IEEE 802.18

Radio Regulatory Technical Advisory Group

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| Reply Comments on FCC19-138 NPRM Revisiting Use of the 5.850-5.925 GHz Band |
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Abstract

r02:

r01: 03apr, .18 ad hoc – update based on edits suggested by Joseph Levy (merged by Sebastian Schiessl), additional clarifications on cellular connectivity, new section on non-periodic traffic and variable size messages. ad-hoc discussions inserted.

r00: 31mar, .18 ad hoc - initial draft based on clean copy of 18-20-0045-r4, with EC comments and ad-hoc call edits and ad-hoc discussions inserted

**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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Standards Committee

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26 April 2020

# 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 IEEE as a whole.[[1]](#footnote-1)

# 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. In this NPRM it is proposed 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 as they relate to the DSRC technology, its evolution, as well as make recommendations for Commission’s consideration.

First, DSRC is not outdated; it incorporates the same state-of-the-art 802.11 technology that is in many products on the market today. Furthermore, the IEEE 802.11 WG is in the process of developing next generation V2X technology, IEEE P802.11bd, as an amendment to the IEEE 802.11 standard that ensures backward compatibility and coexistence with current DSRC deployments.

Second, DSRC has been and continues to be deployed. There are over a hundred sites around the US and thousands of vehicles outfitted with DSRC, all successfully executing ITS safety and efficiency services.

Third, IEEE 802 believes C-V2X is not superior to DSRC as it has several shortcomings that make DSRC better-suited for deployment of ITS safety and efficiency services. For example IEEE 802 believes IEEE 802.11 Working Group practice of insuring same channel backwards compatibility and the same coexistence for evolving IEEE 802.11 technologies is greatly superior than the proposed C-V2X evolution plan for Release 14 LTE V2X to 5G NR V2X that does not provide same channel backward compatibility nor same channel coexistence .

Fourth, IEEE 802 recommends that the V2X technology of choice for the ITS band 1) must be the subject of a mature set of standards, 2) must be proven through real-world testing to work effectively in ITS environments, and 3) must be future-proof by having a well-defined evolutionary path that maintains backward compatibility and coexistence with previous generations, including coexistence with DSRC which already occupies the ITS band.

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 (Basic Service Set)) was introduced in IEEE Std 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 (Vehicle-to-everything) amendment with the IEEE P802.11bd project. The IEEE P802.11bd 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 P802.11bd to operate together in the ITS band. It should be noted that one of the advanced features being specified for the IEEE P802.11bd project is 20 MHz bandwidth operation that co-exists with 10 MHz DSRC specified in IEEE Std 802.11-2016.

# Advantages of DSRC

## Performance and Deployment of DSRC

IEEE 802 disagrees with comments thatdismissedaan technology or imply that LTE V2X offers better performance solely based on the fact that DSRC was standardized at an earlier date, e.g., [1, pages 2, 7], [2, page 2], and [3, pages 2, 3]~~These comments also falsely imply that this is the reason for the slow adoption of DSRC.~~

First, IEEE 802 notes that there is no reason to assume that the physical layer performance of LTE V2X is superior to DSRC (more specifically, the current DSRC standard IEEE 802.11p). ~~The physical layer performance of IEEE Std 802.11p is at least on par with that of LTE V2X.~~ 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 configuration, they use different parameter settings which may favor transmission range or spectral efficiency. However, when similar configuration parameters are chosen, the performance of these technologies is inherently similar and we are not aware of any evidence showing significantly different performance of any of the V2X technologies for ad-hoc communication when the evaluation is performed in a fair, unbiased manner.

}} .18 ad hoc 2020-04-03: Long discussions on this paragraph. Should not sound defensive but more positive and confident about DSRC. Additional references on the performance comparison between DSRC and LTE V2X could be inserted, for example, measurement results by NXP.

Second, the maturity of DSRC technology is not a disadvantage but an asset for traffic safety applications. DSRC devices have been extensively deployed and tested in a large number of diverse environments and these tests have confirmed the suitability of the technology and its ability to provide traffic safety. These evaluations and deployments have also allowed for optimization of system parameters to address multiple environments, providing a mature set of specifications addressing the whole of ITS, not just the air interface portion. Furthermore, DSRC devices are available from a variety of manufacturers and are ready for mass deployment, providing a competitive free market environment.

