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

COMMENTS OF 5G AMERICAS

Chris Pearson

5G AMERICAS
1750 112th Avenue NE, Suite B220
Bellevue, WA 98004

President of 5G Americas

March 9, 2020

TABLE OF CONTENTS

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554

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

COMMENTS OF 5G AMERICAS

5G Americas, the voice for 5G and LTE in the Americas, submits these comments in response to the Commission's Notice of Proposed Rulemaking ("*Notice*") in the above-referenced proceeding concerning use of the 5.850-5.925 MHz ("*5.9 GHz*") band. Since 1999, the 75 MHz in the 5.9 GHz band has been designated by the Commission for Intelligent Transportation Systems ("ITS") and restricted to the use of Dedicated Short-Range Communications ("DSRC") technology, thereby precluding the use of new cellular-based ITS direct communications technology (known as C-V2X PC5), which has been standardized in the 3GPP standards group. The Commission was right to issue the Notice proposing to change its rules to allocate some of the band for C-V2X PC5, and 5G Americas supports the proposals to allocate the upper 30 MHz for this purpose. However, the Notice does not allocate sufficient spectrum to enable deployment of 5G-based C-V2X PC5, and the rest of the band should be allocated for that technology.

5G Americas has a broad membership of leading wireless operators and vendors. 5G Americas facilitates and advocates for the advancement and transformation of LTE, 5G and

beyond throughout the Americas.[1] 5G Americas is a Market Representation Partner ("MRP") of 3GPP, in order to promote seamless interoperability and convergence for broadband customers. Release 14 of 3GPP's[2] standards included the standard for LTE-based C-V2X PC5, the 4G cellular technology which enables vehicles to communicate directly with each other, with road infrastructure and pedestrians. Release 16 will be the first standard with 5G-based C-V2X PC5, the first use of 5G for this purpose, which particularly supports the use of this technology for direct communication between and among automated vehicles. The public interest warrants changing the rules for the current spectrum allocation in the 5.9 GHz band to permit these new technologies which can substantially improve roadway safety.

1. INTRODUCTION

The Commission notes in its 5.9 GHz *Notice* that C-V2X is gaining momentum.[3] 5G Americas concurs with this assessment and offers below information to that effect. Indeed, C-

[1] 5G Americas Board of Governor members include AT&T, Cable & Wireless Communications, Ciena, Cisco, Commscope, Ericsson, Intel, Mavenir, Nokia, Qualcomm, Samsung, Shaw, Sprint, T-Mobile USA, WOM, and Telefónica.

[2] 3GPP unites seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as "Organizational Partners", and provides their members with a stable environment to produce the reports and specifications that define 3GPP technologies. New features are 'functionality frozen' and are ready for implementation when a Release is completed.

[3] *See Notice* at ¶ 5. The Commission observes that Japan has authorized ITS spectrum in the 700 MHz band (for DSRC), and Europe has designated 5875-5905 MHz for ITS. However, many other countries, notably including China, have authorized C-V2X in portions of the 5.9 GHz band. *See, e.g.,* 5GAA White Paper on *ITS spectrum utilization in the Asia Pacific Region*, referencing Australia, China, Japan, S. Korea, and Singapore. Moreover, at the recently concluded World Radiocommunication Conference ("WRC"), the International Telecommunication Union ("ITU") adopted a WRC Recommendation recommending that countries harmonize spectrum regionally or globally for ITS, and which references *Recommendation* ITU-R M.2121, that lists the 5.9 GHz band as a band for such harmonization. *See* WRC Recommendation COM4/1 (WRC-19), *Harmonization of frequency bands for evolving Intelligent Transportation Systems applications under mobile service allocations,* referring to ITU-R Recommendation M.2121, *Harmonization of frequency bands for Intelligent*

