Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

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

FURTHER REPLY COMMENTS OF CISCO SYSTEMS, INC.

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EXECUTIVE SUMMARY

The comments filed in response to the Commission's June 1, 2016 Public Notice confirm that there is substantial support in the automotive industry for Cisco's "detect and vacate" approach to sharing in the 5.9 GHz band between U-NII-4 devices and Dedicated Short Range Communications ("DSRC"). Conversely, a variety of interests have expressed considerable opposition to the rechannelization proposal in the Public Notice. Ultimately, however, the problem before the Commission remains the same: rechannelization's proponents have not submitted the technical details necessary for a full evaluation of the merits of rechannelization, and for development of a test plan that would determine how rechannelization will perform and how it will impact DSRC.

Cisco wishes to clarify that it does not oppose the idea of setting the upper 30 MHz of the 5.9 GHz band aside for DSRC, provided that 10 MHz channelization is preserved in the 5.9 GHz spectrum. U-NII-4 devices will not transmit above 5895 MHz in any case. Cisco also generally endorses the concept of technological neutrality and therefore believes that U-NII-4 operations should be afforded the flexibility to select whichever technology best achieves their business objectives, provided that U-NII-4 devices remain obligated to protect DSRC operations from interference.

By the same token, the record reaffirms that rechannelization is fraught with difficulty. A principal advantage of "detect and vacate" is that it would require no change to the existing 5.9 GHz band plan, and thus would allow planned and future DSRC deployments to move forward without redesign of equipment, while maintaining consistency with the DSRC band plan in Europe (which is based on 10 MHz channelization). Rechannelization, on the other hand, would require Basic Safety Messaging ("BSM") Channel 172 to be moved to the upper 30 MHz of the 5.9 GHz, adjacent to higher powered channels. Rechannelization's proponents treat this as relatively insignificant, when in fact moving Channel 172 to a slot where it will be adjacent to at least one higher power channel plainly has far different interference consequences than leaving Channel 172 where it is.

Also, rechannelizing the 5.9 GHz band is not, as Qualcomm would have it, merely a software fix. Moving lower power BSM Channel 172 next to higher power channels will require new DSRC receiver filters. The cost of that filtering is unknown, in part because it remains unclear exactly where Channel 172 will be placed in the upper 30 MHz of the 5.9 GHz band. And, given the absence of a guard band between the upper 30 MHz and lower 40 MHz of the rechannelized spectrum, the Commission and rechannelization's proponents must still confront whether safety-related communications in the upper 30 MHz could function with a "hard" OOBE emissions limit vis-à-vis U-NII-4 devices in the lower 45 MHz, and vice-versa.

In its initial comments on the Public Notice, Cisco advised that its then-current proposal would not be its "last and final" submission on the subject. Accordingly, attached hereto is a

modified version of Cisco's proposal, which is intended to address any lingering concerns that "detect and vacate" will not be robust enough to protect DSRC from interference. Otherwise, the general criticisms in the record of "detect and vacate" are either inapposite or unsupported. For example, adoption of Cisco's proposal will not require an amendment to the IEEE 802.11ac standard, and Cisco has yet to see any engineering studies supporting the claim that, under "detect and vacate," "DSRC vehicles will prevent unlicensed users from accessing the entire U-NII-4 band within vehicles and in and around homes and businesses up to several hundred meters away from DSRC communications." Equally unsupported are claims that "detect and vacate" (1) effectively leaves too large a guard band between DSRC and U-NII operations, and (2) provides significantly more temporal isolation than necessary. Lastly, rechannelization's proponents have understated the amount of testing that will be required to verify the efficacy of rechannelization, and overstated the amount of testing that will be required to verify the efficacy of "detect and vacate."

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FURTHER REPLY COMMENTS OF CISCO SYSTEMS, INC.

Cisco Systems, Inc. ("Cisco") hereby submits its reply comments in response to the Commission's June 1, 2016 Public Notice asking interested parties to update and refresh the record on potential sharing solutions for U-NII-4 devices and Dedicated Short Range Communications ("DSRC") in the 5.850-5.925 GHz ("5.9 GHz") band.[1]

I. INTRODUCTION

The comments filed in response to the Public Notice reflect substantial support within the automotive industry for Cisco's "detect and vacate" approach to sharing in the 5.9 GHz band. For example, the Alliance of Automobile Manufacturers, Association of Global Automakers, Intelligent Transportation Society of America and DENSO International America, Inc. observed that "detect and vacate" (also referred to in the record as "detect and avoid") "is the most promising sharing solution because it is designed to work around DSRC operations and allow the spectrum to be used for U-NII operations only when and where DSRC devices are not operating. . . . [C]urrently deployed DSRC applications, vehicles, and RSUs would not need to be

