Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

In the Matter of	)	
	)	
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

REPLY COMMENTS OF THE ALLIANCE OF AUTOMOBILE MANUFACTURERS, INC. AND THE ASSOCIATION OF GLOBAL AUTOMAKERS, INC.

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EXECUTIVE SUMMARY

The Alliance of Automobile Manufacturers ("Alliance") and the Association of Global Automakers ("Global") understand that the Federal Communications Commission ("FCC") hopes to allocate additional 5 GHz spectrum for Unlicensed National Information Infrastructure ("U-NII) use. However, as the Alliance and Global, as well as numerous other commenters in this proceeding, have already explained, permitting U-NII devices to operate in the 5850 – 5925 MHz ("5.9 GHz") or adjacent bands without first determining whether U-NII devices would cause harmful interference to Dedicated Short Range Communications Service ("DSRC") systems could derail the development of DSRC services and eclipse potential advancements in road safety.

Years of exhaustive research and testing of DSRC connected vehicle technologies are expected to culminate in a rulemaking decision by the United States Department of Transportation's ("USDOT") National Highway Traffic Safety Administration ("NHTSA") later this year regarding initial deployment of connected vehicle technologies using DSRC in the United States. However, the Commission's proposal to allow U-NII devices to operate in the 5.9 GHz and adjacent bands threatens to undermine over a decade of DSRC development, waste hundreds of millions of dollars of public and private investment, and diminish safety improvements on America's roadways. Commenters in this proceeding have overwhelmingly explained that expanded 5 GHz U-NII operations could cause harmful interference to DSRC communications, and that the issuance of the Notice of Proposed Rulemaking in this proceeding has led some to question the viability of connected vehicle technologies altogether. Commenters have also pointed out that premature introduction of U-NII devices into the 5.9 GHz or adjacent bands, prior to the completion of rigorous interference testing, could in the long-term significantly

undermine the further deployment of U-NII devices in the 5 GHz band and negate any perceived short-term benefits of opening up additional 5 GHz spectrum for U-NII use.

As discussed more fully below, the Commission should not allow expanded 5 GHz U-NII use unless it determines, through rigorous bench and field testing, that such use will not cause harmful interference to DSRC "safety-of-life" services. The Commission should also reject as outside the scope of this proceeding any proposals to amend through this docket the DSRC rules or relocate DSRC operations.

The Alliance and Global are hopeful that the DSRC interference issues raised in this proceeding can be resolved, and are prepared to work with the Commission and advocates of expanded 5 GHz U-NII use to address these concerns. But it is vital that the Commission continue to preserve the spectrum dedicated to DSRC to maximize the potential of this very promising technology.

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ASSOCIATION OF GLOBAL AUTOMAKERS, INC.

I. INTRODUCTION

The Alliance of Automobile Manufacturers, Inc. (the "Alliance")[1] and the Association of Global Automakers, Inc. ("Global"),[2] which together represent the manufacturers of approximately ninety-nine percent of all cars and light trucks sold in the United States,[3] submit these reply comments in response to the Notice of Proposed

[1] The Alliance is an association of twelve of the world's leading car and light truck manufacturers, including BMW Group, Chrysler Group LLC, Ford Motor Company, General Motors Company, Jaguar Land Rover, Mazda, Mercedes-Benz USA, Mitsubishi Motors, Porsche, Toyota, Volkswagen Group of America, and Volvo Cars. *See* Alliance of Automobile Manufacturers, Members, http://www.autoalliance.org/members (last accessed July 14, 2013).

[2] Global Automakers represents international motor vehicle manufacturers, original equipment suppliers, and other automotive-related trade associations. Members include American Honda Motor Co., Aston Martin Lagonda of North America, Inc., Ferrari North America, Inc., Hyundai Motor America, Isuzu Motors America, Inc., Kia Motors America, Inc., Maserati North America, Inc., McLaren Automotive Ltd., Nissan North America, Inc., Peugeot Motors of America, Subaru of America, Inc., Suzuki Motor of America, Inc., and Toyota Motor North America, Inc. *See* Global Automakers, Members, http://www.globalautomakers.org/members (last accessed July 14, 2013).

[3] *See* Auto Sales, Market Data Center, Wall St. J., July 2, 2013, http://online.wsj.com/mdc/public/page/2_3022-autosales.html#autosalesE (last accessed July 14, 2013).

Rulemaking ("NPRM") issued by the Federal Communications Commission ("Commission") in the above-captioned proceeding.[4] The NPRM seeks comment on, *inter alia*, the possibility of making spectrum in the 5.850 – 5.925 GHz band ("5.9 GHz band") available for Unlicensed National Information Infrastructure ("U-NII") use.[5]

As numerous commenters in this proceeding have shown, tremendous progress has been made toward the deployment of 5.9 GHz Dedicated Short Range Communications Service ("DSRC") systems. That progress will be eviscerated, however, if such systems are not protected from harmful interference. Expanded U-NII operations in the 5 GHz band could cause harmful interference to DSRC systems, endangering the "safety-of-life" services that DSRC has the potential to deliver. To ensure that harmful interference from U-NII devices does not derail the development and deployment of DSRC, most commenters agree that rigorous testing (which was not conducted prior to the NPRM's issuance) is needed to determine whether U-NII devices operating in or near the 5.9 GHz band can coexist with DSRC operations.

Like the Alliance and Global, many parties specifically urge the Commission to await the results of testing by the National Telecommunications and Information Administration ("NTIA"), ongoing international studies on band sharing in the vicinity of 5.9 GHz, and public comment on any proposed rules and interference mitigation measures, before taking further action in this proceeding. The Commission should heed

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[4] 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, *Notice of Proposed Rulemaking*, 28 FCC Rcd 1769 (2013) ("*NPRM*").

[5] *Id.* ¶¶ 2, 75.

these suggestions in order to have an adequate record upon which to resolve the issues raised in this proceeding.

A majority of commenters point out that coexistence between new 5 GHz U-NII devices and 5.9 GHz DSRC systems will be extremely challenging and may not be possible, consistent with the technical analysis submitted by the Alliance and Global. Commenters also point out that the NPRM did not adequately address the complexity of coexistence, raising concerns within the DSRC stakeholder community regarding the protection of DSRC systems. Given these concerns, it is important for the Commission to incorporate the required coexistence testing and analysis into its decision-making process in this proceeding.

Rigorous testing will be required not only to determine whether co-channel interference to 5.9 GHz DSRC systems from U-NII devices can be avoided, but also to determine the viability of the Commission's proposal to extend the upper-edge of the U-NII-3 band to 5850 MHz, the lower edge of the DSRC band. Thus, commenters urge the Commission not to extend the U-NII-3 band to 5850 MHz without first determining whether U-NII-3 operations adjacent to the DSRC spectrum will cause harmful interference to DSRC systems.

Finally, the Commission should not use this proceeding to relocate DSRC vehicle-to-vehicle ("V2V") operations from their existing channel assignment, as Qualcomm suggests, or make any other changes to the 5.9 GHz DSRC rules. Any such changes would be outside the scope of this proceeding and make the DSRC spectrum less useful for new and envisioned applications.

Although the Alliance and Global appreciate the Commission's goal of unleashing additional spectrum for Wi-Fi services, that goal cannot be elevated above the more substantial goal of ensuring that "safety-of-life" DSRC services operate as intended. To avoid disrupting promising "safety-of-life" DSRC services, the Commission should make clear in this proceeding that such services will be sufficiently protected from harmful interference.

II. THE COMMISSION SHOULD NOT ALLOW U-NII USE OF THE 5.9 GHZ BAND AND ADJACENT SPECTRUM UNLESS IT CAN BE OBJECTIVELY DEMONSTRATED THAT SUCH USE WILL NOT INTERFERE WITH THE VIABILITY OF DSRC

A. DSRC Will Only Be Viable if it is Protected From Harmful Interference

DSRC-based connected vehicle technologies may soon be a leading factor in the safe and efficient operation of America's highway transportation systems. These technologies, which include V2V and vehicle-to-infrastructure ("V2I") communications, have the capability to improve motor vehicle traffic safety. Indeed, according to the National Highway Traffic Safety Administration ("NHTSA"), DSRC systems have the potential to address up to 80% of non-impaired light-vehicle accidents, representing a huge step forward in automotive safety.[6]

To fulfill the promise of DSRC, however, it is vital that DSRC systems be protected from harmful interference. The Commission has previously recognized that V2V and V2I applications are "exceptionally time-sensitive and should not be conducted

[6] *See* National Highway Traffic Safety Administration ("NHTSA"), Connected Vehicles, About V2V, http://stnw.nhtsa.gov/safercar/ConnectedVehicles/pages/v2v.html.

on potentially congested channels,"[7] and specifically designated DSRC channels 172 and 184 exclusively for "safety-of-life" and public safety applications, such as vehicle collision warning, avoidance, and mitigation.[8] The NPRM acknowledged that applications using V2V and V2I communications "need secure, wireless interface dependability in extreme weather conditions, and short time delays."[9] And the United States Department of Transportation ("USDOT") recently explained that "safety-of-life" DSRC applications require highly reliable reception with "an instantly available communication link with very low latency."[10] In fact, some DSRC safety applications will require data to be transferred in real time. Any interference that delays or compromises these transmissions could jeopardize the viability of DSRC and eliminate some of its potential safety benefits.

B. Commenters Agree That Expanded U-NII Use of the 5 GHz Band Should Not be Allowed Unless it Can be Objectively Shown That Such Use Will Not Cause Harmful Interference to "Safety-of-Life" 5.9 GHz DSRC Operations

In light of DSRC's latency-sensitive nature and its status as a "safety-of-life" service, commenters in this proceeding have overwhelmingly identified the possibility

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[7] Amendment of the Commission's Rules Regarding Dedicated Short-Range Communication Services in the 5.850-5.925 GHz Band (5.9 GHz Band), Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services, WT Docket No. 01-90, ET Docket No. 98-95, RM-9096, *Memorandum Opinion and Order*, 21 FCC Rcd 8961, ¶ 16 (2006) ("*2006 MO&O*").

[8] *Id.* ¶¶ 16-17.

[9] *NPRM* ¶ 93.

[10] Letter from United States Department of Transportation ("USDOT") to Lawrence E. Strickling, Administrator, National Telecommunications and Information Administration, on FCC NPRM on U-NII Devices in the 5 GHz Band, Technical Appendix, ET Docket No. 13-49, at 2 (May 16, 2013) ("USDOT Letter").

that expanded use of U-NII devices in the 5 GHz band, as proposed by the Commission, will cause harmful interference to DSRC operations.[11] For instance, like the Alliance and Global, Ford Motor Company observed that "U-NII use … could cause harmful co-channel, adjacent channel, and out-of-band interference to DSRC services in numerous ways."[12] OmniAir Consortium similarly explained that expanding U-NII operations in the 5 GHz band "could possibly be life threatening to drivers and pedestrians whose lives will depend on the applications under development for use in the DSRC band."[13]

Many commenters also agree that the Commission should not allow expanded 5 GHz U-NII operations unless it can be objectively proven through rigorous testing that harmful interference will not be caused to "safety-of-life" DSRC operations.[14] Even

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[11] *See, e.g.*, Comments of American Association of State Highway & Transportation Officials, ET Docket No. 13-49, at 11 (May 28, 2013) ("AASHTO Comments"); Letter from Arizona Department of Transportation to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 13-49, at 1 (June 18, 2013) ("ADOT Letter"); Letter from California Department of Transportation to Federal Communications Commission, ET Docket No. 13-49, at 2 (May 28, 2013) ("CalTrans Letter"); Letter from Colorado Department of Transportation to Marlene H. Dortch, Secretary, Federal Communications Commission, ET Docket No. 13-49, at 1 (May 16, 2013) ("CDOT Letter"); Comments of Delphi Automotive, ET Docket No. 13-49, at 1 (May 28, 2013) ("Delphi Comments"); Comments of Ford Motor Company, ET Docket No. 13-49, at 3 (May 28, 2013) ("Ford Comments"); Comments of Members of the ITS Program Advisory Committee, ET Docket No. 13-49, at 1 (May 28, 2013) ("ITSPAC Member Comments"); Comments of Mercedes-Benz USA, ET Docket No. 13-49, at 2 (May 28, 2013) ("Mercedes-Benz Comments"); Comments of OmniAir Consortium, ET Docket No. 13-49, at 2 (May 28, 2013) ("OmniAir Comments"); Letter from Utah Department of Transportation to Julius Genachowski, Chairman, Federal Communications Commission, ET Docket No. 13-49, at 1-2 (Mar. 28, 2013) ("UDOT Letter").

[12] Ford Comments at 3.

[13] OmniAir Comments at 2.

[14] *See, e.g.*, Comments of American Honda Motor Company, ET Docket No. 13-49, at 4 (May 28, 2013) ("Honda Comments"); CalTrans Letter at 2; Delphi Comments at 1-2; Ford Comments at 3; Comments of General Motors Company, ET Docket No. 13-49, at 3 (May 24, 2013) ("GM

proponents of expanded 5 GHz U-NII use believe that extensive testing to determine whether harmful interference will occur is necessary.[15] Without first ensuring through rigorous and conclusive bench and field testing that expanded 5 GHz U-NII use will not cause harmful interference to DSRC systems, an opportunity to improve safety on America's roadways will be squandered; the continued development and deployment of DSRC V2V and V2I systems will be jeopardized; and hundreds of millions of dollars in investment, research, testing, and manufacturing of DSRC-enabled vehicles and devices will be wasted.

C. The Commission Should Carefully Consider the Views of Government Stakeholders in Resolving the Issues Affecting 5.9 GHz DSRC in this Proceeding

Several government agencies, including NTIA, the USDOT, NHTSA, the National Transportation Safety Board ("NTSB"), and state departments of transportation, have long-standing interests in the success of DSRC. The Commission should take full account of their views when evaluating its 5 GHz U-NII proposal.

In January 2013, NTIA released a report studying spectrum-sharing technologies in the 5350 – 5470 MHz and 5850 – 5925 MHz bands ("NTIA 5 GHz Report").[16] In that

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Comments"); Comments of the Intelligent Transportation Society of America, ET Docket No. 13-49, at 38-39 (May 28, 2013) ("ITSA Comments"); ITSPAC Member Comments at 2; Mercedes-Benz Comments at 3; OmniAir Comments at 2; Comments of Savari Networks, ET Docket No. 13-49, at 35 (May 28, 2013) ("Savari Comments"); Comments of the Toyota Motor Corporation, ET Docket No. 13-49, at 2, 17 (May 28, 2013) ("Toyota Comments").

[15] *See, e.g.*, Comments of Cisco Systems, Inc., ET Docket No. 13-49, at 58, 64-65 (May 28, 2013) ("Cisco Comments"); Comments of Ericsson, ET Docket No. 13-49, at 10 (May 28, 2013) ("Ericsson Comments"); Comments of the Telecommunications Industry Association, ET Docket No. 13-49, at 13-14 (May 28, 2013).

[16] United States Department of Commerce, 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

report, NTIA found that additional analysis is needed to determine whether U-NII devices can operate in the 5.9 GHz band without causing harmful interference to "safety-of-life" DSRC operations.[17] NTIA is currently conducting additional research and analysis to determine the effects of U-NII use of the band on DSRC, and estimates that it will make a final recommendation on band sharing to the Commission in mid-to-late 2014.[18] Additionally, NTIA explained that further research on compatibility between U-NII devices and DSRC operations is underway and being coordinated by the State Department's International Telecommunication Advisory Committee as the United States develops its position on potential international uses of the 5.9 GHz band ahead of the International Telecommunication Union's World Radiocommunication Conference and other international fora.[19]

Many commenters urged the Commission to await the conclusion of NTIA's testing and analysis before making a final decision on whether to allow expanded U-NII use of the 5 GHz band.[20] For instance, SAE International urged the Commission not to make a decision on spectrum sharing in the 5.9 GHz band "until … additional insight is provided by NTIA's analysis."[21]

2012 (2013), *available at* http://www.ntia.doc.gov/files/ntia/publications/ntia_5_ghz_report_01-25-2013.pdf ("NTIA 5 GHz Report").

[17] *Id.* at 5-13.

[18] *Id.* at 5-13, 6-4.

[19] *Id.* at 6-3.

[20] *See, e.g.,* AASHTO Comments at 12; GM Comments at 3; Comments of SAE International, ET Docket No. 13-49, at 3-4 (May 28, 2013) ("SAE Comments").

[21] SAE Comments at 3-4.

