February 3, 2017

<u>Ex Parte</u>

Marlene H. Dortch, Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Revision of Part 15 of the Commission's Rules to Permit Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band, ET Docket No. 13-49

Dear Ms. Dortch,

The 5.9 GHz band is the Commission's single best near-term opportunity to make additional unlicensed spectrum available for broadband services. No other band both holds such promise for consumers or presents a better environment for sharing with incumbent users. This is the case because the 5.9 GHz band is positioned immediately adjacent to an existing core band used by Wi-Fi, and commercial Dedicated Short Range Communications (DSRC) deployment has yet to begin. The time to act on opening a portion of this band for unlicensed is now, so that all parties, proponents of Wi-Fi and DSRC alike, have a clear understanding of the technical rules, channelization, and interference protection mechanisms before they deploy systems, particularly since the Commission has been considering this matter since 2013, when it issued the Notice of Proposed Rule Making on this subject.

Qualcomm, Broadcom, and NCTA – The Internet & Television Association (NCTA) strongly believe that the Commission can best achieve its goals of protecting important, emerging crash-avoidance technologies *and* meeting the exploding demand for Wi-Fi by rechannelizing the 5.9 GHz band. Rechannelization's core proposition—protecting latency-sensitive safety-critical services by moving them away from other traffic—is a clear and straightforward plan that will allow both uses of the band to thrive without any harmful interference.

In developing the rechannelization proposal, we have adopted a practical approach. All of our companies are fully committed to not causing harmful interference to latency-sensitive, safety-critical services, and we stand ready to continue applying our technical resources and expertise to ensuring that rechannelization succeeds. We therefore welcome the opportunity to address automakers' questions and concerns, some of which appear to rest on misunderstandings of the rechannelization approach, and to work with the Commission to resolve any issues it identifies in the testing process.

The automakers are asking the Commission to retain the existing DSRC band plan and make no changes to the DSRC rules, but this is neither a viable solution for Wi-Fi nor a sound long-term strategy for DSRC. The rechannelization approach, on the other hand, would give DSRC exclusive access to the 30 MHz at the upper end of the band for latency sensitive, safety-critical services. This approach also includes a well-developed sharing mechanism in the lower

45 MHz portion of the band that allows for both Wi-Fi and DSRC operations in those channels. But unlike detect-and-vacate, rechannelization would allow efficiency-enhancing sharing without requiring all Wi-Fi users to unnecessarily vacate the entire band for long periods of time whenever an access point detects a DSRC signal—even where DSRC is used for commercial purposes—as the automakers' approach requires. This aspect of the automakers' detect and vacate approach, as currently contemplated, would make the proposed U-NII-4 band effectively unusable for Wi-Fi. The automakers go so far as to argue that the FCC should apply this unworkable sharing approach to the upper portion of the current U-NII-3 band, presumably with the hope that the Commission will recall millions of consumer Wi-Fi devices already in the market or block the use of future devices. This is not a viable sharing approach.

With these goals in mind, this letter (1) discusses, in detail, recommended sharing mechanisms for the lower 45 MHz of the band, (2) clarifies the automakers' misconceptions about rechannelization, and (3) analyzes rechannelization's impact on co-channel, adjacent-channel, and DSRC-to-DSRC interference.

I. Wi-Fi and DSRC Sharing Mechanisms in the Bottom 45 MHz of U-NII-4

Qualcomm, Broadcom, and NCTA recommend that the Commission designate the upper 30 MHz of the U-NII-4 band exclusively for DSRC to accommodate latency-sensitive safety-critical signals and permit Wi-Fi to share the lower 45 MHz of the band with other DSRC services that are non-latency-sensitive such as e-commerce, informational, and entertainment applications.[1] As the Commission has recognized, the current DSRC rules designate two 10-MHz channels for safety-critical applications.[2] The rechannelization proposal provides three 10-MHz channels exclusively for safety-critical applications, thereby increasing the amount of spectrum reserved for safety signals, rather than decreasing channels as some automakers incorrectly assert.[3] Consequently, the rechannelization approach designates more than sufficient spectrum for latency-sensitive safety-critical systems.

Importantly, this approach eliminates any co-channel operation between latency-sensitive safety-critical DSRC operations and Wi-Fi. Less latency-sensitive DSRC operations can remain in the lower, shared 45 MHz, ensuring that the Intelligent Transportation Systems (ITS) industry would have exactly the same amount of spectrum available to it after rechannelization, despite

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1 The automakers' November 17, 2016 filing includes a number of incorrect statements about Qualcomm's technical expertise and its rechannelization proposal. *See* Letter from The Alliance of Automobile Manufacturers and the Association of Global Automakers, Inc., ET Docket No. 13-49 (filed Nov. 17, 2016) (Nov. 17 Letter). As the Commission well knows, Qualcomm has a long, distinguished record as a wireless technology innovator, developer, and provider of DSRC technology as well as 3G, 4G LTE and 5G and Wi-Fi, Bluetooth and other unlicensed technologies.

2 *See The Comm'n Seeks to Update and Refresh the Record in the "Unlicensed Nat'l Info. Infrastructure (U-NII) Devices in the 5 GHz Band" Proceeding*, Public Notice, 31 FCC Rcd 6130, 6133 (2016) (*Public Notice*); 47 C.F.R. § 95.1511(a).