[1] *The Commission Seeks to Update and Refresh the Record in the "Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band" Proceeding*, Public Notice, FCC 16-68, (rel. June 1, 2016) ("Public Notice").

reconfigured or abandoned."[2] Toyota Motor Corporation asserts that "detect and vacate" "has the best chance of avoiding harmful interference to DSRC operations. . . . [I]t is a proven, low-risk sharing approach."[3] General Motors Company believes that the "detect and vacate" approach "potentially presents a promising pathway to support DSRC and its safety-critical communications."[4]

Conversely, a variety of interests have expressed considerable opposition to the rechannelization proposal in the Public Notice. The Washington State Department of Transportation states that "re-channelization of the 5.9 GHz DSRC spectrum will essentially damage or severely delay the future of much safer traffic and the promise of V2V, V2I and V2P."[5] Similarly, Panasonic Corporation observes that "re-channelization of the 5.9 GHz DSRC spectrum will significantly impair the ability of V2X systems to avoid accidents – thus saving lives – and impede the deployment of efficient transportation solutions."[6] The Motor & Equipment Manufacturers Association is equally direct: "Rechannelization would . . . result in significant re-design, re-testing and re-validation – making all of the progress [with DSRC] so far futile. Such a set-back is unacceptable and would thwart all of the R&D and planned

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[2] Comments of the Alliance of Automobile Manufacturers et al., ET Docket No. 13-49, at 26 (filed July 7, 2016) ("Alliance Comments").

[3] Comments of the Toyota Motor Corporation, ET Docket No. 13-49, at 1 (filed July 7, 2016) ("Toyota Comments").

[4] Comments of General Motors Company, ET Docket No. 13-49, at 5-6 (filed July 6, 2016) ("GM Comments"). *See also* Comments of Ford Motor Company, ET Docket No. 13-49, at 2 (filed July 7, 2016) ("Ford Comments"); Comments of the Car 2 Car Communications Consortium, ET Docket No. 13-49, at 2-3 (filed July 7, 2016) ("Car 2 Car Comments"); Comments of the Truck & Engine Manufacturers Association, ET Docket No. 13-49, at 2 (filed July 7, 2016) (endorsing Alliance Comments).

[5] Comments of Washington State Department of Transportation, ET Docket No. 13-49, at 3 (filed July 7, 2016).

[6] Comments of Panasonic Corporation of North America, ET Docket No. 13-49, at 5 (filed July 7, 2016).

deployments [of DSRC]. . . . At the very moment when the transportation sector is about to unleash revolutionary technologies that will make transportation safer and more efficient, it makes no sense for the FCC to issue a new channel plan for 5.9 GHz."[7]

With that summary as background, the problem before the Commission remains the same: rechannelization's proponents have not submitted the technical details necessary for a full evaluation of the merits of rechannelization and for development of a test plan that would determine how rechannelization will perform and how it will impact DSRC. Cisco is disappointed that the initial round of comments still leaves many questions unanswered. The simple fact is that DSRC is an incumbent service, and those seeking to share with it bear the burden of articulating a plan for how DSRC will function in the future – with sufficient specificity to enable Commission staff to design a relevant test plan. To date the rechannelization proposal fails to specify which DSRC channels will be moved, fails to provide even a calculation that Basic Safety Message ("BSM") channel (Channel 172) can operate without harmful interference (which appears to be a challenge given the absence of a guard band), and does not specify a prioritization technique for the two 20 MHz channels that rechannelization advocates wish to create for DSRC. In sum, the comment round provided no additional information in support of the rechannelization argument relative to what was previously known. The Commission – and the interested parties on the transportation side – are left with promises that rechannelization will work and not even an inkling of how prototype technology has been designed to operate.

Cisco's overriding objective remains the same, *i.e.*, to work with interested parties to identify a feasible, mutually acceptable approach to U-NII-4/DSRC sharing at 5.9 GHz. Subject

[7] Comments of the Motor & Equipment Manufacturers Association, ET Docket No. 13-49, at 5 (field July 7, 2016). *See also* Comments of Ubiquiti Networks, Inc., ET Docket No. 13-49, at 6-8 (filed July 7, 2016); Alliance Comments at 26-27; Toyota Comments at 7-13; GM Comments at 6; Car 2 Car Comments at 2-3; Ford Comments at 2-3.

to the modifications discussed herein, Cisco continues to believe that its "detect and vacate" proposal is the optimal solution. Cisco looks forward to reviewing and commenting on any technical studies submitted by other parties who believe otherwise.

