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Roskilde, 2020-03-09

Subject: In the Matter of Use of the 5.850-5.925 GHz Band, ET Docket No. 19-138

CAR 2 CAR Communication Consortium (C2C-CC) respectfully submits its comments on the Federal Communications Commission's ("FCC's") public notice on the use of the 5.850-5.925 GHz band (ET Docket No. 19-138), dated February 6, 2020. According to the notice, the FCC will amend its rules for the 5.850-5.925 GHz band by allowing unlicensed Wi-Fi users to operate in the lower 45 MHz of the band and Intelligent Transportation System ("ITS") operations in the upper 30 MHz. Additionally, ITS operations would consist of Cellular Vehicle-to-Everything ("C-V2X") devices at 5.905-5.925 GHz (20 MHz), and C-V2X and/or Dedicated Short-Range Communication ("DSRC") devices at 5.895-5.905 GHz (10 MHz).

We would like to answer in a general way. In addition we attach from page xxx C2C-CC refer to some of the specific FCC questions.

Introduction

Every day, almost 100 people die in road traffic and almost ten times more get injured in the U.S.¹ This is painstakingly high numbers, devastating for affected individuals causing unimaginable sorrow and grief when friends and families are struck by this tragic. There is no silver bullet that can from one day to another magically remove accidents, it is a continuous introduction of new technologies, a supportive regulatory environment, and acceptance by society that can lead us towards the "zero vision". If motor vehicles had been introduced today and the forecast would have stated that up to 100 people may die every day, this had never been accepted by society. Out of the accidents involving two or more light vehicles, V2V communication can decrease the fatality with 25%¹ but V2V needs frequency spectrum to operate.

The uncertain regulatory environment has delayed the introduction of DSRC and, while we are waiting for necessary decisions to be made, fatal crashes that could have been prevented continue to happen. Delaying DSRC deployment by three years results in 44,000 fatalities² that could have been avoided. Families suffer from accidents as we argue over technologies and at the same time the available safety spectrum is proposed to be reduced substantially with disastrous consequences in terms of loss of lives and societal cost.

Regarding the matter of use of the 5.850-5.925 GHz band
the CAR 2 CAR Communication Consortium (C2C-CC):

1. urges FCC to preserve the 75 MHz spectrum band for transportation safety
2. identifies that innovative deployment of V2X is stalled with new proposed band plan
3. acknowledges other regions such as EU, Japan overtaking US in development and deployment of cooperative automated driving. Other

¹ https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/v2v_nprm_web_version.pdf

² <http://www.umtri.umich.edu/what-were-doing/news/cost-fatalities-injuries-and-crashes-associated-waiting-deploy-vehicle-vehicle>

regions such as EU, Japan, Korea, Australia, Canada, Mexico, Singapore, and Russia extend or establish their V2X spectrum

4. urges to protect the 75 MHz band from harmful interference by U-NII devices
5. suggests strong protection of incumbent DSRC deployment
6. opposes any kind of spectrum band split inside the 75 MHz spectrum
7. does not see the economic incentive to yield V2X spectrum to U-NII devices, with diminishing perspectives for improving road safety, traffic efficiency and stopping autonomous driving
8. identifies a major risk to lose the capability of protecting vulnerable road users (such as pedestrians, bicyclists)
9. acknowledges the US lacking spectrum resources for establishing cooperative automated driving in comparison to, e.g., Europe
10. estimates negative safety impact in the range of \$100 to \$150 billion annually in the US due to additional fatalities.

Regarding 1: C2C-CC urges FCC to preserve the 75 MHz spectrum band for transportation safety

There is no evidence that the ITS spectrum requirements have decreased. Other technologies mentioned in the NPRM such as radars are useful in complementing ITS by improving the vehicles’ perception capabilities in order to estimate the present location of other road users that are in the line-of-sight, however they cannot replace the need for communication, the only way to learn about road users not in the line-of-sight, about their future location (based on transmission of driving direction and speed, as well as intended manoeuvres) and to achieve coordination between vehicles.

C2C-CC has performed a spectrum study³ showing that deployed as well as planned applications for increasing road traffic safety towards cooperative automated driving may consume more than 70 MHz. This study only takes the applications’ needs of bandwidth in MHz into account and it is communication technology agnostic. Table 1 summarizes the results of this study by tabulating different message types and their spectrum needs in MHz given three different scenarios. The results show that the 7x10 MHz channels are required for existing and planned safety applications, thus preserved spectrum is a necessity. Table 2 explains the different message types found in Table 1, which are already well defined and specified in standardization bodies.

Table 1. Spectrum needs for different message types for a single communication technology implementation

Message type	Scenario			No of 10 MHz channels
	Urban [MHz]	Suburban [MHz]	Highway [MHz]	
BSM	9	10	9	1
I2V	1	1	1	0.5
PSM	4	1	2	0.5
PCM	3	6	10	1
CPM	23	26	24	2
MCM	23	26	24	2
Σ	63	70	70	7

Applications based on V2X communication are introduced in steps, where so-called day one scenarios increasing the information horizon for the driver are introduced first. Day one scenarios or basic safety applications are intended to inform the driver about impending dangerous situation and the driver needs to react accordingly. Day two scenarios intend to increase the information horizon for the vehicle and day-two applications involve for example truck platooning and cooperative adaptive cruise control (CACC).

