Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
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Phase I Testing of Prototype U-NII-4 Devices	)	ET Docket No. 13-49
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	)	

COMMENTS OF

TOYOTA MOTOR CORPORATION

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I. INTRODUCTION AND SUMMARY

The Commission's Office of Engineering and Technology (OET) has requested comment on the report for Phase I of tests performed to evaluate potential sharing solutions between Unlicensed National Information Infrastructure (U-NII) devices and Dedicated Short Range Communications (DSRC) operations in the 5850-5925 MHz (U-NII-4) frequency band. As comprehensive testing is essential to determining whether U-NII devices can share the band with DSRC, OET is commended for completing this first phase of testing consistent with the test plan announced in June of 2016 and for releasing the testing results for public comment.

By rule, Part 15 U-NII devices must not impart harmful interference to licensed users of the band.[1] While the Phase I test report does not draw conclusions about whether either of the two tested sharing approaches can reliably avoid harmful interference to DSRC, it does present empirical evidence of such interference in the case of the "re-channelization" approach. In fact, the Phase I test results indicate both cross-channel and co-channel harmful interference with potentially significant implications for incumbent DSRC operations in the band.

Because the Phase I test results suggest the presence of harmful interference, the Commission must remain committed to additional phases of testing before proceeding with any decision to open the 5850-5925 MHz band to U-NII devices. Field testing in real-world environments is essential to analyzing and quantifying the interference potential introduced to DSRC from unlicensed use in the band. To that end, future phases of testing should incorporate additional scenarios and factors not considered in Phase I that will better emulate the conditions that are likely to be present in the real world. In addition, testing should consider the impairment

[1] 47 C.F.R §15.5

and degradation of DSRC operations that are likely to occur because of changes required of DSRC under the "re-channelization" approach.

DSRC has already been deployed in the United States using all channels in the band. In fact, DSRC deployments have accelerated substantially since the Commission initiated the 5 GHz proceeding in 2013. Despite attempts to discredit or devalue DSRC technology by some lacking any experience with or commitment to automotive safety, DSRC continues to have the widespread support of a broad coalition of automakers, the U.S. Department of Transportation, state and local transportation departments, safety advocates, and other stakeholders for its potential to increase safety and reduce crashes. The reality is that DSRC is a proven, reliable and mature technology that is moving forward in the United States.

The Commission should not entertain sharing solutions that will disrupt the deployment or further development of DSRC technology, strand DSRC technology in the market, or otherwise undercut the significant public and private sector investment that has been made to realize the benefits of this innovative technology.

II. TOYOTA REMAINS COMMITTED TO DSRC

By helping vehicles identify potential hazards that are beyond the range or capability of sensor technology, DSRC can help create a safer driving environment and contribute to Toyota's long-standing goal of a future with zero fatalities from crashes. For this reason, Toyota became the first company in the world to deploy vehicle-to-vehicle (V2V) communication by incorporating DSRC technology into production vehicles in Japan in 2015. In April of this year, Toyota and Lexus announced plans to start deployment of DSRC systems on vehicles sold in the United States with the goal of adoption across most of the Toyota and Lexus lineup by the mid-2020s. Because of this product announcement, Toyota has a strong and direct interest in ensuring that DSRC operations in the 5.9 GHz band remain free from harmful interference and are not otherwise degraded.

III. TEST RESULTS SUBSTANTIATE CONCERNS OVER THE POTENTIAL FOR HARMFUL INTERFERENCE TO DSRC

A. Test Results Fail to Demonstrate that Post-Detection Activity is Sufficient to Avoid Harmful Interference

As OET notes in the Phase I test report, testing demonstrated that prototype U-NII devices can detect a DSRC signal and implement post-detection steps.[2] Certainly, these are important foundational elements of determining whether DSRC and U-NII devices can coexist within the band. However, while detection is necessary, it is not sufficient. The critical question is not whether detection occurs or whether post-detection steps take place, but whether the post-detection steps that are taken avoid harmful interference to incumbent DSRC operations. Unfortunately, when it comes to the "re-channelization" approach, the test results indicate that the post-detection steps are likely insufficient.

B. Test Results Indicate Harmful Cross-Channel Interference to DSRC from Commercially-Available Wi-Fi Devices

The Phase I test results expose the flawed assumption underlying the "re-channelization" approach that shifting safety-of-life communications to the upper three channels will "fully protect"[3] them from out-of-band emissions (OOBE) interference from unlicensed operations in the U-NII-4 band.