II. DISCUSSION

A. RECHANNELIZATION LACKS DEFINITION

To review, the proposed rechannelization plan would reconfigure the 5.9 GHz band by reserving the upper 30 MHz for three contiguous 10 MHz channels (*i.e.*, Channels 180, 182 and 184) that would be used exclusively for safety-related DSRC communications. Rechannelization's proponents have asked the Commission to move the low-power BSM Channel 172 and the DSRC control channel (Channel 178) to the upper 30 MHz of the rechannelized band, such that they would be next to the higher powered public safety Channel 184.[8] The remaining four 10 MHz DSRC service channels below 5895 MHz would be consolidated into two 20 MHz channels that would be shared by U-NII-4 devices and DSRC.

As an initial matter, Cisco wishes to clarify that it does not oppose the idea of setting the upper 30 MHz of the 5.9 GHz band aside for DSRC, provided that 10 MHz channelization is preserved throughout the entire 5.9 GHz spectrum (excluding the guard band spectrum at 5850-5855 MHz). U-NII-4 devices will not transmit above 5895 MHz in any case.[9] Cisco also generally endorses the concept of technological neutrality and therefore believes that U-NII-4 operations should be afforded the flexibility to select whichever technology best achieves their

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[8] *See* Comments of Qualcomm Incorporated, ET Docket No. 13-49, at 4-5 (filed July 7, 2016) ("Qualcomm Comments").

[9] *See* Further Comments of Cisco Systems, Inc., ET Docket No. 13-49, at 14 (filed July 7, 2016) ("Cisco Comments").

business objectives, provided that U-NII-4 devices remain obligated to protect DSRC operations from harmful interference.[10]

The fact remains, however, that the automotive industry and others have warned the Commission about the highly disruptive impact rechannelization of the 5.9 GHz band would have on DSRC deployments and the substantial investments being made towards bringing DSRC to market.[11] By contrast, a principal advantage of "detect and vacate" is that it would require no change to the existing 5.9 GHz band plan, and thus would allow planned and future DSRC deployments to move forward without redesign of equipment, while maintaining consistency with the DSRC band plan in Europe (which is based on 10 MHz channelization).[12]

Qualcomm nonetheless asserts that "[r]echannelization can be achieved without any changes to DSRC chipsets or related hardware."[13] Further, Qualcomm claims that "radio characteristics of DSRC band transmission are relatively uniform across the 75 MHz-wide DSRC band . . . . Hence, the channel and radio behavior of channel 172 is similar to the channels in the upper portion of the DSRC band"[14]

There are difficulties with Qualcomm's argument. Channel 172 is a lower power channel that presently is not adjacent to any higher power channels in the 5.9 GHz band. Hence, moving

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[10] *See* Comments of Ericsson, ET Docket No. 13-49, at 2 (filed July 7, 2016) (urging the Commission to expand access to the U-NII-4 band on a technology-neutral basis "with access to the band open to any technology that meets the Commission's U-NII rules").

[11] *See supra* notes 5-7 and the comments cited therein. *See also* Alliance Comments at 13 ("Today's DSRC systems are the products of more than a decade of research and years of real-world testing – all of which relied on the FCC's current DSRC channelization, channel bandwidth, and use restriction rules, and which have resulted in substantial capital investments."); Toyota Comments at 21-22.

[12] *See* Cisco Comments at 4-6; Alliance Comments at 21; Toyota Comments at 21.

[13] Qualcomm Comments at 9.

[14] *Id.* at 10.

Channel 172 to a slot where it will be adjacent to at least one higher power channel (the relocated control channel and/or Channel 184) plainly has far different interference consequences than leaving Channel 172 where it is. "[Basic Safety Messaging] was placed at Channel 172 precisely to avoid interference from these high power channels. By placing the BSM in or immediately adjacent to one or both of these high power channels, the BSM will experience interference from those signals over a larger geographic range than under the existing bandplan."[15] Notably, Qualcomm has provided no engineering demonstrating that Channel 172 could be moved adjacent to higher power channels without suffering additional interference.