Figure 1 shows the roadmap C2C-CC has developed to plan for reaching true cooperative automated driving with reduced number of accidents, increased road traffic efficiency with decreased environmental footprint. The roadmap shows V2X applications starting with awareness driving over sensing driving with CPM towards higher levels of cooperative automation including the message types MCM and PCM detailed in Table 2, three phases of V2X deployment:

- awareness driving (day-1) (BSM, I2V, PSM)
- sensing driving (CPM)

³ CAR-2-CAR Communication Consortium Spectrum Study: "[Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz for C-ITS and Cooperative Automated Driving](#)"

- cooperative automated driving (MCM, PCM)

Table 2: Explanation of different message types

Message type	Deployment phase	Description	
BSM	Awareness driving	Basic Safety Message (BSM) increases the awareness horizon for the driver by alerting about impending dangerous situations through an HMI. BSM is outlined in SAE J2735 and SAE 2945/1. BSM provides information about the vehicle transmitting it.	
I2V		Infrastructure to vehicle (I2V) messages are a collection of messages providing information to the driver and the vehicle from smart road infrastructure. An excerpt of I2V messages follows here.	
		SPAT	Signal, phase and timing (SPAT) information is sent by red lights to provide the next green phase. Described in J2735, ISO/TS 19091:2017 and SAE 2945/10.
		MAP	MAP describes road lane topology, intersections and to some extent traffic maneuvers. It is outlined in J2735, ISO/TS 19091:2017 and SAE 2945/10.
		IVI	In-vehicle information carries information such as speed limits. It is outlined in J2735, ISO/TS 19091:2017 and SAE 2945/10.
PSM	Personal safety message (PSM) provides protection for vulnerable road users. Found in SAE J2735, SAE J2945/9.		
CPM	Sensing driving	Collective perception message (CPM) provides information about objects in the surrounding of vehicles. Currently being standardized in ETSI and SAE collaboratively, see draft ETSI TS 103 324, ETSI TR 103 562, and SAE J2945/8.	
PCM	Cooperative automated driving	Platooning control message (PCM) is a draft specification in ETSI TR 103 298 based on the research project on multi-brand truck platooning in Europe called ENSEMBLE ⁴ .	
MCM		Maneuver coordination message (MCM) facilitates negotiation between automated vehicles for tricky situations such as left turn or merge assist in highway scenarios. See draft ETSI TR 103 578 and J2945/6.	

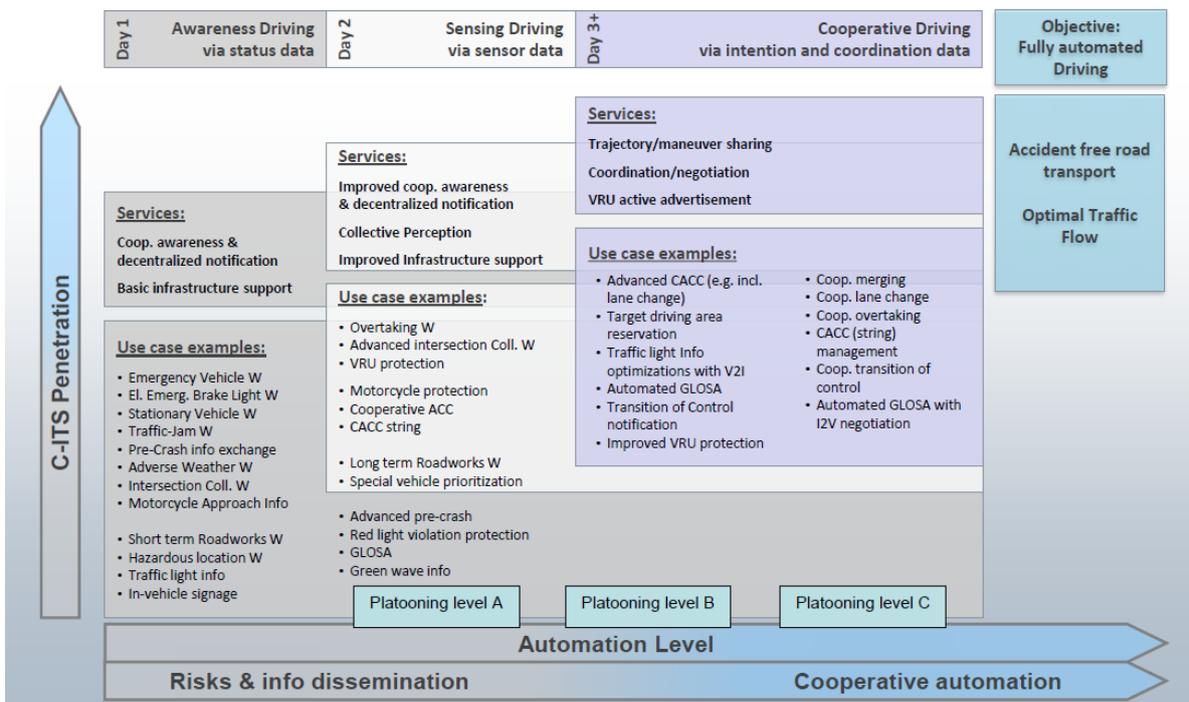


Figure 1: C2C-CC roadmap for V2X application⁵

⁴ The H2020 research project ENSEMBLE, <https://platooningensemble.eu/>

⁵ Source C2C-CC: https://www.car-2-car.org/fileadmin/downloads/PDFs/roadmap/CAR2CAR_Roadmap_Nov_2018.pdf

Regarding 2: C2C-CC identifies that innovative deployment of V2X is stalled with new proposed band plan

Given the newly proposed band plan, only phase one “awareness driving” (day one scenarios) can be supported and any application after phase one awareness driving is prevented, regardless of the chosen V2X technology. Hence, advanced applications such as maneuver coordination or collective perception for automated vehicles would be impossible, see Table 1 and Figure 1.