Figure 11 shows the impact on packet completion rate for DSRC occurring on Channel 180, Channel 182, and Channel 184 with a U-NII device operating simultaneously at Channel 177. The figure indicates that DSRC operations at Channel 180 are impacted once the U-NII device's

[2] *Phase I Testing of Prototype U-NII-4 Devices*, TR-1006 (October 22, 2018), p. 94
[3] Comments of Qualcomm Incorporated, ET Docket No. 13-49, pp. 3-4 (July 7, 2016)

signal power reaches -60 dBm and then falls precipitously until there is a 0% packet completion rate by -48 dBm. The implication is that the signal of a U-NII-4 device operating with the proposed maximum transmit power of +36 dBm Equivalent Isotropically Radiated Power (EIRP) could experience 96 dB of attenuation and still drown out critical DSRC transmissions. Assuming a free-space propagation mode, 96 dB of attenuation is roughly equivalent to an interference range of 250 meters or more. In other words, if high power outdoor U-NII-4 Wi-Fi devices are permitted to operate under the "re-channelization" approach, there could be a permanent interference zone of at least 250 meters around such devices. Considering that a preferred location for such high power outdoor Wi-Fi devices would often be near an intersection or along a street, the test results reveal that the critical DSRC collision avoidance benefits expected in those same areas would likely be permanently lost.

Figure 11 also demonstrates that DSRC operations at Channel 182 are impacted once the U-NII device's signal power reaches -52 dBm, and fall to a 0% packet completion rate by -38dBm. At Channel 184, DSRC operations are impacted once the U-NII device's signal power reaches –48dBm and fall to a 0% packet completion rate by -26 dBM. Using the same free-space propagation model, a high power U-NII-4 signal could be associated with permanent interference zones in Channel 182 and Channel 184 of approximately 100 meters and 62 meters, respectively. These permanent interference zones would similarly render these channels unreliable for DSRC safety applications. In fact, the data demonstrates that a single U-NII-4 transmission in Channel 177 would likely drown out critical DSRC transmissions within 62 meters of the U-NII device in all three of the upper channels. Such an outcome is understandably objectionable.

A similar analysis can be applied to interference from a modest power (20 dBm EIRP) U-NII-4 transmission, resulting in interference ranges of approximately 40 meters, 16 meters, and 10 meters in Channel 180, Channel 182, and Channel 184, respectively. This demonstrates that even transmissions from a U-NII-4 device in use by a nearby pedestrian or by a passenger in a vehicle may significantly, and unacceptably, impact all DSRC transmissions in the upper three channels.

In its observations, OET notes that the probability of interference due to adjacent channel operation is considerably less than the probability of co-channel interference under the "re-channelization" approach.[4] Even if this is true, it should not be determinative. The focus should not be on the relative probability of interference, but on whether the interference is in fact harmful to DSRC operations. Certainly, shutting down DSRC operations throughout an entire intersection – even if less probable than co-channel interference – would be considered harmful interference. At the same time, since the "re-channelization" approach proposes consolidating "safety" communications in the upper three channels of the band, it is entirely appropriate – if not essential - that the probability of cross-channel interference to "safety" communications be considerably less than the probability of co-channel interference to "non-safety" communications.

Furthermore, there is a risk that some language in the Phase I Test Report could be misconstrued. The report states that, with respect to the "re-channelization" approach, the probability of adjacent channel unmitigated operation "is reduced by a factor equal to the Adjacent Channel Rejection Ratio (ACRR) of a DSRC device."[5] It would be a misinterpretation to conclude that the DSRC device has full control of the ACRR. As used in this report, ACRR is a function of the U-NII-4 interference energy that leaks into the channel occupied by the DSRC device. This interference energy is controlled by the U-NII-4 device's transmit power and transmit spectral mask, and is outside the control of the DSRC receiver.

[4] *Phase I Testing of Prototype U-NII-4 Devices*, p. 97
[5] *Phase I Testing of Prototype U-NII-4 Devices*, p. 97

i. Stricter OOBE Limits and a Prohibition on In-Vehicle Use Should be Considered

It is important to note that these analyses are based on an OOBE measured with the U-NII-4 prototypes provided to OET for testing. However, according to the IEEE 802.11 standard spectral mask (seen in Figure 164 of the Phase I test results), it would be permissible for a U-NII-4 device to impart 10 to 15 dB more interference energy in these channels than was measured by the prototype devices. If the Commission relies on these measurements, it should strongly consider imposing out-of-channel emission limits for U-NII devices consistent with what is actually exhibited by the prototypes.