3 *See Public Notice* at 6135.

automakers' claims to the contrary. Automakers and their ITS suppliers are free to determine which DSRC services will use which channel under this plan,[4] but they will always have exclusive use of three full channels where core crash-avoidance operations (i.e., latency-sensitive, safety-critical communications) may be placed that led the Commission to create the allocation more than a decade ago. Significantly, these operations are the only communications addressed by regulation in the pending Department of Transportation Notice of Proposed Rulemaking (DOT NPRM).[5]

NCTA is concerned that the central reason DSRC interests are working to exclude consumer broadband from the entire 5.9 GHz band is to keep control of 75 MHz of spectrum for commercial, non-safety applications, without participating in a spectrum auction and without any sharing responsibilities.[6] But while it may be legitimate for the Commission to grant this extraordinary privilege to core safety-critical operations, NCTA believes that the DSRC industry can and should design any and all DSRC commercial, informational, and e-commerce applications to share with Wi-Fi. The fact that these non-safety DSRC applications are neither addressed by the DOT NPRM nor even commercially available today makes such a design decision eminently achievable. Rechannelization proponents have identified two different methods for sharing between these DSRC operations and Wi-Fi using aligned 20 MHz channels

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[4] The automakers fault rechannelization proponents for failing to specify which DSRC channels or traffic would be moved to which of the three available channels in the upper 30 MHz under rechannelization. *See, e.g.*, Letter from Ari Q. Fitzgerald, Counsel, the Alliance of Automobile Manufacturers, *et al.*, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-29 at 3-4 (filed Apr. 14, 2016). At this time, applications that use basic safety message (BSM) transmissions are the only ones that are fully developed. We understand that these transmissions include latency sensitive communications and therefore recommend moving them to the upper 30 MHz via rechannelization. Rechannelization proponents submit that the DSRC industry is best positioned to determine which of their future applications should occupy the upper 30 MHz, including which latency-sensitive traffic should take place on which of the three exclusive-use 10 MHz channels. Broadcom has proposed one way that automakers might choose to use these channels to accommodate both the BSM and other potential future DSRC applications. *See* Comments of Broadcom Ltd. at 11-12, ET Docket No. 13-49 (filed July 7, 2016).

[5] Department of Transportation, National Highway Traffic Safety Administration, *Federal Motor Vehicle Safety Standards; V2V Communications*, Notice of Proposed Rulemaking, Docket No. NHTSA-2016-0126, 82 Fed. Reg. 3854 (Jan. 12, 2017).

[6] Reply Comments of the National Cable & Telecommunications Association on the Request to Update the U-NII-4 Band Record at 4-6, ET Docket No. 13-49 (filed July 22, 2016) (NCTA Record Refresh Comments); *see also* United States of America, *Proposed Text for Subsection 7.5*, INTERNATIONAL TELECOMMUNICATION UNION, Doc. 5A/216-E, at 10-14 (Oct. 31, 2016) (describing a host of commercial DSRC applications, including e-commerce and infotainment, wireless advertising, vehicle-to-infrastructure Internet connection, drive-thru payments, parking and other electronic payments, vehicle-to-vehicle messaging, and in-vehicle signage).

in the lower 45 MHz of the band, and recommend an out-of-band emission (OOBE) mask to protect latency-sensitive safety-critical signals in the top 30 MHz of the band, as detailed in the following sections.

A. Sharing without DSRC prioritization

The Commission has long since abandoned the practice of picking winners in the marketplace by gifting spectrum to particular companies or promoting one competing technology over another. Instead, the Commission has promoted efficiency and economic growth by allowing market forces, rather than the government, to decide how commercial spectrum will be used, either through spectrum auctions or by allowing open access on an unlicensed basis.[7] Proponents of the detect-and-vacate approach, however, would have the Commission reject that important policy by allowing DSRC to parlay a safety-critical band into preferential—or, in effect, exclusive—access to 75 MHz of spectrum. And they ask the FCC to allow them exclusive access to this band for non-latency-sensitive non-safety applications, including commercial applications that can use other bands.

The Commission should reject this gambit. The Commission can still provide DSRC with exclusive access to the spectrum it needs for latency-sensitive safety-critical applications by reserving the top 30 MHz of the band—more than enough reserved spectrum for those applications. This would leave 45 MHz for any and all other DSRC applications, including commercial and non-latency-sensitive safety applications, to share equally with Wi-Fi. NCTA believes that the FCC should not intervene in the market and choose one technology over another by granting DSRC priority over all other technologies in this lower portion of the band. An FCC decision to unreasonably, and inefficiently, subsidize non-safety and non-latency-sensitive commercial DSRC applications through the grant of such priority, at the expense of competing technologies, is exactly the sort of guaranteed-to-fail industrial policymaking that the Commission long ago abandoned. The rechannelization approach, with interference protections tailored to the licensee's legitimate protection needs, on the other hand, would protect all latency-sensitive safety applications, would be permissible under Part 15, and would advance, rather than undermine, modern FCC spectrum policy.

Under such rules, Wi-Fi systems would share fairly with DSRC using carrier-sense multiple access with clear-channel assessment (CSMA/CA) mechanisms, in aligned 20 MHz channels. Both technologies employ compatible implementations of CSMA/CA because both are based on the IEEE 802.11 standard that defines the CSMA/CA mechanism.[8] Using CSMA/CA, DSRC and Wi-Fi devices listen for traffic on the channel before transmitting. This involves two

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[7] *See generally* Fed. Commc'ns Comm'n, *Connecting America: The National Broadband Plan* at 5 (Mar. 17, 2010), https://transition.fcc.gov/national-broadband-plan/national-broadband-plan.pdf.