Third, the label "outdated" could more easily be applied to LTE V2X (Rel. 14) than to DSRC. The LTE standard is now more than 10 years old. Neither IEEE Std 802.11p nor LTE V2X (Rel. 14) 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 that was seen in both 3GPP-defined cellular standards and IEEE 802.11-based WLAN standards over the past years. Both of the respective newer standards (IEEE 802.11bd and 5G NR V2X) will support these features that may greatly improve data rates for unicast transmissions at short range. However, LTE V2X (Rel. 14) will not be able to evolve towards 5G NR V2X (Rel. 16) in the same frequency channels, as 5G NR V2X is not same-channel backward-compatible with LTE V2X. Contrary to that, IEEE Std 802.11p can evolve seamlessly in the same channel towards IEEE 802.11bd to enable next-generation services. This is possible because IEEE 802.11bd is being developed to ensure same channel backwards-compatibility and coexistence with IEEE Std 802.11p. If the Commission is considering now to allocate 20 or 30 MHz of spectrum to LTE V2X, it should note that 4G-based LTE V2X has no ability to evolve in the same channel towards future 5G NR V2X technology. Therefore, IEEE 802 recommends that the Commission continue to allocate ITS spectrum for current and backward compatible future generations of DSRC in order to enable improved efficiency and future innovation in the ITS band.

LastlyIEEE 802 believes that market adoption of V2X systems was not impacted by the standardization date of DSRC. We believe the market adoption was delayed for a variety of other reasons, most importantly the voluntary deployment scheme, where individual customers experience little benefit until a high market penetration has been achieved. The US TAG TC204 [14] 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 [15]: "Regrettably, the significant uncertainty of the rules created by ongoing FCC statements [...] have threatened any further deployments". Thighlight DSRC deployments and This includes that . the basis ofenhancements under development in

## Layer-2 Unicast Support

IEEE 802 disagrees with 5G Americas’s [6, 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. Moreover [7], DSRC supports a wide range of “advanced V2X” [8] services that 3GPP concedes Release 14 LTE V2X was never intended to support such as vehicle platooning and sensor data sharing. Furthermore, Release 14 LTE V2X uses only broadcast, without a native unicast capability on the medium access layer (layer 2). Even though LTE V2X Release 14 could implement unicast transmissions using protocols above layer 2, such an approach is less 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 IEEE Std 802.11p medium access allows DSRC devices to respond to 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: important services related to infrastructure-to-vehicle warnings (e.g. Wrong-Way Driving Alert [9]), 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.

## Support for Non-Periodic and Variable-Size Messages

While the strictly time-slotted medium access scheme of LTE V2X Release 14 might be efficient in case the messages are strictly periodic and remain at fixed size, IEEE 802 notes that many traffic-related messages may be generated at non-periodic intervals (for example, due to congestion control, vehicle dynamics, or the asynchronous occurrence of critical events like hard-braking). Furthermore, the resource allocation algorithm of LTE V2X is designed for packets of a particular size but not as efficient for variable-size data. While Basic Safety Messages (BSMs) will contain basic fixed-size data like position, speed, and orientation, there exists a large amount of variable-size data, for example the number of path history points and the size of the security overhead. For LTE V2X, a slight increase in message size could mean that a message that ordinarily occupies only a single time slot would suddenly be split into two time slots, occupying twice as many resources and experiencing twice the delay. In the future, such a design might discourage the adoption of innovative new features that require the use of additional message data fields. Contrary to that, extensive field trials of DSRC devices have been conducted, none of which have revealed any major problems with maintaining efficient channel access under high load and with non-periodic and variable-size messages. Therefore, DSRC provides very high flexibility to support future innovations that require additional data fields.

}} .18 ad hoc 2020-04-03: Insert comment to reply to, e.g., any comment on future evolution and innovation, or any comment that claims LTE V2X is superior, or simply reply to IEEE 802 comments.

}} .18 ad hoc 2020-04-03: Might be difficult to get approved. Any factual statements on LTE V2X should be backed up by references.

## Additional Services Enabled by Commercial Cellular Networks

Several commenters [1, pages 5-7] [2, page 3] [3, page 2]] suggest that many of the benefits that can be derived from providing cellular connectivity to vehicles can only accrue by allocating ITS spectrum specifically to LTE V2X Release 14, or alternatively imply that an LTE V2X modem can provide cellular connectivity without the need for additional hardware resources. This is inaccurate. Any Release 14 LTE V2X module used for ITS safety and efficiency services in ITS spectrum must be available 100% of the time for ITS services and would not be available to provide connectivity to commercial cellular networks in different bands. Cellular connectivity will therefore 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. Connectivity to a commercial cellular network is just as easily coupled with a DSRC 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 for additional services that can tolerate the lower reliability and increased latency of commercial cellular networks. IEEE 802 acknowledges that these additional services can be highly valuable, and notes that cellular connectivity is unrelated to the technology choice for direct vehicle-to-vehicle communication in the ITS band to achieve traffic safety.