That being said, an absolute OOBE limit of -27 dBm / MHz would still result in interference energy of -17 dBm in a 10 MHz channel. If that is emitted by a U-NII-4 device inside a vehicle, which is approximately one meter away from the vehicle's DSRC antenna, it could harm DSRC receptions in that vehicle from DSRC sources more than 32 meters away. This would effectively render DSRC useless for most applications. To address this possibility, the Commission should consider whether in-vehicle use of the U-NII-4 band should even be permitted and, if so, under what conditions.

ii. Interference from U-NII Devices is not Comparable to Interference from DSRC Devices

The proponents of the "re-channelization" approach will likely attempt to diminish or discount the apparent cross-channel interference identified in the Phase I report. They will most likely claim that DSRC transmissions in the upper part of the band are already subject to comparable cross-channel interference from DSRC transmissions in the lower part of the band. However, this claim ignores the fact that DSRC standards and the Commission's regulations impose a very strict out-of-band channel emission mask to DSRC transmissions. Specifically, a

Class C spectral mask applies to transmissions up to 20 dBm and a Class D spectral mask applies to transmissions over 20 dBm.[6] The impact of the strict DSRC spectral mask can be observed side-by-side with the more relaxed Wi-Fi mask in Figures 164 and 165 in the Phase I test results.

Additionally, the DSRC community has undertaken efforts to further mitigate cross-channel interference in the industry consensus band usage plan under the SAE J2945/0 standard. Specifically, the standard minimizes the possibility that one vehicle will transmit while a neighboring vehicle is attempting to receive in the adjacent channel.[7]

Finally, and importantly, this claim ignores the fact that the standard by which interference is judged is different when it comes from a U-NII device ("no harmful interference") than when it comes from another licensed DSRC device ("coordination").

C. Test Results Indicate the Presence of Harmful Co-Channel Interference to DSRC under the "Re-channelization" Approach

Figure 48 explores U-NII-4 and DSRC Co-channel Interaction utilizing the Broadcom prototype device. The figure shows a significant reduction in packet completion rate across all mitigation modes when U-NII devices and DSRC devices are operating on the same primary 20 MHz channel. For Mode 0, the packet completion rate drops to approximately 35% when the U-NII device signal power increases from -88 dBM to -84 dBm and stays below 50% until the U-NII device signal power increases to -69 dBm. The packet completion rate increases steadily but does not return to back above 90% until -54 dBm. Equally problematic observations are made with respect to the other tested modes and with the other U-NII prototype devices provided to OET.

[6] *Standard Specification for Telecommunications an Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specification*, ASTM E2213-03, pp. 11-12 (2018)
[7] *Dedicated Short Range Communication (DSRC) Systems Engineering Process Guidance for SAE J2045/X Documents and Common Design Concepts*, SAE J2945_201712, §4.1.2.4 (2017)

Part 15.3(m) of the Commission's rules and regulations defines "harmful interference" as "[a]ny emission, radiation or induction that endangers the functioning of a radio navigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a radiocommunications service operating in accordance with this chapter."[8] Using this established and prevailing definition, the dramatic reduction in packet completion rate observed over a wide range of power levels is a strong indication of harmful interference to DSRC when U-NII devices are operating in the same 20 MHz channel. The unacceptably low packet completion rates reflected in Figure 48 will degrade DSRC operations in the overlapping part of the band.

i. Proposed "Safety" vs. "Non-Safety" Distinction Continues to Expose Further Challenges for the "Re-channelization" Approach

It will come as little surprise if proponents of the "re-channelization" approach claim that such interference is irrelevant because, as envisioned, DSRC communication in the lower part of the band will be "non-safety" and therefore less impacted by the lower packet completion rates. Unfortunately, the very same proponents have declined to address important questions about what specific DSRC communications they would deem to be "safety" communications worthy of protection in the upper part of the band (above 5895 MHz) and what specific DSRC communications they would deem to be "non-safety" communications relegated to the shared portion of the band (below 5895 MHz) and therefore subject to the harmful co-channel interference witnessed during Phase I testing.