V2X for connected cars is one of the fastest growth areas in 5G use cases, and the fastest growth area in consumer IoT.[4] The Commission also notes that the technology has improved to the point where automated driving is anticipated.[5] C-V2X was first standardized in Release 14. C-V2X includes two modes of communication: direct mode (PC5) for the most immediate, latency sensitive communications, and network mode (known as Uu), which uses an existing cellular network for broadcast-type communications. C-V2X was and further improved upon in Release 15, which enhanced V2X by introducing features such as carrier aggregation on the PC5 interface (direct device-to-device communications), 64 quadrature amplitude modulation (64QAM), reduced latency. Release 15 also included a feasibility study on transmission diversity and short transmission time interval (TTI) for the sidelink. 3GPP's Release 16, which is expected to be finalized in March 2020,[6] focuses on using 5G-based C-V2X PC5 for automated vehicles ("AV").

With 3GPP Release 14, C-V2X was expanded through cellular technologies to support a wider, richer range of services than is possible using DSRC, and Release 15 enhances these

---

Transportation Systems in the mobile service (2019). That ITU-R Recommendation recommends that administrations should consider using the 5850-5925 MHz band or parts therefor for current and future ITS applications. The WRC Recommendation additionally references Recommendation ITU-R M.2084, *Radio Interface Standards of Vehicle-to-Vehicle and Vehicle-to-Infrastructure Two-Way Communications for Intelligent Transport System Applications* (Nov. 2019), which reports on ATIS, Europe's ETSI, So. Korea's TTA, and China's CCSA transposing and standardizing 3GPP's C-V2X technical specifications) and *Report* ITU-R M.2445, *Intelligent Transport Systems (ITS) Usage*, (Nov. 2018), reporting on the developments in and operations of C-V2X.

[4] *See* 5G Americas, *5G – The Future of IoT* at §2.8.3 (July 2019), https://www.5gamericas.org/wp-content/uploads/2019/07/5G_Americas_White_Paper_on_5G_IOT_FINAL_7.16.pdf ("5G – *The Future of IoT*").

[5] *Notice at* ¶ 5.

[6] *See., e.g.,* 5G Americas, *The 5G Evolution: 3GPP Releases 16 and 17* at 5, §2.3 (Jan. 2020), https://www.5gamericas.org/wp-content/uploads/2020/01/5G-Evolution-3GPP-R16-R17-FINAL.pdf.

services. 3GPP Release 16 will enable even more C-V2X services through 5G technology, by providing longer range, higher density of connected vehicles and other nodes (everything, or "X"), very high throughput and reliability, highly precise positioning and ultra low-latency (including through the use of the direct PC5 mode in the 5.9 GHz band). For instance, Rel-16 will reflect studies on communications involving micro-mobility vehicles like motorized scooters and skateboards.[7] Evolution in C-V2X is continuing with Release 17, which among its studies will review sidelink performance and spectral efficiency optimization for use over smartphones.[8] To support the promise of C-V2X, 5G Americas respectfully requests that the Commission change the rules for the 5.9 GHz band to allocate the entire band for C-V2X PC5. This allocation is essential to enabling both Basic C-V2X PC5 in the upper portion of the 5.9 GHz band and Advanced C-V2X PC5 using the lower 45 MHz portion of the band.

2. ADVANCES IN CONNECTED CAR TECHNOLOGY

C-V2X PC5 will further complement and enable connected car use cases, including eventually AV. The Commission seeks comment on how 5G systems fit into the overall connected vehicle ecosystem.[9] A connected car is equipped with internet access, and usually also with a wireless local area network. This allows the car to share internet access, and hence data, with other devices both inside and outside the vehicle. Connected cars will be enabled by 5G technology through Vehicle-to Everything or V2X technology, enabling direct communication between cars, buses, trucks, trains, roads, pedestrians and road infrastructure, our

[7] *See e.g.*, Qualcomm blog, https://www.qualcomm.com/news/onq/2019/12/13/3gpp-charts-next-chapter-5g-standards.
[8] *Id.*
[9] *Notice* at ¶ 30.

smartphones and other devices.[10] V2X[11] will offer advantages over technologies now appearing in high-end vehicles, such as radar, lidar, cameras, and other sensors. For one thing, V2X will offer greater range than on-board vehicle sensors and radar systems, allowing alerts of hazardous situations over much greater distances and thus much earlier, providing motorists with more time to react and prevent an accident.