[8] IEEE Standard 802.11 § 10.3, *Part 11: Wireless LAN Medium Access Control (MAC) & Physical Layer (PHY) Specifications*, IEEE STANDARDS ASSOC. (Dec. 7, 2016) (IEEE 802.11); SAE J2945 § 5.2.1, *On-Board System Requirements for V2V Safety Communications*, SAE INTERNATIONAL (Mar. 2016) (SAE J2945).

related processes: preamble detection (PD), which 802.11 standards refer to as "carrier sense," and energy detection (ED). When possible, a device seeking to transmit will attempt to decode any message currently being transmitted to determine the value of the length field included in the header of each 802.11 message. This field allows the transmitting device to announce how long it will take to finish sending the current message. Any device listening will, accordingly, regard the channel as "busy" for that period of time, and avoid making any transmissions.[9] Because DSRC and Wi-Fi use compatible 802.11 frame structures, DSRC and Wi-Fi can use this approach to avoid mutual interference. This process is called preamble detection and occurs at -82 dBm in a 20 MHz bandwidth.

In other cases, however—for example, when there is significant noise—a device seeking to transmit may be unable to decode the 802.11 transmission, and therefore be unable to determine its length in advance. In this situation, the device will instead attempt to detect any energy present in the band in excess of a predetermined threshold energy level. This process is called Energy Detection (ED) and occurs at -62 dBm in a 20 MHz bandwidth. If there is energy in excess of this threshold, the device will regard the channel as "busy."[10] These two processes, ED and PD, are the "CS" in "CSMA/CA."

Once the "busy" period expires, a device seeking to transmit will continue to wait for a period of time in order to give other devices a fair opportunity to transmit. This period consists of both a fixed period, known as the interframe space, and a period of variable length, known as the contention window, which has a randomly chosen length between predetermined minimum and maximum values.[11] This "back-off" period minimizes the likelihood that multiple devices will begin transmitting simultaneously once the channel is no longer busy, which would cause interference to both devices. Instead, one device will typically begin transmitting first. Other devices will then (1) detect these transmissions, (2) wait to transmit until the channel is no longer busy, (3) observe the prescribed interframe space again, and (4) wait for the remaining portion of the previously determined contention window. This back-off process is referred to as "collision avoidance" and is the "CA" in "CSMA/CA."

This process allows Wi-Fi devices to share fairly with other Wi-Fi devices and can similarly enable fair sharing with DSRC without prioritization. It has been in the 802.11 standard since it was first adopted, hence all Wi-Fi products incorporate it. Since DSRC uses 802.11p, it also employs CSMA/CA.

B. Sharing with DSRC priority

Rechannelization advocates Qualcomm and Broadcom have identified a method that would prioritize DSRC messages in the lower portion of the band for Commission analysis, if the Commission decides to require such prioritization. This mechanism leverages a proven prioritization mechanism, called Enhanced Distributed Channel Access (EDCA), already built into the DSRC and Wi-Fi protocols, and requires only that DSRC and Wi-Fi operate in aligned

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9 IEEE 802.11 §§ 10.3.2, 17.3.2.1; *see* SAE J2945 § 5.2.1.

10 IEEE 802.11 § 10.3.2; *see* SAE J2945 § 5.2.1.

11 IEEE 802.11 § 10.3.4; *see* SAE J2945 § 5.2.1.

20 MHz channels. This prioritization approach would be a superior alternative to the detect-and-vacate mechanism. As noted above, rechannelization would make the lower portion of the band usable by Wi-Fi as well as non-latency sensitive DSRC messages. It does not require complete vacation of the band by Wi-Fi operations in favor of safety or non-safety DSRC signals (as the automakers demand). The approach described below instead provides priority to DSRC using well established technical mechanisms.

Today, EDCA would permit both DSRC and Wi-Fi to achieve sharing goals by modifying the default interframe space and contention windows—which 802.11 devices observe once a channel ceases to be busy—in order to provide different priority levels for various classes of traffic.[12] More specifically, 802.11 permits granting higher contention priority to higher-priority traffic through the use of a shorter interframe space, and smaller contention windows.[13] The result of establishing a shorter interframe space and smaller contention window for a particular class is that traffic of that class will enjoy superior contention status, compared to devices sending lower-priority traffic. Depending on the values used for a particular traffic class's EDCA parameters, that traffic class can have either an absolute (through shorter interframe spacing) or probabilistic (through smaller contention window) degree of priority over other classes.

Both Wi-Fi and DSRC already use four priority classes. From lowest to highest priority, these are AC_BK (background), AC_BE (best efforts), AC_VI (video), and AC_VO (voice). The names of these four classes represent examples of uses of different priority levels, but the classes are not otherwise constructed for those particular uses. It is more accurate to understand each of the four as graduated priority levels for any applications.[14]

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[12] The automakers acknowledge that DSRC currently uses EDCA to prioritize among different classes of DSRC service. *See* Nov. 17 Letter at 9 ("Under existing band usage rules, if one DSRC device is waiting to send a safety-of-life packet while another DSRC device is waiting to send a non-safety-of-life packet on the same channel, Enhanced Distributed Channel Access ('EDCA') mechanisms could be used to give the safety-of-life packet prioritized channel access, both reducing the probability of a packet collision and reducing latency.").