The fact that these questions remain unanswered is significant. As has been previously noted, in addition to the Basic Safety Message (BSM), there are a variety of communications - such as communications intended to support Cooperative-Adaptive Cruise Control, platooning,

[8] 47 C.F.R. 15.3(m)

object identification, sensor data sharing, emergency vehicle alerts, merge assist, vulnerable road users, and red light warnings – that are part of the existing DSRC band plan and *could* be considered "safety" communications. Despite continued pleas for clarity since the "re-channelization" approach was first proposed more than five years ago, it is still far from clear whether these types of communications will occur in the protected part of the band or the shared part of the band. Until these pending issues are resolved, the true impact of this reduced packet completion rate cannot be fully assessed.

If the proponents of the "re-channelization" approach intend some of these communications to occur in the lower part of the band, the packet completion rate witnessed in Phase I testing would almost certainly constitute harmful co-channel interference, as defined in Part 15.3(m) of the Commission's rules. A reduction in packet completion rates for these types of communication is likely to have significant safety implications, including crashes and potential loss of life, that simply cannot be ignored by the Commission. In addition, many of the other potential benefits of intelligent transportation services – including improved traffic and fuel efficiency – could be negatively impacted.

On the other hand, if proponents intend for all of these communications to be combined in the upper part of the band, these three channels will become heavily congested. This heavy channel load is likely to result in a higher probability of frame collisions and higher average latency, even when no U-NII-4 devices are using the band. In addition, if these three channels become "all safety," the vital tool of channel access prioritization between safety and non-safety communications, which is currently employed in the majority of DSRC channels, would be lost. Safety communications would face more competition for channel access with equal or higher priority safety traffic, resulting in greater packet loss or packet delay. Such packet loss and latency would likely endanger the functioning of the safety services relying on those packets. The potential for this type of degradation to DSRC communications under the "re-channelization" approach was not explored by OET as part of this first phase of testing, but should be fully examined and understood before the "re-channelization" approach is considered further.

IV. THE COMMISSION SHOULD PROCEED WITH COMPREHENSIVE TESTING

A. Testing of "Re-channelization" Devices Was Necessarily Limited

As OET notes in the Phase I test results, the ability to fully test the "re-channelization" approach was "limited by practical considerations."[9] Although prototype DSRC devices were modified to operate in 20 MHz channel configurations for purposes of the testing, the DSRC devices that are currently available have been designed to comply with existing Commission channelization requirements and with the current 10-MHz channel band plan.

In addition, the DSRC devices made available to OET for Phase I testing did not incorporate DSRC applications other than the BSM on Channel 172. As a result, as acknowledged by OET, it was unable to quantify the potential impact of U-NII transmissions to DSRC operations beyond the BSM at Channel 172. Emerging applications, such as platooning, may present even more stringent performance requirements than the BSM application (e.g., a need to send 20 or more messages per second per vehicle). The impact of potential harmful interference on such applications should certainly be considered by the Commission.

[9] *Phase I Testing of Prototype U-NII-4 Devices*, p. 16

B. Phase II and Phase III Testing Must Be Completed

There has long been an understanding that three phases of testing, as laid out by OET in the June 2016 test plan[10], are essential to determining whether and how U-NII devices can safely operate in the 5.9 GHz band.

In the Phase I test results itself, OET acknowledges that this first phase of testing was limited and outlines why additional phases of testing are required. Specifically, OET notes: "The laboratory test results provide baseline data for performing analysis of additional operational scenarios and other 'real-world' empirical tests as part of the future phases of the coexistence test effort."[11]

The commitment to three phases of testing was also the cornerstone of a deal reached between stakeholders, Chairman John Thune and other members of the Senate Commerce, Science & Transportation Committee, and the Chairman of the Commission, the Secretary of Transportation, and the Secretary of Commerce in September of 2015. At that time, Chairman Wheeler, Secretary Foxx, and Secretary Pritzker noted that "[t]he three phases of testing are interdependent" and that, "to ensure the future automotive safety and efficiency of the traveling public", "all three phases of the FCC test plan must be completed before reaching any conclusions as to whether unlicensed devices can safely operate in the 5.9 GHz band."[12]

Commissioner O'Rielly and Commissioner Rosenworcel reiterated an expectation that there would be three phases of testing in their letter to James Lentz, CEO of Toyota Motor North

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[10] *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, ET Docket 13-49 (2016).
[11] *See Phase I Testing of Prototype U-NII-4 Devices*, p. 13
[12] Letter from Penny Pritzker, Anthony Foxx, and Tom Wheeler to John Thune, Chairman, Committee on Commerce, Science, & Transportation, https://docs.fcc.gov/public/attachments/DOC-337251A1.pdf (2015)