In addition to the tremendous safety benefits of connected vehicles, they also promise to increase transportation options and reduce travel times. Traffic managers will be able to control the flow of traffic more easily with the advanced communications data available and prevent or lessen developing congestion. This could have a significant impact on the environment by helping to cut fuel consumption and reduce emissions.[12]

Connected cars are already contributing significantly to the bottom line of service providers. For example, by the fourth quarter of 2018, AT&T added more than 1.5 million cars to its network for the ninth straight quarter for a total of 32 million connected vehicles.[13] A year later, AT&T had 37 million connected vehicles operating on its network, including 32 million connected cars and an additional 5 million fleet vehicles.[14]

---

[10] *5G – The Future of IoT* at §2.8.3.
[11] 5G Americas, as an MRP partner of 3GPP, uses "V2X" interchangeably with "C-V2X" in these comments.
[12] The Commission recognizes at ¶ 67 of its *Notice* that in addition to improving traffic safety, the ITS service was envisioned as having the potential to decrease traffic congestion, facilitate the reduction of air pollution, and help conserve vital fossil fuels. 5G Americas is confident that C-V2X will deliver these social goods.
[13] *See* Kelly Hill, *Connected Cars are a 'Key Component' of AT&T's IoT Strategy*, RCR WIRELESS (Jan. 24, 2020), www.rcrwireless.com/20200124/internet-of-things/connected-cars-are-a-key-component-of-the-companys-iot-strategy.
[14] *See id*.

This growth rate is expected to continue.[15] Worldwide shipments of connected vehicles, which includes options for embedded and aftermarket cellular connectivity, are estimated to reach 51.1 million units in 2019, an increase of 45.4 percent over 2018.[16] By 2023, worldwide shipments are expected to reach 76.3 million units with a five-year compound annual growth rate (CAGR) of 16.8 percent.[17] The sustained growth of the connected vehicles market is being driven by a multitude of factors, including consumer demand for a more immersive vehicle experience, the ability of auto manufacturers to better utilize connected vehicles for cost avoidance and revenue generation, evolving government regulations, and mobile network operator investments in increased connectivity and services. The automotive ecosystem is positioning the vehicle as the next, emerging digital platform.[18]

Clearly, more than just mobile operators and automobile manufacturers are investing in connected car technology. Through an experimental license from the Commission, Qualcomm is using the 5.9 GHz band for an application of C-V2X PC5 in Virginia – working with Audi and the Virginia DOT to "alert cars to work zones and allow cars to receive countdowns to stoplight changes", such as an alert that there are five seconds until a light changes from red to green.[19] This initial deployment of C-V2X PC5 in 5.9 GHz is designed to focus on improving safety for construction workers and motorists.[20] The technology will deliver work zone warnings on

---

[15] *See, e.g., id.*; *see also* 5G – *The Future of IoT* at 43-45, § 2.8.
[16] Michael Shirer & Matt Arcaro, *Worldwide Connected Vehicle Shipments Forecast to Reach 76 Million Units by 2023, According to IDC*, IDC (May 23, 2019), https://www.idc.com/getdoc.jsp?containerId=prUS45092819.
[17] *Id*.
[18] *Id*.
[19] John Eggerton, *Pai Praises C-V2X Deployment*, MULTICHANNEL NEWS (Jan. 22, 2020), https://www.multichannel.com/news/pai-praises-c-v2x-deployment.
[20] Tracy Cozzens, *Audi, Qualcomm and Virginia DOT to Deploy C-V2X*, GPS WORLD (Jan. 24, 2020), https://www.gpsworld.com/audi-qualcomm-and-virginia-dot-to-deploy-c-v2x/.