}} .18 ad hoc 2020-04-03: Two different false claims are addressed: False claim 1: There is hardware synergy between cellular connectivity and LTE V2X (you only need to buy an LTE modem, you get LTE V2X for free). This claim is false, but our counter-argument “must be available 100% of the time” must be corrected. False claim 2: In order to allow additional services through cellular connectivity, there needs to be spectrum for LTE V2X in the 5.9 GHz band. This is obviously false, but we must find read the comments again and check if this was stated as a fact or only implied.

## Evolution of Standards, Same-Channel Co-Existence

IEEE 802 finds a statement from 5G Americas misleading. 5G Americas notes that 3GPP Release 16 5G NR V2X has considered “support of … mechanisms for coexistence between LTE and NR.” [6, page 11] It is important to understand that LTE V2X (Release 14) and 5G NR V2X (Release 16) is not designed to coexist in the same channel. 3GPP’s consideration is only for coexistence in adjacent channels.[16]

The Commission should take into account what this lack of in the same channel evolution and backward-compatibility of LTE-V2X (Release 14) will mean in the future, for example in the year 2030 or 2040. While mobile phones might already support the 6-th and 7-th generation of cellular communication standards, vehicles would need to continue using a 4G-based standard. At that point, redistributing this spectrum to a newer technology would become nearly impossible, as it would require recalling tens of millions of vehicles, while ensuring that this recall is followed by virtually all car owners, because even a small fraction of vehicles transmitting the old waveforms could create harmful interference and substantially reduce traffic safety. The lack of evolution and backward-compatibility may prevent automakers from deploying V2X today.

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# Technology Choice

IEEE 802 believes that the criteria for permitting a given V2X technology to use the ITS band, 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 [10, page 45] that the Commission should exclusively designate the major share of the ITS spectrum to “5G-based” technology which is not ready for deployment, and which has not even seen significant field trials[[2]](#footnote-2). ~~that has not even completed the standardization phase, 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.[10, page 46] 3GPP has standardized one V2X technology and is standardizing another (LTE V2X and 5G NR V2X, respectively). They do not coexist in the same channel as AT&T also has stated [11, pages13 and 14], they are not backward compatible, and they lack interoperability. 5GAA’s request that these incompatible technologies be permitted to occupy the same channel is evidence of 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.

# Implications of “Technology-Neutral” Approaches

IEEE 802 agrees with the following DoT comments [12] 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.”
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 supports the concept of the technology selection process being based on scientific principles and extensive testing. IEEE 802 also believes that the Commission should keep existing rules that allow field testing of LTE V2X and in the future, also the more capable 5G NR V2X technologies, in order to allow a fair, scientific and objective performance evaluation. 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 should adopt a “technology-neutral” approach and allow vehicle manufacturers to choose between different technologies that are not interoperable, then the involved vehicles would not be able to communicate with each other and ITS systems would fail to prevent collisions between them. Therefore, IEEE 802 is opposed to comments by AT&T [11], which suggest to let the technologies “succeed or fail in the marketplace on the basis of their merits and other market factors”. Contrary to that, IEEE 802 believes that in matters of public safety, a lack of interoperability can be fatal. To provide a historic example, in the Great Baltimore Fire of 1904, fire departments from neighboring cities like Washington D.C. could not assist in extinguishing the fire due to the use of incompatible hose couplings, and had to stand by and watch while the fire eventually destroyed 1,526 buildings [13]. Instead of waiting several years for different hose couplings to “succeed or fail in the marketplace on the basis of their merits and other market factors”, the National Fire Protection Association (NFPA) created a national standard for fire hydrants in 1905, and most fire hydrants now provide at least one connector adhering to this standard [13], which has greatly improved fire safety. Out of similar considerations for traffic safety, IEEE 802 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. Instead, IEEE 802 respectfully requests the Commission to decide and mandate an interoperable ITS safety standard that is to be supported by all commercially deployed vehicles and other traffic users in the ITS band. The Commission’s original decision [insert reference to 1999 decision] to mandate the use of a specific technology (DSRC) in the unlicensed 5.9 GHz ITS band was unprecedented, and IEEE 802 believes that this unprecedented decision was largely motivated by the very similar considerations: a common interoperable standard is required to stop the preventable loss of human lives. This decision is not interfering with free markets: customers can now decide between the offers from many different DSRC device manufacturers based on performance and cost-efficiency of different devices. Furthermore, this decision for an interoperable ITS standard is not preventing evolution of the technology: any standards organization remains free to define a new technology with more efficient modes of transmissions, as long as the devices continue to supports one transmission mode that allows communication with DSRC devices.

