Before the

Federal Communications Commission

Washington, D.C. 20554

In the Matter of	)	
	)	
Petition for Waiver to Allow Deployment of	)	GN Docket 18-357
Intelligent Transportation System Cellular	)	
Vehicle to Everything (C-V2X) Technology	)	

Ex Parte OF IEEE 802

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I. Introduction

IEEE 802 LAN/MAN Standards Committee (LMSC) is pleased to provide a response in the above-captioned proceeding to the *ex parte* from 5GAA dated 05 April 2019.

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.[1]

The IEEE Std 802.11p-2010 amendment, now incorporated into IEEE Std 802.11-2016, provides core technology for Dedicated Short Range Communication (DSRC). The term "OCB" (outside the context of a BSS) was introduced in IEEE 802.11p, which specified "Wireless Access in Vehicular Environments". The OCB specifications within IEEE Std 802.11 continue to support DSRC-compatible operation.

The IEEE 802.11 Working Group (WG) is now specifying an IEEE Next Generation V2X (NGV) amendment the P802.11bd project. As described below, the IEEE NGV amendment is intended to provide a seamless evolution path from DSRC in the 5.9 GHz DSRC band. Any consideration of the rules governing use of the 5.9 GHz band must recognize the societal value of allowing DSRC and IEEE NGV to operate together throughout the band.

II. Current deployments are using the entire band

As the US Department of Transportation noted, in October 2018 there were already more than 70 active DSRC deployments, using all seven channels and with thousands of vehicles on the road[2]. IEEE 802 believes that allowing automakers and infrastructure owner-operators to evolve their deployments to NGV over time will protect past and future investments in DSRC, providing a critical incentive for additional deployment of these life-saving technologies. As outlined below, we are concerned that alternative deployment models, like that advocated by 5GAA, will undermine existing investments and discourage widespread deployment of V2X technology.

[1] 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.

[2] U.S. Department of Transportation's National Highway Traffic Safety Administration issues statement on safety value of 5.9 GHz spectrum, October 24, 2018, https://www.nhtsa.gov/press-releases/us-department-transportations-national-highway-traffic-safety-administration-issues

III. Contrasting visions of technology evolution and the value of interoperability

The 5GAA *ex parte* clarifies the vision of evolution for V2X technology that was initially articulated in the 5GAA waiver request. IEEE 802 has adopted a quite different vision for V2X technology evolution, and we think it is important for the Commission to be fully aware of the contrasts between the 5GAA and IEEE 802 visions, and of the implications of those contrasts, as it considers the future of the 5.9 GHz DSRC band.

IV. Definitions:

To facilitate this discussion, we offer specific definitions of key terms. These definitions describe various relationships between IEEE 802.11p devices and IEEE P802.11bd devices (also known as DSRC and IEEE NGV devices, respectively). While these definitions are for devices implementing the DSRC and NGV technologies, they may also be applied more generally to analyze the relationship between other V2X technologies. These definitions are agreed[3] within IEEE 802.11 TGbd (the task group developing the IEEE P802.11bd NGV amendment):

- **Interoperability –** IEEE 802.11p devices to be able to decode at least one mode of transmission of IEEE 802.11bd devices, and IEEE 802.11bd devices to be able to decode IEEE 802.11p transmissions
- **Co-existence** – IEEE 802.11p devices to be able to detect IEEE 802.11bd transmissions (and hence defer from transmissions during IEEE 802.11bd transmissions causing collisions) and vice versa
- **Backward compatibility** – Ability of IEEE 802.11bd 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

V. IEEE 802 vision of V2X technology evolution:

The IEEE 802 vision for V2X technology evolution is documented in the approved Project Authorization Request for the IEEE NGV amendment[4], which requires that:

[3] "TGbd agreed terminology and requirements," IEEE 802.11 document 11-19-0202/r1, which can be found at https://mentor.ieee.org/802.11/dcn/19/11-19-0202-01-00bd-tgbd-definitions-and-requirements.pptx, January 2019

[4] "P802.11bd Project Authorization Request", https://development.standards.ieee.org/get-file/P802.11bd.pdf?t=99204200003, December 2018

> "This amendment shall provide interoperability, coexistence, backward compatibility, and fairness with deployed OCB (Outside the Context of a BSS) devices."[5]

In other words, IEEE next generation V2X technology (NGV) will have fair same-channel coexistence with DSRC and will be interoperable and backward compatible with DSRC.