highways as well as signal timing information on approaches to signalized intersections on arterial roadways. In both cases, C-V2X PC5 communications will deliver critical safety messages directly between vehicles and from vehicles to roadside infrastructure with minimal latency over 5.9 GHz, while less time-sensitive alerts are designed to be provided via C-V2X Uu interface using the cellular network.[21]

3. RELEASE 16

3GPP started Release16 New Radio ("NR") V2X to study an evaluation methodology for new V2X cases, with Radio Access Network ("RAN") Working Group 1 developing technical solutions supporting the 5G V2X use cases. The evaluation methodology encompasses simulation models as well as performance metrics.[22] The simulation models include:

• New sidelink channel models (used for V2V or V2P (vehicle-to-pedestrian)) extend those in LTE with additional modelling components such as blocking and moving scatterers.

• Deployment models including urban and highway scenarios with new vehicle dropping models (compared to Rel-14), including a clustered user equipment ("UE") dropping model for platooning; and

• Traffic models with a large degree of variation in terms of packet arrivals (including periodic and aperiodic), data rates, and packet sizes. In addition, mobile broadband (MBB) traffic is also being considered.[23]

Packet Reception Ratio (PRR) has served as a performance metric for reliability and latency since Rel-14, but has been redefined in Rel-16 to cover broadcast, multicast and unicast

[21] *Id*.
[22] 5G Americas white paper on *The 5G Evolution: 3GPP Releases 16-17*, at § 3.2.2.9 (January 2020).
[23] *Id*.

transmissions. Additional performance metrics such as Packet Inter-Reception (PIR) and absolute/relative positioning error have been introduced to evaluate persistent collisions as well as the accuracy of positioning-related features.

A new Release-16 study item on enhancing 5G NR to support PC5 C-V2X was started in June 2018 and completed in March 2019. 5G NR V2X will complement and interwork with LTE V2X by supporting more advanced use cases, grouped into four areas (three of which are predicated on the PC5 mode of direct communications). The four areas:

• Vehicle platooning, which is the ability of a group of vehicles traveling together to organize into a platoon, with a lead vehicle communicating directly with other vehicles in the platoon, thereby allowing for smaller intervehicle distances;

• Extended sensors, which allow for the exchange of sensor data and live video between vehicles, pedestrians, infrastructure units, and V2X application servers to extend the UE's perception of the surrounding environment;

• Advanced driving, which allows for automated or partially automated driving by exchanging sensor data and driving intention directly between vehicles so they can coordinate their trajectories;

• Remote driving (or teleoperation), which allows for a remote driver or V2X application to remotely drive a vehicle for passengers who can't drive themselves, or vehicles driven in dangerous environments. The main requirement for remote driving is 5G NR-based low-latency communication over cellular networks.

5G NR V2X targets lower latency, higher reliability, higher capacity, and better coverage than LTE V2X, and is intended to be future proof for future development of advanced V2X safety-enhancing services. To achieve these objectives, several enhancements are part of the 5G

NR Release-16 V2X work item.[24] New NR sidelink design should be considered future proof for further enhancements in upcoming releases, including in-network coverage, out-of-network coverage as well as partial network coverage. The sidelink design in Release 16 includes:

• Sidelink Physical Channels;

• Operation on dedicated carrier(s) or on carrier(s) shared with 5G NR cellular usage of user (Uu) and/or LTE Uu in licensed spectrum, in the same channel or adjacent channels;

• Operation in sub-6 GHz and mmWave spectrum. The primary focus of Release 16 C-V2X is sub-6 GHz;

• Support of sidelink unicast, sidelink groupcast and sidelink broadcast;

• Support of two resource allocation modes, that can be configured separately or simultaneously;

• Support of different synchronization mechanisms including sidelink synchronization channel, with the ability to select the synchronization reference;

• Support of TDM-based and FDM-based mechanisms for coexistence between LTE and NR sidelinks;

• Support of link adaptation with up to two antenna ports;

• Cross-Radio Access Technology Control: Downlink Control Indicator-based activation/deactivation of LTE sidelink using the NR Uu interface;

• UE reports to assist with Next Generation Node B (gNB) scheduling; and

• Quality-of-Service ("QoS") management of the radio interface.[25]

[24] 3GPP RP-190984, "5F V2X with NR Sidelink" (Work-item description) 23.
[25] 5G Evolution: 3GPP Releases 16 and 17 at § 3.2.2.9.

