
**Before the
Federal Communications Commission
Washington, D.C. 20554**

In the Matter of)
)
Use of the 5.850-5.925 GHz Band) ET Docket No. 19-138
)

Reply Comments of IEEE 802

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1 Introduction

IEEE 802 LAN/MAN Standards Committee (LMSC) is pleased to provide reply comments on the above-captioned proceeding to the NPRM on the use of the 5850-5925 MHz Band dated 06 February 2020 in the United States Federal Register.

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 reply 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 the IEEE as a whole.¹

¹ This document solely represents the views of the IEEE802 LAN/MAN Standards Committee and does not necessarily represent a position of either the IEEE, the IEEE Standards Association or IEEE Technical Activities.

2 Executive Summary

With the release of FCC NPRM 19-129 (E.T. Docket 19-138), the United States Federal Communications Commission has requested comments and reply comments regarding assessing the 5.9 GHz band rules and proposing appropriate changes to ensure the spectrum supports its highest and best use. The Commission proposes to: "... continue to dedicate spectrum — the upper 30 megahertz portion of the band — for transportation and vehicle safety purposes, while repurposing the remaining lower 45 megahertz part of the band for unlicensed operations to support high-throughput broadband applications."

In the following pages, IEEE 802 will address several key points made by commenters as they relate to the Dedicated Short-Range Communication (DSRC), as specified in IEEE Std 802.11p-2010 amendment for 5.9 GHz operations, now incorporated into IEEE Std 802.11-2016, for V2X (Vehicle-to-everything) communications, and make recommendations for the Commission's consideration. Key highlights are:

(1) DSRC is neither outdated nor inferior compared to LTE V2X (C-V2X as specified in 3GPP Rel. 14). Several field tests have shown that DSRC can outperform LTE V2X on the physical layer, while the medium access layer of DSRC can provide lower latency for messages generated at unforeseen time instances, for example in emergency braking events.

(2) DSRC has been and continues to be deployed in over a hundred sites around the US. Thousands of vehicles are outfitted with DSRC onboard units, all successfully executing ITS safety and efficiency services.

(3) IEEE 802 believes that C-V2X has significant shortcomings that make DSRC better-suited for future evolution of ITS safety and efficiency services. For example, DSRC provides higher flexibility for variable-size messages, encouraging the addition of innovative features that require new data fields. Most importantly, the IEEE 802.11 WG is in the process of developing a next generation V2X (NGV) standard in the IEEE P802.11bd project, as an amendment to the IEEE 802.11 standard, ensuring interoperability, backward-compatibility and coexistence with current DSRC deployments in the same channel and allowing seamless evolution towards a new ITS standard. In contrast, 5G NR V2X (C-V2X as specified in future 3GPP Rel. 16) is not being designed for same-channel backward-compatibility or same-channel coexistence with LTE V2X (Rel. 14).

(4) IEEE 802 believes that the investment uncertainty created by the Commission's considerations to allocate spectrum for up to three different mutually incompatible technologies (DSRC, LTE V2X, and 5G NR V2X) might be slowing down market adoption of ITS technology in general.

(5) IEEE 802 recommends that the V2X technology of choice for the ITS band a) must be the subject of a mature set of standards, b) must be proven through real-world testing to work effectively in ITS environments, and c) must be future-proof by having a well-defined evolutionary path that maintains interoperability, backward-compatibility and same-channel coexistence with previous generations, including coexistence with DSRC that already occupies the ITS band. IEEE 802 notes that DSRC meets all these criteria.

3 Advantages of DSRC

3.1 Evolution of Standards, Same-Channel Co-Existence

In its comments, 5G Americas stated that 3GPP Release 16 5G NR V2X has considered “support of ... mechanisms for coexistence between LTE and NR.” [1, p. 11]. IEEE 802 finds this statement from 5G Americas misleading. IEEE 802 agrees with Toyota that “5G NR V2X is not being designed to be backwards compatible to LTE V2X” [2, p. 25], as noted also by the Car-2-Car Communication Consortium [3, p. 6]. Furthermore, the 3GPP considerations on coexistence methods between 5G NR V2X and LTE V2X consider only operations in different, adjacent channels [4, p. 22] and do not address same-channel operations. The proponents of C-V2X have proposed only the use of different channels when addressing compatibility and coexistence between LTE V2X and 5G NR V2X, for example [5, p. 7]: “To be clear, the basic safety messages will continue to be carried over 4G LTE in a 20 MHz channel. New vehicles supporting 5G-based advanced C-V2X will use a separate wider 40 MHz (or 55 MHz) channel for these advanced applications”. Hence, same-channel coexistence and compatibility modes are not being specified for the evolution of LTE V2X to 5G NR V2X based deployments.