In addition to releasing its 5 GHz Report, on June 10, 2013, NTIA submitted a letter in this proceeding, explaining that its 5 GHz Report had "identified a number of risks to FCC-authorized ITS stations operating Dedicated Short Range Communication Service (DSRCS) systems in the 5850 – 5925 MHz band and suggested mitigation strategies."[22] NTIA also indicated its view that "direct interaction and cooperation between wireless and transportation industry representatives is essential for the development of constructive proposals to accommodate evolving U-NII and ITS technologies."[23] In light of the interference concerns NTIA raised in its 5 GHz Report, the Commission should pay particular attention to NTIA's recommendations that further study and close collaboration between the wireless and transportation industries are required in order to adequately resolve the issues affecting DSRC in this proceeding.

The USDOT has also addressed the Commission's 5 GHz U-NII proposal, noting that it "remains critically interested in the deployment of ITS."[24] In its submission, the USDOT asked that "the FCC and the NTIA take steps to ensure that [the 5.9 GHz] spectrum remains adequately protected for ITS purposes."[25] In its filing, the USDOT explained that "[o]ver the past decade, the DOT ITS program has invested approximately $450 million in researching and developing the technology and applications that will fully leverage the DSRC spectrum," and detailed its work testing and analyzing

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[22] Letter from the National Telecommunications and Information Administration to Julius Knapp, Chief, Office of Engineering and Technology, Federal Communications Commission, ET Docket No. 13-49, at 1 (June 10, 2013).

[23] *Id.*

[24] USDOT Letter at 4.

[25] *Id*.

DSRC-enabled safety applications, collaborating with global automobile manufacturers, and cooperating with its counterparts in Europe and Japan to harmonize DSRC allocations and allow for international interoperability of connected-vehicle technologies.[26] The USDOT also recommended that the Commission and NTIA "ensure that unlicensed devices, if permitted to operate in the 5.9 GHz band, 'do not cause harmful interference' to the ITS architecture, operations or safety-critical applications," and explained that "NTIA has not completed its statutorily mandated study to evaluate spectrum sharing in the 5.9 GHz band. Consequently, it would appear untimely for the FCC to move forward prior to the conclusions of such an evaluation."[27]

NHTSA and NTSB have also long been involved in the development and deployment of DSRC systems. Currently, NHTSA is in the process of making a decision, expected later in 2013, on whether to commence a rulemaking proceeding that could mandate the deployment of connected vehicle technologies using DSRC in all new vehicles.[28] And in its comments in this proceeding, NTSB explained that while it does not oppose spectrum sharing in principle, U-NII use of the 5.9 GHz band could endanger DSRC operations.[29] Moreover, NTSB recently recommended to NHTSA that NHTSA "[d]evelop minimum performance standards for connected vehicle technology," and

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[26] *Id.* at 3-4.

[27] *Id.* at 5.

[28] *See* NHTSA, Vehicle Safety and Fuel Economy Rulemaking and Research Priority Plan 2011-2013 at 7 (2011), *available at* http://www.regulations.gov/contentStreamer?objectId=0900006480e78ab2&disposition=attachment&contentType=pdf.

[29] Letter from National Transportation Safety Board ("NTSB") to Aole Wilkins, Electronics Engineer, Office of Engineering and Technology, Federal Communications Commission, ET Docket No. 13-49, at 3-4 (May 28, 2013) ("NTSB Letter").

"once minimum performance standards … are developed, require this technology to be installed on all newly manufactured highway vehicles."[30]

Finally, the departments of transportation of California, Colorado, and Utah, as well as the American Association of State Highway and Transportation Officials ("AASHTO"), each expressed concerns regarding the Commission's proposal due to the possibility that shared use of the 5.9 GHz band could endanger DSRC.[31] AASHTO recommended that the Commission table its current proposal regarding U-NII operations in the 5.9 GHz band and convene interested stakeholders to simulate, test, demonstrate, and provide guidance on whether any spectrum sharing scenarios and interference mitigation techniques will allow for U-NII and DSRC to coexist in the band.[32] The Arizona Department of Transportation concluded that "[t]he promise offered by [DSRC] technology to reduce deaths, injuries, loss of property, [and] reduc[e] [] energy use and emissions is just too great" to sacrifice in order to "provid[e] additional capacity for Internet access to consumers and their wireless devices."[33]

Because these government stakeholders have invested hundreds of millions of dollars in the development and roll-out of DSRC and are responsible for improving safety on America's roadways, the Commission should take their expert input fully into account

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[30] NTSB, Highway Accident Report: School Bus and Truck Collision at Intersection Near Chesterfield, New Jersey February 16, 2012 at 6 (2013), *available at* http://www.ntsb.gov/news/events/2013/chesterfield_nj/Abstract_Chesterfield_NJ.pdf.

[31] *See* AASHTO Comments at 11; ADOT Letter at 1-2; CalTrans Letter at 1-2; CDOT Letter at 1-2; UDOT Letter at 1-2.

[32] AASHTO Comments at 18.

[33] ADOT Letter at 2.

in resolving the important interference and DSRC viability issues raised in this proceeding.

D. Premature Introduction of U-NII Devices in the 5.9 GHz Band Could Prove Costly and Disruptive to U-NII Equipment Suppliers if U-NII Use of the Band Causes Harmful Interference to DSRC Operations

Allowing U-NII devices to operate in the 5.9 GHz and adjacent bands prior to the completion of testing to determine whether such devices will cause harmful interference to DSRC services could prove costly and disruptive to U-NII equipment suppliers and consumers if it is subsequently discovered that U-NII operations cause harmful interference to DSRC services. Therefore, the Commission should not act hastily in this proceeding.

As discussed above, expanded 5 GHz band U-NII use could cause harmful interference to DSRC operations. Nonetheless, some commenters have urged the Commission to allow expanded 5 GHz U-NII use as soon as possible.[34] While rapid expansion of the 5 GHz band available for U-NII use could spur Wi-Fi deployment in the short-term, it could prove very costly and disruptive in the long-term if harmful interference to DSRC is not avoided.

If the Commission opts to allow expanded 5 GHz band U-NII use prior to the completion of the rigorous bench and field testing necessary to objectively determine whether U-NII operations will not cause harmful interference to "safety-of-life" DSRC services, the costs of such a mistake could be high. If harmful interference occurs after

[34] *See e.g.*, Comments of Motorola Mobility LLC, ET Docket No. 13-49, at 7 (May 28, 2013); Comments of the National Cable and Telecommunications Association, ET Docket No. 13-49, at 19 (May 28, 2013) ("NCTA Comments").

new 5 GHz U-NII equipment has been developed and widely sold, the Commission will need to take quick action to prevent widespread interference from such devices. Such action could include adopting new, more restrictive U-NII rules, and equipment recalls could be necessary. Such developments would cause delays in both DSRC and U-NII deployment.

III. CONNECTED VEHICLE MODEL DEPLOYMENT IS NEAR COMPLETION

A. DSRC Connected Vehicle Technology is at an Advanced Stage of Development

The Connected Vehicle Safety Pilot Program begun in August 2012 is a year-long scientific research initiative involving the real-world implementation of connected vehicle safety technologies, applications, and systems using everyday drivers. The effort is evaluating connected vehicle performance, human factors and usability, policies and processes, and collecting empirical data to obtain a more accurate, detailed understanding of the potential safety benefits of connected vehicle technologies. This empirical data will be used by NHTSA to determine whether to proceed with a rulemaking regarding a potential industry-wide mandate by late-2013.[35] Proof-of-concept testing has already been completed and the USDOT and the United States automobile industry are now in the midst of the world's most comprehensive on-the-road test of DSRC V2V communications ever conducted.[36] The USDOT and AASHTO are also actively planning

[35] *See* USDOT, Research and Innovative Technology Administration ("RITA"), Connected Vehicle Safety Pilot Program, http://www.its.dot.gov/factsheets/pdf/SafetyPilot_final.pdf.

[36] USDOT Letter at 3-4.

initial deployment of infrastructure to support V2I messaging.[37] Moreover, several states are already implementing or planning connected vehicle projects using DSRC.[38] Finally, the automobile industries in Europe and Japan are conducting their own real-world tests, and ITS using DSRC will be deployed in Europe beginning in 2015 on an opt-in basis.[39] In sum, 5.9 GHz DSRC connected vehicle technologies are in the final stages of refinement before a rulemaking decision intended to make connected vehicle technologies generally available.

Research and development of DSRC technologies began decades ago, and federal support for DSRC systems began in 1991.[40] Since then, Congress has repeatedly authorized hundreds of millions of dollars for DSRC research and testing.[41] Indeed, the most recently enacted highway reauthorization provides $200 million for DSRC in fiscal years 2012 and 2013, and directs the USDOT to carry out operational tests on the

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[37] *Id.* at 5.

[38] Comments of the Alliance of Automobile Manufacturers, Inc. and the Association of Global Automakers, Inc., ET Docket No. 13-49, at 25 (May 28, 2013) ("Alliance & Global Comments") (citing AASHTO Connected Vehicle Infrastructure Deployment Analysis, Final Report, Publication Number: FHWA-JPO-11-90, 20-21 (2011), *available at* www.its.dot.gov/index.htm).

[39] USDOT Letter at 5; Alliance & Global Comments at 5 (citing Press Release, Car 2 Car Communications Consortium, European vehicle manufacturers working hand in hand on development of cooperative Intelligent Transport Systems and Services (C-ITS) (Oct. 10, 2012), *available at* http://www.car-to-car.org/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/downloads/forum08/PressReleases/Press_release_on_MoU.pdf&t=1369177568&hash=e10dbbc1b4f6ba5990d73e5b90ed19fc72b3b436).

[40] Savari Comments at 12 (citing Federal Transit Amendments Act of 1991, 105 Stat. 1914, Pub. L. 102-240 (1991)).

[41] *Id.* at 12-14.

technology.[42] Alongside these federal efforts, the automobile industry has contributed significant financial and human resources to developing DSRC in reliance on the continued viability of a spectral environment that makes latency-sensitive DSRC applications possible.

Proof-of-concept testing of DSRC devices, standards, and technologies was conducted by the USDOT from 2004 through 2009.[43] Using data from these tests, the initial DSRC standards were updated and a second generation of technology was developed.[44] As noted above, the USDOT is now partnering with eight global automobile manufacturers and other private industry stakeholders to conduct a large-scale, real world assessment of DSRC through the Connected Vehicle Safety Pilot Program.[45] The program is divided into two stages: (1) Driver Acceptance Clinics and (2) Model Deployment. The Driver Acceptance Clinics were designed to evaluate driver acceptance of the new DSRC technologies. Completed in January 2012, the clinics showed overwhelming driver support.[46] The Model Deployment phase is currently underway and consists of a 30-month long, real-world test of over 2,800 private,

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[42] *Id*. at 14 (citing Moving Ahead for Progress in the 21st Century Act, 126 Stat. 405, Pub. L. 112-141 (2012)).

[43] USDOT Letter at 3-4.

[44] *Id.*

[45] Alliance & Global Comments at 5 (citing USDOT, RITA, Connected Vehicle Safety Pilot Program, http://www.its.dot.gov/factsheets/pdf/SafetyPilot_final.pdf); USDOT Letter at 4.

[46] Savari Comments at 22 (citing USDOT, Safety Pilot Connected Vehicle Technology, Fact Sheet: "Improving Safety and Mobility Through Connected Vehicle Technology" (2012), *available at* http://icsw.nhtsa.gov/safercar/ConnectedVehicles/pages/resources.html).

commercial, and fleet vehicles using a variety of DSRC devices in multi-modal traffic.[47] This mix of cars, trucks, and buses will test DSRC devices travelling on 73 miles of freeways and city streets in Ann Arbor, Michigan.[48]

The results of this testing will be key inputs into NHTSA's upcoming decision this year regarding whether to require automobile manufacturers to include DSRC devices in all new light vehicles.[49] In 2014, NHTSA will consider mandating DSRC in all new heavy vehicles.[50] Even in advance of any such mandate, however, states, counties, and private parties have already begun to deploy DSRC. Several states, including Minnesota, California, Idaho, New York, Arizona, Washington, Michigan, and Virginia, are implementing or planning to implement DSRC-based systems, including in-vehicle signage, stop-sign assist, and signal prioritization at intersections.[51] For example, Maricopa County Department of Transportation in Arizona has created a SMARTDrive prototype near Phoenix.[52] Kapsch TrafficCom, a private company, is

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[47] Alliance & Global Comments at 20 (citing University of Michigan Transportation Research Institute, Program Overview, http://www.safetypilot.us/program-overview.html).

[48] *Id.* (citing University of Michigan Transportation Research Institute, How It Works, http://www.safetypilot.us/how-it-works.html).

[49] USDOT Letter at 4.

[50] *Id.*

[51] Savari Comments at 25-26 (citing USDOT, RITA, AASHTO Connected Vehicle Infrastructure Deployment Analysis, Final Report, Publication Number: FHWA-JPO-11-90, 20-21 (2011), *available at* http://ntl.bts.gov/lib/43000/43500/43514/FHWA-JPO-11-090_AASHTO_CV_Deploy_Analysis_final_report.pdf).

[52] *Id.* at 26 (citing National Spotlight on Maricopa County Test Site for High Tech Traffic Management, http://www.mcdot.maricopa.gov/news/2012/smartdrive-demonstration.htm).

using DSRC devices for commercial vehicle credentialing in a pilot program in Indiana, Ohio, and Illinois.[53]

Similar developments are occurring in Europe and Japan, with real world tests currently underway and broader deployments scheduled or expected soon.[54] ABI Research projects that government mandates and private efforts will lead to the widespread adoption of DSRC technologies, reaching a projected 61.8% penetration rate by 2027.[55]

As detailed above, efforts to implement DSRC are well underway and a path exists toward its widespread use. However, the Commission's 5 GHz proceeding has the potential to delay and disrupt the roll-out of these services. Testing of DSRC technologies and applications did not contemplate spectrum sharing with U-NII devices. Consequently, introducing U-NII devices into the 5.9 GHz and adjacent bands at this late date could require extensive re-testing and significantly delay DSRC deployment.

B. Commenters Agree that the Commission Should Proceed Cautiously to Avoid Disrupting DSRC Deployment

As discussed in detail in Section IV below, the record in this proceeding is replete with comments urging the Commission to proceed cautiously to avoid disrupting DSRC deployment. For example, the Volkswagen Group of America recommended that any decision be "thoroughly vetted with all industry partners and … validated through testing

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[53] *Id*. (citing Kapsch TrafficCom, Brochure: "e-Screening Pilot Corridor Powered by 5.9 GHz").

[54] USDOT Letter at 4.

[55] Alliance & Global Comments at 6 (citing ABI Research, V2V Penetration in New Vehicles to Reach 62% by 2027 (2013), http://www.abiresearch.com/press/v2v-penetration-in-new-vehicles-to-reach-62-by-202).

prior to any potential FCC rulings."[56] Similarly, Ford Motor Company advocated that "before any rules allowing 5.9 GHz U-NII unlicensed use … are promulgated, the Commission should seek formal public comment on such rules to ensure that they adequately protect DSRC services."[57]

Beyond these procedural precautions, many commenters remarked on the need for additional testing and analysis. For example, the members of the Intelligent Transportation Systems Program Advisory Committee ("ITSPAC") commented that the Commission should not act "unless thorough data-driven review testing demonstrates that no harmful interference would occur to the existing frequency allocation."[58] The California Department of Transportation urged the Commission to "order additional studies … be performed to determine the extent of any detrimental effects of U-NII devices on nearby DSRC devices."[59] Delphi Automotive recommended that the Commission conduct "exhaustive testing … to guarantee no harmful interference will occur from unlicensed use of the 5 GHz spectrum before the FCC moves forward with the current proposal for unlicensed use."[60]

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[56] Comments of Volkswagen Group of America, Inc., ET Docket No. 13-49, at 3 (filed May 28, 2013) ("Volkswagen Comments").

[57] Ford Comments at 3.

[58] ITSPAC Member Comments at 2.

[59] CalTrans Letter at 2.

[60] Delphi Comments at 1-2.

In particular, several commenters urged the Commission to proceed to a decision only after NTIA completes its study on spectrum sharing.[61] NTSB, for example, argued that NTIA's analysis "should be conducted before safety-sensitive frequencies are opened up to UNII devices."[62] Likewise, General Motors advocated that the Commission align its decision timeline with NTIA's testing schedule.[63] Even a number of commenters who support expanding U-NII use of the 5 GHz band recommended that the Commission conduct compatibility testing.[64] For example, Cisco encouraged opening additional 5 GHz spectrum for U-NII use, but also agreed with NTIA that additional analysis is needed to determine and mitigate the risks to DSRC.[65] Similarly, Ericsson requested further study to evaluate U-NII/DSRC sharing.[66]

IV. UNDER THE FCC'S CURRENT PROPOSAL, U-NII DEVICES WOULD CAUSE HARMFUL INTERFERENCE TO 5.9 GHZ DSRC SYSTEMS AND THREATEN THE VIABILITY OF DSRC

The Commission's proposal to allow expanded 5 GHz U-NII use would, if implemented without significant modification, cause harmful co-channel and adjacent channel interference to DSRC systems, and this interference would be exacerbated over time by the widespread use of both Wi-Fi and DSRC in the band. As noted above, such

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[61] *See*, *e.g.*, Comments of the National Association of Broadcasters, ET Docket No. 13-49, at 3 (May 28, 2013).

