is amended by modifying or adding the following definitions:

§95.3103 Definitions, OBUs.

Cellular Vehicle to Everything (C-V2X) Service. A service providing for data transfer between various mobile and roadside transmitting units for the purposes of improving traffic flow, highway safety and performing other intelligent transportation functions. See §90.7 of this chapter for a more detailed definition.

On-Board Unit (OBU). OBUs are low-power devices on vehicles that transfer data to roadside units or other OBUs in the Dedicated Short-Range Communications Service or the Cellular Vehicle to Everything (C-V2X) Service (see §§90.371-90.383 of this chapter), to improve traffic flow and safety, and for other intelligent transportation system purposes. See §90.7 of this chapter for a more detailed definition.

NOTE: The definition for C-V2X is added, while the definition for OBU is modified to add C-V2X under the same conditions as DSRC.

Section 95.3159 is deleted in its entirety.

NOTE: §95.3159 is deleted to reflect the fact that all C-V2X communications can be accommodated under the new band plan due to the capabilities of C-V2X technology.

Section 95.3161 is amended to read as follows:

§95.3161 OBU transmitter certification.

(a) Each Dedicated Short Range Communications On-Board Unit (DSRCS-OBU) or Cellular Vehicle to Everything (C-V2X) On-Board Unit (C-V2X-OBU) that operates or is intended to operate in the DSRCS or C-V2X service must be certified in accordance with this subpart and subpart J of part 2 of this chapter.

(b) A grant of equipment certification for this subpart will not be issued for any OBU transmitter type that fails to comply with all of the applicable rules in this subpart.

NOTE: §95.3161 is modified to add C-V2X under the same conditions as DSRC.

Section 95.3163 is amended to read as follows:

§95.3163 OBU channels.

The following table lists the channels allotted for use by On-Board Units (OBUs):

Channel use	**Frequency range (MHz)**
Reserved	5850-5855
DSRC Service Channel	5855-5865
C-V2X	5865-5905
Basic C-V2X Service Channel	5905-5925

*****

NOTE: §95.3163 is modified to reflect the new band plan.

Section 95.3167 is amended to read as follows:

§95.3167 OBU transmit power limit.

The maximum output power for portable DSRC On-Board Unit transmitter types is 1.0 mW. The maximum output power for portable C-V2X On-Board Unit transmitter types is 20 dBm. This may be referenced to the antenna input, so that cable losses are taken into account. For purposes of this paragraph, a portable is a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user.

NOTE: §95.3167 is modified to add a power limit for C-V2X.

Section 95.3189 is amended to read as follows:

§95.3189 OBU technical standard.

(a) DSRC On-Board Unit transmitter types operating in the 5850-5925 MHz band must be designed to comply with the technical standard ASTM E2213-03, Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems—5 GHz Band Dedicated Short-range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications published 2003 (ASTM E2213-03). ASTM E2213-03 is incorporated by reference into this section with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Federal Communications Commission must publish a document in the Federal Register and the material must be available to the public. The material is available for inspection at the Federal Communications Commission, 445 12th Street SW., Washington, DC 20554 and may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.: http://www.astm.org. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030 or go to http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

(b) C-V2X On-Board Unit transmitter types operating in the 5850-5925 MHz band shall comply with the V2X sidelink service for this band as described in the ATIS transposed standards of the 3GPP specifications except where these rules and regulations take precedence. The published ATIS standards are available at: https://www.atis.org/docstore/default.aspx. The 3GPP specifications can be obtained at http://www.3gpp.org/specifications.

NOTE: §95.3189 is modified to clarify that the ASTM E2213-03 standard applies only to DSRC stations, and that C-V2X stations will adhere to the ATIS standards.

Section 95.3191 is added to read as follows:

§95.3191 C-V2X emissions

C-V2X On-board Units shall comply with the following emission limits, which may be measured at the antenna input.

For use of the 20 MHz band from 5905 to 5925 MHz, C-V2X On-board Units shall not exceed:

Δf_{OOB} (MHz)	Frequency (MHz)	Emission Limit (dBm)	Measurement Bandwidth
-50	5855	-30	1 MHz
-40	5865	-53	100 kHz
-20	5885	-50	100 kHz
-10	5895	-40	100 kHz
-1	5904	-32	100 kHz
-0	5905	-29	100 kHz
0	5925	-29	100 kHz

1	5926	-32	100 kHz
10	5935	-40	100 kHz
20	5945	-50	100 kHz
40	5965	-53	100 kHz
50	5875	-30	1 MHz

For use of the 40 MHz band from 5865 to 5905 MHz, C-V2X On-board Units shall not exceed:

Δf_{OOB} (MHz)	**Frequency (MHz)**	**Emission Limit (dBm)**	**Measurement Bandwidth**
-100	5765	-30	1 MHz
-40	5825	-50	100 kHz
-20	5845	-43	100 kHz
-10	5855	-38	100 kHz
-2	5863	-36	100 kHz
-0	5865	-32	100 kHz
0	5905	-32	100 kHz
2	5907	-36	100 kHz
10	5915	-38	100 kHz
20	5925	-43	100 kHz
40	5945	-50	100 kHz
100	6105	-30	1 MHz

NOTE: §90.3191 is added to provide C-V2X emission limits.