The Commission should take into account what the lack of same-channel evolution and backward-compatibility of LTE-V2X (Release 14) will mean in the future, for example in the year 2030 or 2040. This is particularly important because cars in the US remain in use for a long time, they are on average more than 11 years old [6]. While mobile phones might already support the 6th and 7th generation of cellular communication standards, safety messages might still be transmitted via a 4th generation standard. At that point, redistributing this spectrum to a newer technology would become nearly impossible, as it would require modifying millions of ITS devices, while ensuring that this modification is carried out simultaneously on virtually all devices, because even a small fraction of devices transmitting the old waveforms could create harmful interference and substantially reduce traffic safety. A lack of evolution and backward-compatibility may prevent automakers from deploying V2X today.

In this regard, safety-critical systems are very different from commercial communication systems, where there is no need for a single air interface standard. For example, 3GPP 3G (UMTS), 4G (LTE), and 5G (NR) standards can all exist in the same handset, operating on different sub-bands and requiring different radios since each standard has unique over-the-air protocols and waveforms. This 3GPP definition of coexistence differs greatly from the IEEE 802.11 WG definition of coexistence, as IEEE Std 802.11 assumes coexistence is the ability of all generations to share the same frequency and time resources. IEEE Std 802.11 assures through backwards compatibility that communication is possible even when older radios do not have all the advanced capabilities of newer radios.

Following this philosophy of coexistence, IEEE P802.11bd is developing next generation V2X (NGV) solutions as an amendment to the IEEE 802.11 standard, in order to ensure backwards-compatibility and coexistence with current DSRC deployments. This amendment will allow for seamless technology evolution in the same frequency channel. Specifically, when there are ITS devices that only support current DSRC communication modes, safety messages will be sent such that they can be received by all devices, providing certainty that current investments will still be operable in the future. Where advanced communication modes can be supported between ITS devices, it will be done in a manner that is interoperable with ITS devices relying on current DSRC communication modes.

Therefore, IEEE 802 recommends that the Commission allow only DSRC (current and backward-compatible future generations) in any spectrum that is designated for ITS in order to maximize efficiency and allow future innovation in the ITS spectrum.

3.2 Performance of DSRC

IEEE 802 disagrees with comments that are dismissive of DSRC as an “outdated” technology or imply that LTE V2X (Rel. 14) offers better performance solely based on the fact that LTE V2X was standardized at a later date than DSRC, e.g., [5, pages 2, 7], [7, page 2], and [8, pages 2, 3].

Regarding the physical layer performance, there is no reason to assume that LTE V2X is superior to DSRC. Both standards share common technologies such as OFDM waveforms, and are subject to the same restrictions imposed by physical laws and high Doppler spreads in vehicular environments. In their default configurations, they use different parameter settings which may favor transmission range or spectral efficiency. However, when similar configuration parameters are chosen, the achievable physical layer performance of these technologies is inherently similar, at least in theory. In practice, a number of real-world field tests have shown that DSRC devices significantly outperformed LTE V2X devices. For example, u-blox found that a competitive DSRC device offers “significantly better performance under field trial conditions” than LTE V2X [9, p. 11]. Other sources also indicate that DSRC may offer superior physical layer performance compared to LTE V2X. For example, Cohda Wireless offers a DSRC on-board unit [10] that has almost 6 dB better receive sensitivity than their LTE V2X device [11]. Experiments conducted by NXP showed that DSRC covers an approximately 65% longer range than LTE V2X in a non-line-of-sight setting [12, slide 6]. This performance advantage of DSRC on the physical layer – which exists despite the use of similar waveforms – is evidence of the maturity and market-readiness of DSRC. DSRC devices have been extensively deployed and tested in the field, which has allowed optimization of all relevant system parameters. More importantly, DSRC devices are available from multiple manufacturers, who have steadily improved their designs over the past years in a competitive free market environment.