[62] NTSB Letter at 4.

[63] GM Comments at 3.

[64] *See*, *e.g.*, Comments of Consumer Electronics Association, ET Docket No. 13-49, at 14, 16 (May 28, 2013) ("CEA Comments").

[65] Cisco Comments at 57-58, 64-65.

[66] Ericsson Comments at 1-2, 10.

harmful interference could significantly undermine the viability of DSRC and threaten further development and deployment of connected vehicle technologies.

A. Commenters Recognize That the FCC's Current Proposal is Insufficient to Protect 5.9 GHz DSRC Operations

Commenters in the docket recognize that, if implemented without modification, the Commission's proposal would not adequately protect DSRC operations from harmful interference.[67] Specifically, the USDOT's letter to NTIA observed that the Commission's proceeding is not ripe for consideration because "DOT has not, to this point, encountered any proposed technical solution to maintaining the channel [] access needed to guarantee interference-free operation of the critical safety applications if U-NII devices were granted access."[68]

1. Commenters Agree that Existing U-NII Rules Would Not be Sufficient to Protect "Safety-of-Life" 5.9 GHz DSRC Services from Harmful Interference

Commenters in this proceeding agreed that allowing U-NII devices to operate in or near the 5.9 GHz band under section 15.407 of the Commission's rules would be insufficient to protect "safety-of-life" 5.9 GHz DSRC services from harmful interference.[69] As AASHTO explained, the Commission's proposal to apply the U-NII-3 technical rules to U-NII devices in the 5.9 GHz band would permit those devices to operate at power levels which could "cause frequent, harmful interference to existing and

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[67] *See, e.g.*, Mercedes-Benz Comments at 2; Comments of Qualcomm Inc., ET Docket No. 13-49, at 6-7 (May 28, 2013) ("Qualcomm Comments"); UDOT Letter at 2; USDOT Letter at 5-6.

[68] USDOT Letter at 5.

[69] *See NPRM* ¶ 97.

planned DSRC operations" in the band.[70] Toyota Motor Corporation observed that the transmitting power and spectral power density of devices operating below 5.850 GHz under the Commission's current rules may be too strong to avoid harmful interference to DSRC and, if U-NII devices are permitted in the 5.9 GHz band itself, they must be addressed by reasonable interference models.[71] Moreover, "[e]xisting U-NII regulations were not developed to detect DSRC signals."[72] Therefore, new U-NII devices operating in or near the 5.9 GHz DSRC band may not be capable of detecting DSRC signals. In addition, existing U-NII regulations were not devised to protect transmitters and receivers in different locations, such as on-board DSRC units, and "[c]hanges to U-NII DFS detection parameters may not protect DSRC systems from serious performance degradation."[73]

2. If U-NII Operations in the 5.9 GHz Band are Allowed, U-NII Devices Must Avoid Occupied DSRC Channels

If the Commission moves forward with its proposal, it should ensure that U-NII devices operating in the 5.9 GHz band avoid occupied DSRC channels. In addition, the Commission should ensure that any mechanism developed to prevent U-NII devices from operating on channels where DSRC systems are in use is thoroughly tested. Interference mitigation system failures would result in harmful interference to DSRC systems. Currently, many commenters do not believe that the spectrum in or near the 5.9 GHz

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[70] *See* AASHTO Comments at 2-3, 10.

[71] *See* Toyota Comments at 15.

[72] *Id.* at 7.

[73] *Id.* (citing NTIA 5 GHz Report at 6-2).

band is ripe for sharing due to the multitude of interference-related issues that make coexistence between U-NII devices and DSRC systems improbable at this time.[74]

a. U-NII Use of the 5.9 GHz Band Pursuant Solely to Section 15.407 Would Cause Harmful Co-Channel Interference to DSRC Systems

As the Alliance and Global discussed in their comments, use of U-NII devices in the 5.9 GHz band could result in harmful co-channel interference to DSRC systems.[75] There are a myriad of potential causes of this co-channel interference, including detection issues due to the disparity in channel size between U-NII and DSRC systems, power limit disparities that may prevent U-NII devices from detecting lower-powered DSRC signals, and channel congestion.

Power limit disparity-related interference problems will arise if the Commission adopts its proposed (1 Watt) power limit for U-NII-4 devices. Such a power limit would allow the transmission range of the U-NII-4 devices to be significantly greater than the 300 meter maximum range of DSRC devices. As such, U-NII-4 devices could initiate transmissions before in-range DSRC devices could transmit detectable signals.[76] As a result, U-NII-4 packets would be sent at the same time that DSRC units sent packets for critical safety applications, causing the DSRC packets to be unreadable by DSRC receiving devices.[77]

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[74] *See, e.g.*, AASHTO Comments at 18; ITSA Comments at 39-41; Toyota Comments at 16.

[75] *See* Alliance & Global Comments at 27-30.

[76] *See* Alliance & Global Comments, Technical Appendix at 1.4-1.5 ("Technical Appendix").

[77] *Id.*

In addition, some U-NII-4 transmitters might not be able to identify a DSRC signal as a valid orthogonal frequency-division multiplexing ("OFDM") waveform because those devices do not use the 802.11j standard extension, or they are not OFDM devices.[78] In these instances, U-NII-4 devices might be able to identify the DSRC signal by using physical carrier sensing, but the detection level for physical carrier sensing is approximately -65dBm.[79] By contrast, DSRC transmissions at their maximum range occur with received signal strengths as low as -92 to -94 dBm.[80] At such low DSRC transmission values, U-NII-4 devices simply will not be able to detect DSRC signals and avoid harmful interference. This could lead to unreadable DSRC packets and, in some cases, stop the DSRC signals from arriving at their intended destination.[81]

Despite this potential for harmful interference, a number of commenters voiced support for the Commission's proposed power limits.[82] In light of the foregoing, though, the Alliance and Global urge the Commission to reject these suggestions. Moreover, if the Commission ultimately allows U-NII-4 devices to share the 5.9 GHz band, it should impose a much lower power limit on U-NII-4 transmissions. Even commenters who support allowing U-NII devices to operate in the 5.9 GHz band concede that the Commission's proposed (relatively high) power limit of 1 Watt is not necessary. For

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[78] *Id*.

[79] *Id*.

[80] *Id*.

[81] *Id.*

[82] *See*, *e.g.*, NCTA Comments at 17-18; Comments of Comcast Corp., ET Docket No. 13-49, at 22 (May 28, 2013) ("Comcast Comments"); Comments of Cablevision Systems Corp., ET Docket No. 13-49, at 5 (May 28, 2013).

example, Qualcomm noted that power limits of "approximately 20 dBm for VHT40/80/160 packets and 12 dBm for VHT20 packets … are still sufficient for the intended low power short-range communication Wi-Fi use cases for this band."[83]

The Attachment to these reply comments provides additional detail on the harmful interference scenarios that U-NII-4 operations in the 5.9 GHz band could create.[84]

b. Adjacent Channel Operations by U-NII Devices Pursuant Solely to Section 15.407 Would Cause Harmful Interference to DSRC Systems

Operations by U-NII devices in bands that are adjacent to 5.9 GHz DSRC systems also have the potential to cause harmful interference to DSRC. The Commission's proposal to allow adjacent band U-NII devices to operate under the U-NII-3 band rules would result in the U-NII devices operating at maximum power levels well above that of 5.9 GHz DSRC applications. This power disparity could cause harmful interference to geographically proximate DSRC safety applications, even if the U-NII devices are not operating specifically in the 5.9 GHz band.[85] As noted in the Technical Appendix to the Alliance and Global comments, even if U-NII devices were confined to spectrum that did not include DSRC operations, the U-NII devices operating at the power levels proposed

[83] Qualcomm Comments at 11-12.

[84] *See* Attachment 1 at 7-24.

[85] *See id.* at 10.

by the Commission could cause harmful interference to V2V safety applications if they were transmitting closely adjacent to the DSRC channel being used for V2V safety.[86]

c. Out-of-Band Interference to DSRC Systems Would Occur if U-NII Devices Were Allowed to Operate in Close Spectral Proximity to the 5.9 GHz Band Solely Pursuant to Section 15.407

The Commission's proposal could also result in harmful out-of-band interference to DSRC systems. As discussed in detail below, the Commission has proposed to expand the U-NII-3 band upwards by 25 MHz to the bottom edge of the 5.9 GHz DSRC band.[87] If the Commission ultimately implemented that proposal, U-NII-3 devices would be permitted to operate under section 15.407 and its associated power levels, which, because of the power disparity mentioned above, would create the potential for out-of-band interference to DSRC systems. In such an instance, the same DSRC signal detection problems discussed above with respect to co-channel and adjacent channel U-NII operations could cause harmful interference to DSRC systems on account of the transmit power disparity between U-NII and DSRC devices.[88] DSRC services in the lower end of the band, such as V2V safety communications in DSRC channel 172, are most likely to be affected by out-of-band interference.[89]

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[86] Technical Appendix at 1.6.2.

[87] *NPRM* ¶ 27.

[88] *See* Part IV.A.2.a, *supra*, the Technical Appendix at 1.4-1.5, and Attachment 1 at 7-24 for additional detail.

[89] *See* Attachment 1 at 27 (illustrating that V2V safety applications are located in Channel 172 at the lower end of the DSRC spectrum).

d. These Interference Concerns are Bolstered by the Reality that Wi-Fi Use is Likely to be Widespread and Particularly Heavy in the Areas Where "Safety-of-Life" DSRC Operations Will be Most Needed

The interference concerns expressed by numerous commenters in this docket are bolstered by the reality that U-NII use is likely to be widespread and particularly heavy in urban centers and other areas where Wi-Fi devices and vehicles using V2V technologies are likely to converge.[90] For instance, AASHTO noted that the problem of U-NII devices causing harmful interference to DSRC will be exacerbated and become increasingly complicated as the number of U-NII users rises, which is likely due to "increasing use by cellular carriers as they continue to support the customer's use of available Wi-Fi hotspots."[91] Indeed, proponents of expanded 5 GHz U-NII use acknowledge that urban Wi-Fi deployments occur most prominently in areas of high pedestrian and vehicle traffic, including stadiums, parks and heavily-traveled thoroughfares.[92] In addition, customers within vehicles are and will continue to be using U-NII devices to provide in-vehicle connectivity. These are precisely the areas where DSRC services will be most heavily used and where the need for DSRC reliability is greatest. Comcast noted in its comments that the need for additional Wi-Fi spectrum is especially high in densely populated areas.[93] Again, given projected DSRC deployments,

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[90] *See, e.g.*, AASHTO Comments at 16; SAE Comments at 3.

[91] AASHTO Comments at 16.

[92] *See, e.g.*, Comments of Time Warner Cable Inc., ET Docket No. 13-49, at 8 (May 28, 2013).

[93] Comcast Comments at 15.

these comments suggest a looming interference crisis in heavily-traveled and densely populated areas.

B. Interference from U-NII Devices Would Significantly Undermine the Viability of 5.9 GHz DSRC Systems

Numerous commenters have made clear that harmful interference from U-NII devices would undermine the viability of DSRC.[94] As the USDOT pointed out, DSRC-enabled safety applications need instant availability and high reliability "so that safety information is immediately shared with recipients in real time to be useful."[95] As Savari Networks explained, "[c]oncerns about … the integrity of the 5.9 GHz band could have a negative impact on a very promising emerging market for DSRC-based safety applications,"[96] and "the regulatory uncertainties arising from the NPRM potentially cast grave doubts in the minds of key decision makers, company planners and investors."[97] Finally, the European Automobile Manufacturers' Association and Car-2-Car Consortium, and Mercedes-Benz, importantly pointed out that the market for V2V and V2I technologies is global, and a decision by the Commission to allow expanded U-NII use of the 5 GHz band would have global implications because automakers across the world have not designed DSRC systems to account for U-NII transmissions.[98] If DSRC

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[94] *See, e.g.*, Comments of the European Automobile Manufacturers' Association and Car-2-Car Consortium, ET Docket No. 13-49, at 2-3 ("ACEA & C2C Comments"); ITSA Comments at 2-3, 37-38; Mercedes-Benz Comments at 2; NTSB Letter at 3-4; OmniAir Consortium Comments at 2; UDOT Letter at 2; Volkswagen Comments at 2-3.

[95] USDOT Letter at 5.

[96] Savari Comments at 31.

[97] *Id.* at 33.

[98] *See* ACEA & C2C Comments at 1; Mercedes-Benz Comments at 2.

and U-NII operations cannot coexist, the Commission will have made impossible the world-wide viability of DSRC systems.[99] This point is echoed by the USDOT, which described the ongoing international efforts to harmonize spectrum allocations for DSRC and "significantly reduce overall costs for all participants through global economies of scale."[100] The Commission's proposal would undermine these international efforts and "likely significantly delay, or even cancel, planned implementations at a moment when the global transportation community is poised to deploy [c]onnected [v]ehicle safety, mobility, and environmental solutions, and related infrastructure applications."[101]

C. Additional Study is Needed to Determine Whether (and Under What Circumstances) DSRC and Expanded 5 GHz U-NII Operations Can Co-exist

Because of the risks this proceeding poses for DSRC,[102] additional study, including rigorous bench and field testing of U-NII/DSRC interference and potential mitigation techniques, is needed to determine whether (and under what circumstances) DSRC and expanded 5 GHz U-NII operations can coexist. As discussed above, numerous parties, including supporters of the Commission's proposal,[103] have stressed this need, and we urge the Commission to recognize it as well.

The Commission should allow NTIA to conclude its ongoing testing and analysis and also encourage the relevant stakeholders to convene to determine whether new

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[99] Mercedes-Benz Comments at 2.

[100] USDOT Letter at 4.

[101] *Id.*

[102] *See* NTIA 5 GHZ Report at 5-10 – 5-12.

[103] *See, e.g.*, Cisco Comments at 58, 64-65; Ericsson Comments at 10.

5 GHz U-NII devices can co-exist with DSRC systems. It should also engage in a rigorous, data-driven process to resolve the relevant compatibility issues. Many commenters, including both supporters and skeptics of the Commission's proposal, support such a collaborative process.[104] In addition, the Commission should seek formal public comment prior to issuing any rules it devises based on the testing and analysis that does take place. The stakes are too high for the Commission to rush to judgment on these critical issues.

V. THE COMMISSION SHOULD NOT EXTEND THE UPPER EDGE OF THE U-NII-3 BAND TO 5850 MHZ UNLESS IT CAN BE OBJECTIVELY DEMONSTRATED THAT U-NII USE OF THE SPECTRUM WILL NOT CAUSE OUT-OF-BAND INTERFERENCE TO DSRC SYSTEMS

A. Extending the Upper Edge of the U-NII-3 Band to 5.850 GHz Could Cause Harmful Out-Of-Band Interference to DSRC Systems

The Commission should reject the suggestions of some commenters to extend the upper edge of the U-NII-3 band by 25 MHz to 5.850 GHz.[105] These commenters ignore the potential for harmful out-of-band interference that such an extension would create.

As an initial matter, DSRC operations in the 5.9 GHz band are already subject to harmful interference from unlicensed users in adjacent bands. The Commission currently permits unlicensed devices to operate on bands up to 5.850 GHz under section 15.247 of

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[104] *See, e.g.,* AASHTO Comments at 12; CEA Comments, at 16; Cisco Comments at 65; Comments of IEEE 802, ET Docket No. 13-49, at 4, 30-31 (May 28, 2013) ("IEEE 802 Comments"); ITSA Comments at 38-39; Savari Comments at 33, 35; Toyota Comments at 7; Volkswagen Comments at 3.

[105] *See, e.g.*, IEEE 802 Comments at 12; Ericsson Comments at 4; Comments of the Wireless Internet Service Providers Association, ET Docket No. 13-49, at 12 (May 28, 2013).

its rules.[106] Extending the upper edge of the U-NII-3 band to 5.850 GHz would only serve to multiply the number of unlicensed devices operating in bands adjacent to the 5.9 GHz band, with a corresponding increase in the number of unlicensed systems that could negatively affect DSRC users and increase the potential for harmful interference. Adjacent band unlicensed operations have already proven problematic and should not be allowed to proliferate further.