[13] IEEE 802.11 §§ 9.4.2.29, 10.22; *see* SAE J2945 § 5.2.1.

[14] Toyota appears to misunderstand this aspect of the EDCA system. It has suggested that—contrary to the overwhelming economic evidence—Wi-Fi in the 5.9 GHz band will not be a significant driver of economic growth and innovation, because at least some of it may be classified as "background" traffic. *See* Letter from Hillary Cain, Director, Technology and Innovation Policy, Toyota, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-49 at 2 (filed Dec. 14, 2016); *see also* Letter from Hillary Cain, Director, Technology and Innovation Policy, Toyota, to Marlene H. Dortch, Secretary, FCC, ET Docket No. 13-49 at 3 (filed Jan. 31, 2017) (Jan. 31 Letter). But this classification simply reflects the fact that it will be transmitted at a lower priority than some DSRC and perhaps also other Wi-Fi traffic, not that it is unimportant or valueless. In fact, most DSRC stakeholders already appear to agree with this assessment, given that DSRC also uses the "background" traffic class for certain messages, including certain BSMs. SAE J2945/1 § 6.3.4.

If the Commission determines to reserve the upper 30 MHz of the band for latency-sensitive safety-critical DSRC traffic and to require Wi-Fi to provide priority to DSRC in the lower 45 MHz, EDCA would facilitate such prioritization.[15]

Technical staff from DSRC and Wi-Fi companies could jointly determine the ideal values for these Wi-Fi EDCA parameters in the 5.9 GHz band if DSRC proponents provide specific latency requirements of DSRC traffic in the lower 45 MHz. Thus far, however, the DSRC industry's advocates have not provided such information. With encouragement from the Commission, stakeholders could identify the correct values for these priority levels. Wi-Fi proponents stand ready to further develop this concept and suggest appropriate priority levels, once given access to the appropriate DSRC devices. The Office of Engineering and Technology could also readily test sharing between Wi-Fi and DSRC using the default EDCA parameters and also with Wi-Fi parameters modified to further prioritize DSRC traffic with assistance from Qualcomm and Broadcom.

Note that, although DSRC and Wi-Fi are based on 802.11 standards, this would not prevent other technologies from also prioritizing DSRC traffic. The contention-based sharing protocol used in 802.11 is one proven sharing mechanism, but others may also be possible, such as a system that prescribes the length of time a non-802.11 system has to wait after sensing the medium before transmission is allowed.

C. Out-of-Band Emissions from the Lower 45 MHz into the Upper 30 MHz

Automakers have also raised concerns about out-of-band emissions from Wi-Fi operations in the lower 45 MHz of the U-NII-4 band into the upper, DSRC-only 30 MHz portion of the band. Qualcomm, Broadcom, and NCTA agree that the Commission should establish an OOBE mask to address this concern if testing determines that a mask will mitigate harmful interference into the upper 30 MHz from the adjacent shared channels. But the FCC should recognize that rechannelization would further *reduce* OOBE from Wi-Fi into the DSRC basic safety message (BSM) channel by increasing the spectral separation between Wi-Fi and the BSM. Under the current channelization scheme, the BSM is 5 MHz away from the top of the U-NII-3 band, which is critical for and heavily used by modern Wi-Fi systems. But under rechannelization, automakers can place BSM signals as many as 20 MHz away from any Wi-Fi operations, if they choose to use the uppermost channel, or 10 MHz away if they use the middle channel in the top 30 MHz.

The detect-and-vacate proposal, on the other hand, is a completely unworkable manner of reducing OOBE into the existing BSM channel. Detect-and-vacate would require that the FCC effectively increase the spectral separation between Wi-Fi and the BSM in channel 172 by

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[15] Alternatively, EDCA could prioritize crash-avoidance DSRC messages above all Wi-Fi traffic throughout the band, if DSRC and Wi-Fi use aligned 20 MHz channels, simply by selecting appropriate Wi-Fi EDCA parameters, although Qualcomm, Broadcom, and NCTA believe that rechannelization is the better path forward. For example, crash-avoidance DSRC operations could use the AC_VO DSRC traffic class while every class of Wi-Fi traffic could use longer interframe space parameters and contention windows.

forcing millions of existing Wi-Fi users in the top of *the U-NII-3 band* off the air whenever a DSRC signal is present in U-NII-4.[16] The automakers could not possibly be asking the Commission to recall millions of U-NII-3 Wi-Fi devices, and substantially reduce the performance of the devices that replace them by crippling U-NII-3. U-NII-3 is a crucial band for Wi-Fi and among the most economically valuable spectrum bands in the United States—especially taking into account the government's recent decision to terminate consideration of allowing Wi-Fi to operate in U-NII-2B.[17] The impact on U-NII-3 alone therefore renders the detect-and-vacate approach completely unworkable.

It is also important to recognize that the existing channelization plan permits DSRC operations—including commercial operations, and sometimes at significant power levels—directly adjacent to one another. Thus, it is important to ensure that any new Wi-Fi OOBE mask addresses interference levels above and beyond any OOBE interference concerns that exist under the current band plan. Finally, since adjacent channel interference depends not just on Wi-Fi transmitter characteristics but also on DSRC receiver characteristics, Commission test results should determine the real-world interplay between these performance characteristics.