Furthermore, the physical layer of LTE V2X (Rel. 14) might soon be considered outdated. LTE V2X (Rel. 14) does not support advanced features such as higher-order modulation schemes (256-QAM) and multi-antenna operations for increased throughput (MIMO) that were the main driving factors for the massive increase in data rates in all wireless systems over the past years. Only the respective newer standards currently in development in IEEE P802.11bd and 3GPP Rel. 16 (5G NR V2X) will support these features. However, LTE V2X (Rel. 14) will not be able to evolve towards 5G NR V2X (Rel. 16) in the same frequency channels [2, p. 25]. If the Commission were to allocate any spectrum to LTE V2X (Rel. 14), all devices operating in that spectrum would need to continue transmitting 4G-based signals, which might be considered outdated in the near future. On the other hand, IEEE P802.11bd is developing the next-generation V2X standard that will allow seamless evolution in the same frequency channel and will thus soon offer the benefits of new features for improved physical layer performance.

Regarding the performance of the medium access layer, IEEE 802 notes that while the strictly time-slotted medium access scheme of LTE V2X Release 14 might be efficient when all the messages are strictly periodic and of a particular size, many traffic-related messages are generated at non-periodic intervals (for example, due to congestion control, vehicle dynamics, or the asynchronous occurrence of critical events like hard-braking) and are of variable size. Due to the semi-persistent scheduling scheme of LTE V2X, such messages generated at random times can experience delays up to 100 milliseconds, depending on the parameter configuration, which is significantly higher than the 2 milliseconds that can

be observed for the vast majority of DSRC messages [13]. Toyota also found superior performance of DSRC in congested environments [14]. Furthermore, the resource allocation algorithm of LTE V2X is designed for packets of a particular size and is therefore not efficient for variable-size data. While Basic Safety Messages (BSMs) will contain basic fixed-size data like position and speed, there exists a large amount of variable-size data, for example the number of path history points and the security overhead. For LTE V2X, a slight increase in message size can result in the need for an additional time slot having to be allocated which significantly decreases user efficiency and increases latency, both of which substantially degrade ITS safety and efficiency. Such a design could easily discourage the adoption of innovative new features that require the use of additional message data fields. In contrast, in extensive field trials and more recently in deployments of large numbers of DSRC devices, efficient channel access has been achieved under high load and with non-periodic and variable-size messages. Therefore, DSRC provides better latency performance and provides flexibility to support future innovations.

3.3 Deployments of DSRC

Some commenters have downplayed the extent of existing deployments of DSRC [5, p. 2], [8, pp. 2-3]. IEEE 802 notes that a significant number of DSRC deployments has been reached. The U.S. Department of Transportation (DOT) in their comments of March 9, 2020 [15] highlight DSRC deployments and state that “Currently, over 123 sites across the Nation are putting the 5.9 GHz band into use. This number grew from 87 sites in June 2019.” This includes the large number of ITS safety and ITS efficiency services deployed today in the Connected Vehicle Pilot programs in New York City, Tampa, FL, Wyoming, and Columbus, Ohio [16]. DSRC is a state-of-the-art technology that has been and continues to be deployed for ITS safety and ITS efficiency services around the world.

3.4 Obstacles to Market Adoption

Some commenters have also implied that the slow market adoption of DSRC technology was due to performance issues or that LTE V2X would achieve faster market adoption [5, pages 5], [8, pages 2]. IEEE 802 believes that the market adoption was delayed for a variety of other reasons, most importantly the lack of a mandate to deploy the technology. This “voluntary deployment scheme” suffers from the fact that individual customers experience little benefit until a high market penetration has been achieved. The US TAG TC204 [17] notes that “had the original NHTSA NPRM mandating V2V deployments in vehicles starting in 2019 been adopted, these deployments would have been much farther along”. Furthermore, as noted by General Motors [18]: “Regrettably, the significant uncertainty of the rules created by ongoing FCC statements [...] have threatened any further deployments”. These obstacles to market adoption apply to LTE V2X as well. There is no reason to assume that using a voluntary deployment scheme, LTE V2X would experience significantly improved deployment rates compared to DSRC technology. On the contrary, LTE V2X is not yet deployed, providing less incentive to customers, while DSRC is now reaching a significant number of deployments that provide a direct benefit to market adoption. In addition, any decision made by the Commission that allocates spectrum to LTE V2X in some parts of the ITS band will further contribute to the market uncertainty. As long as there is spectrum allocated to both technologies, automakers and truck manufacturers, along with providers of public infrastructure, as well as pedestrians and bicyclists, will remain uncertain about the future of ITS technology and might refrain from investments.