Moreover, the Commission's proposed unwanted emissions limits for U-NII-3 devices would allow emissions "below -17 dBm/MHz within 10 megahertz of the band edge, and below -27 dBm/MHz beyond 10 megahertz of the band edge."[107] Extending the U-NII-3 band to 5.850 GHz under such conditions would place these unwanted emissions directly into spectrum occupied by DSRC devices. U-NII-3 emissions at the proposed levels would likely cause harmful interference for any DSRC devices located within 22.2 meters of an emitting U-NII-3 device.[108] Given the potentially large scale penetration of U-NII-3 devices, this could seriously undermine DSRC operations across large geographic areas, compromising DSRC's safety benefits.

The expected density of U-NII-3 devices (not to mention the presence already of unlicensed section 15.247 devices) also raises the potential for aggregate interference impacting DSRC operations. Even if operating under the Commission's proposed power, antenna, and emission mask rules, the sheer number of U-NII-3 devices emitting out-of-band signals into the 5.9 GHz DSRC band would raise the noise floor in the band

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[106] *See* 47 C.F.R. § 15.247.

[107] *NPRM* ¶ 34.

[108] Technical Appendix at 1.7.1.

significantly. Given DSRC's need for extremely high reliability and low latency, this could seriously degrade DSRC operations.[109] The Commission has previously recognized the potential hazard posed by aggregate interference in other contexts, including when deciding to permit DSRC operations in the 5.9 GHz band.[110]

B. Proponents of Expanding the U-NII-3 Band Should Be Required to Demonstrate Why Extending the Band Will Not Cause Harmful Interference to DSRC Systems

The Commission's rules and precedent require that the proponents of expanding the U-NII-3 band bear the burden of demonstrating that doing so would not cause harmful interference to DSRC services. U-NII devices are unlicensed and, as such, must comply with the requirements of Part 15 of the Commission's rules. The primary operating condition for unlicensed devices is that they not cause harmful interference to authorized services.[111] Indeed, unlicensed users are required to cease operations immediately if they are unable to eliminate interference.[112] By contrast, DSRC users are incumbent, primary users in the 5 GHz band, and therefore must be protected from harmful interference. The responsibility to avoid harmful interference rests squarely with unlicensed users and therefore they bear the burden of demonstrating that the proposed

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[109] *See, e.g.*, Comments of SES S.A. and Intelstat S.A., ET Docket No. 13-49, at 5-8 (May 28, 2013) (explaining, in the context of satellite operations, the harmful interference that the aggregate effect of many unlicensed devices can have).

[110] *See* Amendment of Parts 2 and 90 of the Commission's Rules to Allocate the 5.850-5.925 GHz Band to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services, *Report and Order*, 14 FCC Rcd 18221 ¶ 15 (1999) ("*DSRC Allocation R&O*").

[111] *NPRM* ¶ 3; *see also* 47 C.F.R §15.5(b)-(c).

[112] *NPRM* ¶ 3; 47 C.F.R. § 15.5(b)-(c).

expansion of the U-NII-3 band to 5.850 GHz will not cause harmful interference to DSRC services.

VI. THE COMMISSION SHOULD NOT MANDATE THE RELOCATION OF DSRC V2V OPERATIONS OR MAKE ANY CHANGES TO THE 5.9 GHZ DSRC RULES WHATSOEVER IN THIS PROCEEDING

A. Qualcomm's Proposed Modification of DSRC Channel Uses Is Outside the Scope of This Proceeding

The Commission should reject Qualcomm's proposed changes to the DSRC rules. The changes proposed by Qualcomm would move core DSRC V2V safety messages to DSRC channels 182 and 184 from their current location at DSRC channel 172.[113] In Qualcomm's view, such a relocation would make it more likely that U-NII-4 devices could share portions of the 5.9 GHz DSRC band by separating U-NII-4 operations from "safety-of-life" DSRC communications.[114] In addition, Qualcomm proposed increasing from 10 to 20 MHz the channel bandwidths required for the portion of the DSRC band that Qualcomm believes should be shared with U-NII-4 devices in order to make U-NII-4/DSRC sharing easier.[115] The Commission should not implement these recommendations because they are outside of the scope of this rulemaking, could cause harmful interference to DSRC operations, and could profoundly disrupt DSRC deployment, investment, and innovation.

As an initial matter, such a far-reaching reconfiguration of the DSRC rules is inappropriate in this proceeding, which focuses not on changing the rules for primary

[113] Qualcomm Comments at 9.

[114] *Id.* at iv.

[115] *Id.* at 12-16.

DSRC operations but on whether U-NII devices can share with DSRC certain portions of the 5 GHz band. Moreover, to the extent that the Commission wishes to relocate DSRC uses and change DSRC channel bandwidths, it must do so in a separate rulemaking. DSRC use of the 5.850 – 5.925 GHz band is codified channel by channel in section 95.1511 of the Commission's rules.[116] That rule specifically designates DSRC channel 172 for "public safety applications involving safety of life and property."[117] The Commission rarely limits the uses that can be made of particular frequencies in this way, but took special care to do so in the DSRC context in order to protect latency-sensitive, "safety-of-life" DSRC services from harmful interference. Indeed, the 2006 Memorandum Opinion and Order that prescribed the uses stated that "[w]e designate Channel 172 (frequencies 5.855 – 5.865 GHz) exclusively for vehicle-to-vehicle safety communications for accident avoidance and mitigation, and safety of life and property applications."[118] The Order also defined the permissible uses of channel 184 (5.915-5.925 GHz) as "exclusively … high-power, longer-distance communications to be used for public safety applications involving safety of life and property, including road intersection collision mitigation."[119]

Qualcomm's proposal to alter the uses applicable to channels 172, 182, and 184 would thus require the Commission to change its DSRC rules. However, such a change was not contemplated in the NPRM. Instead, the NPRM focused exclusively on potential

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[116] *See* 47 C.F.R. § 95.1511.

[117] *Id.* § 95.1511(a).

[118] *2006 MO&O* ¶ 1.

[119] *Id.*

modifications to the Part 15 rules governing U-NII devices and the spectrum bands in which they are allowed to operate.[120] As such, a new rulemaking would be required to implement Qualcomm's proposal.

Nor could a change in the DSRC rules be deemed a "logical outgrowth" of the NPRM in this proceeding. In order for the Commission's final rules to qualify as a "logical outgrowth," an affected party must have been able to anticipate them in light of the initial notice.[121] "[A] final rule is not a logical outgrowth of a proposed rule 'when the changes are so major that the original notice did not adequately frame the subjects for discussion.'"[122] In this proceeding, it is telling that no other commenter raised the DSRC rule changes proposed by Qualcomm, and no commenter submitted studies evaluating the proposed interference levels or re-location expenses that could be expected as a result of such changes. Even those arguing for opening up new 5 GHz spectrum for U-NII-4 devices merely discussed the possibility of U-NII-4 devices operating on a shared basis with DSRC devices operating under existing DSRC rules. Moreover, it is noteworthy that when modifying the DSRC rules in the past, the Commission has used distinct rulemakings focused strictly on the DSRC service to do so.[123]

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[120] *See NPRM*.

[121] *See Covad Commc'ns Co. v. FCC*, 450 F.3d 528, 548 (D.C. Cir. 2006) ("[w]hether the 'logical outgrowth' test is satisfied depends on whether the affected party 'should have anticipated' the agency's final course in light of the initial notice" *Small Refiner Lead Phase-Down Task Force v. EPA*, 705 F.2d 506, 548-49 (D.C. Cir. 1983)).

[122] *Omnipoint Corp. v. FCC*, 78 F.3d 620, 631 (D.C. Cir. 1996) (quoting *Connecticut Light & Power Co. v. Nuclear Regulatory Comm'n*, 673 F.2d 525, 533 (D.C. Cir.1982), *cert. denied*, 459 U.S. 835 (1982).

[123] *See, e.g., DSRC Allocation R&O; 2006 MO&O.*

In the current proceeding, Qualcomm's proposal raises a host of issues, including significant questions of technical feasibility, potential harmful interference, international harmonization, device deployment and development implications, and V2V re-location costs. Because the proposal to move DSRC V2V operations and reconfigure some DSRC channel bandwidths raises a number of critical issues, at a minimum, Qualcomm's proposal requires its own rulemaking, where interested parties can carefully consider and comment on the merits or dangers of the proposal.

In view of the need for a separate rulemaking, the Commission should, at most, consider Qualcomm's comments as a Petition for Rulemaking, in which case normal Commission procedure would dictate that the Commission separately seek public comment on the Qualcomm proposal before deciding whether to initiate a separate rulemaking proceeding (requiring a separate NPRM) addressing it.

B. Qualcomm's Proposed V2V Channel Relocation Scheme Could Cause Harmful Interference That Jeopardizes DSRC "Safety-Of-Life" Operations

Qualcomm's channel relocation proposal assumes that relocating DSRC V2V uses out of DSRC channel 172 would protect the V2V applications from harmful interference while simultaneously opening up DSRC spectrum for U-NII-4 use. Unfortunately, the proposal could subject V2V communications operating in new channels 182 and 184 to harmful interference from out-of-band emissions and from other, higher-powered public safety uses currently residing in DSRC channel 184.

Qualcomm's proposal contemplates allowing U-NII-4 devices to operate in spectrum immediately adjacent to the relocated DSRC V2V uses on channel 182. The proposal further specifies power limits of "-17 - G dBm/MHz at [10 MHz from the band

edge]" and "-27 - G dBm/MHz at [20 MHz from the band edge]" ("where G is the Tx antenna gain").[124] This creates a situation identical to the one contemplated above with regard to the proposed extension of the U-NII-3 band to 5.850 GHz. As described in more detail in Section V, such high-powered U-NII operations immediately adjacent to lower-powered DSRC "safety-of-life" V2V operations could create unwanted emissions sufficient to cause harmful interference to the V2V communications. Given the expected widespread use of U-NII devices, this could seriously undermine DSRC operations and compromise DSRC's safety benefits.

There are also potentially interfering uses at the other end of the DSRC band. In particular, the upper part of the band is adjacent to a band used for high-powered satellite uplink operations.[125] These high-powered satellite uplink operations could degrade the performance of relocated DSRC "safety-of-life" applications.

In addition, there are already high-powered public safety uses prescribed for DSRC channel 184. Channel 184 is currently reserved for "high-power, longer-distance communications to be used for public safety applications."[126] By contrast, current Channel 172 uses are for lower-powered V2V communications that require extremely high availability and low latency periods. In designating channel 172 for exclusive V2V use, the Commission recognized that those "applications are exceptionally time-sensitive

[124] Qualcomm Comments at 8.

[125] *See* Table of Frequency Allocations, 47 C.F.R. § 2.106.

[126] *2006 MO&O* ¶ 1.

and should not be conducted on potentially congested channels." [127] Qualcomm's proposal reverses this judgment. It would group multiple safety-related uses closer together and place critical safety uses on channels that will become increasingly congested, particularly as the uses for DSRC expand and the devices become more widespread. Moreover, the specific uses currently prescribed for DSRC channel 184 pose particular interference risks because of the relatively higher power allowed for public safety applications in channel 184, which, if operating in close spectral proximity to V2V communications, could cause harmful interference.

Qualcomm's proposal also poses significant challenges for the critical communications currently occurring on Channel 178, the DSRC "Control Channel." The DSRC control channel advertises DSRC services, which is essential for managing the 75 MHz of DSRC spectrum. Qualcomm's proposal places operations on this critical channel at the risk of degradation from "sharing" with U-NII-4 devices. Without a well-functioning and reliable control channel, certain safety-related DSRC applications could be vulnerable to interference from other DSRC applications, jeopardizing the integrity of the DSRC regime.

Moreover, Qualcomm's proposed change to increase the DSRC channel size to 20 MHz in some portions of the 5.9 GHz band runs counter to the conclusions of previous research into channel sounding. These studies considered the possibility of

[127] *Id.* ¶ 16. The Commission also stated that "[a]lthough [it] has long recognized that shared use of spectrum promotes spectrum efficiency there are cases in which public safety concerns dictate exclusive use of frequencies. We believe that such is the case here where the delay associated with shared use of a time-critical DRSC channel could be literally life-threatening." *Id.*

20 MHz DSRC channels, but rejected them in favor of 10 MHz channels. One study found that 20 MHz DSRC channels would have a disadvantage compared to 10 MHz channels because in the study the delay spread for a 20 MHz channel too often exceeded the channel's cyclic prefix length, leading to inter-symbol interference.[128] Qualcomm's proposal does not refute this study or other analyses.

C. Qualcomm's Proposed Change in DSRC Channel Usage and Bandwidth Could Disrupt DSRC Deployment, Investment, And Innovation

Altering the channel usage requirements for DSRC at this late stage could also be disruptive to DSRC operations and plans, contrary to Qualcomm's assertions.[129] DSRC devices are currently undergoing the last stages of testing in the Ann Arbor Model Deployment prior to the anticipated regulatory decision by NHTSA.[130] Indeed, as discussed above, DSRC devices are already being deployed by some states, local governments, and private parties.[131]

These efforts, all based around DSRC V2V communications occurring on channel 172, would have to be halted if Qualcomm's proposal were adopted. At best, DSRC operations would be delayed for some significant period as DSRC stakeholders attempted to understand the new spectral environment and make technical adjustments. At worst, implementing the Qualcomm proposal could raise entirely new complications, requiring

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[128] *See* Lin Cheng et al., "A Measurement Study of Time-Scaled 802.11a Waveforms Over The Mobile-to-Mobile Vehicular Channel at 5.9 GHz," 46 IEEE COMMC'NS MAGAZINE 84 (2008).

[129] Qualcomm Comments at iii.

[130] USDOT Letter at 4.

[131] Savari Comments at 25-26.

additional research, making necessary entirely new testing programs, and effectively destroying the current DSRC deployment schedule. In its comments, Qualcomm argued that its proposal would facilitate the "rapid rollout" of DSRC services, and asserted that a plan that "significantly delay[ed] any rollout of DSRC … should be unacceptable to the Commission."[132] Because Qualcomm's plan would result in significant delay, even under the best of circumstances, the Commission should reject Qualcomm's proposal.

Moreover, Qualcomm's proposal implicitly assumes that only one or two DSRC channels are required for "safety-of-life" uses, and that the remaining channels are reserved for non-"safety-of-life" uses. This assumption is inaccurate. Five of the seven DSRC channels host "safety-of-life", security, autonomous driving, and public safety applications.[133] The remaining two channels include arguably "safety-of-life" uses such as road and curve speed warnings and highway automation.[134] Despite Qualcomm's assumption, DSRC "safety-of-life" applications are numerous and utilize far more than just one or two channels.

Finally, allowing U-NII devices to share the lower portion of the DSRC band under a new DSRC channel usage and bandwidth scheme could foreclose future innovation in DSRC technology. New DSRC applications and technologies are being researched continuously. Over time, an increasing number of these devices will reach commercial deployment and, as the uses of DSRC proliferate, increasing amounts of spectrum will be required to accommodate them. This is particularly true for

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[132] Qualcomm Comments at iii.

[133] *See* Attachment 1 at 27-28.

[134] *Id.*

non-safety-related DSRC uses, as they must ensure that they do not cause harmful interference to safety-related DSRC communications. Qualcomm's proposal would limit the amount of spectrum available for new DSRC applications, and thus severely limit innovation.

VII. CONCLUSION

For the reasons discussed above, and as discussed by numerous commenters in this proceeding, the Commission should not take any action to allow expanded U-NII use of the 5 GHz band unless it can be determined, via rigorous testing and analysis, that such expanded 5 GHz U-NII use will not cause harmful interference to "safety-of-life" DSRC services. The Commission's current proposal for expanding the U-NII-3 band up to the 5850 MHz edge of the DSRC band, and allowing U-NII use of the DSRC band itself, could cause harmful interference to DSRC communications and threaten the viability of this critically important and promising service. Before any action is taken to allow such expanded U-NII use, all of the stakeholders, including stakeholders in the automobile industry, should be convened to ensure that rigorous testing of U-NII/DSRC compatibility is conducted, and the Commission should seek formal public comment on any potential rules or interference mitigation measures that such rigorous testing shows could protect DSRC operations from harmful interference. Finally, the Commission should reject Qualcomm's proposal for moving DSRC V2V communications from their current home in DSRC channel 172, and increasing from 10 MHz to 20 MHz the channel bandwidths applicable in the lower DSRC bands, as potentially disruptive to DSRC deployment at this late stage, and as outside the scope of this proceeding.

Respectfully,

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July 24, 2013

ATTACHMENT 1

Harmful Interference to 5.9 GHz DSRC Connected Vehicles for Intelligent Transport Systems

AUTO ALLIANCE

DRIVING INNOVATION®

GlobalAutomakers

July 25, 2013

Harmful Interference - Background

- The basic goal in spectrum management is to maximize use of the spectrum provided that interference is limited to an acceptable level.
- The issue of harmful interference has been at the heart of many controversial FCC spectrum policy decisions in the past.
- But what does this actually mean in the context of DSRC?
- How do we define, interpret and understand harmful interference to DSRC safety-of-life services?