The proposed band plan dividing the spectrum between two V2X technologies will also remove truck platooning from the picture, as platooning requires frequent message exchanges, which cannot be performed on the same channel as safety messages, because basic safety must remain at the highest priority. Further, by dividing the spectrum between two V2X technologies that cannot talk to each other, the safety benefit diminishes.

All promising applications for connected and automated driving being researched and standardized currently will never see the light of day. Non-exhaustive list:

- Overtaking Warning with collective perception
- Extended Intersection Collision Warning with collective perception
- Vulnerable Road User Protection for non-V2X-equipped VRU's
- Cooperative Adaptive Cruise Control
- Long-term Road Works Warning
- Special Vehicle Prioritization
- Cooperative Lane Change
- Cooperative Overtaking
- Maneuver coordination for automated driving

For the Automotive Industry V2X plays an essential role in enabling autonomous driving. While V2X is seen as key technology to support automated driving functions in general, it will be a pre-condition in deploying fully automated driving including urban and suburban traffic with SAE level 5⁶.

To this end, the proposed band plan will effectively end innovative V2X applications for connected and automated mobility.

Regarding 3: C2C-CC acknowledges other regions such as EU, Japan overtaking US in development and deployment of cooperative automated driving

In contrast to the FCC proposal, the World Radio Conference 2019 (WRC19) suggests in WRC recommendation 208⁷ in conjunction with ITS ITU-R recommendation M.2121-0⁸ to designate 75 MHz band in 5850-5925 MHz for ITS in all regions worldwide. In reality, many countries have already designated the same or a similar amount of spectrum in the 5.9 GHz band for V2X communications, including Canada (75 MHz), Mexico (75 MHz), Australia (70 MHz), Korea (70 MHz), Singapore (50 MHz), CEPT member states (70 MHz), Europe (70 MHz), and Russia (70 MHz). While correctly noted, Japan currently dedicates 10 MHz of spectrum exclusively for transportation safety communications, Japanese authorities are investigating the possibility to include additional V2X technologies in an 80 MHz band allocated to electronic toll collection. The European Union (EU) regulation (Commission Decision 2008/671/EC⁹ and Commission Implementing Decision (EU) 2019/1345) is currently being revised for extending the frequency band at 5.9 GHz from 50 MHz to 70 MHz for cooperative ITS. However, many member states of EU have already a 70 MHz designation that has followed from work within CEPT (ECC decision (08)01¹⁰ and ECC recommendation (08)01).

In Europe, VW already deployed in 2019 the new VW Golf 8¹¹, the top selling car model in Europe, with V2X technology based on DSRC with 100% equipment rate. This decision is accompanied by massive deployments of road infrastructure by the European C-Roads platform¹² and EU member states.¹³ Road

⁶ European automotive manufacturer and their supplier: ACEA and CLEPA position paper "ACEA-CLEPA paper: Future C-ITS spectrum needs" https://www.acea.be/uploads/publications/ACEA-CLEPA_paper-Spectrum_needs-November_2019.pdf

⁷ WRC recommendation 209 on page 555 in <https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf>

⁸ ITU-R recommendation M.2121-0 in https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2121-0-201901-I!!PDF-E.pdf

⁹ <http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:32008D0671>

¹⁰ <https://www.ecodocdb.dk/document/412>

¹¹ <https://www.volkswagen-newsroom.com/en/press-releases/the-new-benchmark>

¹² C-Roads platform <https://www.c-roads.eu/platform.html>

¹³ European C-ITS deployment takes off, more than 50 Road Operators, automotive suppliers, automotive OEMs support the deployment of DSRC, see <http://c-its-deployment-group.eu/>

operators of majority of European member states and others are harmonizing short-range V2X infrastructure based on ITS-G5/DSRC (IEEE802.11p) as well as long-range V2X cellular communication. C-Roads profiles are basis for public tenders to equip road side units (e.g. traffic lights) with short-range V2I (vehicle-to-infrastructure) communication. 3700 miles of European roads are already equipped with DSRC V2I road side units to cover traffic hot spots.