Performance requirements for enhanced C-V2X scenarios are defined in 3GPP Release 16 based on different levels of automation, such as driver assistance, partial automation, conditional automation, high automation and full automation.[26] With respect to AV connected vehicles, based on 3GPP Rel-16 specifications, a 5G system can support up to five user devices, or UEs, on a connected vehicle for a user group supporting V2X application. For vehicle platooning, the 5G system can support reliable V2V communications between a specific V2X UE and up to nineteen other V2X UEs and relative longitudinal position accuracy of less than 0.5 meters (m) for the Vehicle Platooning UEs in proximity.[27] In the case of advanced driving, the maximum allowable latency has to be small enough to ensure timely communication among vehicles in proximity. To coordinate among vehicles and to avoid collision, the maximum allowable end-to-end latency is 10 milliseconds ("ms"). In order to support emergent trajectory alignment among vehicles, only up to 3 ms end-to-end latency is allowed under Release 16.

In a 5G system, vehicle platooning has to ensure much higher reliability of the communication. In some cases, to support extended sensors, the minimum required communication range is much larger. A 5G system can provide up to 1-kilometer ("km") communication range when sensor information is shared among V2X UEs. For remote driving, a 5G system supports reliable and fast message exchange between a V2X UE and V2X application server over a mobile network. The moving speed of the V2X UEs is allowed to reach up to 250 km/hour. The maximum allowable end-to-end latency is required to be 5 ms and the reliability 99.999 percent.

4. RELEASE 17

[26] 5G Evolution: 3GPP Releases 16 and 17 at §3.2.3.
[27] *Id*. At 57.

Initial discussions on the content of 3GPP Release 17 began at the 84th Plenary Meeting of 3GPP RAN in June 2019 with the final decisions on Release 17 having occurred in December of 2019. Release 17 will consist of enhancements to Release-16 features, including massive multiple-input, multiple-output (MIMO), unlicensed access and Integrated Access Backhaul (IAB) as well an extension of operating spectrum beyond 52.6 GHz. Release 17 will also introduce support for new use cases, particularly for specific IoT use cases including V2X.[28]

Relative to C-V2X, under Release 17, a 5G system includes requirements to support various enhanced, proximity-based services, system architecture[29] and scenarios including those discussed above – vehicle platooning, advanced semi-automated or fully automated driving, sensor data exchanged among vehicles, RSU, application servers, pedestrian devices, remote, cloud-based driving, and dynamic notification of QoS support. For instance, the system architecture group at 3GPP has a Phase 2 work item for Release 17 on architecture enhancements for 3GPP support of advanced V2X services.

In addition, further enhancements and extensions to 5G NR PC5 communication (also known as sidelink) will be introduced as part of Release 17. The aim of these enhancements or extensions is to enhance sidelink communication for V2X and public-safety use cases in order to support requirements and operation scenarios not fully covered by the Release-16 sidelink, as well as to extend sidelink communication to new commercial use cases.[30] Key areas of enhancements include reduced device energy consumption To better support sidelink in battery-powered devices, Rel-17 will seek to provide sidelink power and spectral efficiency optimizations. Additionally, Release 17 will study how the Rel-16 sidelink can provide relay

[28] *The 5G Evolution: 3GPP Releases 16 and 17* at §3.2.3.
[29] *Id*. at §4.2.1.1.
[30] *The 5G Evolution: 3GPP Releases 16 and 17* at §3.2.3.5.

capabilities.[31] Release 17 can advantageously reuse the high-reliability and low-latency features of the NR cellular Uu interface and the advanced features of the sidelink interface developed for V2X applications.[32]