Furthermore, this vision is extensible to further generations. A future extension of IEEE 802.11p and IEEE P802.11bd will also be able to achieve fair, same-channel co-existence, interoperability, and backward compatibility with previous generations. Backward compatibility across generations of IEEE 802.11 technology is fundamentally based on use of a common packet preamble and channel access mechanism.

The IEEE 802 vision of V2X technology evolution ensures that investments in DSRC are protected over the long lifetimes of automotive on-board units (OBUs) and roadside units (RSUs). This protection is critical for encouraging DSRC deployments today and in the near future. By contrast, any proposals that threaten to impair these investments will discourage deployment and delay the realization of societal benefits from this spectrum.

VI. 5GAA vision of V2X technology evolution:

By contrast, the 5GAA vision for technology evolution appears to be that none of these attributes will apply between two V2X technologies or two generations of the same technology. LTE V2X PC5 has been specified in a way that it does not achieve fair same-channel coexistence with incumbent DSRC technology, nor does it interoperate with DSRC, nor is it backward compatible with DSRC.

3GPP is now specifying a new generation of cellular V2X (i.e. New Radio, NR). The study item phase of NR V2X PC5 is complete and the terms for the specification phase have been agreed. It is now clear that NR V2X PC5 will fail to achieve any of these key evolution characteristics not only with DSRC but also with the previous generation cellular V2X (LTE V2X PC5). To be clear, NR V2X PC5 will not be able to coexist in the same channel, interoperate, or be backward compatible with LTE V2X PC5.

VII. Implications of different evolution models:

[5] OCB is a type of communication introduced for DSRC in the IEEE 802.11p-2010 amendment.

The 5GAA V2X technology evolution model implies a high societal cost, a cost that is completely avoided in the IEEE 802 V2X evolution model. The 5GAA model implies that V2X spectrum must be fragmented into sub-bands associated with every different V2X technology. The 5GAA waiver request indicated a two-fragment requirement, with 50 MHz for DSRC and 20 MHz dedicated to LTE V2X PC5. In the new 5GAA *ex parte*, in recognition that NR V2X PC5 cannot coexist with the technologies in either of those sub-bands, 5GAA requests a three-fragment band, with only 10 MHz for incumbent DSRC, with 40 MHz for the yet-to-be-specified NR V2X PC5, and with 20 MHz for LTE V2X PC5. Presumably, as 3GPP introduces future generations under the 5GAA evolution vision, additional fragmentation of the 5.9 GHz band will be required, or new V2X spectrum will need to be allocated.

Band fragmentation carries significant costs. First, it disrupts the Commission's vision of uniformly interoperable communication among all V2X devices based on a single technology family. With multiple non-interoperable technologies operating in different sub-bands, some devices will not be able to communicate with others. For example, if two automakers choose different technologies and different sub-bands for sending Basic Safety Messages (BSMs), vehicle collisions that could have been prevented if those BSMs were successfully exchanged will not be prevented, leading to unnecessary loss of life and property. Many vehicles are already equipped to send BSMs with DSRC. The 5GAA proposal would allow some automakers to send BSMs using only LTE V2X PC5 or only NR V2X PC5. So, this loss of interoperability and attendant increase in road fatalities is a direct result of the fragmentation evolution model. This also extends to all other use cases supported by DSRC and by non-interoperable cellular V2X technologies. V2X evolution under the IEEE 802 model does not suffer this cost. Every vehicle will be interoperable with every other vehicle, whether the vehicles are DSRC-capable or NGV-capable.

