

**Before the  
US Department of Transportation  
Washington, D.C. 20554**

In the Matter of  
V2X Communications –“Notice of Request for Comments (RFC)”;  
Docket No. DOT-OST-2018-0210

To:  
Mr. Finch Fulton  
Deputy Assistant Secretary for Transportation Policy Office of the Secretary (OST)  
U.S. Department of Transportation (DOT)  
1200 New Jersey Avenue S.E.  
Washington, DC 20590

**COMMENTS OF IEEE 802**

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I. Introduction

IEEE 802 LAN/MAN Standards Committee (LMSC) is pleased to provide comments in the above-captioned proceeding.

IEEE 802 LMSC is a leading consensus-based industry standards body, producing standards for wireless networking devices, including wireless local area networks (“WLANs”), wireless specialty networks (“WSNs”), wireless metropolitan area networks (“Wireless MANs”), and wireless regional area networks (“WRANs”). We appreciate the opportunity to provide these comments to the Commission.

IEEE 802 is a committee of the IEEE Standards Association and Technical Activities, two of the Major Organizational Units of the Institute of Electrical and Electronics Engineers (IEEE). IEEE has about 420,000 members in about 190 countries and supports the needs and interests of engineers and scientists broadly. In submitting this document, IEEE 802 acknowledges and respects that other components of IEEE Organizational Units may have perspectives that differ from, or compete with, those of IEEE 802. Therefore, this submission should not be construed as representing the views of IEEE as a whole.<sup>1</sup>

## II. Answers to questions asked in the Request for Comments

1. *Please provide information on what existing or future technologies could be used for V2X communications, including, but not limited to, DSRC, LTE C-V2X and 5G New Radio. What are the advantages and disadvantages of each technology? What is the timeframe for deployment of technologies not yet in production? Please provide data supporting your position.*

Response:

As noted in the question, there are three known existing and future V2X technology families that are applicable to the 5.9 GHz band:

1. DSRC/IEEE NGV
2. LTE V2X (PC5)
3. New Radio (NR) V2X (PC5)

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<sup>1</sup> This document solely represents the views of the IEEE 802 LAN/MAN Standards Committee and does not necessarily represent a position of either the IEEE, the IEEE Standards Association or IEEE Technical Activities.

DSRC is specified in IEEE Std 802.11: initially in ASTM 2213-03 and the IEEE Std 802.11p-2010 amendment, and subsequently in the consolidated IEEE Std 802.11-2012 and IEEE Std 802.11-2016 standards. The IEEE 802.11p amendment, which specified “Wireless Access in Vehicular Environments,” introduced the term “outside the context of a basic service set OCB,” which is used within IEEE Std 802.11 to refer to the medium access control layer facilities used for DSRC.

Currently the IEEE 802.11 Working Group (WG) is specifying an evolution of DSRC called Next Generation V2X (NGV) in the IEEE P802.11bd amendment project (planned for completion in 2021).

IEEE 802 considers DSRC and NGV to be one unified IEEE V2X technology family because the NGV amendment is required by its authorization documentation to maintain interoperability, coexistence, backward compatibility, and fairness with DSRC (scope of NGV amendment and definition of terms are quoted in answer to Question 2 below).

By contrast, LTE V2X and NR V2X specify none of those relationships to DSRC – interoperability, coexistence, backward compatibility, or fairness. Furthermore, 3GPP has decided not to study same-channel coexistence of NR V2X and LTE V2X.<sup>2</sup>

DSRC is the incumbent technology in FCC V2X regulations (Part 90 Subpart M, Part 95 Subpart L). Furthermore, as US DOT has noted, there are more than 70 active deployments of DSRC today, and these deployments use all seven channels in the DSRC band<sup>3</sup>. Advantages and disadvantages of non-DSRC technologies are thus fundamentally a function of their relation to DSRC. IEEE 802 considers the NGV evolution to represent a positive development that achieves innovation without sacrificing interoperability. By contrast, LTE V2X and NR V2X are not able to achieve interoperability with DSRC or with each other. Given the ad hoc nature of direct V2X communication, interoperability is imperative. We think NGV has a significant advantage over these non-DSRC technologies.

2. *Of the V2X communications technologies previously discussed, at present only DSRC is permitted to be used in the 5.9 GHz spectrum band for transportation applications. If that allocation were to be changed to allow any communication technology for transportation*

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<sup>2</sup> See 3GPP TR 38.885 and 3GPP RP-182491

<sup>3</sup> “U.S. Department of Transportation’s National Highway Traffic Safety Administration issues statement on safety value of 5.9 GHz spectrum,” October 24, 2018

*applications, could DSRC and other technologies (e.g., C-V2X, 5G or any future technology) operate in the same spectrum band or even the same channel without interference? Why or why not? If there are any technical challenges to achieving this goal, what are they and how can they be overcome?*

Response:

It is only feasible for technologies other than DSRC to operate the 5.9 GHz spectrum without destructive interference and impairment of the safety functions if the other technologies are required to provide interoperability, coexistence, compatibility, and fairness with DSRC. Because the medium access control and physical layers of DSRC are specified in IEEE Std 802.11, the functional definitions of these terms are as follows: Interoperability means the ability of the DSRC devices to decode at least one mode of transmission by the other technology devices and of the other technology devices to decode DSRC transmissions. Coexistence means the ability of the other technology devices to detect and defer to transmissions by DSRC devices to avoid collisions, and vice versa. Compatibility means the ability of the other technology devices to operate in a mode that can exchange messages with DSRC devices. Fairness means that DSRC devices and other technology devices have the same opportunities to access the assigned channel of the wireless medium for safety communications. The other technologies proposed for use in the 5.9 GHz spectrum, including C-V2X and 5G, meet **none** of these requirements, hence are unable to operate without exclusion of, or serious impairment to, DSRC communication. Importantly, the IEEE 802.11 Working Group is currently developing its NGV (Next-Generation V2X) amendment (IEEE P802.11bd) that will fulfil **all** of these criteria for usage in conjunction with DSRC, thereby providing a seamless evolution path for DSRC V2X technology. Indeed, the scope statement for the P802.11bd amendment includes these specific requirements:

“This amendment shall provide interoperability, coexistence, backward compatibility, and fairness with deployed OCB (Outside the Context of a BSS) devices.” [Project Authorization Request P802.11bd (“Enhancements for Next Generation V2X”), approved 5 December 2018, which can be found at <https://development.standards.ieee.org/get-file/P802.11bd.pdf?t=99204200003>.]

In January 2019 the IEEE 802.11 Working Group affirmed these definitions by a unanimous (44-0) vote:

- ***Interoperability*** – *IEEE 802.11p devices to be able to decode at least one mode of transmission of IEEE P802.11bd devices, and IEEE P802.11bd devices to be able to decode IEEE 802.11p transmissions*
- ***Co-existence*** – *IEEE 802.11p devices to be able to detect IEEE P802.11bd transmissions (and hence defer from transmissions during IEEE P802.11bd transmissions causing collisions) and vice versa*
- ***Backward compatibility*** – *Ability of IEEE P802.11bd devices to operate in a mode in which they can interoperate with IEEE 802.11p devices*
- ***Fairness*** – *Ability of IEEE 802.11p devices to have the same opportunities as IEEE 802.11bd devices to access the channel*

[“TGbd agreed terminology and requirements”, January 17, 2019, IEEE 802.11 document 11-19-0202r1, which can be found at

<https://mentor.ieee.org/802.11/dcn/19/11-19-0202-01-00bd-tgbd-definitions-and-requirements.pptx>.]

Because P802.11bd devices will provide interoperability, coexistence, compatibility, and fairness with DSRC devices, not only in the same frequency band but also in the same channel, P802.11bd can be introduced with no band fragmentation and no loss of DSRC services. The Society of Automotive Engineers (SAE) DSRC Technical Committee recently communicated to the IEEE 802.11 NGV Task Group to state that the combination of a capability for interoperability and fair, same-channel coexistence “form the basis for a seamless evolution strategy from IEEE 802.11p [DSRC] to IEEE 802.11 NGV and beyond.” [SAE DSRC Technical Committee, “Response to IEEE 802.11 Next Generation V2X Study Group (NGV SG) Liaison Request”, November 28, 2018, IEEE 802.11 document 11-18-2097r0, which can be found at <https://mentor.ieee.org/802.11/dcn/18/11-18-2097-00-0000-2018-12-liaison-from-sae-dsrc-tc-re-ngv-use-cases-and-requirements.docx>.]

3. *To what extent is it technically feasible for multiple V2X communications technologies and protocols to be interoperable with one another? Why or why not? Can this be done in a way that meets the performance requirements for safety of life applications, as they were discussed in the V2V NPRM? What additional equipment would be needed to achieve interoperability or changes in standards and specifications? What is the projected cost of any necessary changes? How soon can these changes and equipment prototypes be available for testing?*

Response:

Interoperability between multiple V2X communications protocols is feasible only if the additional protocols are specifically architected to provide such interoperability, which requires the newer/secondary protocol(s) to include a mandatory operating mode to transmit and receive messages that can be decoded by the older/primary protocol(s) as well as a mechanism by which the protocol capabilities of the various devices within communication range can be determined. Without this degree of protocol interoperability, multiple V2X technologies can, at best, achieve only coexistence (wherein transmissions by the two protocols do not collide with each other). Achieving said coexistence requires equipping each vehicle with two (or more) radios, which increases cost, and may reduce reliability. Furthermore, a requirement for multiple radios would impair the safety of life applications by reducing the adoption of V2X technologies by the transportation industry.