Harmful Interference - FCC

- FCC, NTIA, and many other regulatory authorities use the ITU Radio Regulations' definition of "harmful interference":
  - "Interference which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs, or repeatedly interrupts a radiocommunication service operating in accordance with [the ITU] Radio Regulations."
- This definition implicitly contains two subcases.
  - First, in the case of "a radionavigation service or of other safety services," harmful interference is something that "endangers the functioning" of the service.
  - In the case of other radio services, harmful interference is something that "seriously degrades, obstructs, or repeatedly interrupts" the service.

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety - Definition

- *Any unlicensed interference which endangers the functioning of DSRC safety-of-life services constitutes harmful interference, based on the fact that the opportunity for these services to potentially prevent a collision is impaired.*
- Harmful interference should not lead to delay or omission of timely safety action (e.g. warning information or control actions provided to the driver/vehicle) that could have otherwise been provided to the driver/vehicle in order to prevent a crash.
- It should be understood that the threat of an imminent crash could arise all of a sudden during driving conflicts. Therefore, any delay in timely warning or control actions caused by interference must be very small.

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety – Definition (contd)

- With certain pre-crash conflict situations, even small delays caused by interference could result in no warnings or control actions being provided to the driver/vehicle.
- In reality, any U-NII transmission using the currently-proposed rules is likely to cause omission or delay of timely safety action. Therefore, we need to understand how UNII sharing could be accomplished consistent with this definition.
- *One premise for reliable low-latency collision warnings is that safety messages are received at near their threshold sensitivity levels. The U-NII-to-DSRC impairments are not an inherent part of DSRC, and U-NII devices should not cause harmful interference, including raising the noise floor.*

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety - Metrics

- PER: Ratio of the number of missed packets (i.e. safety messages) at a receiver from a particular transmitter and total number of packets sent by that transmitter.

- IPG: Time between successive successful packet (i.e. safety message) receptions from a particular transmitter.

- Link Range: Dependable communication range between a particular transmitter and receiver.

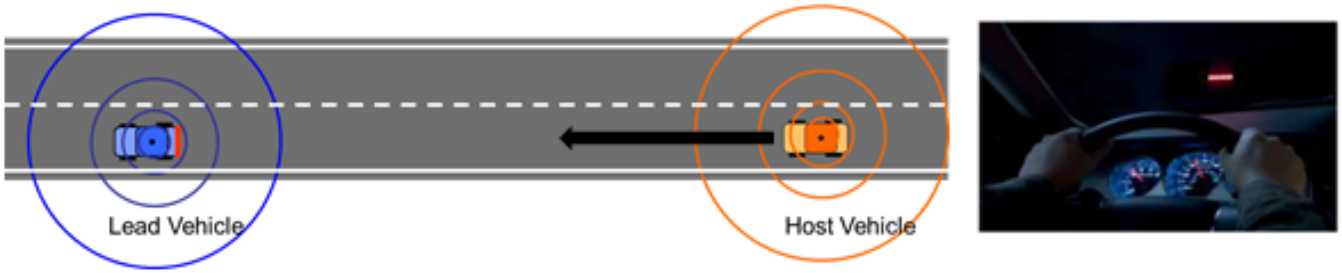
- TTC: Time-to-collision is frequently used as a descriptor of how urgent a conflict situation has become, as well as potentially how a driver perceives stimuli during a pre-crash event.

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety - Sources

- Unlicensed UNII-4 Co-Channel Interference
- Unlicensed UNII-4 Cross-Channel Interference
- Unlicensed UNII-3 Out-of-Band Interference
- All of these
  - Results in raised noise floor
  - Results in increased PER and IPG
  - Results in increased channel congestion
  - Results in channel access delay
  - Results in reduced link range

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety – e.g. FCW

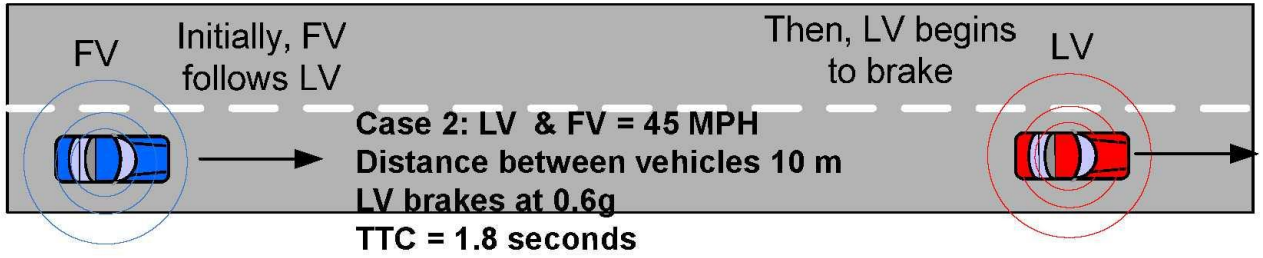
Forward Collision Warning (FCW)



- Cooperative FCW feature provides alerts intended to assist drivers in avoiding or mitigating a rear-end crash.
- FCW may alert the driver to an approaching (or closing) conflict a few seconds before the driver would have detected such a conflict (e.g., if the driver's eyes were off-the-road), so the driver can take any necessary corrective action (e.g., steering, hard braking, etc.).
- The goal of the alert timing approach is to allow the driver enough time to avoid the crash, and yet avoid annoying the driver with alerts perceived as occurring too early, too often or unnecessarily.

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety – e.g. FCW-LVD

Forward Collision Warning (FCW) Lead Vehicle Decelerating Scenario



- In this example, interference from U-NII devices could result in delay of timely warning information provided to the driver, or the warning could be completely missed. In either case, the opportunity for the driver to potentially prevent a crash is impaired.
- U-NII devices operating in the DSRC Band can cause significant interference to packet (i.e. safety messages) reception, leading to unknown and perhaps very high IPG and PER.
- Consequently, they could cause harmful interference affecting the performance (and the benefits to be derived from) these safety systems.
- IPG and PER would also affect security verification since the messages with certificates attached may be lost or delayed due to interference from U-NII devices.

U-NII Transmission Scenarios Manifesting Harmful Interference

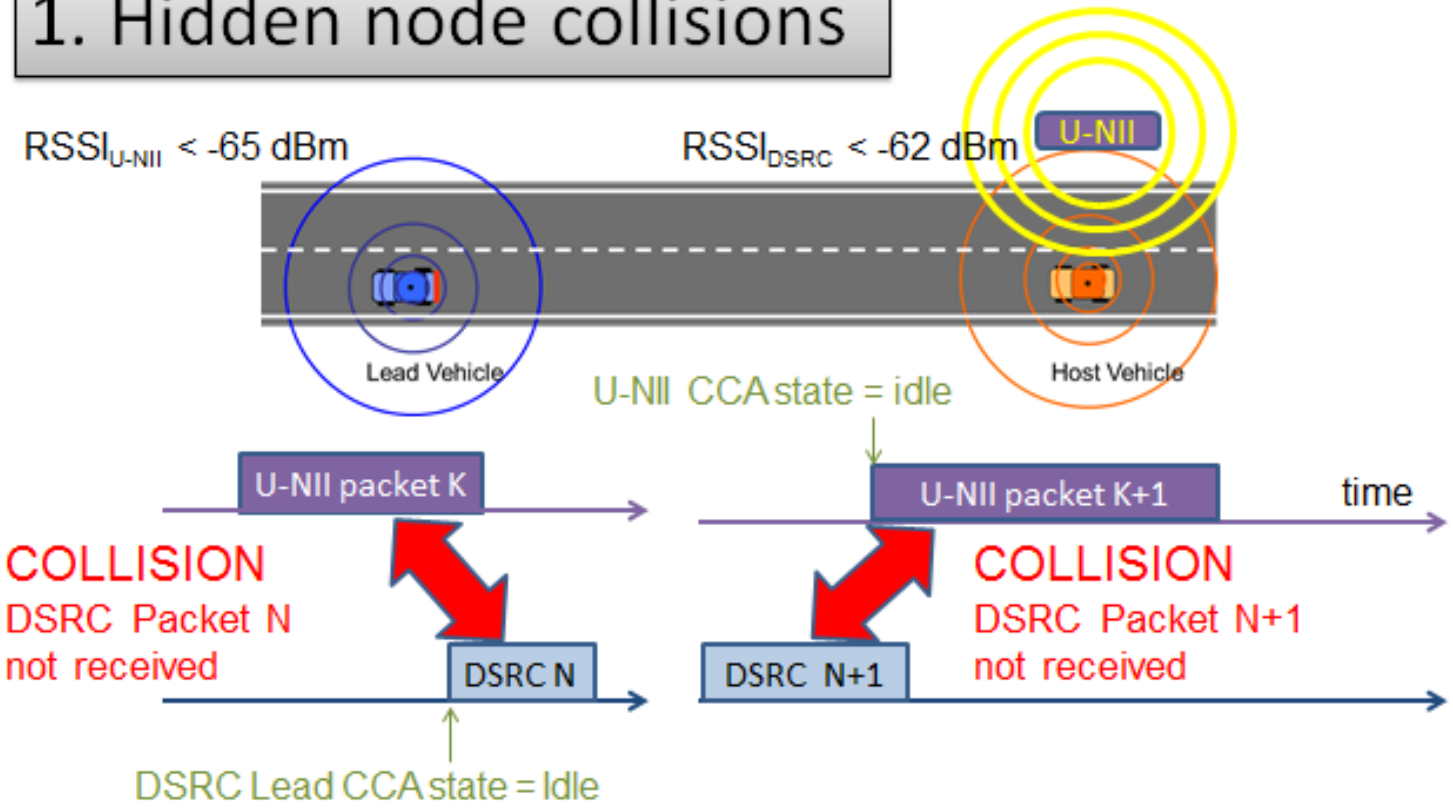
Examples

1. Hidden Node Collisions
2. Hidden Node Collision: one-sided detection
3. Countdown Collision: mutual detection
4. Simple Delay
5. Indefinite Delay
6. Indefinite Delay – Multi-U-NII senders
7. Indefinite Delay – Multi-WLAN

- Note: All of these can be induced via:
  - U-NII-4 Co-channel interference
  - U-NII-4 Cross-channel interference
  - U-NII-3 Out-of-band Interference