II. The Automakers' Recent Filings Demonstrate a Misunderstanding of Key Features of the Rechannelization Proposal

A. Wi-Fi can readily distinguish DSRC messages from Wi-Fi messages

Automakers state that, for 20 MHz aligned messages, Wi-Fi messages will be indistinguishable from DSRC messages.[18] This is incorrect. While there is no single "DSRC bit" or "OCB bit" in the MAC frame of a DSRC transmission, distinguishing DSRC from Wi-Fi traffic can be accomplished by checking one MAC address field and the Frame Control field, as shown in the graphic below. For DSRC devices, the third address field will always be all 1s for a DSRC message, denoting a 'wildcard' BSSID (i.e., the message is intended for devices using *any* BSSID). To determine whether the 802.11 parameter "dot11OCBActivated" was set to "true" at

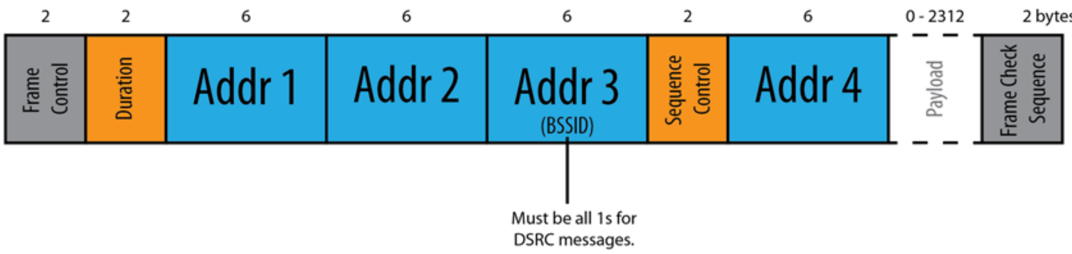
[16] Further Comments of Cisco Sys., Inc. at 3-4, ET Docket No. 13-49 (filed July 7, 2016).

[17] *See* Comments of the National Cable & Telecommunications Association on the Request to Update the U-NII-4 Band Record at 18-19, ET Docket No. 13-49 (filed July 7, 2016).

[18] *See* Nov. 17 Letter at Appendix at 15.

the sender,[19] a device can further verify the presence of an OCB packet by checking the Frame Control field at the beginning of the frame, which is used to identify the packet type.

802.11 MAC FRAME FORMAT



Identifying the MAC address and frame control fields does not require deep packet inspection. Accordingly, there is no ambiguity or delay associated with this detection method.

B. 20 MHz channelization will reduce DSRC congestion and improve the sharing environment

The automakers' recent filings take issue with rechannelization proponents' plan to use 20 MHz channelization in the lower 45 MHz.[20] However, DSRC's use of 20 MHz channels will reduce the congestion that may result from placing a large number of DSRC devices into a relatively confined road space. As research commissioned by NHTSA has confirmed, using 20 MHz-wide channels makes it possible to transmit a larger amount of information in a shorter amount of time which, in turn, reduces the odds of packet collisions and reduces the average amount of time that a device must wait for a clear channel before sending.[21] Indeed, the fact that DSRC successfully operates with 20 MHz channels is confirmed by the fact that DSRC already supports 20 MHz channels.[22]

Moreover, when both DSRC and Wi-Fi use aligned 20 MHz channels, they will be able to detect preambles equally, improving the sharing environment. Using mismatched channel sizes would require Wi-Fi devices to rely on energy detection to share with DSRC transmissions, while using aligned 20 MHz channels supports superior detection and sharing capabilities as described in sections I.A and I.B, above.

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19 *See* IEEE 802.11 §§ 4.3.11, 8.2.4.3.4, 8.3.2.1, E.2.3.

20 Nov. 17 Letter at 4; *see also* Jan. 31 Letter at 1.

21 *See* Booz Allen Hamilton, *Dev. of DSRC Device & Commc'n Sys. Performance Measures: Recommendations for DSRC OBE Performance & Sec. Requirements*, DEP'T OF TRANSP., FHWA-JPO-17-483 at 167-168 (May 2016) (DSRC Performance Report).

22 ATSM E2213–03 at 10, *Standard Specification for Telecomms. & Info. Exch. Between Roadside & Vehicle Sys – 5 GHz Band Dedicated Short Range Comm'ns (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications*, ASTM INT'L (2010).

C. Wi-Fi can detect DSRC on both primary and secondary channels

The automakers' assertion that Wi-Fi can adequately detect DSRC signals only on one 20 MHz channel at a time is also incorrect.[23] While the base 802.11 standard defines only one primary channel at a time, this does not produce the result the automakers suggest. Applying that standard, a Wi-Fi device would first sense the primary 20 MHz channel via preamble detection clear channel access (CCA), and then sense the secondary channel. CCA thresholds for primary and secondary channels are provided in the table below. A device may transmit on its primary channel when the primary channel is idle or transmit on a wider channel (e.g., 40 or 80 MHz) when both the primary and secondary channels are idle.