}} .18 meeting 2020-03-31: fire hydrant to hose example may not fit too well, as fire hydrants are an infrastructure, it’s not a peer-to-peer coupling. Toll collection was suggested as another example, but was not unanimously accepted, as toll collection is not safety-critical, and nation-wide standardization would only improve comfort. The Commission did not decide for DSRC on its own but was pressed to do so by many ITS stakeholders, so these sentences are misleading. Suggestion was to shorten or remove this paragraph, as the benefits of an interoperable standard for traffic safety have been well known by all stakeholders for many years.

In case the Commission is nevertheless considering to allow different non-interoperable devices to communicate in the same ITS band, IEEE 802 notes that at the very least, the different standards should be able to co-exist with each other. Protocols based on IEEE Std 802.11 were designed for same-channel co-existence, whereas LTE V2X (Rel. 14) is not able to co-exist in the same channel with DSRC devices, creating mutual harmful interference. Preliminary studies indicate that LTE V2X may create substantial interference towards DSRC transmissions or at least cause them to defer channel access due to a lack of co-existence methods. As a result, even a small number of LTE V2X devices might significantly disrupt the transmissions of a larger number of existing DSRC devices, somewhat similar to an unintentional jamming. Therefore, in case different non-interoperable technologies are allowed in the same band, the Commission would at the very least need to define a mechanism that ensures fair co-existence.

}} .18 meeting 2020-03-31: Confusion about whether this paragraph is about same-channel co-existence. It was meant to be, nevertheless, we are not aware of any quote specifically calling for same-channel co-existence. The proponents of a technology-neutral approach apparently think that a fair market decision can be reached after allocating 20 MHz to one technology and 10 MHz to the other.

}} .18 meeting 2020-03-31: Co-existence in different bands would be necessary in order to achieve traffic safety when different vehicles transmit safety messages with different technologies. But this might create a major difficulty! A DSRC transmission in one channel would prevent LTE V2X reception in another band. Coordinated channel access is however not possible at the moment. TODO: investigate this further and possibly write a paragraph on this

In this regard, safety-critical systems are very different from commercial communications system, where there is no need for a single air interface standard (e.g. 3GPP 3G (UMTS), 4G (LTE), and 5G (NR) standards can all exist in the same handset, requiring different radios since each standard has unique over the air protocols and wave forms). These 3GPP generations use different sub-bands to allow “coexistence”. This differs greatly from the IEEE 802.11 Working Group definition of coexistence, as IEEE Std 802.11 assumes coexistence is the ability of all generations of technologies deployed per IEEE Std 802.11 being able to share the same frequency and time resources. IEEE Std 802.11 assures through backwards compatibility that sharing is possible even when older radios do not have all the advanced capabilities of newer radios. It is important to allow older radios to continue to operate, while allowing newer radios to use both old and new capabilities.

# Conclusion:

 IEEE 802 believes that the Commission should not allocate ITS spectrum to LTE V2X / 3GPP 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,

By: /ss/ .

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**References:**

[1] Comments of Qualcomm, Inc., FCC ET Docket 19-138, March 9, 2020: <https://ecfsapi.fcc.gov/file/10309941330157/Qualcomm%20Comments%20on%205.9%20GHz%20NPRM.pdf>

[2] Comments of T-Mobile USA, Inc., FCC ET Docket 19-138, March 9, 2020: [https://ecfsapi.fcc.gov/file/1030957937118/T-Mobile%205.9%20GHz%20Comments%20(As-Filed)%203.9.20.pdf](https://ecfsapi.fcc.gov/file/1030957937118/T-Mobile%205.9%20GHz%20Comments%20%28As-Filed%29%203.9.20.pdf)

[3] Comments of The BMW Group, FCC ET Docket 19-138, March 9, 2020: [https://ecfsapi.fcc.gov/file/1031040719061/BMW%20Submission%20ET%20Docket%20No.%2019-138%20(003).pdf](https://ecfsapi.fcc.gov/file/1031040719061/BMW%20Submission%20ET%20Docket%20No.%2019-138%20%28003%29.pdf)

[4] Comments of the NTIA and DOT; [https://ecfsapi.fcc.gov/file/10313251510165/5.850-5.925 GHz Band C ET Dkt No. 19-138.pdf](https://ecfsapi.fcc.gov/file/10313251510165/5.850-5.925%20GHz%20Band%20C%20ET%20Dkt%20No.%2019-138.pdf)

[5] CV Pilot Deployments:

<https://www.its.dot.gov/pilots/index.htm>

<https://www.tampacvpilot.com/learn/resources/>

<https://www.its.dot.gov/pilots/pilots_nycdot.htm>

<https://wydotcvp.wyoroad.info/>

<https://smart.columbus.gov/uploadedFiles/Projects/Smart%20Columbus%20Concept%20of%20Operations-%20Connected%20Vehicle%20Environment.pdf>

[6] Comments of 5G Americas, FCC ET Docket 19-138, March 9, 2020; <https://ecfsapi.fcc.gov/file/1030957873656/5G%20Americas%205.9%20GHz%20Comments%203.9.20%20FINAL.pdf>

[7] "Overall description for RAN aspects for V2X based on LTE and NR (Release 16)", 3GPP TR 37.985, v1.1.0, February 2020, Section 4; <https://www.3gpp.org/ftp/Specs/archive/37_series/37.985/37985-110.zip>

[8] Overall description of Radio Access Network (RAN) aspects for Vehicle-to-everything (V2X) based on LTE and NR (Release 16), 3GPP TR 37.985 v1.1.0, February 2020; <https://portal.3gpp.org/desktopmodules/Specifications/SpecificationDetails.aspx?specificationId=3601>

[9] Dedicated Short Range Communication (DSRC) Systems Engineering Process Guidance for SAE J2945/X Documents and Common Design Concepts, SAE J2945\_201712, December 2017; <https://www.sae.org/standards/content/j2945_201712/>

[10] Comments of 5G Automotive Association, FCC Docket 19-138, March 9, 2020, [https://ecfsapi.fcc.gov/file/10309096401111/5GAA%20Comments%20(3-9-2020).pdf](https://ecfsapi.fcc.gov/file/10309096401111/5GAA%20Comments%20%283-9-2020%29.pdf)

[11] Comments of AT&T, FCC ET Docket No. 19-138, March 9, 2020, [https://ecfsapi.fcc.gov/file/1030982287529/ATT%20Comments%20(final%2003.09.20).pdf](https://ecfsapi.fcc.gov/file/1030982287529/ATT%20Comments%20%28final%2003.09.20%29.pdf)

[12] the March 9, 2020 letter to The Honorable Ajit Pai Re: Use of the 5.850-5.925 GHz Band ET Docket No. 19-138; FCC 19-129; FRS 16447 85 Fed. Reg. 6841 (Feb. 6, 2020); ([https://ecfsapi.fcc.gov/file/10313251510165/5.850-5.925 GHz Band C ET Dkt No. 19-138.pdf](https://ecfsapi.fcc.gov/file/10313251510165/5.850-5.925%20GHz%20Band%2C%20ET%20Dkt%20No.%2019-138.pdf))

[13] Momar D. Seck and David D. Evans, “Major U.S. Cities Using National Standard Fire Hydrants, One Century After the Great Baltimore Fire” NISTIR 7158, NIST, <https://www.govinfo.gov/content/pkg/GOVPUB-C13-c33f9384233e5a13eca491ede462acdf/pdf/GOVPUB-C13-c33f9384233e5a13eca491ede462acdf.pdf>

[14] Comments of US Technical Advisory Group to ISO/TC 204 Intelligent Transport Systems, March 9, 2020 <https://ecfsapi.fcc.gov/file/10310066302855/USTAG%20TC204%20Comments%20on%20FCC%20NPRM%2019-138%202020-03-09.pdf>

[15] Comments by General Motors LLC, March 10, 2020

<https://ecfsapi.fcc.gov/file/103102450728782/3-09-20%20GM%20FINAL.pdf>

[16] 5G V2X with NR sidelink, 3GPP Work Item Description, RP-190984, June 2019; [https://www.3gpp.org/ftp/tsg\_ran/TSG\_RAN/TSGR\_84/Docs/RP-190984.zip](https://urldefense.proofpoint.com/v2/url?u=https-3A__www.3gpp.org_ftp_tsg-5Fran_TSG-5FRAN_TSGR-5F84_Docs_RP-2D190984.zip&d=DwMFaQ&c=pqcuzKEN_84c78MOSc5_fw&r=z8R-nWJ8GIxwjOjNKhEFByb-tZ6XE3GZXWSggNdVo-w&m=5tBZeYDDn0IcC_78W6FTltdHC0VakGnJ3oDc3qaubd4&s=wFSI3TMipYWANPPpDk8coGUil1ivQA5POXMRx_Grym0&e=)

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. [↑](#footnote-ref-1)
2. While there are initial deployments of 5G-based cellular technology, the 5G-based NR V2X technology is not yet market-ready. [↑](#footnote-ref-2)