Any non-DSRC V2X technology needs to be interoperable with DSRC. The IEEE 802.11 Working Group is currently developing its NGV (Next-Generation V2X) amendment (IEEE P802.11bd) that is specifically designed to provide the required interoperability with DSRC, along with coexistence, backward compatibility, and fairness. Accordingly, IEEE P802.11bd will be a V2X technology that can be deployed as an enhancement to DSRC.

4. *To what extent is it technically feasible for different generations of the same V2X communications technologies and protocols to be interoperable with one another? Why or why not? Can this be done in a way that meets the performance requirements for*

*safety of life applications? What additional equipment or changes in standards and specifications would be needed to achieve interoperability? What is the projected cost of any necessary changes?*

Response:

As is typical for 802.11 generations, P802.11bd data rates will be a superset of the existing DSRC data rates. As such, in all scenarios the previous generation devices can communicate with later generation of devices. For the case of the later generation communicating with the previous generation, this is a decision made by the device on a packet by packet basis. The expectation is that the application will take this architecture in consideration when it is designed. Applications can be designed to fully interoperate at all times, they can be designed to only interoperate with a later generation, or they can be designed to selectively choose the rate based on various input. One such input has already been designed by the P802.11bd task group and allows any later generation device to be informed about the generational capabilities of the nearby vehicle population.

IEEE P802.11bd will have these intergenerational interoperability capabilities available for use by upper layer applications including safety of life applications. At a minimum, the DSRC rates, which will form a subset of P802.11bd and have proven to meet the requirements of current safety of life applications, will continue to be available. The addition of later generation P802.11bd rates will only improve performance. Performance improvement is already being studied in two different dimensions. First is longer range to increase the distance at which data can be sent, and second is increased robustness to things like higher vehicle speed and non-line-of-sight reflections.

There should be no incremental cost to add interoperability to the later generation P802.11bd because by definition the later generation is a superset of the data-rates and technology in DSRC. There may be small adjustments to the application layer standards to take advantage of both new rates, and interoperability features. This could be as simple as specifying a certain data transmission rate for a certain application (which is already done by SAE J2945/1 for example), or it could involve more complicated designs that take

advantage of the wider range of data-rates and MCS (modulation and coding schemes) available in P802.11bd.

5. *Even if they are interoperable across different technologies and generations of the same technology, would there be advantages if a single communications protocol were to be used for V2V safety communications? What about other V2X safety applications, such as those involving V2I and V2P communications?*

Response:

IEEE 802 does not have comments at this time.

6. *How would the development of alternative communication technologies affect other V2I and V2P communications, such as those supporting mobility or environmental applications? Do these applications have the same or different interoperability issues as V2V safety communications? Do different V2X applications (e.g., platooning) have different communication needs, particularly latency?*

Response:

IEEE 802 does not have comments at this time.

7. *Do different communication technologies present different issues concerning physical security (i.e., how to integrate alternative communication technologies into vehicle systems), message security (i.e., SCMS design or other approaches), or other issues such as cybersecurity or privacy? Would these concerns be affected if multiple but still interoperable communication technologies are used rather than one?*

Response:

V2X systems that involve direct communication such as DSRC and IEEE NGV as well as



3GPP LTE PC5 mode 4 operating in the 5.9 GHz band are typically designed with the same message security formats and Security Credential Management System (SCMS). One can refer to the work in IEEE 1609.2 on the subject of V2X security, both published standards and current projects.

The privacy provided by the DSRC system involves design requirements that apply to all layers of the stack, as well as interaction between the layers. This is supported by ensuring features in IEEE 802.11, IEEE 1609, and the application layers are all synchronized. If integrating newer generations of radio or alternative radio technologies, care needs to be taken to ensure that identities and privacy aren't compromised.

In addition, we assert that if multiple V2X technologies are employed, some privacy may be compromised if vehicle characteristics (e.g. manufacturer, model) can be inferred from the choice of V2X transmission protocols.

8. *How could communications technologies (DSRC, C-V2X, 5G or some other technology) be leveraged to support current and emerging automated vehicle applications? Will different communication technologies be used in different ways? How?*

Response:

IEEE 802 does not have comments at this time.

9. *How could deployments, both existing and planned, assess communications needs and determine which technologies are most appropriate and whether and how interoperability could be achieved?*

Response:

There are two requirements for deployment of an interoperable technology with enhanced capabilities, relative to DSRC. The first is the ability of the enhanced technology stations to

transmit and receive DSRC frames so that they can communicate directly with the stations which only support DSRC. The second is for the enhanced communication protocol to include a means by which the enhanced stations can detect and distinguish the capabilities of the other stations in their vicinity. If these requirements are met, as they will be for IEEE P802.11bd, there is full interoperability, and the decisions regarding the most appropriate technologies can be made dynamically by each transmitting station, based on the capabilities of the intended recipient station(s) and the population of other nearby stations.

### III. Conclusion

IEEE 802 LMSC would like to thank the US Department of Transportation for the opportunity to respond to their consultation on V2X.

Regards,

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