Also, rechannelizing the 5.9 GHz band is not, as Qualcomm would have it, merely a software fix.[16] Moving lower power BSM Channel 172 next to higher power channels will require new DSRC receiver filters. Hence, Qualcomm is incorrect to the extent it is suggesting that radios designed to operate on Channel 172 in its current location could operate adjacent to higher power channels without additional filtering. The cost of that filtering is unknown, in part because Qualcomm has not specified exactly where Channel 172 will be placed in the upper 30 MHz of the 5.9 GHz band.[17] Neither the Commission, Cisco nor any other interested party can

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[15] Toyota Comments at 7. National Cable & Telecommunications Association's ("NCTA") comments note that adjacent channel interference to BSM channel 172 is an issue even under the *current* DSRC band plan. *See* Comments of the National Cable & Telecommunications Association on the Request to Update the U-NII-4 Record, Technical Appendix at 16 (filed July 7, 2016) ("NCTA Comments") ("Measurement studies in 2007 showed significant packet loss to BSMs when nearby vehicles were transmitting on adjacent service channels. . . . In other words, if the intended range of a BSM message is 100 meters, than operating a service channel on a car closer than 20 meters would cause significant packet loss in the BSM.").

[16] *See* Qualcomm Comments at 9; *id.* at 13 ("[N]o hardware changes are necessary to support rechannelization."); Comments of Broadcom Ltd., ET Docket No. 13-49, at 10 (filed July 7, 2016) ("Broadcom Comments").

[17] Also, in Cisco's view, hardware changes are required to operate 802.11ac within one meter of a DSRC antenna at .11ac power levels above 50 mW conducted. At a minimum, .11ac transmit filters will need to change in order to address OOBE at the 5895 MHz frequency under the rechannelization proposal, if the adjacent DSRC-only channel is to be protected.

properly evaluate the efficacy of rechannelization until Qualcomm specifies a band plan for the upper 30 MHz and provides engineering showing the extent to which Channel 172 will suffer adjacent channel interference from the higher power channels.[18]

Qualcomm further states that "rechannelization allows the FCC to define a stricter U-NII-4 OOBE mask at the onset of U-NII-4 operations, . . . to fully protect DSRC safety-of-life operations located in the upper 30 MHz portion of the DSRC band."[19] Cisco would be happy to comment on this if and when Qualcomm specifies exactly what "stricter" OOBE limit it has in mind, and whether it is a mask that is relative to U-NII-4 EIRP or absolute. Given the absence of a guard band between the upper 30 MHz and lower 40 MHz of the rechannelized spectrum, the Commission and Qualcomm must confront whether safety-related communications in the upper 30 MHz could function with a "hard" OOBE emissions limit vis-à-vis U-NII-4 devices in the lower 40 MHz, and vice-versa.[20]

The comments also fail to specify how DSRC 20 MHz packets can be marked so that they receive prioritization in transmission – if, in fact, that is the intent of the rechannelization proposal. Those packets must be marked in order for stations operating nearby to prioritize DSRC operation, including reception. This is important because DSRC would have to change, not just to use 20 MHz channels, but also to tell other transmitters that the packets come from DSRC operation, probably using some bits in the legacy signal fields. The U-NII-4 devices then

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[18] Broadcom is equally ambiguous, encouraging the Commission to "move the primary BSM channel from channel 172 to one of the three top most DSRC channels." Broadcom Comments at 9. Alternatively, Broadcom contends that "[t]he Commission may even wish to consider designating channel 184 as the primary BSM channel," albeit while providing no engineering showing why this is feasible. *Id.*

[19] Qualcomm Comments at 6.

[20] Cisco Comments at 9; *id.* at n.18 ("That is, what OOBE limit would be stringent enough to prevent Wi-Fi signals from overwhelming DSRC receivers near the band edge, and would the required signal filtering add unreasonable cost to the manufacture of Wi-Fi equipment?").

have to demonstrate that they heard the DSRC transmissions and are taking the appropriate action. But, none of this detail is provided in the comments. On the other hand, if there is no intent to provide prioritization, then that should be stated along with a description of how the two radio systems will operate below 5895 MHz.

The absence of the information described above makes it almost impossible to advance towards consensus in this proceeding. It is no different than claiming that a radio can operate in the TV bands without specifying a level of protection. In fact the DSRC issue is very similar, in that both present a case of weak signal reception where the receiver could be blocked.