America, on May 10, 2018. As the Commissioners wrote: "Having just completed Phase I testing, the plan has been for the Commission to proceed forward, in cooperation with the Department of Transportation, to Phases II and III in the coming months. If testing is successful, it will sufficiently demonstrate that unlicensed devices can share the band without causing harmful interference to DSRC safety-of-life functionality."[13]

Moreover, as recently as October 24, 2018, the National Highway Traffic Safety Administration released a statement with respect to the existing three-phase test plan, noting that "[w]ith lifesaving safety capabilities at stake, the Department maintains that all three phases of research must be completed before any decisions about spectrum reallocation can be made."[14]

A decision at this juncture to depart from the three-phase test plan and proceed with a ruling to permit unlicensed operation in the 5.9 GHz band would be simply inexplicable and entirely inappropriate. The "baseline data" gathered as part of Phase I testing, which provides evidence of harmful interference, is simply insufficient to support such a decision. The empirical data that will be generated in the next two phases of field testing in real-world environments remains essential to analyze and quantify the interference potential introduced to DSRC from U-NII operation in the band.

C. Future Phases Should Evaluate Additional Scenarios and Factors

To better understand the impact and implications of the harmful cross-channel interference and the potential for permanent interference zones observed in Phase I testing, Phase II and Phase III testing should examine potential interference to DSRC operations with more realistic placement

[13] Letter from Commissioners O'Rielly and Rosenworcel to James Lentz, CEO, Toyota Motor North America, https://fcc.gov/document/orielly-and-rosenworcel-letter-james-lentz-ceo-toyota-motor-na (May 10, 2018)
[14] U.S. Department of Transportation's National Highway Traffic Safety Administration issues statement on safety value of 5.9 GHz spectrum, https://www.nhtsa.gov/press-releases/us-department-transportations-national-highway-traffic-safety-administration-issues (October 24, 2018)

of Wi-Fi devices. For example, OET should evaluate the interference potential from a high power, pole-mounted Wi-Fi device at an intersection and from a 20 dBm Wi-Fi device operating on a sidewalk. In addition, OET should measure the impact that a 20 dBm Wi-Fi device operating inside of a vehicle would have on DSRC reception of that vehicle and of neighboring vehicles.

OET should also further explore the potential for co-channel interference with Wi-Fi device placement that is more representative of the real world. The results in Figure 48 were derived from testing that mimics Wi-Fi device placement directly between two stationary DSRC devices. Larger geographical separation of vehicles and vehicular movement under more realistic conditions are likely to expose DSRC senders and receivers to different interference potential. Specifically, this creates a very real and heightened risk of the hidden terminal problem in which a Wi-Fi device placed near a DSRC receiver is completely unaware of a data transmission from a DSRC sender and therefore fails to activate mitigation methods. This scenario, which is likely to lead to more substantial packet loss, should be explored by OET as part of its future testing.

Furthermore, although the pending proceeding contemplates allowing unlicensed technologies other than Wi-Fi to operate in the U-NII-4 band, OET was only able to test Wi-Fi technologies during Phase I testing. The "re-channelization" approach relies on mutual detection and deferral between 20 MHz Wi-Fi and 20 MHz DSRC. As a result, sharing between other unlicensed devices and DSRC is evidently more difficult. If a U-NII-4 device uses a non-Wi-Fi technology, mutual detection will not be possible and co-channel interference is likely to be more significant. To this end, the Commission should encourage the U-NII community to provide non-Wi-Fi prototypes for Phase II and Phase II testing. If these devices cannot be obtained or tested, the Commission should not approve the use of general unlicensed devices under the "re-channelization" approach.

Because the stated motivation for creating U-NII-4 is to join it with adjacent U-NII-3 to enable wider channels, OET should also expand the testing of 40, 80, and 160 MHz Wi-Fi devices in Phases II and III. These wider-channel devices are likely to pose challenges that are not present with 20 MHz devices. For example, out-of-channel energy would be spread over a greater spectral range. As a result, cross-channel interference to Channel 182 and Channel 184 may be even greater than what is indicated in the Phase I test results. In addition, all but one constituent 20 MHz portion of the 40/80/160 MHz channel would be treated as "secondary" with respect to detection sensitivity. If DSRC is used in a 20 MHz channel that was considered secondary by a Wi-Fi device, the Wi-Fi detection of DSRC (for purposes of deferring transmission, for example) would be impaired compared to the results observed in Phase I testing.