Broadcast/Multicast (BC/MC) functionality for NR will also be introduced in Release 17, including for V2X applications.[33]

5. TECHNICAL RULES FOR C-V2X

The Commission seeks comment on the technical rules that should apply to C-V2X in the 5.9 GHz band.[34] As an association dedicated to promoting the 3GPP family of standards, 5G Americas certainly supports allowing power limits and other technical rules for C-V2X provided in relevant 3GPP Releases. The Commission correctly notes that C-V2X is a standards-based communications system based on the 4G LTE-Pro system in 3GPP Release 14, and that additional standard work is currently underway to develop 5G C-V2X peer-to-peer mode.[35] As noted above, 3GPP members in Releases 15 through 17 have added or are exploring new functionality for C-V2X. 3GPP works on several Releases in parallel, starting future work well in advance of the completion of the current Release.

Because 5G Americas expects C-V2X technology to continue to evolve, it cautions the Commission against codifying any particular 3GPP Release into its revised Part 90 and Part 95 subparts.[36] Rather, we support revised power limits and out-of-band emission (OOBE) limits which will be necessary to enable C-V2X to operate without harmful interference.

---

[31] Qualcomm blog, supra at n. 8.
[32] *Id*.
[33] *Id*. at §3.2.3.11.
[34] *See, e.g.*, *Notice* at ¶ 38-52.
[35] *Id*. at ¶ 38.
[36] *See id*. at ¶ 44

The Commission notes that Fixed Satellite Services ("FSS") share the 5.9 GHz band with ITS, but that FSS use is limited to uplinks from earth stations that are typically located on the coasts, to transmit to international inter-continental systems with geosynchronous satellites located over the Atlantic or Pacific Ocean, and hence, there is very low potential for harmful interference at the FSS satellite from C-V2X operations.[37] 5G Americas agrees. Nonetheless, the Commission notes that ITS America and the Satellite Industry Association have stated that they developed a sharing protocol between DSRC and FSS operations.[38] The Commission seeks comment on whether it should codify this sharing protocol for required C-V2X coordination procedures, or whether it is sufficient to leave coordination under the purview of the interested parties.[39] 5G Americas submits that no formal coordination procedure need be incorporated into the Commission's rules, for the reasons the Commission states in its *Notice.* Given the limited number of FSS licensees, their largely coastal location to transmit to inter-continental satellites over the ocean, there is very low probability that C-V2X operations would create harmful interference to FSS operations in the band.

With respect to other non-federal services in the band, such as the secondary allocation to the Amateur Service, and the Industrial Medical Scientific operations permitted under Part 18,[40] 5G Americas agrees with the Commission that no additional rules are necessary to accommodate or protect co-channel C-V2X operations in the band.

6. CONCLUSION

[37] *Id*. at ¶ 50.
[38] *Id*.
[39] *Id*.
[40] *Id*. at ¶ 51.

Widely deployed C-V2X PC5 will enhance roadway safety and efficiency, and improve the environment, helping to us reclaim commute time for new activities in our lives. 5G Americas agrees with the Commission that changing the rules for 5.9 GHz to permit the use of C-V2X PC5 technology will ensure its rapid development and deployment, and of continually improving, transportation and vehicular safety-related applications now and into the future.[41] We further agree with the Commission that authorizing C-V2X PC5 in the 5.9 GHz band will achieve network effects necessary to maximize transportation and vehicular safety-related benefits; facilitate rapid development and deployment; enable improvements, learning, and upgrades; and be robust and secure.[42] For all the above reasons, 5G Americas urges the Commission to authorize C-V2X operations in the 5.9 GHz band in accordance with the technical proposals that 5GAA has submitted in April 2019 in GN Docket No. 18-357 and ET Docket No. 13-49.

Respectfully submitted,

Chris Pearson

5G AMERICAS
1750 112th Avenue NE, Suite B220
Bellevue, WA 98004

President of 5G Americas

[41] *Id*. at ¶ 24.
[42] *Id*.