3.5 Layer-2 Unicast Support

IEEE 802 disagrees with 5G Americas's [1, page 5] assertion that 3GPP Release 14 LTE V2X supports a "richer range of services than is possible using DSRC". DSRC supports every ITS service supported by Release 14 C-V2X sidelink. Furthermore, Release 14 LTE V2X uses only broadcast [2, p. 6] and lacks a native unicast capability on the medium access layer (layer 2). Even though systems using LTE V2X Release 14 on the lower layers could implement unicast transmissions using protocols in upper layers, such an approach is not efficient, especially when it comes to acknowledgment messages, which would have significant delay and large packet size overhead due to higher-layer protocols. In contrast, the medium access used in DSRC ensures that devices respond to a unicast message by sending an acknowledgment message within 32 microseconds with minimal packet sizes. Many ITS safety and efficiency services require direct unicast transmissions, for example, infrastructure-to-vehicle warnings (e.g. Wrong-Way Driving Alert [19]), communication to a V2X security credential management system (SCMS), and collection of probe vehicle data. These services will not be natively supported by the lower layers of LTE V2X but are natively supported by DSRC.

3.6 Additional Services Enabled by Commercial Cellular Networks

Several commenters [5], [7], [8] make ambiguous comments suggesting that, by allocating ITS spectrum specifically to Release 14 LTE V2X, many of the benefits that can be derived from using (5G) cellular connectivity to vehicles accrue. This is inaccurate. Any Release 14 LTE V2X module that is actively used for ITS safety and efficiency services in ITS spectrum must be available for ITS services and would not be available to provide cellular connectivity. Cellular connectivity will require separate communication resources (i.e. radios and non-ITS channels). Hence, the advantages of cellular connectivity are orthogonal to C-V2X. The fact that C-V2X is also specified by 3GPP does not mean they are an integrated V2X solution. Cellular connectivity is just as easily coupled with a DSRC ITS safety and efficiency communication module. In fact, all on-board units deployed today have cellular interfaces in addition to DSRC ITS communication modules operating in ITS spectrum and, as such, are already utilizing the benefits of cellular connectivity when and where appropriate.

4 Spectrum needed for ITS

While several commenters wrote in favor of retaining the 75 MHz for ITS safety and efficiency services, others wrote in favor of the proposed reallocation. Of those that spoke in favor of retaining 75 MHz for ITS, some indicated a tolerance for C-V2X in a 20 MHz portion of that 75 MHz band. First, IEEE 802 cautions not to infer from such comments a support for C-V2X in a reduced bandwidth ITS band. Second, from a technical perspective, the considerations of which V2X technologies should be permitted in the ITS band are different for a 75 MHz ITS band than for a reduced bandwidth ITS band (e.g. for 30 MHz as the NPRM proposes). In a 30 MHz ITS band, same-channel evolution and spectral efficiency become imperative. IEEE 802 stresses that DSRC has advantages over LTE V2X with respect to both same-channel evolution and spectral efficiency.

The next generation IEEE Std 802.11 technology being developed in the IEEE P802.11bd amendment is intended to provide a seamless evolution path from DSRC in the 5.9 GHz ITS band. Any consideration of the rules governing use of the 5.9 GHz band must recognize that current DSRC deployments and the next generation V2X standard under development in IEEE P802.11bd will operate together in the same ITS channels and can coexist and share resources without interfering with each

other. This coexistence and resources sharing even extends to the introduction of advanced features such as 20 MHz bandwidth operation.