Finally, under the detect-and-vacate approach, a U-NII-4 device will cease transmission anywhere in the band should it successfully detect DSRC activity in any one of the channels. Presumably, once DSRC activity has been detected, U-NII transmission will cease temporarily but be permitted to operate in the band at a future time when and if there is no DSRC activity present. However, it is not yet clear when or how a U-NII device would come back into the band. As these are important threshold questions that need to be addressed before the detect-and-vacate approach could be adopted by the Commission, OET should consider incorporating such considerations into future phases of testing.

D. Testing Should Measure Impairment and Degradation of DSRC from Required Changes under "Re-channelization" Approach

While the Phase I testing provided important insights into the potential for harmful co-channel and harmful cross-channel interference, there are additional elements that OET should consider as part of its testing going forward. Specifically, OET should test baseline DSRC degradation that is likely to occur based on the changes required of DSRC under the "re-channelization" approach.

For example, OET should fully examine the potential for cross-channel DSRC-to-DSRC interference created by placing high power public safety communication (currently at Channel 184) near the BSM, as well as possible interference to the BSM from the Fixed Satellite Service operating in the adjacent band. These cross-channel and cross-band interference concerns do not exist in the same way with the current placement of the BSM at Channel 172, but would exist with the placement of the BSM at either Channel 180 or Channel 182. As this type of interference could endanger the basic functioning of the BSM, it needs to be fully analyzed and understood.

In addition, as noted above, it is likely that DSRC traffic will face impairments such as increased packet loss and channel access latency if the mix of traffic within Channel 180, Channel 182, and Channel 184 is modified from the current SAE J2945/0 band plan. Similarly, it is likely that the 20 MHz channels required under the "re-channelization" approach will cause degraded performance to DSRC compared to the existing 10 MHz channels. The Commission should evaluate this impairment and degradation as part of its testing.

E. The Commission Should Be Aware of and Consider Next Generation V2X Development

The IEEE 802.11 Working Group recently initiated a "Next Generation V2X" (NGV) study group, which is expected to create an amendment to the 802.11 standard. The agreed scope of the amendment is to "provide interoperability, coexistence, backward compatibility, and fairness with deployed OCB (Outside the Context of a BSS) devices."[15] As a result, the NGV amendment is

[15] *802.11 NGV Proposed PAR*, IEEE 802.11-18/0861r9, p. 3 (2018)

expected to preserve the current and near-term investment in DSRC by providing a seamless evolution path in the future from DSRC to NGV. This will allow onboard units and roadside units deployed with DSRC to continue to fully participate in the V2X system for their entire product lifetimes.

There may be some impact on the ability of U-NII-4 devices to share spectrum with IEEE NGV devices in the future. As OET works toward execution of Phase II and Phase III testing, it should gather information about IEEE NGV standards development and assess whether changes to the sharing proposals would be needed to accommodate NGV development.

V. THE INTRODUCTION OF NEW TECHNOLOGIES FOR AUTONOMOUS VEHICLES DOES NOT ELIMINATE THE NEED FOR DSRC

The claim that new technologies for autonomous vehicles eliminates the need for V2V and V2I communication has been repeatedly disproved and rejected. At this point, claims to the contrary are simply uninformed or intentionally misleading.

Sensor-based technology has not leapfrogged or superseded the need for communication between vehicles. In fact, communication between vehicles is an extension of and complementary to sensor technology. Sensor technology has inherent limitations with respect to range, field-of-view, and line-of-site. For example, sensors can only see a certain distance, can only see in one direction, cannot see around corners, and cannot see through other things. In addition, current sensor technology has significant challenges "seeing" in certain weather conditions (e.g., in fog or snow, or at night). V2V and V2I communication has the potential to address these limitations.

Moreover, autonomous vehicle technology will likely increase the automotive industry's need for V2V communication. V2V and V2I communication can enable sensor data sharing between vehicles. Coupled with novel sensor fusion and artificial intelligence techniques, the sensor data from neighboring vehicles has the potential to strengthen the overall robustness and social utility of autonomous vehicles. For example, one car may "see" something that another car cannot "see" (e.g., a child running out into the road, a patch of ice, etc.) and can share that information with the other vehicle using V2V technology.