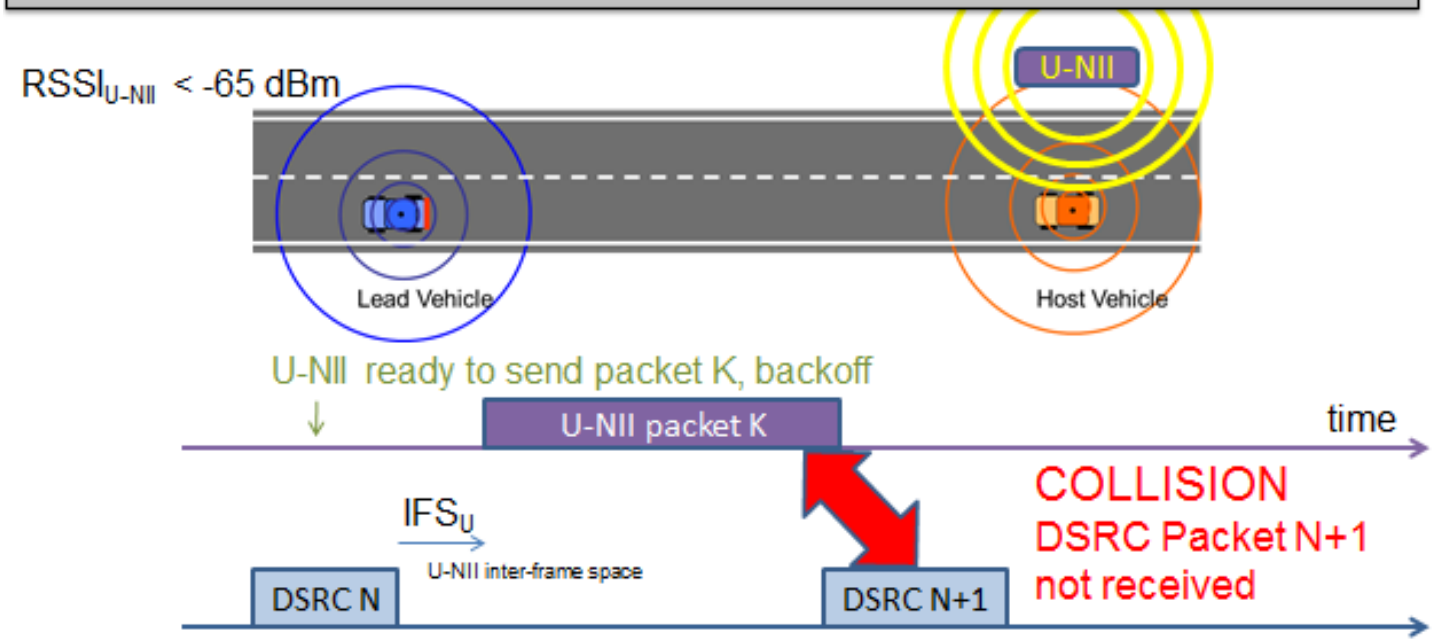
U-NII Harmful Interference

1. Hidden node collisions



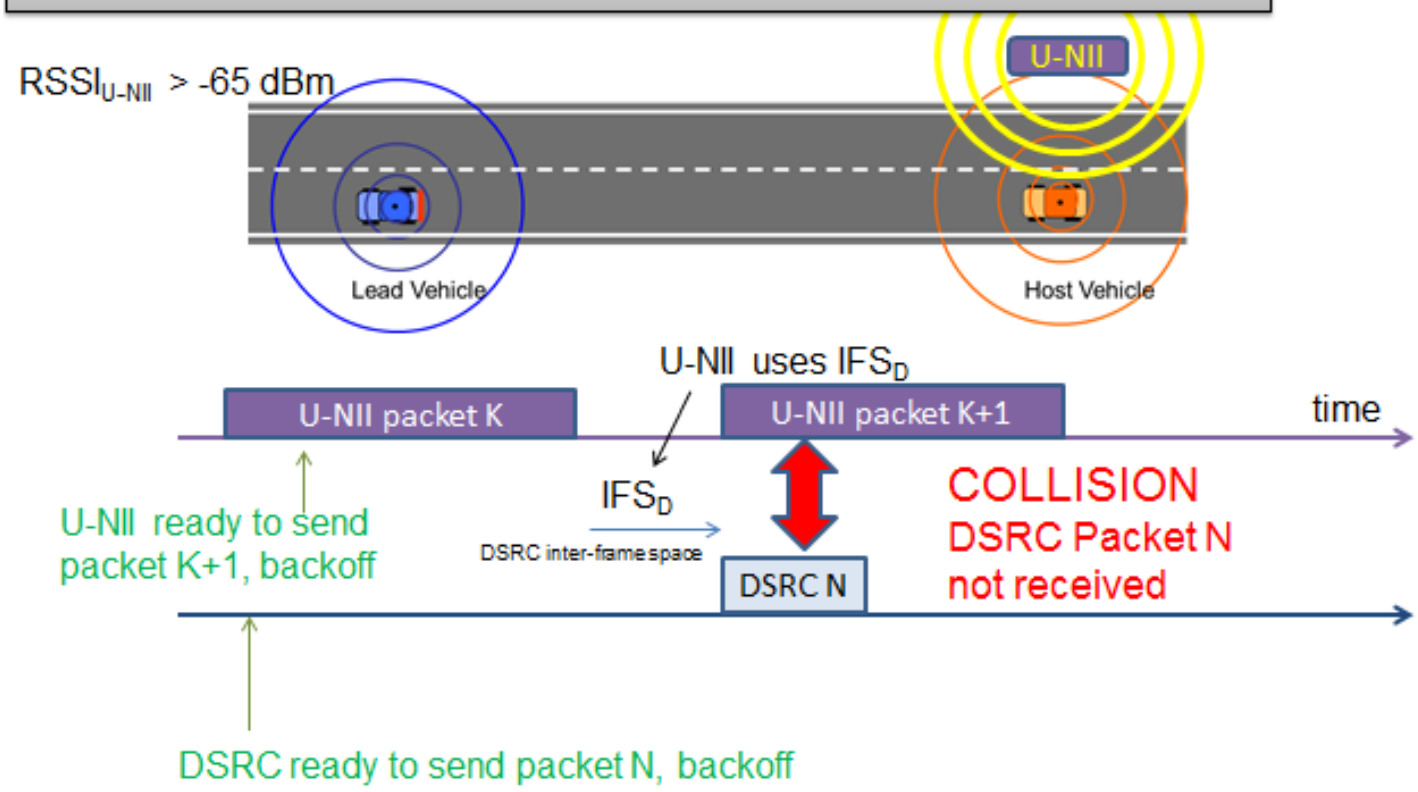
U-NII Harmful Interference

2. Hidden node collision: one-sided detect



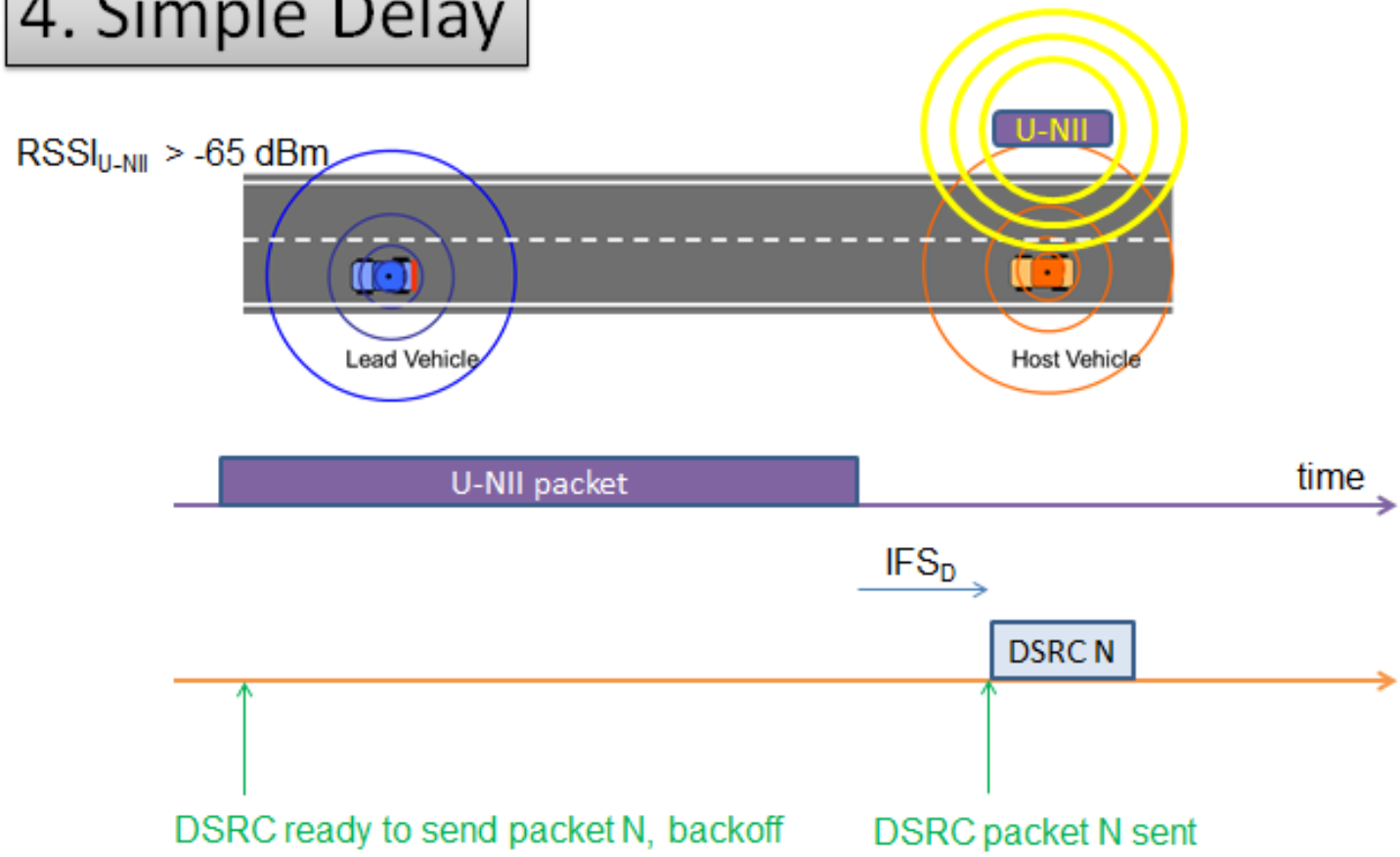
U-NII Harmful Interference

3. Countdown collision: mutual detect



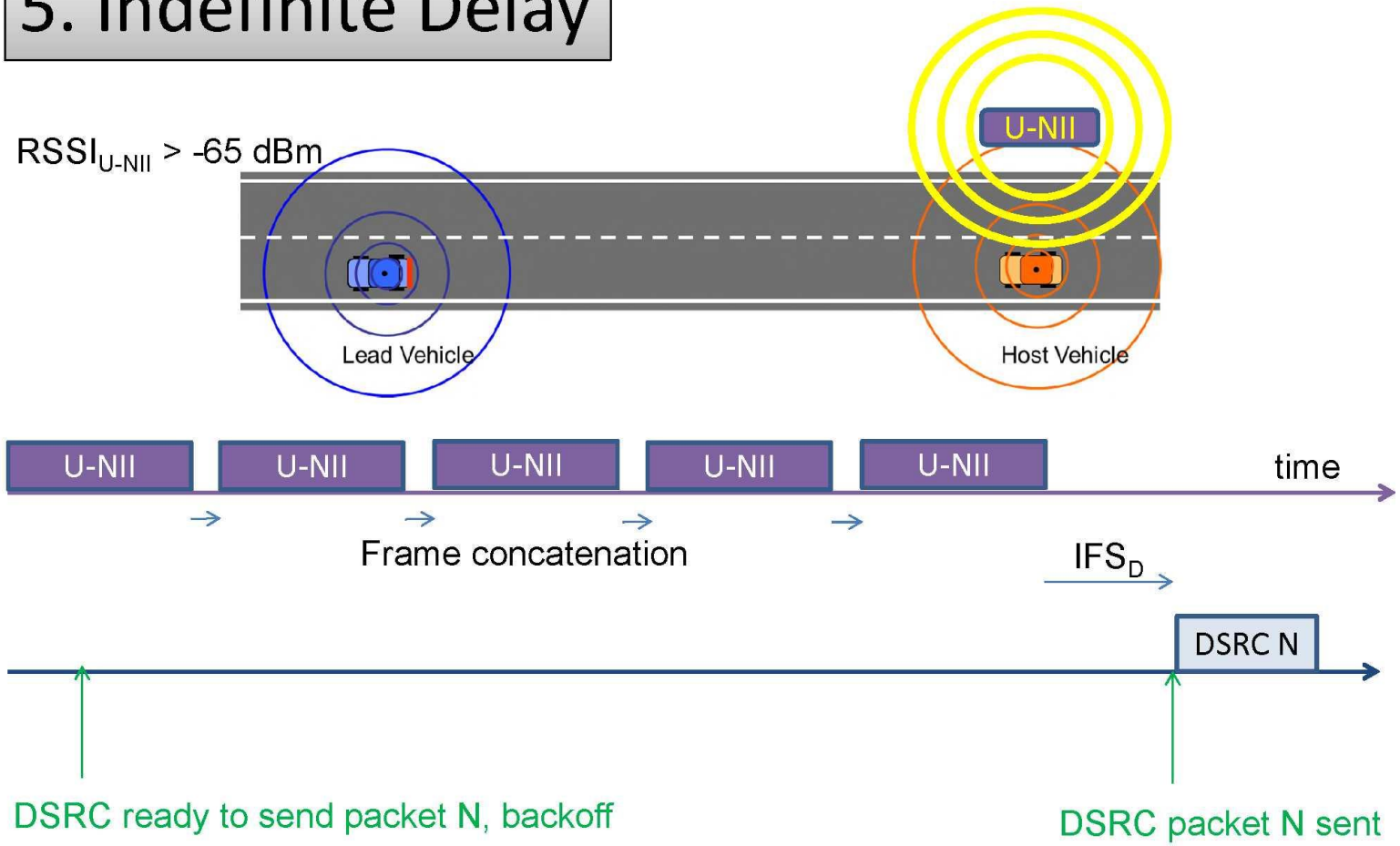
U-NII Harmful Interference

4. Simple Delay



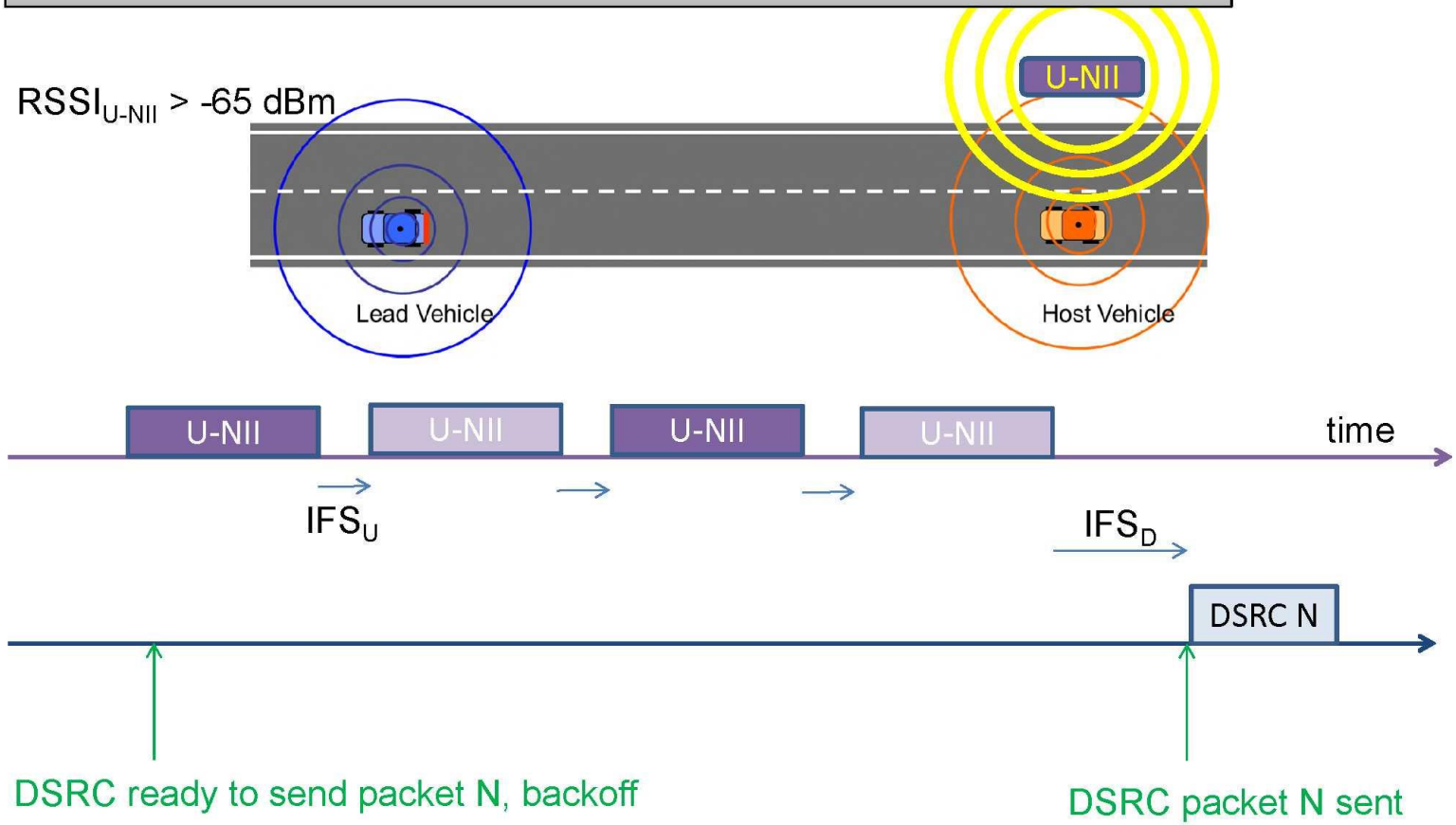
U-NII Harmful Interference

5. Indefinite Delay



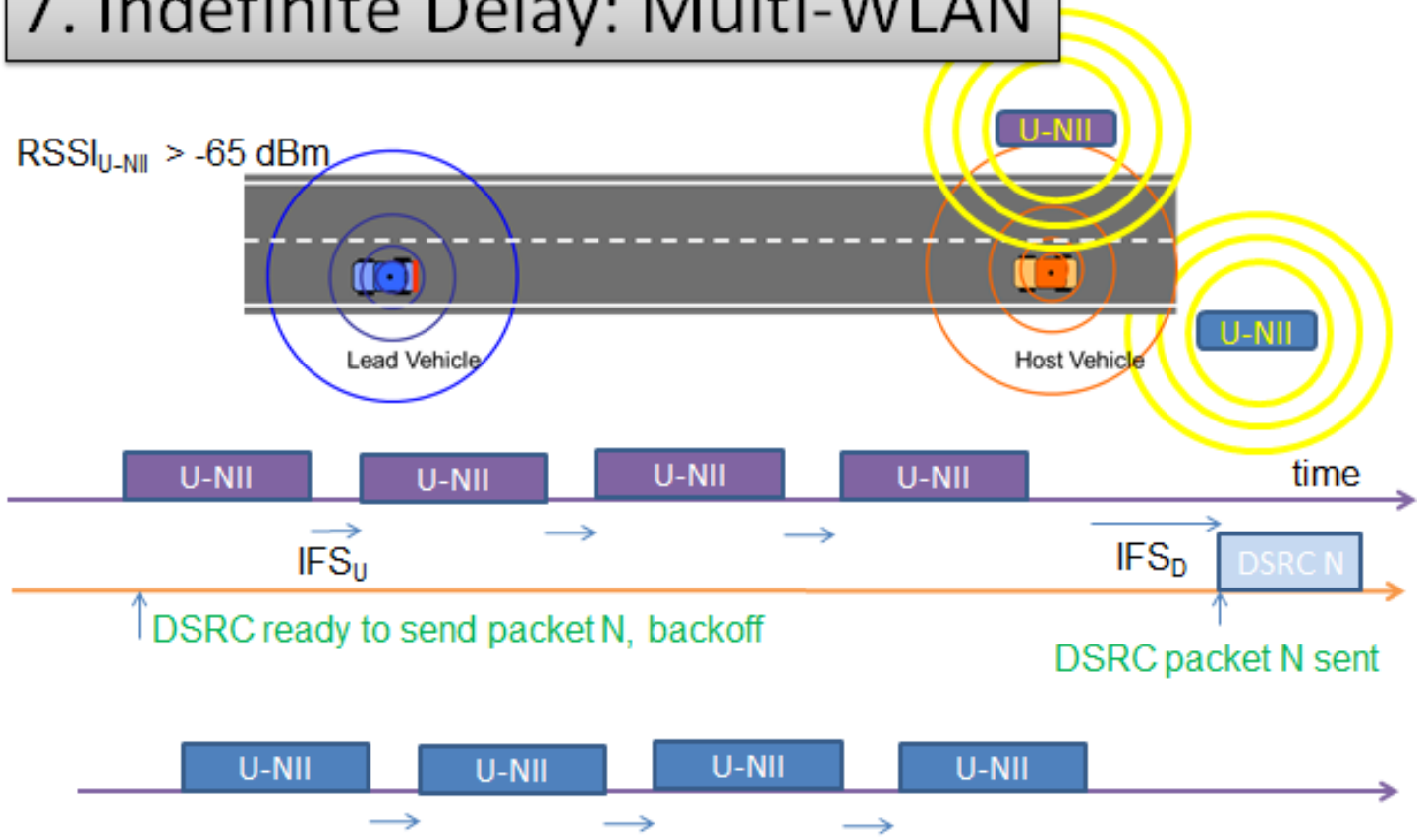
U-NII Harmful Interference

6. Indefinite Delay: Multiple senders



U-NII Harmful Interference

7. Indefinite Delay: Multi-WLAN

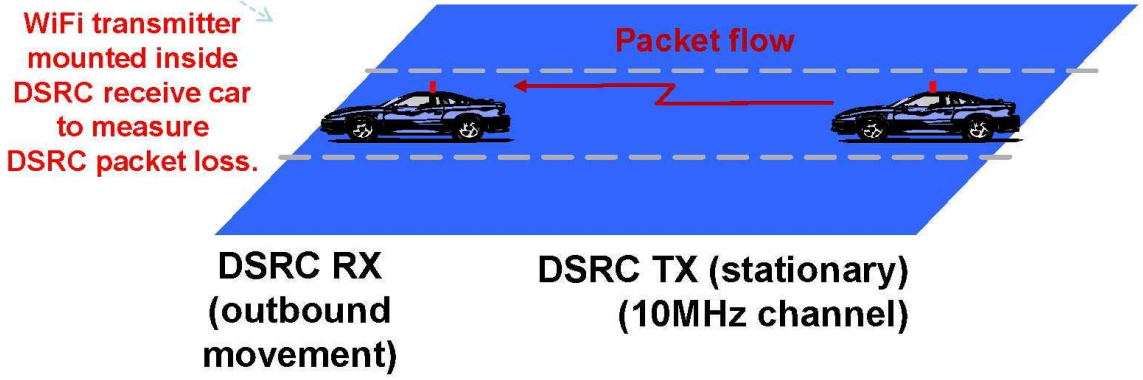


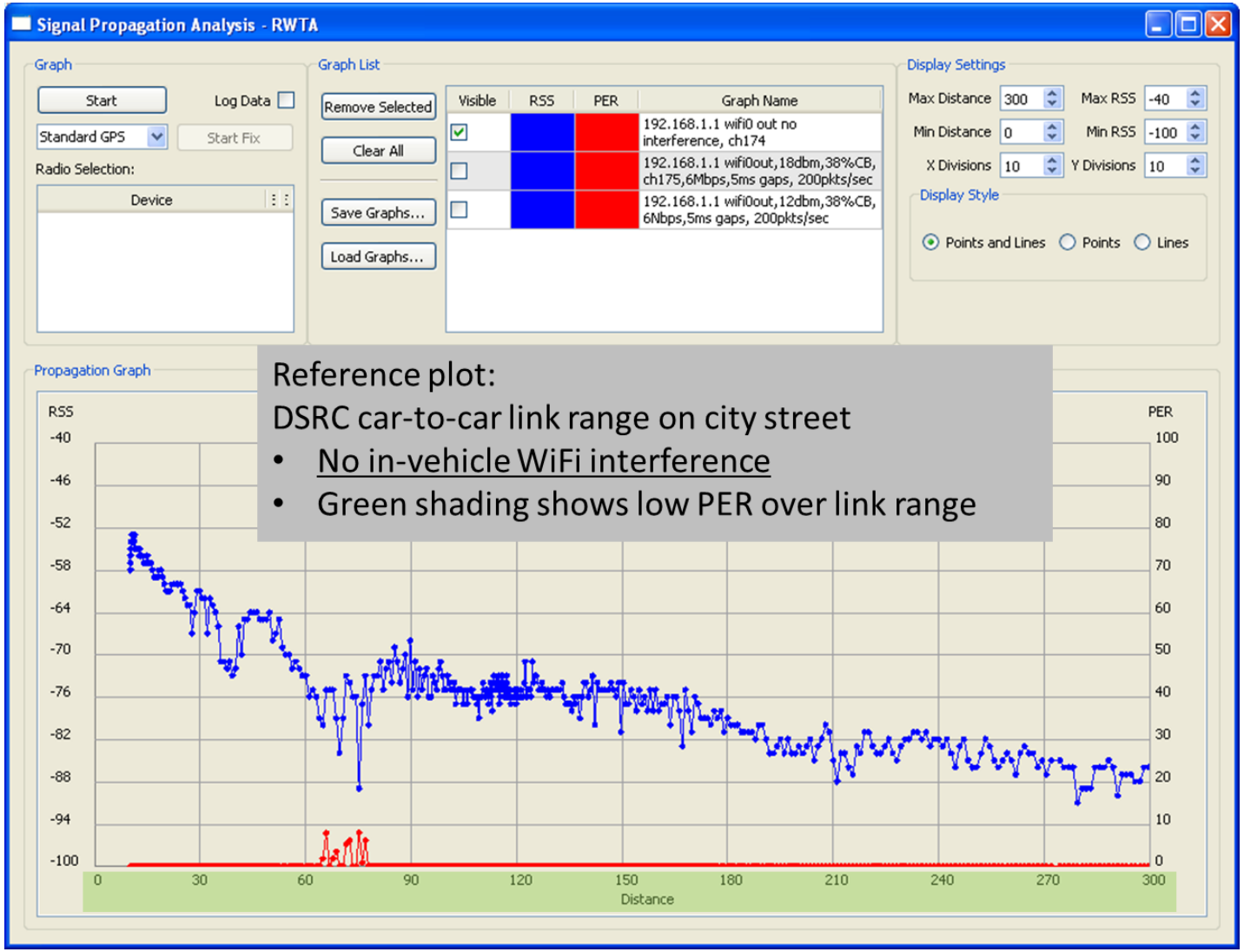
Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety – DSRC Packet Loss

SAMPLE LOS LINK RANGE TEST WITH IN-VEHICLE WIFI INTERFERENCE

(V2V test shows high-CCA-threshold issue for **overlapping** WiFi packets)

- DSRC LINK ON **CH174** (**10**MHZ CHANNEL)
- WIFI TRANSMITTER ON CH 175 (**20**MHZ CHANNEL, **CH174** + CH176)
- EXAMPLE CAR-TO-CAR OUTBOUND DRIVE TEST

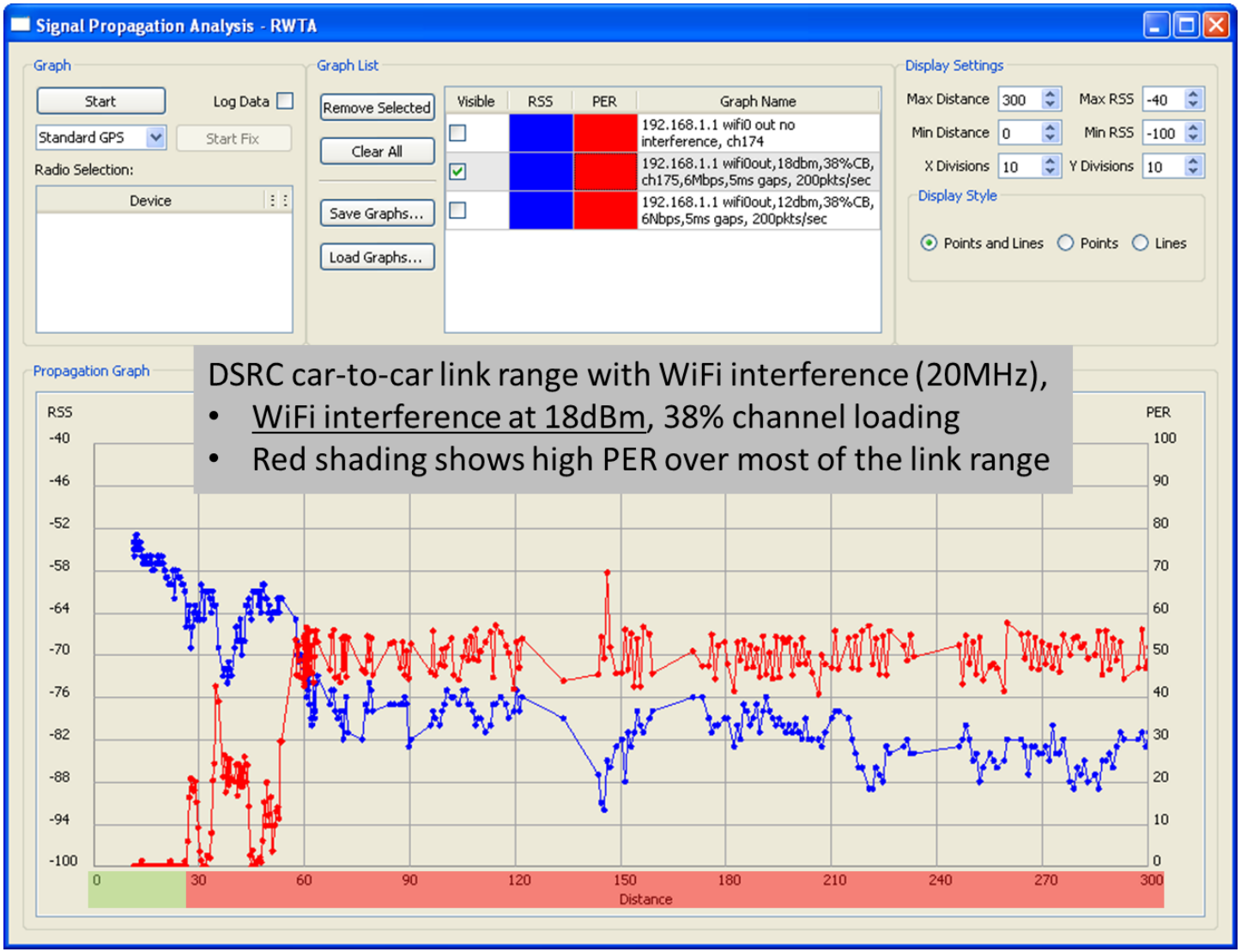




Reference plot:

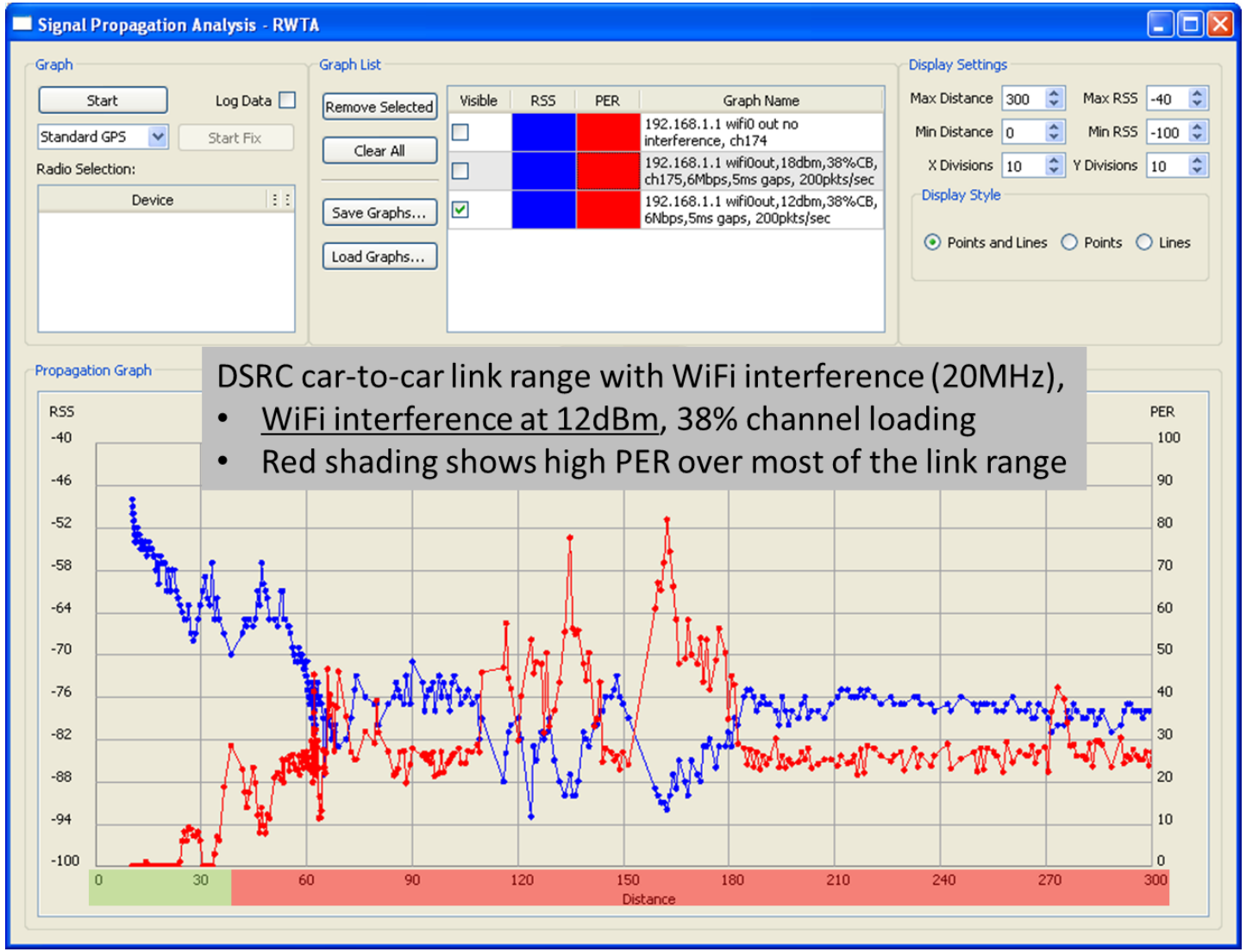
DSRC car-to-car link range on city street

- No in-vehicle WiFi interference
- Green shading shows low PER over link range



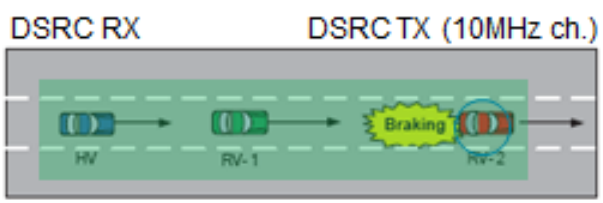
DSRC car-to-car link range with WiFi interference (20MHz),

- WiFi interference at 18dBm, 38% channel loading
- Red shading shows high PER over most of the link range