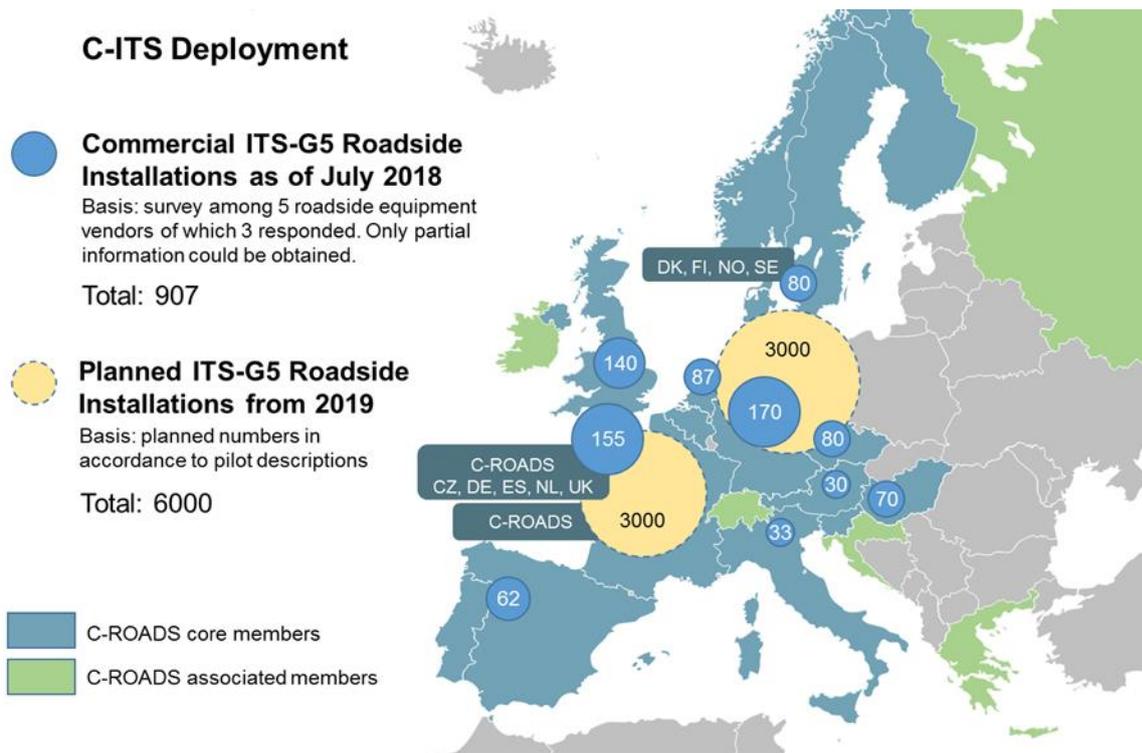


Figure 2: In Europe operational V2X infrastructure already uses ITS-G5 (DSRC) and deployment is ongoing¹⁴

Next steps are truck platooning and VRU protection with collective perception, which will be introduced in the European market. As V2X is on the roadmap of Euro-NCAP for 2024 a huge deployment increase is expected by 2022. In Japan Toyota vehicles and infrastructure based on DSRC are deployed.

To this end, the proposed new band plan in the US is on the contrary compared to the development in other regions of the world for facilitating cooperative automated mobility.

Regarding 4: C2C-CC urges to protect the 75 MHz band from harmful interference by U-NII devices

U-NII-3 and U-NII-4 Wi-Fi devices can severely interfere with DSRC equipment in the 5.850-5.925 GHz band as shown in the NHTSA study¹⁵, leading to unacceptable packet error rates of up to 70% and above for V2X safety communication. Harmful effects of this interference are noticeable within several hundred meters of the interfering device, potentially reducing the traffic safety on many roads in urban areas. To avoid harmful interference, C2C-CC suggests that adjacent unlicensed devices should be allowed to maximum interfere into V2X communication with the same level as V2X is permitted to interfere outside its channel, which is -40 dBm/MHz¹⁶ out-of-band emissions of U-NII at the band edges of 5.855-5.925 GHz. Any emissions above that level would harmful interference into V2X safety communication and would impact the high reliable packet reception necessary for transportation safety benefits.

¹⁴ published in ECC [CEPT report 71](https://www.ecodocdb.dk/document/9683) in March 2019, <https://www.ecodocdb.dk/document/9683>

¹⁵ [“Vehicle-to-Vehicle Communications Research Project \(V2V-CR\) DSRC and Wi-Fi Baseline Cross-channel Interference Test and Measurement Report”](#) by US DoT, 12/2019,

¹⁶ Derived from Class C devices in IEEE802.11p current DSRC spectrum mask in Unites States.

10 MHz above/below the DSRC channel edge the attenuation requirement is 50 dB

The "typical" or "default" in-channel transmit power in the US is 20 dBm, or 10 dBm/MHz. That taking into account

10 MHz above/below the DSRC channel edge the attenuation requirement is -40 dBm/MHz

Wi-Fi (U-NII) should not be permitted to interfere outside its band at higher levels than DSRC is permitted to interfere outside its channel, -40 dBm/MHz OOB would be upper bounds on acceptable U-NII OOB.

For comparison, the existing U-NII-3 OOB breakpoints are:

- at 5850 MHz, OOB limit = +27.0 dBm/MHz
- at 5855 MHz, OOB limit = +15.6 dBm/MHz
- at 5875 MHz, OOB limit = +10.0 dBm/MHz
- at 5925 MHz, OOB limit = -27.0 dBm/MHz

Regarding 5: C2C-CC suggests strong protection of incumbent DSRC deployment

Rechannelization of deployed DSRC channel would be disastrous and difficult to perform in reality. Recall of deployed RSU and deployed GM vehicles would cost an immensely amount of money not to mention the loss in trust for FCC, who should vouch for a stable spectrum regulation. Stability and continuity of the ITS spectrum allocation is especially important in a voluntary deployment scheme. Rechannelization might lead to an end for V2X (V2V, V2I, V2P) deployment in the US as a whole.

Regarding 6: C2C-CC opposes any kind of spectrum band split inside the 75 MHz spectrum

C2C-CC proposes to keep the 75 MHz preserved and designated for DSRC with deployed use cases and devices. The spectrum can be opened for additional V2X technology, if coexistence and interoperability with incumbent DSRC technology can be guaranteed.

At the moment four different V2X communication technologies are mature or in drafting:

- DSRC based IEEE 802.11p (mature)
- IEEE 802.11bd (draft)
- LTE-V2X, 3GPP release 14 (trialled)
- 5G-NR V2X, 3GPP release 16 (draft)

IEEE 802.11bd (currently being drafted in standardization) will be backward compatible and interoperable with legacy DSRC based IEEE 802.11p equipment. Thus, both IEEE 802.11bd and IEEE 802.11p can co-exist and share the same frequency channel with full compatibility leading to an efficient use of spectrum resources and full support for basic safety and advanced use cases.