In its recent *Preparing for the Future of Transportation: Automated Vehicles 3.0* (*AV 3.0*), the Department of Transportation – the federal agency with responsibility over automotive safety and autonomous vehicle technology – clearly and unmistakably rejected the claim that autonomous vehicle technology eliminates the need for V2V and V2I. Specifically, the Department of Transportation noted that "[c]ommunication both between vehicles (V2V) and with the surrounding environment (V2X) is an important complementary technology that is expected to enhance the benefits of automation at all levels."[16]

VI. C-V2X IS NOT CURRENTLY RELEVANT TO THE EXISTING TESTING EFFORT

While some may be discussing or promoting other communication technologies for V2V and vehicle-to-infrastructure (V2I) purposes, these potential alternatives are at present irrelevant to the current test plan. The Phase I testing was focused on whether U-NII devices could share the band with DSRC without harmful interference. Certainly, if cellular vehicle-to-everything (C-V2X) was permitted to also operate in the 5.9 GHz band, significant new challenges would emerge with respect to both potential interference to or degradation of DSRC operations and the ability to successfully accommodate any unlicensed operation in the band. For example, the sharing proposals that were tested by OET would only enable sharing between DSRC and U-NII devices and cannot accommodate sharing with an alternative technology such as C-V2X.

[16] U.S. Department of Transportation, *Automated Vehicles 3.0: Preparing for the Future of Transportation*, https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/320711/preparing-future-transportation-automated-vehicle-30.pdf (October 4, 2018), p. 13.

Without any doubt, a decision to permit additional technologies into the band would require significant modifications to the test plan and invalidate much of the Phase I testing that has already been conducted. However, because these challenges are only hypothetical at this point, it is arguably premature to raise them and almost certainly premature to attempt to address them.

VII. DSRC SERVICES HAVE BEEN DEPLOYED UNDER THE CURRENT BAND PLAN

Assertions that DSRC is a "failed experiment" [17] or that the band is not being used today are simply not true. Significant and irrefutable progress has been made with respect to DSRC development and deployment since the Commission first initiated the 5 GHz proceeding in February of 2013. The National Highway Traffic Safety Administration's large-scale pilot deployment with approximately 3,000 DSRC-equipped vehicles was completed in 2013. Deployment-ready standards for DSRC were finalized by the stakeholder community in 2015. In 2017, General Motors released the first DSRC-enabled production vehicles into the United States market. Earlier this year, Toyota announced its plans to deploy DSRC vehicles in the United States and GM expanded its United States-based product plans for DSRC.

These commitments by automakers build upon significant investment by transportation departments and infrastructure operators throughout the country. There are currently thousands of deployed or planned DSRC-enabled roadside units in dozens of states that support a variety of safety critical applications using all seven channels in the band.

There are indications that these investments are accelerating. In fact, earlier this month, New York City announced plans to outfit 8,000 vehicles in the next year with DSRC as part of its

[17] Letter from NCTA to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 13-49 (October 16, 2018)

effort to reduce road injuries and deaths. [18] The city also plans to outfit roadside sensors and traffic signals with DSRC, and to pilot a DSRC-enabled smartphone app that could help visually impaired pedestrians cross the street safely.

The investment in and commitment to DSRC was acknowledged by the Department of Transportation just recently. In *AV 3.0*, the Department noted that "[o]ver the past 20 years, the U.S. DOT has invested over $700 million in research and development of V2X through partnerships with industry and state/local governments. As a result of these investments and partnerships, V2X technology is on the verge of wide-scale deployment across the Nation."[19] It is important to note that these investments do not include commitments made by automakers, road authorities, and stakeholders throughout the supply chain.

These deployments are real and tangible. Any action that would undermine or discount these investments, strand technology in the market, or force companies and other stakeholder to delay or cancel their DSRC deployments would be devastating.

VIII. A BROAD COALITION OF STAKEHOLDERS CONTINUES TO SUPPORT PRESERVING THE ENTIRE 5.9 GHZ SPECTRUM FOR INTELLIGENT TRANSPORTATION

The coalition of stakeholders interested in preserving the entire 5.9 GHz band for V2V and V2I communications is broad and enduring. In just the last six months, stakeholders have continued to weigh in on the existing 5 GHz proceeding to reiterate the importance of maintaining the band for intelligent transportation systems.