802.11 CCA THRESHOLDS FOR PRIMARY & SECONDARY CHANNEL DETECTION

Channel width	Threshold (primary)	Threshold (secondary)
20 MHz	-82 dBm	-72 dBm
40 MHz	-79 dBm	-72 dBm
80 MHz	-76 dBm	-69 dBm

Using these specifications, a Wi-Fi device seeking to use the 40 MHz wide channel 175 would treat channel 173 as the primary 20 MHz channel. The device would also sense for activity on channel 177 using a preamble detection level of -72 dBm before operating on channel 175. Thus, while preamble detection in the secondary channel currently operates at a different sensitivity to the primary channel, the Wi-Fi device could be required to transmit only in the primary channel if it senses DSRC traffic in the secondary channel. Moreover, many existing Wi-Fi devices using certain vendor implementations have the ability to detect 20 MHz DSRC traffic in both primary and secondary channels simultaneously at very low preamble detection levels, beyond the base standard's requirements. The Commission could make this currently available capability a U-NII-4 operational requirement if it is deemed necessary to protect DSRC.

III. Rechannelization Provides the Best Interference Protection for Latency-Sensitive Safety-Critical Communications

In a recent *ex parte*, automakers claimed that rechannelization creates new interference concerns that "must be thoroughly tested and recognized."[24] Most of these "new" or

[23] As an initial matter, simultaneous detection of 20 MHz DSRC traffic on both channel 173 and channel 177 would only be necessary when Wi-Fi is using both channels. In cases where both 20 MHz DSRC channels overlap with Wi-Fi channels, DSRC traffic on both channels will need to be detected.

[24] Nov. 17 Letter at 2.

"exacerbated" sources of interference are neither new nor made more serious by the relocation of latency-sensitive safety-critical DSRC safety operations to the upper portion of the band. And, none is an impediment to adopting the rechannelization approach.

A. Co-channel interference

Automakers first claim that DSRC would face exacerbated co-channel interference from other licensed users in the upper 30 MHz of the band under the rechannelization plan.[25] This claim does not withstand scrutiny. As automakers have known since they began DSRC research nearly two decades ago, federal radar and satellite earth station licensees will operate co-channel with DSRC throughout the 5.9 GHz band.[26] DSRC supporters have repeatedly assured the Commission that safety-critical services can operate under those conditions.[27] Rechannelization should not change automakers' confidence in those assurances.

Federal radar. Rechannelization *improves* the interference environment for DSRC with regard to federal radar systems because it allows placement of the BSM channel above 5900 MHz. In this band, federal radar operations "are primarily military systems that can tune across the entire 5400-5900 MHz frequency range."[28] Before the Commission adopted the DSRC rules, NTIA performed an extensive study for the Federal Highway Administration of spectrum occupancy by federal radar and other users in and around the 5.9 GHz band.[29] NTIA's measurements showed that radar interference in the 5.9 GHz band comes primarily from

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25 *Id.* at 2, Appendix at 9.

26 It appears that one CF licensee (at 5874.85 MHz) and one AR licensee (at 5400-5900 MHz) have been licensed to operate in the 5.9 GHz band despite the lack of an allocation for those services. *See* ULS Call Sign KPZ82; ULS Call Sign WQMN904. Like the allocated services discussed here, DSRC companies should have already factored these existing licensees into DSRC design and, for similar reasons discussed infra with respect to federal radar, rechannelization increases spectral separation from these localized sources of interference.

27 *See, e.g.*, Petition of the Intelligent Transp. Society of Am. for Amendment of the Comm'ns Rules to Add Intelligent Transp. Servs. (ITS) as a New Mobile Serv. with Co-Primary Status in the 5.850-5.925 GHz Band at 47-49, ET Docket No. 98-95 (filed May 19, 1997) ("Given the nature of DoD emitters in this band, suitable mitigation techniques (e.g. filters and overpower protection) should alleviate any concerns. . . . Interference studies indicate that DSRC systems can co-exist with all existing users with employment of currently available mitigation techniques."); *Pleading Cycle Established for Comments and Reply Comments on Petition for Rule Making Filed by Intelligent Transp. Society of Am.*, Public Notice, 12 FCC Rcd 6766 (1997).

28 *See* Rebecca Blank & Lawrence E. Strickling, *Evaluation of the 5350-5470 MHz and 5850-5925 MHz Bands Pursuant to Section 6406(b) of the Middle Class Tax Relief and Job Creation Act of 2012*, DEP'T OF COMMERCE at 5-2 (Jan. 2013).

29 *See* Frank H. Sanders, *Measured Occupancy of 5850-5925 MHz and Adjacent 5-GHz Spectrum in the United States*, DEP'T OF COMMERCE, NTIA Report 00-373, (Dec. 1999) (NTIA Report).

"spurious emissions from radars tuned below 5850 MHz, and emissions from radars tuned to frequencies within the 5850-5925 MHz band,"[30] which is the entire DSRC band.

To avoid interference from spurious emissions, NTIA recommended that DSRC systems incorporate front-end preselection (bandpass filtering) to reject 5 GHz emissions occurring at frequencies just below the DSRC band.[31] Moving latency-sensitive safety-critical operations to the upper portion of the band reduces the interference risk caused by those spurious emissions by increasing spectral separation from those sub-5850 MHz interference sources. Rechannelization also reduces the interference risk from co-channel federal radars for similar reasons. Because most federal radars are systems that can tune across the 5400-5900 MHz frequency range, safety operations in the upper 30 MHz are likely to be better protected from federal radar than co-channel operations in the lower part of the band, as only one of three safety channels would be co-channel with federal radar.