LTE-V2X is not interoperable with DSRC based on IEEE 802.11p. Thus, they cannot understand each other and consequently, basic safety applications will not be interoperable, and safety will not be increased if different technologies are used. Additionally, LTE-V2X does currently not allow fair coexistence with DSRC devices. In case LTE-V2X and DSRC are supposed to co-exist in the same channel, the coexistence method to be used must be carefully designed based on detailed studies and analysis, in order to avoid harmful interference between the two technologies.

5G-NR V2X is not interoperable or backward compatible with LTE-V2X. It is possible to build a piece of hardware including both LTE-V2X and 5G-NR V2X, each one operating at different frequency channels. However, this not at all related to backward compatibility, since the same is also applicable for a system integrating an LTE-V2X and a DSRC radio, respectively. Such embodiments, although possible, are neither cost effective nor make efficient use of the spectrum resources. The cost efficiency of ITS devices is essential in a voluntary deployment scheme and could be a decisive factor on the rate of adoption of ITS equipment.

The 5G connectivity using Uu-interface (vehicle-to-network connection with traditional base station coverage) and ad hoc V2X communication support distinct functions and as such the use of 5G connectivity as a complement to a DSRC ITS functionality is not mutual exclusive but seen as a core feature of future hybrid communications systems in support of connected and automated mobility.

Even though 5G-NR V2X, LTE-V2X, and IEEE 802.11bd/IEEE 802.p are not compatible with each other, they share some common technology features (e.g., physical layer structure, OFDM) and adhere to the same restrictions imposed by physical laws. By default, they use different parameter settings which either favour transmission range or spectrum efficiency (same trade-off applies to both technologies). However, when similar parameters are chosen, the performance of the families of technologies are similar and there is no evidence showing superior performance of any of the V2X technologies for ad hoc communication.

Regarding 7: C2C-CC does not see the economic incentive to move V2X spectrum to U-NII devices, with diminishing perspectives for improving road safety, traffic efficiency and stopping autonomous driving

Spectrum allocation for WLAN services already involves 650 MHz of mid-band spectrum with another 1200 MHz being proposed for future expansion into 6 GHz¹⁷. The 45 MHz of additional spectrum will provide a limited gain (less than +2.5%) compared to the benefit of increased safety in transportation.

¹⁷ According to FCC NPRM "Unlicensed Use of the 6 GHz Band, Expanding Flexible Use in Mid-Band Spectrum Between 3.7 and 24 GHz" ET Docket No. 18-295, Released: October 24, 2018: 1200 megahertz of spectrum in the 5.925-7.125 GHz (6 GHz) band

Regarding 8: C2C-CC identifies a major risk to lose the capability of protecting vulnerable road users (like pedestrians, bicyclists)

The necessary 20 to 30 MHz bandwidth for sensing driving with collective perception (CPM) would not be available with the proposed band plan (see spectrum needs study in Table 1). The capability to protect the VRUs with collective perception (also called sensor sharing, sensing driving) can be explained shortly: Collective perception can protect the non-equipped road participants through the V2X equipped road users. Sensors (radar, camera, LiDAR) at smart intersections or in vehicles detect VRUs and communicate their position and movement to all other V2X participants. Through V2X communication the VRU would be effectively protected.

Regarding 9: C2C-CC acknowledges the US lack of spectrum for establishing cooperative automated driving in comparison to, e.g., Europe

The necessary 20 to 30 MHz bandwidth for cooperative driving with manoeuvre coordination messages (MCM) would not be possible with the proposed band plan (see spectrum needs study in Table 1).

Regarding 10: C2C-CC estimates negative safety impact in range of \$100 to \$150 billion annually in the United States due to additional fatalities.

32,999 people lost their lives on U.S. roads in 2010, the economic cost for motor vehicle crashes in total reached staggering \$242 billion and the average discounted lifetime cost for each fatality was amounted to \$1.4 million. Public revenues paid for roughly 7 percent of all motor vehicle crash costs, costing taxpayers \$18 billion – the equivalent of more than \$156 in added taxes for every household in the United States. Seat belts saved 12,500 lives but failure to buckle up in the U.S. caused 3,350 unnecessary fatalities, 54,300 serious injuries and cost America society \$10 billion in easily preventable injury related costs¹⁸. In addition, lost lives due to accidents cause much grief which cannot be translated into money.

Reducing fatalities and the overall expenditures for accidents can be achieved by introducing basic safety using V2X communication. This was envisioned in the V2X NPRM proposed in 2016¹⁹, where up to \$74 billion annually could have been saved by this legislation. However, the remaining 30 MHz for ITS proposed in the FCC NPRM given the interference conditions caused by adjacent WiFi/unlicensed devices implies that not even the safety and cost benefits outlined in the V2X NPRM can be reached anymore. This NPRM only calculated on V2V basic services, the overall reduction of the 75 MHz spectrum will result in that the protection of VRUs through collective perception can no longer be accommodated (see Table 1 for spectrum requirements for existing and planned applications), thus further diminishing safety and cost benefits.

The proposed rulemaking by FCC will cost the society between \$100-150 billion annually in the United States due to the lost safety and cost benefit opportunities that can be facilitated by V2X access to 75 MHz.