5 Technology Choice

IEEE 802 believes that the criteria for permitting a given V2X technology to use the ITS spectrum, whatever its eventual bandwidth, should be that the technology is:

- Fully standardized
- Proven through testing to work effectively
- Future-proof by maintaining backward compatibility, including compatibility with DSRC which already occupies the ITS band.

IEEE 802 disagrees with the 5GAA [20, p. 45] that the Commission should exclusively designate any share of the valuable ITS spectrum to “5G-based” technology that has not even completed the standardization phase² let alone any necessary steps for testing. IEEE 802 also disagrees with 5GAA that the Commission should permit all 3GPP sidelink technologies and exclude all non-3GPP technologies [20, page 46]. 3GPP has standardized one V2X technology and is standardizing another (LTE V2X and 5G NR V2X, respectively). As AT&T also has stated [21, pp. 13 and 14], they do not coexist in the same channel, they are not backward compatible, and they lack interoperability. 5GAA's call for incompatible technologies to occupy the same channel could be construed as a lack of commitment to deploy LTE V2X. IEEE 802 believes the criteria for permission to use the band should not be based on the standards organization from which they emerge, but on the objective criteria listed above.

6 Implications of “Technology-Neutral” Approaches

IEEE 802 agrees with the following US DoT comments [15] regarding a so-called “technology-neutral” approach:

1. “... being technology-neutral is not the same as being outcome-neutral in determining the appropriate technology to be used for V2X communications, especially those related to critical safety-of-life applications. That is, the Department is supportive of any and all communication technologies that could be used for V2X, but these technologies must be proven to meet safety performance requirements before they can be deployed.”
2. “... the work done to develop DSRC under the existing allocation makes clear that moving from an idea to a band plan and technology suitable for safety-of-life communications is a complex process that takes considerable effort. These complications arise from both the unique aspects of V2X communications and the importance of having confidence that V2X technologies can perform critical safety-of-life applications without challenges from harmful interference, and with the assurance that priority is given to safety communications and that testing results show that all the technologies can actually co-exist within the band. These all underscore that V2X is complicated and that all of these factors must be addressed in any effective band plan.”

² Standardization of 3GPP Rel. 16 is not finished. While there are initial deployments of 5G-based cellular technology, the 5G-based NR V2X technology is currently not market-ready.

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3. "... to achieve the reliable connectivity needed to enable safety-of-life communications, V2X must grapple with factors that are, in some respects, more complex than consumer electronic communications."

IEEE 802 believes that the technology selection process should be based on fair scientific principles and extensive testing. Nevertheless, IEEE 802 supports the concept that V2X is a safety-of-life system and not a commercial communications system. Hence all deployed devices in a V2X system must be able to communicate over the air using a single standardized protocol. If the Commission adopts a "technology-neutral" approach that allows vehicle manufacturers to choose between different technologies that are not interoperable, then these non-interoperable ITS devices will not be able to communicate with each other and ITS systems will fail to prevent collisions between them. Therefore, while IEEE 802 largely supports many of the comments made by AT&T [21], it disagrees with the suggestion to let the technologies "succeed or fail in the marketplace on the basis of their merits and other market factors". IEEE 802 is in favor of field trials and scientific research to determine the best ITS technology and opposes the idea of allowing the use of different non-interoperable technologies in the ITS band, as it would take several more years until the markets decide on a preferred technology, with many preventable traffic collisions still occurring in all of those years. It may even take longer than that: when given the choice between two incompatible technologies, automakers also have the option to choose neither of those technologies and instead refrain from investments into a highly uncertain market altogether.

7 Conclusion:

IEEE 802 believes that DSRC is the technology best suited to implementation of ITS safety and efficiency services in the ITS spectrum as it has been shown to offer better performance than LTE V2X. DSRC has been thoroughly tested and deployed throughout the US and has seamless means for inclusion of future innovations. Therefore, IEEE 802 believes that the Commission should not allocate ITS spectrum to C-V2X technologies as they are neither future-proof nor the best technical choice for delivering ITS safety and efficiency services.

IEEE 802 thanks the Commission for providing an opportunity to comment on the NPRM ET Docket 19-138 and respectfully requests these reply comments be considered by the Commission during the final rule making process.

Regards,

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