Satellite earth stations. The 5.9 GHz band is also "lightly-used" for non-federal fixed satellite operations.[32] These uplinks are "limited to international inter-continental systems and . . . subject to case-by-case electromagnetic compatibility analysis"[33] and are "located primarily on the Atlantic and Pacific coasts and point[] out over the oceans."[34] These operations have been a fact of the 5.9 GHz band since the DSRC allocation was first adopted.[35] The Commission found that fixed satellite service operations were no impediment to DSRC deployment, in part because "no commenters question[ed] the spectrum sharing feasibility of FSS operations and DSRC operations."[36] That unanimity was no surprise because, as NTIA has explained, "the maximum effective radiated power (ERP) values from such stations are directed at space, and not toward the terrestrial surface, where new DSRC systems are expected to be deployed."[37] NTIA measurements taken near one of these stations showed that "the maximum incident field strength at the nearest possible approach to an earth station by a motor vehicle is about +70

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30 *Id.* at 18.

31 *Id.* at 28.

32 *Revision of Part 15 of the Comm'ns Rules to Permit Unlicensed Nat'l Info. Infrastructure (U-NII) Devices in the 5 GHz Band*, Notice of Proposed Rulemaking, 28 FCC Rcd 1769, ¶ 90 (2013).

33 *Id*.

34 Comments of Intelligent Transportation Society of America at 11, ET Docket No. 13-49 (filed May 28, 2013) (ITS America Comments); *see Amendment of Parts 2 & 90 of the Comm'ns Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Serv. for Dedicated Short Range Commc'ns of Intelligent Transp. Servs.*, Report and Order, 14 FCC Rcd 18,221 (1999) (1999 Order).

35 ITS America Comments at 11; *see generally* 1999 Order.

36 1999 Order, ¶ 15.

37 NTIA Report at 27.

dBµV/m at frequencies of about 5.9 GHz"—a level comparable to the maximum levels of radar spurious emissions in the 5850-5925 MHz band.[38]

The vast majority of these co-channel earth stations operate in bands that start at 5850 MHz, but in many cases end below 5895 MHz. As a result, there will be more FSS operations in the lower portion of the band than the upper, assuming that these licensees actually occupy the entire band that they are authorized to use. DSRC interests have or should have already tested this existing interference and accounted for it in design decisions, and there is no reason to believe rechannelization would exacerbate the impact of FSS.

B. Adjacent-channel interference.

Automakers next claim that rechannelization exacerbates adjacent-channel interference to DSRC from licensees operating in the band above 5925 MHz. Again, examining the actual source of that interference shows that automakers' concerns are rhetoric rather than reality.

Like co-channel FSS operations, DSRC has expected C-Band uplink operations above the 5.9 GHz band to operate alongside DSRC from day one. In previous proceedings, DSRC advocates, including ITS America, repeatedly assured the Commission that out-of-band emissions from C-band operations had been considered and mitigated in the DSRC standards process.[39] As has always been the case, these operations are unlikely to cause significant harmful interference to DSRC because of antenna directionality and the location of satellite installations.

Likewise, there are a very limited number of cases in which fixed systems would cause interference due to antenna off axis attenuation both vertically and horizontally. Unless co-aligned, these highly directional systems do not cause significant interference. This will be rare because while fixed stations are typically about 60 meters tall, DSRC receivers typically will be between 1.5 and 15 meters above the ground.[40] In backing away from their assertions that DSRC can coexist with adjacent incumbents, the automakers have offered no data to suggest that adjacent operations pose a greater threat under rechannelization than under the current band plan.

C. Cross-channel DSRC interference.

Increased traffic volume. Automakers also assert that DSRC will face exacerbated cross-channel interference under rechannelization because of potentially higher volumes of: (1) safety

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[38] *Id.* at 25.

[39] *See Amendment of the Comm'ns Rules Regarding Dedicated Short-Range Commc'ns Servs. in the 5.850-5.925 GHz Band*, Report and Order, 19 FCC Rcd 2458, ¶ 77 (2004).

[40] Report ITU-R F.2240, *Interference analysis modelling for sharing between HAPS gateway links in the fixed service and other systems/services in the range 5 850-7 075 MHz* (Nov. 2011) (see Table 17); *see also* Annex 20 to Joint Task Group 4-5-6-7 Chairman's Report, DRAFT NEW REPORT ITU-R F.[IMT-FS 5 925-6 425 MHz SHARING], *Sharing and compatibility study between indoor International Mobile Telecommunication small cells and fixed service stations in the 5 925-6 425 MHz frequency band* (Aug. 2014) (see Table 3).

communications in any given channel, and (2) traffic on adjacent channels. In raising this concern, automakers assume that rechannelization would compress DSRC traffic into fewer channels. That is incorrect.

Rechannelization relocates only a limited class of services that require special interference protection: latency-sensitive safety-critical services. The BSM is the only service meeting those criteria that DSRC developers have advanced enough to begin deployment, and the only service contemplated by the DOT NPRM. No company has proposed that other possible DSRC offerings—entertainment, telemetry, e-commerce, or the other elements of the automakers' commercial plans for the band—must be moved into the upper portion of the band.