Conclusions

C2C-CC rejects the proposal of reducing the available spectrum for ITS from 75 MHz to 30 MHz at 5.9 GHz given the existing and planned applications for moving towards true connected and automated mobility, see Table 1, the whole 75 MHz is needed. The proposed band plan cannot even support the forecasted reduction in accidents with V2V basic safety due to interference from WiFi and unlicensed devices, thus, the societal cost savings will diminish. The possibility to include non-equipped vehicles and VRUs in the ITS umbrella through collective perception is no longer accessible since the proposed band plan only accommodate basic safety. Interestingly, the rest of the world, on the contrary to the U.S., extends spectrum for innovative ITS. Connected and automated mobility will be stalled at large if this NPRM will be approved.

C2C-CC does not support a split of available spectrum between V2X technologies since this does not lead to increased road traffic safety and it is an inefficient use of spectrum. Instead of a hard spectrum split between different technologies, C2C-CC would prefer opening the existing spectrum to be used also by other V2X technologies, if coexistence and interoperability with incumbent DSRC technology can be

¹⁸ <https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013>

¹⁹ https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/v2v_nprm_web_version.pdf

guaranteed through appropriate coexistence methods, which must first be determined through compatibility studies.

4G/5G connectivity using the Uu interface is a complement to DSRC based connectivity, both technologies provide distinct functions facilitating connected and automated mobility, so-called hybrid communication approach.

Discussion

It is undoubtedly true that the adoption of ITS has evolved slowly. However, before taking any attempts to improve this situation, it is important to understand the reasons behind this slow adoption, which includes mainly R&D, testing and implementation efforts, which have been on-going for the past decade, before being ripe for the high standards of safety that the automotive industry needs to comply with. Given the important number of pilots, tests and current deployment, there is no evidence that the slow adoption is due to any shortcomings of the DSRC technology based on IEEE 802.11p. On the contrary, these trials and measurement campaigns have proven the ability of this technology to support the needs of ITS. In our view, the slow adoption was more related to the lack of motivation from road operators and automotive OEMs to voluntarily invest in a technology whose benefits are only obvious once a certain level of market penetration is reached. This is in contrast to other safety technologies (from airbags to radars), which provide significant safety advantages without any dependency on deployment by for example other OEMs. The penetration and the dependency issue are not addressed by this NPRM and hence, there is no reason to believe that the situation will change by reducing spectrum and propose new technologies. On the contrary, C2C-CC believes that the uncertainty created by the Commission's plans to repurpose parts of the spectrum have contributed to the slow market adoption. For example, Toyota motivated its decision to stop the planned deployment of DSRC on "a range of factors, including the need for greater automotive industry commitment as well as federal government support to preserve the 5.9 GHz spectrum band for DSRC" according to the report²⁰. Furthermore, there are serious concerns on the maturity of LTE-V2X devices as these have not been tested in any mid or large-scale deployments compared to DSRC.

Regardless of V2X technology, the advanced uses cases including basic traffic safety already occupies the whole 75 MHz ITS spectrum. Removing this spectrum, would not only negatively impact current R&D and deployments, but also give a negative sign to road safety innovation, beyond the huge economic impact on the industry.

With best regards

Dr.-Ing. Karl-Oskar Proskawetz
Administrator
CAR 2 CAR Communication Consortium

Vehicle manufacturers within the CAR 2 CAR Communication Consortium

- General Motors
- Honda
- Hyundai
- KTM MOTORRAD
- MAN
- Group Renault
- Toyota Motor North America
- Volvo Trucks Global
- Volvo Cars Group
- Volkswagen
- Yamaha

²⁰ Reuters, "Toyota abandons plan to install U.S connected vehicle tech by 2021," [Online]. Available: <https://www.reuters.com/article/us-autos-toyota-communication/toyota-abandons-plan-to-install-u-s-connected-vehicle-tech-by-2021-idUSKCN1S2252>

About CAR 2 CAR Communication Consortium

In the CAR 2 CAR Communication Consortium, leading global vehicle manufacturers, equipment suppliers and research institutes join forces for the deployment of Cooperative Intelligent Transport Systems and Services (C-ITS). The main objective of the CAR 2 CAR Communication Consortium is the development, testing and deployment of cooperative systems worldwide based on inter-vehicle, vehicle to roadside and vehicle to other road user equipment short-range communication for improving road safety and road efficiency. Other complementary communication such as cellular is considered where required. The Consortium aims on ensuring the interoperability of cooperative systems, spanning all vehicle classes across brands and borders.

The wireless V2V (vehicle-to-vehicle), V2I (vehicle-to-infrastructure) and V2P (vehicle-to-personal) communication via Vehicular Ad-hoc Network will lead to a safer, more efficient and more comfortable future mobility. It is an inevitable requirement for the long-term vision towards highly automated driving. The Consortium was founded in 2002 with the objective of developing standards for C-ITS, as prerequisite for interoperability of systems improving road safety and road efficiency. Moreover, the CAR 2 CAR members discuss realistic deployment strategies, a roadmap to deployment and business models to speed-up the market penetration. In close collaboration with international stakeholders, especially from the US and Japan, the Consortium pushes the harmonisation of V2X communication standards worldwide.

FCC NPRM 5.9 GHz. CAR 2 CAR Communication Consortium answers specific questions raised in FCC NPRM ET Docket No. 19-138

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7. The Commission proposes to designate the 5.850–5.895 GHz sub-band for unlicensed operations. The Commission believes that the 5.850– 5.895 GHz sub-band (denoted as the U– NII–4 band) could be combined with the adjacent 5.725–5.850 GHz sub-band (denoted as the U–NII–3 band) to provide a large contiguous block of unlicensed spectrum that could be used to deliver more capacity and advanced features to Wi-Fi users. The Commission requests comment on its proposal to designate the 45 megahertz of spectrum at 5.850–5.895 MHz for unlicensed operations.