[18] "NYC Cars to Talk to One Another Under Traffic-Safety Pilot Program," *Wall Street Journal* (November 6, 2018).
[19] See *Automated Vehicles 3.0: Preparing for the Future of Transportation*, p. 16

For example, in October, the U.S. Department of Transportation noted in a public statement that "[p]reserving the 5.9 GHz band for transportation communications is essential to public safety today and in the future" and that "[t]he automotive industry and municipalities are already deploying V2X technology and actively utilizing all seven channels of the 5.9 GHz band."[20]

In October, seven major organizations – the Alliance of Automobile Manufacturers, the Association of Global Automakers, the Intelligent Transportation Society of America, the 5G Automotive Association, the American Association of State Highway and Transportation Officials, the American Trucking Association, and the Motor & Equipment Manufacturers Association - released a statement that they "support protecting the entire 5.9 GHz band for transportation safety applications."[21]

Stakeholders who have already deployed DSRC technology in the United States have also weighed in with the Commission. In a recent Ex Parte filing, following an announcement that it was expanding DSRC technology to other products in the U.S., General Motors reiterated that its "technology relies on DSRC and the entire 5.9 GHz band to communicate between cars and roadway infrastructure and to bring next-generation automotive safety to drivers everywhere."[22] The Utah Department of Transportation urged the Commission to "put safety first" and "protect the [5.9 GHz spectrum] for this critical, life-saving use"[23] and the Michigan Department of

[20] See U.S. Department of Transportation's National Highway Traffic Safety Administration issues statement on safety value of 5.9 GHz spectrum

[21] *Multi-Stakeholder Statement on Preserving the 5.9 GHz Band*, https://autoalliance.org/2018/10/24/multi-stakeholder-statement-preserving-5-9ghz-band/ (October 24, 2018).

[22] Letter from Paul Hemmersbaugh, General Motors Company to Marlene H. Dortch, Secretary, Federal Communications Commission, Docket ET-39 (July 13, 2018).

[23] Letter from Carlos M. Braceras, Executive Director, Utah Department of Transportation, to Marlene H. Dortch, Secretary, Federal Communication Commission, Docket ET 13-49 (June 25, 2018)

Transportation urged the Commission "to move cautiously and preserve the current usage of the DSRC band solely for transportation safety."[24]

In addition, suppliers have urged the Commission to preserve the band for V2V and V2I. For example, NXP Semiconductors noted that it "opposes any change to the band allocated for ITS in North America"[25] and DENSO International reiterated that it "supports the continued allocation of the 5.850 – 5.925 GHz band to Intelligent Transportation Systems in North America."[26]

Moreover, safety advocates have continued to promote the safety benefits of V2V and V2I technology. In a recent Ex Parte filing, Mothers Against Drunk Driving stated that these systems "can have a significant impact on reducing drunk driving crashes and improve overall highway safety."[27] The National Safety Council also recently noted that "[p]reserving DSRC spectrum will keep all vehicle and infrastructure safety options available, ensuring we save more lives."[28]

At the end of the day, those who have direct and real-world experience with and a demonstrated commitment to automotive safety continue to tout the benefits of V2V and V2I technology and urge the Commission to preserve the spectrum for intelligent transportation systems.

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[24] Letter from Kirk T. Steudle, Director, Michigan Department of Transportation, to Marlene H. Dortch, Secretary, Federal Communications Commission, Docket ET 13-49 (June 4, 2018).
[25] Letter from Peter J. Esser, Head of Government Affairs, NXP Semiconductors, to Marlene H. Dortch, Secretary, Federal Communications Commission, Docket ET 13-49 (May 7, 2018).
[26] Letter from Terry Helgesen, Senior Vice President Government Affairs, to Marlene H. Dortch, Secretary, Federal Communications Commission, Docket ET 13-49 (May 22, 2018).
[27] Letter from J.T. Griffin, Chief Government Affairs Officer, Mothers Against Drunk Driving, to Marlene H. Dortch, Secretary, Federal Communications Commission, Docket ET 13-49 (July 9, 2018).
[28] National Safety Council, Twitter Post @NSCSafety (May 16, 2018)

IX. CONCLUSION

Toyota continues to support the Commission's efforts to conduct and complete comprehensive testing of potential sharing solutions between DSRC and U-NII devices in the 5.9 GHz band. The results of the first phase of testing reveal indications of both harmful co-channel and harmful cross-channel interference to DSRC operations that would invalidate the "re-channelization" approach as a viable sharing solution. Certainly, future phases of testing will help the Commission to better understand and address this potential harmful interference. Moreover, data gathered from real-world testing scenarios, as envisioned in Phase II and Phase III testing, is essential to determining whether and how U-NII devices can safely operate in the 5.9 GHz band. If further testing confirms or reveals that a sharing solution will result in harmful interference to DSRC or otherwise disrupt the existing, planned, or anticipated deployment of the technology, the Commission should refrain from any further consideration of that sharing solution.