B. CISCO'S MODIFIED SHARING PROPOSAL ADDRESSES ANY LINGERING CONCERNS ABOUT THE EFFICACY OF "DETECT AND VACATE"

The details of Cisco's proposal were set forth in Cisco's December 22, 2015 *ex parte* submission in this docket.[21] In its initial comments on the Public Notice, however, Cisco advised that this would not be its "last and final" submission on the subject.[22] Rather, Cisco intends that its proposal inform the next phase of development and testing, with the ultimate goal of designing an elegant and simple solution that optimizes opportunities for Wi-Fi while protecting DSRC from harmful interference. To that end, attached hereto as Exhibit 1 is a modified version of Cisco's December 22, 2015 filing, which is intended to address any lingering concerns that "detect and vacate" will not be robust enough to protect DSRC. The attachment emphasizes that the timing values for U-NII-4 should reflect Cisco's experience in testing to date. First, we have proposed to change the channel non-occupancy for U-NII-4 to 10 seconds once a U-NII-4 device

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[21] Letter from Mary L. Brown, Senior Director, Government Affairs, Cisco Systems, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 13-49 (filed Dec. 22, 2015), *corrected*, Letter from Mary L. Brown, Senior Director, Government Affairs, Cisco Systems, Inc., to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 13-49 (filed Dec. 23, 2015).

[22] Cisco Comments at 4.

has detected DSRC. Second, we have proposed to use future channel guidance on U-NII-4 systems to move Wi-Fi operation from DSRC bands to another U-NII channel.[23] Third, we propose to make an initial message period of 250 microseconds instead of 200 microseconds to allow 802.11ax probe messages to fit into this initial message time. Finally, we explicitly state that we will detect DSRC preambles, specifically the training signals. We believe these improvements both create a more robust sharing case, while facilitating easier U-NII-4 use of the 5.9 GHz spectrum.

Otherwise, the general criticisms in the record of "detect and vacate" are either inapposite or unsupported. Qualcomm, for example, appears to suggest that "detect and vacate" would require an amendment to the 802.11ac standard.[24] We agree that "detect and vacate" will require an amendment to the 802.11 base standard, but not to 802.11ac. Moreover, the history of unlicensed use is rife with examples of Commission rulemakings preceding standards development. Qualcomm also complains that four-channel 10 MHz detection is not in the base 802.11ac standard.[25] This too is a non-impediment, since adding U-NII-4 support to existing U-NII-3 devices adds negligible costs and device complexity.[26]

Qualcomm likewise strays off course with the following: "Based on our technical assessment of the interference environment, widely-deployed DSRC roadside infrastructure and

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[23] Future channel guidance is expected to be adopted into standards in the next eight months. *See* Wireless LANs IEEE P802.11-16/0292r3, First Recirc Sponsor ballot – proposed resolution for comments assigned to the author (May 13, 2016), https://mentor.ieee.org/802.11/dcn/16/11-16-0292-04-000m-sb1-ecclesine-resolutions.docx.

[24] Qualcomm Comments at 8.

[25] *Id.*

[26] Qualcomm wrongly takes Cisco to task for failing to "guarantee" that Wi-Fi will not interfere with DSRC. *Id.* at 14. This is ironic given Qualcomm's rather obvious failure to "guarantee" that rechannelization will not do the same thing. In any case, no such guarantees are possible. Engineering is a matter of *probabilities* that are confirmed through studies and testing.

DSRC-equipped vehicles will prevent unlicensed users from accessing the entire U-NII-4 band within vehicles and in and around homes and businesses up to several hundred meters away from DSRC communications."[27] Cisco cannot evaluate the accuracy of this statement, since Qualcomm did not include its "technical assessments" with its comments, nor has it explained how its conclusion can be squared with the fact that the vast majority of Wi-Fi usage is indoors.[28] From what we can discern, the statement appears to assume devices are running at U-NII-3 power levels. At lower power levels, we disagree that the complaint is accurate.

Similarly, while NCTA has the basic premise of "detect and vacate" right (*i.e.*, when a U-NII-4 device "hears" a DSRC signal, it vacates the entire 5.9 GHz band), it contends that "detect and vacate" effectively leaves too large a guard band between DSRC and U-NII operations.[29] But, NCTA never specifies what size guard band would be appropriate in this case, nor does it provide or cite to any receiver blocking or other technical studies that have addressed the issue. Cisco is unaware of any such studies but would be happy to review and comment on them if and when they are put into the record.

NCTA also provides no support for its claim that "Cisco's proposal provides significantly more *temporal* isolation than necessary."[30] Cisco knows of no way (and NCTA cites to none) to interleave U-NII-4 and DSRC operations (*i.e.*, transmission frames) in time and in a manner that would not delay reception of DSRC. Identifying such a solution would require extensive testing, and Cisco instead has endeavored to find a simpler, more robust approach that can be

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[27] *Id.* at 12.

[28] Cisco has never said that in-vehicle usage of Wi-Fi might not be impaired under "detect and vacate." Again, no solution to the sharing issue is perfect, and tradeoffs are to be expected.

[29] NCTA Comments at 24-25.