Comment C2C-CC

C2C-CC opposes this proposal for several reasons. Please refer to our answer above in the general statement [“Regarding 1. C2C-CC urges FCC to preserve the 75 MHz spectrum band for transportation safety”](#)

8. The Commission suggests that because the 5.850–5.895 GHz sub-band is adjacent to the U–NII–3 band, equipment manufacturers should be able to readily and cost-effectively manufacture devices to expand operations into this sub-band. The Commission seeks comment on how easily existing U–NII equipment could be modified to take advantage of the additional 45 megahertz of spectrum proposed for unlicensed operations.

Comment C2C-CC

C2C-CC opposes this proposal according to answer of question 7.

9. With this NPRM, the Commission revisits how best to make use of the 5.9 GHz band as part of a larger ecosystem that includes a variety of spectrum resources—including spectrum outside of the 5.9 GHz band—that can improve and enhance delivery of transportation and vehicular safety-related communications. The Commission seeks comment on the state of DSRC- based deployment and the extent to which existing licensees currently operate on some or all of the existing channels in the 5.9 GHz band.

Comment C2C-CC

As the US Department of Transportation noted in October 2018²¹, there were already more than 70 active DSRC deployments, using all seven channels and with thousands of vehicles on the road²². Currently, there are approximately 18,000 vehicles and 6,000 road-side units (RSUs) in 25 states²³. General Motors has already deployed DSRC technology in consumer vehicles²⁴. C2C-CC is in favour of and promoting the future evolution of ITS technology. It is crucial however that any new technology will be backwards compatible with existing deployments so that these large investments are protected and ongoing investments are promoted. Any decision that fails to ensure backward-compatibility with current deployments will not invalidate all current investments but will also stop any planned investments until the rules have officially changed. This will significantly delay the market adoption of ITS technology.

One good example of a backwards-compatible and interoperable ITS technology is 802.11bd, an evolution of 802.11p/DSRC which can coexist in the same channel with full access-layer compatibility and thus can make the most efficient use of spectrum resources. Next-generation 802.11bd devices will be fully backward-compatible, which means that they support at least one

²¹ US DoT, "Preserving the 5.9GHz Safety Band For Transportation," [Online]. Available:

<https://www.transportation.gov/research-and-technology/preserving-59ghz-safety-band-transportation-0>.

²² US DoT, "5.9 GHz Spectrum Use Today," [Online]. Available:

<https://www.transportation.gov/sites/dot.gov/files/docs/research-and-technology/359561/59-fact-sheet-channel-usage.pdf>.

²³ US DoT, "Preserving the 5.9GHz Safety Band For Transportation," [Online]. Available:

<https://www.transportation.gov/research-and-technology/preserving-59ghz-safety-band-transportation-0>.

²⁴ GM, "V2V Safety Technology Now Standard on Cadillac CTS Sedans," [Online]. Available:

<https://media.gm.com/media/us/en/cadillac/news.detail.html/content/Pages/news/us/en/2017/mar/0309-v2v.html>.

legacy mode of transmission that can be received and decoded by existing 802.11p devices. In this legacy transmission mode, the compatibility to the 802.11bd protocol will be signalled, allowing a gradual and seamless transition from 802.11p to 802.11bd devices in the future.

Toyota vehicles would have been deployed if FCC would not have stopped the implementation of DSRC with the following letter²⁵. In April of 2018, Toyota announced that it would deploy Dedicated Short Range Communications (DSRC) systems on vehicles sold in the United States starting in 2021, with the goal of adoption across most of its automotive lineup by the mid-2020s.

The Commission also seeks comment on the transportation and vehicular safety- related applications that are particularly well-suited for the 5.9 GHz band as compared to spectrum outside of the 5.9 GHz band, and how spectrum outside the 5.9 GHz band can be used efficiently and effectively to provide transportation and vehicular safety-related applications.

Comment C2C-CC

C2C-CC sees the following roadmap/applications for short-range ad hoc V2X communication where different message types (see some also in table 1) are broadcasted to all neighbouring vehicles, pedestrians and V2X infrastructure, C2C-CC Roadmap of V2V, V2I, V2P applications are illustrated in figure 1.