A second cost of band fragmentation is inefficient use of spectrum. As noted, the 5GAA proposal is to duplicate some V2X use cases in both the DSRC channels and in one or both C-V2X sub-bands. For example, under existing Commission rules, all BSMs can be sent in one 10 MHz DSRC channel. Under the 5GAA proposal, BSMs will occupy at least 30 MHz of the spectrum (10 MHz for DSRC, 20 MHz for LTE V2X). This duplication necessarily limits the capacity of the band to support other important V2X use cases, such as cooperative automated driving. Efficient use of this valuable spectrum is a key responsibility for the Commission and all stakeholders. The 5GAA proposal uses the spectrum inefficiently. V2X evolution under the IEEE

802 model does not suffer this cost. There is no band fragmentation, so services never need to be duplicated in different sub-bands.

Furthermore, the 5GAA evolution model leads to a second form of spectral inefficiency by requiring that all LTE V2X BSMs are sent twice, regardless of the level of congestion in the LTE V2X channel.[6] LTE V2X apparently requires this packet duplication to achieve an acceptable reliability of delivery. Scheduling of transmissions in LTE V2X uses a periodic model, which also leads to periodic semi-persistent packet collisions. Neither DSRC nor NGV uses a periodic time slot schedule reservation, so DSRC and NGV packets do not experience persistent collisions and do not require duplicated transmissions in order to achieve highly reliable delivery. Duplicated packet transmissions in LTE V2X are another form of spectral inefficiency, as evidenced by the fact that 5GAA has requested 20 MHz for the channel that would carry BSMs, in contrast to the 10 MHz channel needed for BSMs in the DSRC/NGV model.

A final cost of the band-fragmentation model is in monetary investment by stakeholders. An automaker or infrastructure owner-operator may be compelled to invest in three different radio technologies in the future: DSRC/NGV plus LTE V2X plus NR V2X. These technologies all need to be active at the same time in different sub-bands, for example to receive a DSRC/NGV BSM on one channel, to receive an LTE V2X BSM on another channel, and to participate in some other service in the NR V2X sub-band. In other words, three distinct radio functions are needed. It is apparent that stakeholders are quite sensitive to cost in a voluntary deployment regulatory environment. In this sense, the IEEE 802 V2X evolution model that requires just one V2X technology per device is more likely to optimize the societal benefits of the band than the 5GAA evolution model that requires investment in three radio technologies.

In summary, the V2X technology evolution model promoted by IEEE 802 is much more favourable to deployment than the vision of 5GAA. The IEEE 802 vision includes fair, same-channel coexistence, interoperability, and backward compatibility. The 5GAA model lacks these properties, even among the different generations of cellular V2X. The IEEE 802 vision allows for a single wholistic band, in which all radios can interoperate in any channel. The 5GAA model leads directly to band fragmentation to accommodate multiple incompatible technologies, with

[6] This duplicated transmission of BSMs is specified in the draft SAE J3161 standard, “On-Board System Requirements for LTE V2X V2V Safety Communications”, April 2019

three fragments proposed now and additional fragments possibly needed in the future. The IEEE 802 vision of V2X evolution maximizes societal benefits from the 5.9 GHz band:

- by ensuring uniform interoperability among all devices,
- by avoiding duplication of services in different channels,
- by obviating the need for duplicate transmissions of the same packet, and
- by keeping costs low through the employment of a single technology (DSRC or NGV) in each vehicle OBU or infrastructure RSU.

The 5GAA model of band-fragmentation has none of these advantages and creates significant societal costs

VIII. Conclusion

Considering the points mentioned above, we therefore ask the Commission to enhance the value to society of the 5.9 GHz band by protecting existing investments in DSRC, by maintaining DSRC access throughout the 5.9 GHz band, by allowing seamless evolution to NGV (based on fair same channel coexistence, interoperability and backward compatibility) throughout the band, and by avoiding fragmentation of the band into a set of small technology-specific sub-bands.

Regards,

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