[30] *Id.* at 25.

implemented in the near term and at reasonable cost. Again, Cisco will review and comment on any technical proposals put forth by other parties on this point.

C. PROPONENTS OF RECHANNELIZATION HAVE UNDERSTATED THE AMOUNT OF TESTING IT WILL REQUIRE

Qualcomm states that "[w]hile some testing may be needed to measure the impact of DSRC traffic in adjacent channels, such measurements may have been carried out already since DSRC applications have always planned to use all 7 DSRC channels."[31] This observation is irrelevant, as Cisco is unaware of any studies by rechannelization's proponents that show the interference consequences of moving Channel 172 adjacent to higher powered channels in the upper 30 MHz of the 5.9 GHz band, and Qualcomm cites to no such studies in its comments. Qualcomm also fails to account for the fact that moving Channel 172 and the control channel (Channel 178) to the upper 30 MHz will require testing of three radios, not just one.[32] By contrast, "detect and vacate" will not require a re-do of the large scale Department of Transportation testing done to date to support the efficacy of DSRC, and what testing is required is relatively straightforward and comparable to testing for DFS. Fundamentally, the testing for "detect and vacate" only needs to demonstrate that detection occurs reliably, that the U-NII-4 device will vacate the band, and that in a DSRC test bed a concentration of U-NII-4 devices does not change the result.

III. CONCLUSION

Cisco continues to believe that "detect and vacate" is the superior mechanism for maximizing the amount of 5.9 GHz spectrum for U-NII-4 devices without compromising the

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[31] Qualcomm Comments at 10.

[32] The radios are: (1) a radio that operates exclusively on the BSM channel; (2) a radio that operates on the control channel and other channels in conjunction with the control channel; and (3) the channels below 5895 MHz operating with 20 MHz channels.

legitimate interference protection expectations of the DSRC industry, and without disrupting existing and planned DSRC operations conceived in reliance on the existing DSRC band plan. The paucity of contrary technical evidence in the record has only reinforced Cisco's view. Accordingly, Cisco urges the Commission to adopt the Cisco proposal and otherwise craft its rules in a manner consistent with these reply comments and Cisco's initial comments on the Public Notice.

Respectfully submitted,

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EXHIBIT 1

Detect and Vacate Methodology – Cisco's Current View (July 22, 2016)

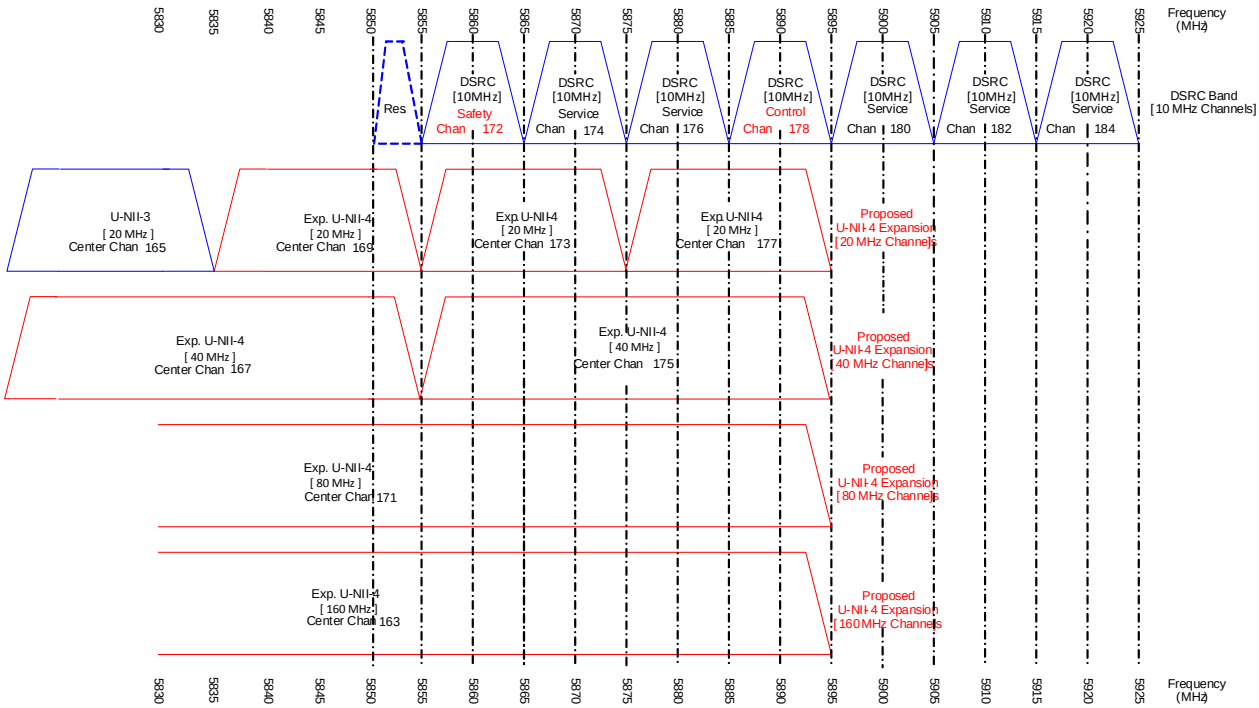
The following information represents Cisco's view of a D&V approach.[1]