Signal Propagation Analysis - RWTA
Graph
Start
Log Data
Standard GPS
Start Fix
Radio Selection:
Device
Graph List
Remove Selected
Clear All
Save Graphs...
Load Graphs...
Visible
RSS
PER
Graph Name
192.168.1.1 wifi0 out no interference, ch174
192.168.1.1 wifi0out,18dbm,38%CB, ch175,6Mbps,5ms gaps, 200pkts/sec
192.168.1.1 wifi0out,12dbm,38%CB, 6Nbps,5ms gaps, 200pkts/sec
Display Settings
Max Distance 300
Max RSS -40
Min Distance 0
Min RSS -100
X Divisions 10
Y Divisions 10
Display Style
Points and Lines
Points
Lines
Propagation Graph
DSRC car-to-car link range with WiFi interference (20MHz),
• WiFi interference at 12dBm, 38% channel loading
• Red shading shows high PER over most of the link range
RSS
-40
-46
-52
-58
-64
-70
-76
-82
-88
-94
-100
PER
100
90
80
70
60
50
40
30
20
10
0
0
30
60
90
120
150
180
210
240
270
300
Distance

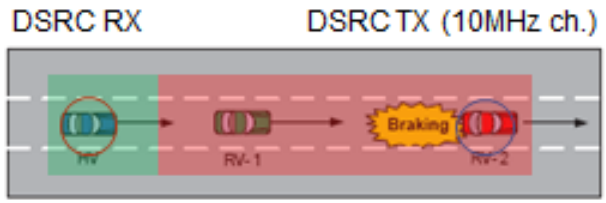
Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety – DSRC Packet Loss in EEBL (Overlapping WiFi packets)

EEBL (Emergency Braking warning rec'd)



HV = Host Vehicle
(Receives BSMs & gives collision warnings

EEBL (no Emergency Braking warning)

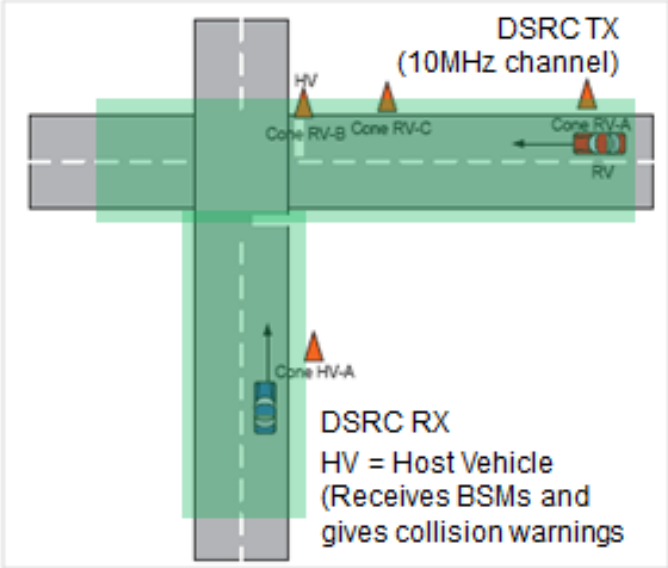


◯ = In-Vehicle
WiFi xmtr (20-160MHz channel)

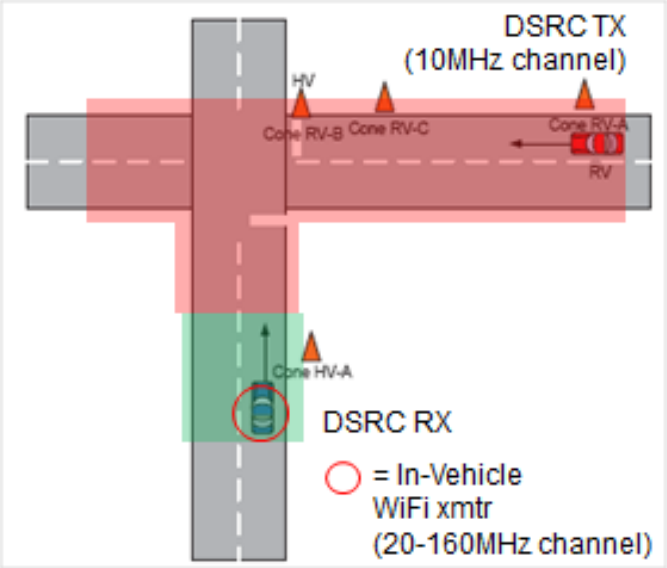
- The driver of the HV won't be warned of the hard braking event due to interference.
- The green area indicates low packet error between the BSM sender and the HV.
- The red area indicates regions with high packet loss due to overlapping WiFi packets.

Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety – DSRC Packet Loss in Cross-Path Collision (Overlapping WiFi)

Cross-Path Collision (driver gets warning)



Cross-Path Collision (no driver warning)



- The driver of the HV will not receive the cross-path collision warning.
- The green area indicates low packet error between the BSM sender and the HV.
- The red area indicates regions with high packet loss due to overlapping WiFi packets.

WiFi Network Types: Notional Impact on DSRC

WiFi network Interference source	BSM loss/ packet loss (CCA-below threshold)	DSRC hidden node -packet collisions/IPG (unbalanced EIRP)	DSRC IPG growth (deferral with CCA-above threshold)	TTC/ IPG growth	Reduced link range
In-Vehicle WiFi	X		X	X	X
City/Cable WiFi	X	X	X	X	X
WISP WiFi	X	X	X	X	X
Carrier WiFi	X	X	X	X	X

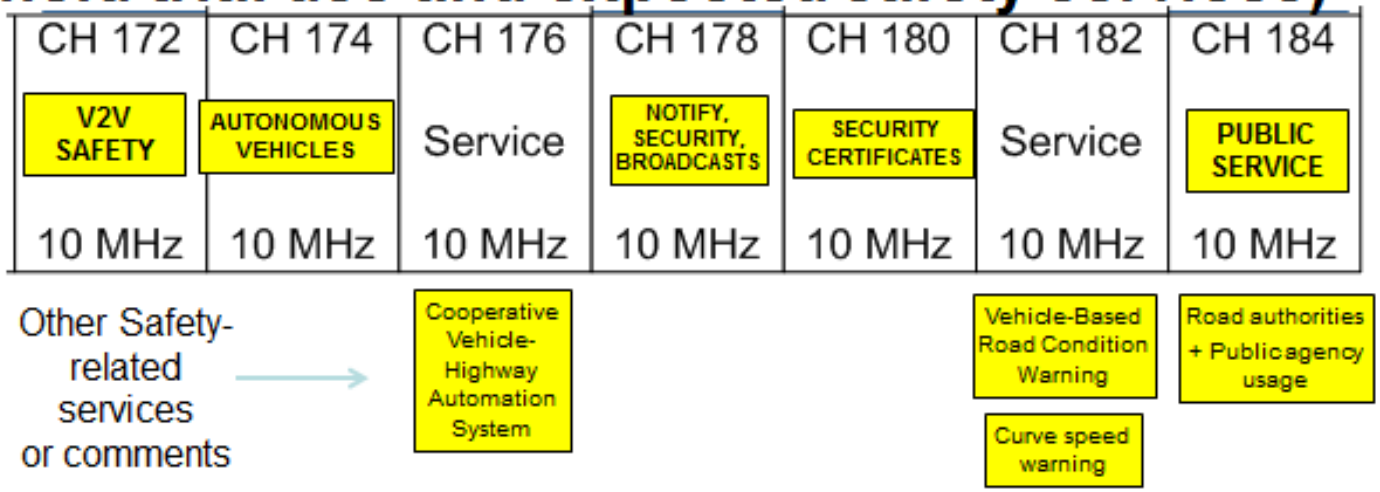
Harmful Interference to 5.9 GHz DSRC Connected Vehicle Safety - Testing

- Significant real world testing is required to assess the consequences of introducing U-NII devices into the DSRC band.
- Need to understand the various options and proposals for sharing between U-NII devices and DSRC services in the DSRC band, including U-NII operations in the U-NII-3 band that may cause out-of-band harmful interference.
- Develop prototype implementations of devices that implement the sharing protocols.
- Develop a test plan to conduct detailed harmful interference testing to address:
  - U-NII-4 Co-Channel Interference
  - U-NII-4 Adjacent-Channel Interference
  - U-NII-3 Out-of-Band Interference

V2X Safety and Automation Applications Must Be Free From Harmful Interference

- OEMs and NHTSA have focused on V2V Crash-Imminent Warnings. In the Model Deployment, Basic Safety Messages are on one DSRC channel, service announcements on another channel, and services on several others. That is the subject on the NHTSA 2013 regulatory decision.
- Additional applications which require low-latency communications will use other DSRC channels. A sample channel plan is shown on the next slide.
- For example, from NHTSA recent guidance on automated vehicles:
  - Automated vehicles may use on-board sensors, cameras, GPS, and telecommunications to obtain information in order to make their own judgments regarding safety-critical situations and act appropriately by effectuating control at some level. In fact, the realization of the full potential benefits and broad-scale implementation of the highest level of automation may conceivably rely on V2V technology as an important input to ensure that the vehicle has full awareness of its surroundings.

Sample DSRC CHANNEL PLAN (Based on field trial use and expected safety services)



- Five of seven channels are safety-of-life, security, autonomous driving, and public safety. Underlying boxes give examples and more details.
- Other channels run applications such as highway automation and road and curve speed warnings, which should be considered safety applications.
- A service channel could be dedicated to a single service, such as collaborative support for emerging autonomous vehicle development.
- A list of safety applications being researched are shown on next page.

V2X Safety Applications

Communications Between Vehicle and Infrastructure

- Blind Merge Warning
- Curve Speed Warning
- Emergency Vehicle Signal Preemption
- Highway/Rail Collision Warning
- Intersection Collision Warning
- In Vehicle Amber Alert
- In-Vehicle Signage
- Just-In-Time Repair Notification
- Left Turn Assistant
- Low Bridge Warning
- Low Parking Structure Warning
- Pedestrian Crossing Information at Intersection
- Road Condition Warning
- Safety Recall Notice
- SOS Services
- Stop Sign Movement Assistance
- Stop Sign Violation Warning
- Traffic Signal Violation Warning
- Work Zone Warning

Communications Between Vehicles

- Approaching Emergency Vehicle Warning
- Blind Spot Warning
- Cooperative Adaptive Cruise Control
- Cooperative Collision Warning
- Cooperative Forward Collision Warning
- Cooperative Vehicle-Highway Automation System
- Emergency Electronic Brake Lights
- Highway Merge Assistant
- Lane Change Warning
- Post-Crash Warning
- Pre-Crash Sensing
- Vehicle-Based Road Condition Warning
- Vehicle-to-Vehicle Road Feature Notification
- Visibility Enhancer
- Wrong Way Driver Warning
- Do Not Pass Warning
- Intersection Movement Assist
- Control Loss Warning

Applications developed and evaluated under the Safety Pilot Model Deployment

Background

Introduction to DSRC

- Congress created the Intelligent Transportation System (ITS) program in 1991.
- Administered by USDOT.
- Uses advanced electronics to improve traveler safety, decrease traffic congestion, reduce air pollution, and conserve fossil fuels.
- Dedicated short-range communications (DSRC) is a wireless (IEEE 802.11) ITS system designed for automotive use.
- DSRC is a short-to-medium-range wireless communication protocol that permits very low latency data transfer critical in communications-based active safety applications.

Introduction to DSRC (cont'd)

- DSRC includes both on-board units (OBUs) and roadside units (RSUs).
- An OBU is a DSRC transceiver that is normally mounted in or on a vehicle, or which may be portable. OBUs can operate while a vehicle is stationary or mobile, and they transmit and receive on one or more radio frequency channels.
- An RSU is a DSRC transceiver that is mounted along a roadway or other fixed location. It may also be mounted on a vehicle or be hand carried, but may only operate when stationary.

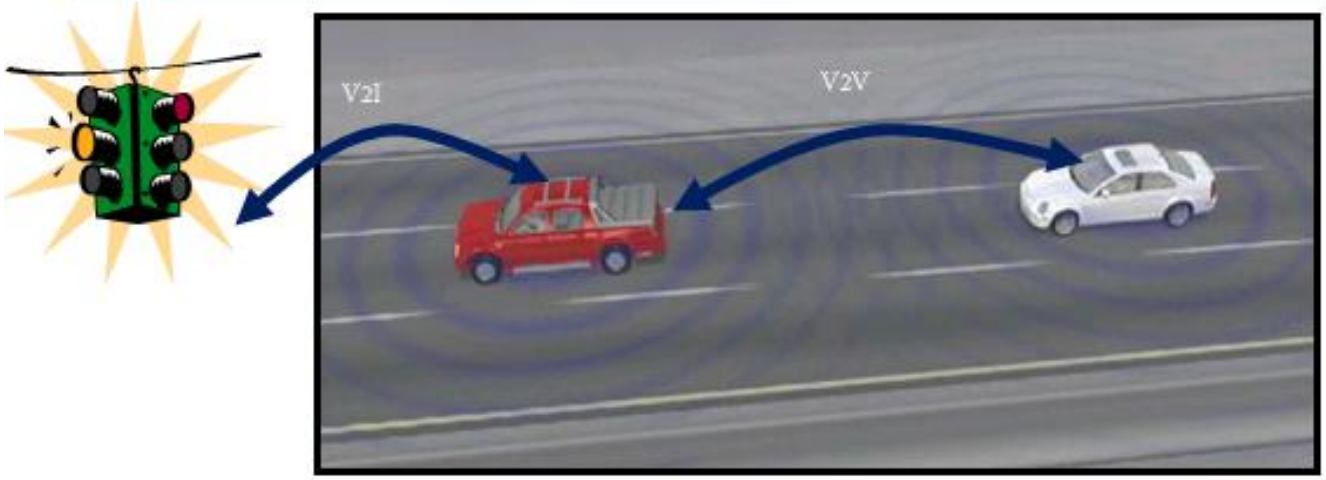
DSRC = OPPORTUNITY FOR SAFER DRIVING

Vehicle crashes account for:
32,367 deaths/year (2011)
5,338,000 crashes/year
leading cause of death for ages 4-34

NHTSA estimates that connected vehicles have the potential to address approximately 80% of vehicle crash scenarios involving unimpaired drivers

- Greater situational awareness
  - Your vehicle can "see" nearby vehicles and knows roadway conditions (e.g., road works) you can't see
  - 360 degree "visibility"
- Reduce or even eliminate crashes thru:
  - Driver Advisories
  - Driver Warnings
  - Vehicle Control

DSRC + GPS: A New Safety Sensor



- Lower cost enables deployment to all market segments, not just luxury
- Offers new features not possible with existing obstacle detection-based driver assistance systems
- Enhances existing obstacle detection-based driver assistance systems
- Reduced cost & complexity
- Robust performance: Immune to extreme weather conditions

Safety Applications *vs.* Crash Scenarios Mapping

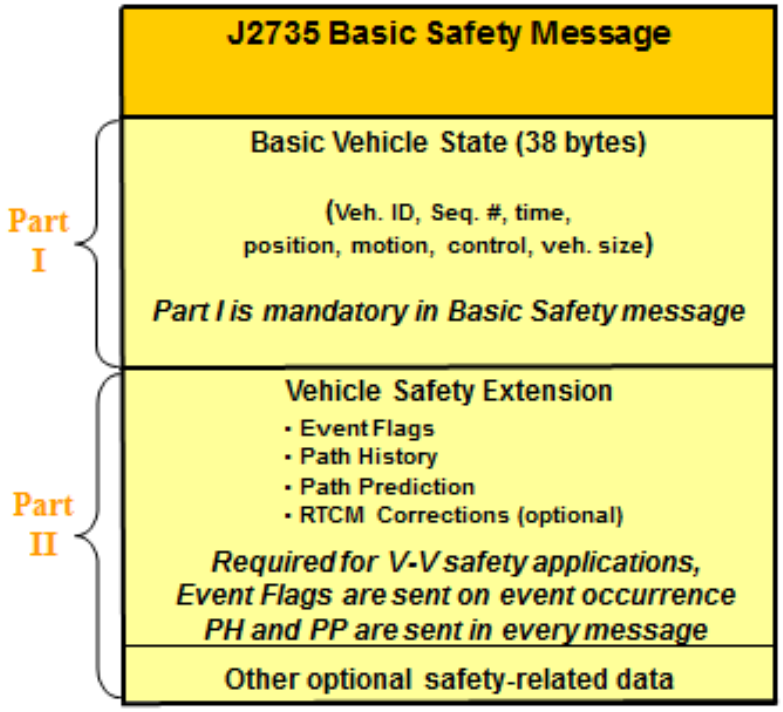
	V2V Safety Applications → / Crash Scenarios ↓	EEBL	FCW	BSW	LCW	DNPW	IMA	CLW
1	Lead Vehicle Stopped		✔					
2	Control Loss without Prior Vehicle Action							✔
3	Vehicle(s) Turning at Non-Signalized Junctions						✔	
4	Straight Crossing Paths at Non-Signalized Junctions						✔	
5	Lead Vehicle Decelerating	✔	✔					
6	Vehicle(s) Not Making a Maneuver – Opposite Direction					✔		
7	Vehicle(s) Changing Lanes – Same Direction			✔	✔			
8	LTAP/OD at Non-Signalized Junctions						✔	

Note: Crash Scenario reference: "VSC-A Applications_NHTSA-CAMP Comparison v2" document, USDOT, May 2 2007. Selected based on 2004 General Estimates System (GES) data and Top Composite Ranking (High Freq., High Cost and High Functional Years lost).

EEBL: Emergency Electronic Brake Lights
FCW: Forward Collision Warning
BSW: Blind Spot Warning
LCW: Lane Change Warning
DNPW: Do Not Pass Warning
IMA: Intersection Movement Assist
CLW: Control Loss Warning

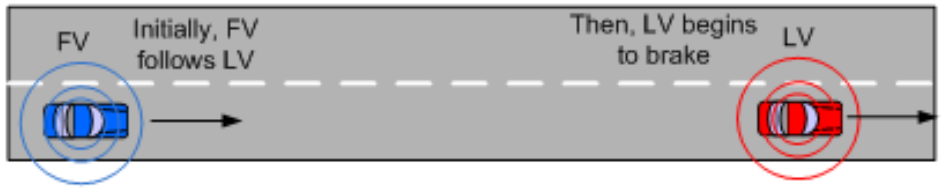
V2V Interoperable Communication: The SAE Basic Safety Message

- Single safety message format supports all V2V applications
- Periodic safety message broadcast (10 times per second)
- Event-driven safety message broadcast (immediate on event occurrence)
- Consistent packet reception is critical for crash avoidance safety applications

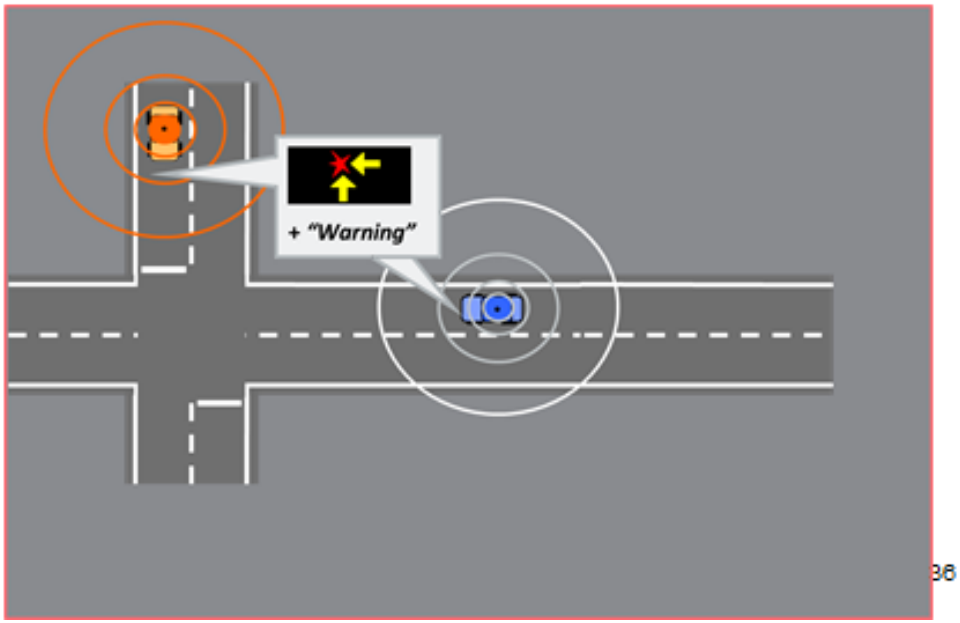


V2V Safety Feature Examples

Cooperative Forward Collision Warning Feature



Cooperative Intersection Movement Assist Feature



Cooperative Intersection Collision Avoidance System – Violations (CICAS-V)