The current DSRC band plan designates two channels, channels 172 and 184, for public safety uses.[41] The ITS community determined long before U-NII-4 sharing was proposed that all BSM traffic would share channel 172.[42] Moving that traffic to a different frequency location should have no impact on congestion. BSM traffic can operate with exactly the same channel space planned for BSMs today and still leave room on two additional channels for operations that may be developed in the future. That being the case, it is not clear why the automakers believe that there should be a higher volume of safety traffic in a given channel. Rechannelization still allows the automakers 75 MHz of spectrum in which to operate; moving all of the most latency-sensitive traffic to the top 30 MHz does not change the volume of latency-sensitive safety-critical traffic.

Differentiation. For similar reasons, rechannelization does not prevent the differentiation of different classes of DSRC traffic. Both Wi-Fi and DSRC employ the same set of four EDCA priority classes. The Automakers' argument on this point is vague, but its filing provides no reason why four classes would be insufficient. However, if needed, prioritization can be further refined using changes to contention windows, inter-frame spaces, and other factors. If automakers' concern is that the four traffic classes will not be sufficient to prioritize both Wi-Fi and DSRC traffic in the same channel with sufficient granularity, this can be addressed by using different EDCA parameters for DSRC and Wi-Fi, which provides higher priority for DSRC.[43]

On the other hand, if the automakers' concern is the ability to prioritize different types of DSRC traffic in the top 30 MHz, these concerns are also unfounded. Simply moving BSM traffic to a channel in the top 30 MHz of the band would have no effect on devices' ability to prioritize these messages. The contention environment in this channel will be identical to the environment that would have existed in channel 172. And increasing the homogeneity of traffic in other channels in the top 30 MHz of the band will increase, not decrease, manufacturers' ability to

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[41] *Public Notice* at 6133.

[42] *See* John Harding et al., *Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application*, NAT'L HIGHWAY TRAFFIC & SAFETY ADMIN., DOT HS 812 014 at 93-94 (Aug. 2014) (noting that a "dedicated channel for the BSM" is required).

[43] *See* Section I above for a detailed discussion of these parameters, how they could be changed, and how they relate to traffic priority.

differentially prioritize between different latency-sensitive safety applications by eliminating the need to also prioritize these applications relative to non-safety traffic in the channel.

Separation distances. Additionally, automakers also claim that DSRC would face exacerbated cross-channel DSRC interference as a result of moving the lower-power vehicle-to-vehicle (V2V) traffic currently on channel 172 closer to the higher-power control or vehicle-to-infrastructure traffic at the top of the band. As a threshold matter, some of these concerns appear to turn on the misunderstanding that rechannelization would restrict all safety communications to three channels. As explained above, the rechannelization proposal only recommends relocating latency-sensitive safety-critical operations. Many of the examples the automakers list are not latency-sensitive and thus can operate in other DSRC channels.[44]

In order to fully evaluate this concern, the Commission must first evaluate DSRC self-interference under the *existing* channelization scheme. And, under the existing rules, DSRC self-interference is already a significant challenge. Research commissioned by NHTSA suggests that congestion is likely to present a major problem for DSRC, including the BSM, as the system is currently conceived.[45] And as Qualcomm has previously explained, transmissions on channel 184, if DSRC interests ultimately implement their plans to use it, will block the reception of a BSM on channel 172 (or any other DSRC message) by the second radio in the same device.

Automakers point to a CAMP study that, they claim, establishes that there will be no self-interference from channel 184 under the existing channel plan.[46] But the study shows nothing of the sort. First, the cited study does not address interference from channel 184 to the BSM. This is likely because widespread use of channel 184 remains hypothetical. DSRC interests base their claimed spectrum needs on widespread deployment of applications that are still in early planning stages today.

Second, for the channels it does examine, the CAMP study—consistent with other NHTSA-sponsored research[47]—indicates that DSRC will experience crippling self-interference under the existing channel plan. For example, the study reveals that a DSRC device transmitting on channel 178—the greatest spectral separation to channel 172 that was tested—will cause the complete loss of BSM traffic, a packet error rate of 100%, at ranges of more than 200 meters when an interfering signal 2.5 meters away transmits at a power level only 10 dB higher than the BSM.[48] The high-power operations that DSRC interests envision in channel 184—if they are ever widely deployed—will likely exceed BSM transmit power by far more than 10 dB. Thus, the CAMP study, instead of supporting automakers' claims, actually shows that rechannelization

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[44] *See* Nov. 17 Letter at Appendix at 10.

[45] DSRC Performance Report at 74, 160.

[46] *See* Nov. 17 Letter at Appendix at 11.

[47] DSRC Performance Report at 74, 160.

[48] Vinuth Rai et al., *Cross-Channel Interference Test Results: A Report from the VSC-A Project*, Document IEEE 802.11 11-07-2133-00-000p at 14 (July 2007), https://mentor.ieee.org/802.11/dcn/07/11-07-2133-00-000p-cross-channel-interference-testresults-a-report-from-the-vsc-a-project.ppt.

will not exacerbate the substantial DSRC self-interference problems already inherent in DSRC's existing architecture.

IV. Conclusion

Qualcomm, Broadcom, and NCTA applaud the Commission for its continued pursuit of a plan to provide consumers more benefit from the 5.9 GHz band. We remain confident that Wi-Fi and DSRC can share the lower portion of this critical band in a way that brings the spectrum into meaningful commercial use, while ensuring that the automakers can rely on the band for future DSRC applications.

Sincerely,

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