As with any problem set involving sharing of spectrum, the approach outlined here is band-specific and DSRC technology specific. It is also designed to both protect DSRC and provide an achievable means by which Wi-Fi can access spectrum in a commercially useful way. Cisco is not suggesting this sharing proposal as a "final" view, but one that would inform the next phase of development and testing. The goal is to permit as elegant and simple a solution as is possible for Wi-Fi while still protecting DSRC from interference. Accordingly, this proposal differs in certain respects from the proposal presented earlier to the IEEE Tiger Team and discussed in various industry fora. It represents Cisco's latest, best thinking on mitigation requirements for protecting DSRC.

Cisco views the 5850-5925 MHz ITS band as a band where every two seconds, everything is new again. If a U-NII-4 device sleeps or fails to communicate for two seconds, it cannot assume the other stations in the BSS are still active.

The DSRC and U-NII channel designations are shown in Figure 1.

Figure 1 DSRC and I-NII-4 channelization



The 10 MHz OFDM transmissions used in ITS are specified in IEEE 802.11-2012 clause 18, Annex D and Annex E. The clause 18 short training symbols begin each valid OFDM transmission, and U-NII-4 devices

[1] Timing values in square brackets [] are recommended starting values for testing and validation.

seeking to operate in the ITS band should be required to detect DSRC preambles at -85 dBm in any 10 MHz channel within 5855-5895 MHz and at -65 dBm within 5895-5905 MHz.

Figure 2 10 MHz DSRC preamble

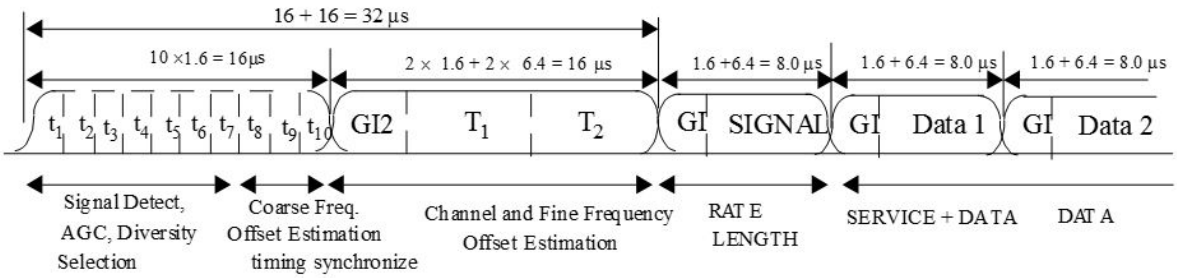


Figure 2 shows the 10 MHz OFDM training structure (PLCP preamble), where t1 to t10 denote short training symbols and T1 and T2 denote long training symbols. The total training length is 32 µs. The PLCP preamble is followed by the SIGNAL field and DATA.

U-NII-4 devices that operate in the 5850-5925 MHz ITS band shall be capable of detection of ITS transmissions in 10 MHz channels between 5855 MHz to 5905 MHz.

Cisco proposes that in addition to normal Clear Channel Assessment (CCA) to determine whether the channels above 5835 MHz are idle or busy, U-NII-4 devices use four 10 MHz preamble detectors that detect 10 MHz 802.11p transmissions on channels 172, 174, 176, 178 and at a higher threshold detect digital images from channel 180 using the channel 178 Detector. Together the four 10 MHz preamble detectors assert DSRC Not Busy (no DSRC preambles detected) or DSRC Channels Busy (one or more DSRC preambles detected on any one of channels 172, 174, 176, 178 and 180 within [32 microseconds]). The DSRC Channels Busy remains true for [ten seconds]. We call the use of these four DSRC preamble detectors DSRC Clear Channel Assessment (DCCA), which is independent of and concurrent to normal CCA.

Cisco proposes that initial CCA period of [one millisecond] be used whenever a U-NII-4 station has not successfully transmitted or received within the last [two seconds], and both CCA and DCCA shall concurrently indicate channel idle and DSRC Channels Not Busy for [one millisecond] before a U-NII-4 device is allowed to transmit.

An initial CCA for [one millisecond], before an initial transmission of less than [250 microseconds] is proposed, and if a unicast frame (and its' retransmissions) is not acknowledged within the retry limit, then a [ten second] wait or a successful U-NII-4 frame reception is required.

After the initial transmission, normal RLAN operation continues while DSRC Channels Not Busy is true.

All U-NII-4 devices shall restrict their transmit period to 3 milliseconds or less to minimize the probability of interference to DSRC radios.

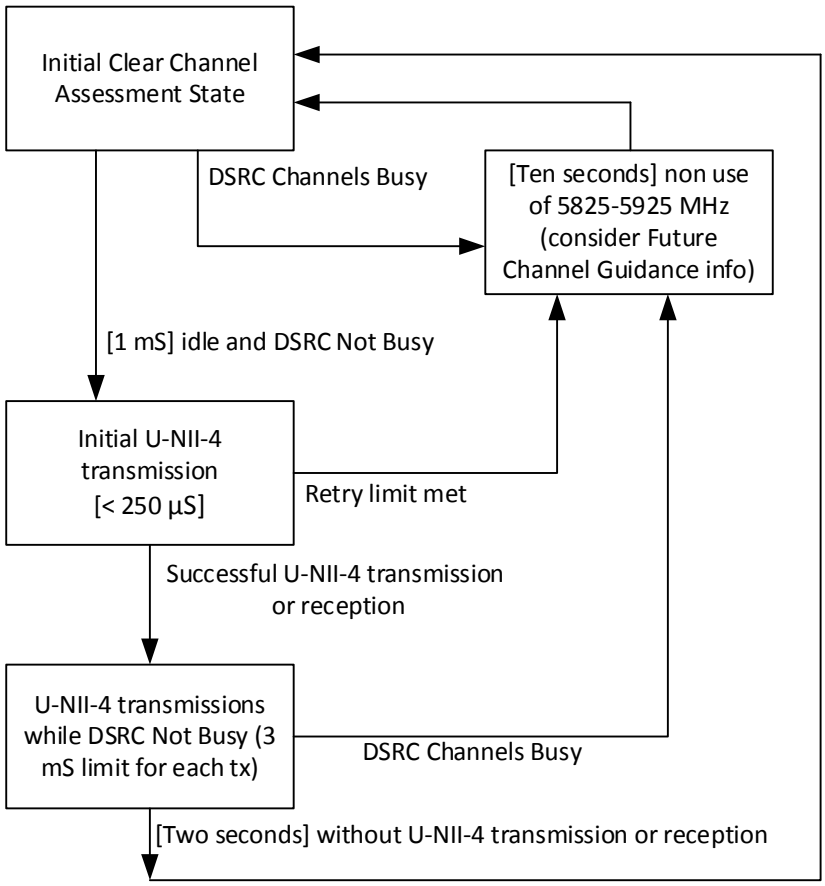
When the preamble of a DSRC transmission at a receive signal level equal to or greater than -85 dBm/10 MHz is detected in 10 MHz channels of 5855-5895 MHz, or equal to or greater than -65 dBm/10 MHz

within 5895-5905 MHz, then the U-NII-4 device shall not transmit in 5825 MHz to 5925 MHz for [ten seconds].

Stated differently, if the DSRC preamble detectors detect 10 MHz transmissions on any of the 10 MHz channels up to 5905 MHz, then the U-NII-4 devices will vacate channels from 5825 MHz to 5925 MHz for [ten seconds]. After [two seconds] without successful transmission or reception above 5825 MHz, the initial CCA process repeats so that if continual DSRC usage is present, the U-NII-4 band and channel 165 will not be used by U-NII-4 devices.

Figure 3 shows the U-NII-4 state transition machine.

Figure 3 U-NII-4 transition state machine



Cisco proposes the U-NII-4 transmit power limit be [50 mW] conducted power, using the same antennas as are used for DSRC detection.

Cisco believes the approach benefits DSRC by extending protection down to 5825 MHz (an additional 25 MHz of protection compared to today). Moreover, a detection of any 10 MHz DSRC transmission below 5905 MHz means the U-NII-4 will stop transmitting in any part of the DSRC band. Finally, every U-NII-4 device (including client devices) will be listening for 802.11p DSRC transmissions before using the band.

The approach benefits Wi-Fi by allowing more channels to be available for wide bandwidth transmissions where DSRC is not detected.