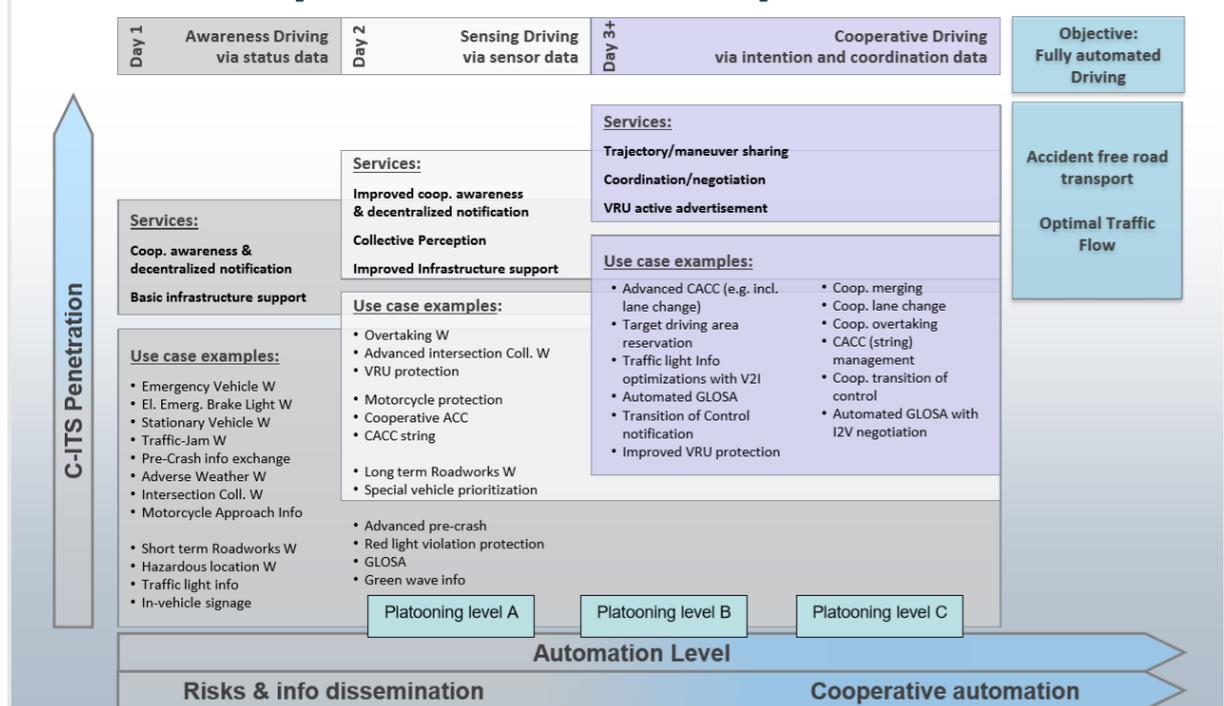


Figure 1: C2C-CC application roadmap²⁶

A dedicated ITS spectrum for direct peer-to-peer communications between road users is necessary to improve traffic safety and efficiency. Other technologies mentioned in the NPRM such as LiDAR, automotive radar, and automotive cameras are extremely useful in complementing traffic safety by improving the vehicles' Line-of-Sight (LoS) perception capabilities and thus have the ability to avoid many collisions and reduce fatalities. Nevertheless, these technologies only work in LoS and cannot detect obstacles, pedestrians, vehicles behind corners, buildings, road bends or other vehicles. Technologies like cameras, e.g. in challenging environmental conditions, still often mis detect objects or road signs, and can be easily

²⁵ Reuters, "Toyota abandons plan to install U.S connected vehicle tech by 2021," [Online]. Available: <https://www.reuters.com/article/us-autos-toyota-communication/toyota-abandons-plan-to-install-u-s-connected-vehicle-tech-by-2021-idUSKCN1S2252>.

²⁶ Source: C2C-CC https://www.car-2-car.org/fileadmin/downloads/PDFs/roadmap/CAR2CAR_Roadmap_Nov_2018.pdf

manipulated²⁷. For example, a short piece of tape could cause cars to suddenly accelerate²⁸. Moreover, although Radars and Lidars are generally capable of detecting the speed of an object, this may take several sensor readings and may require extensive signal processing, leading to substantial delays in the range of several hundred milliseconds until a dangerous situation can be identified. Most importantly, these technologies can only observe the present situation and cannot predict the vehicle's intentions, i.e., they cannot easily predict if the change in speed of the leading car is due to a slight speed adjustment or due to an emergency braking manoeuvre. Thus, sensors cannot replace the need for communication, which is necessary to exchange information about future manoeuvres, vehicle's intentions and to enable coordination between vehicles.

V2X communications in general should be differentiated in

- 1) cellular vehicle-to-network (V2N) communication on IMT spectrum bands
- 2) direct, peer-to-peer communications, most importantly vehicle-to-vehicle (V2V) communications on dedicated ITS spectrum bands. For brevity, we will refer to the latter as direct V2V, but note that the underlying technology can also provide vehicle-to-infrastructure (V2I) and vehicle-to-pedestrian (V2P) communications.

The 5.9 GHz ITS band is suitable for direct vehicle-to-vehicle (V2V) communications. It is important to clarify that a possible vehicle-to-network (V2N) connection to commercial cellular networks constitutes a distinct functionality using different technology and different frequency resources. Cellular V2N and direct V2V are both necessary and complement each other. Existing cellular networks can already provide entertainment and a few other services to vehicles. Notably, such systems could already distribute mid-term and long-term driving or traffic information, for example to warn about accidents or traffic jams on the planned route. Although it might therefore seem appealing to provide more and more vehicular-related services via V2N through existing cellular networks, cellular networks are currently unsuited for low-latency traffic safety applications, as cellular networks have a limited coverage area in general, have reduced capacity towards the outer areas of the coverage area (which quickly becomes insufficient for simultaneous transmissions to and from a vast number of vehicles, and are not reliable enough for safety applications. On the other hand, a dedicated ITS safety band for direct V2V, V2I, V2P enables communications to all affected road users in the vicinity for traffic safety. These peer-to-peer communications can be realized with very low latencies below one millisecond -proven for DSRC- , work not only in close proximity to a cellular base station but everywhere, and are not affected by blackouts or software crashes in the base station. For example, direct V2V allows periodic broadcasts of position and driving direction of vehicles to other traffic users (including pedestrians) in the vicinity, in order to enable collision warnings and other safety-related features. These broadcasts are periodically sent up to 10 times per second, and broadcasts from a large number of vehicles and pedestrians would thus quickly congest any cellular network. Therefore, while cellular V2N is very well suited to provide occasional warnings about previous accidents even at long distances, only direct V2V communications have the ability to prevent future accidents.

10. To ensure the most efficient and effective use of the 5.9 GHz band, the Commission proposes to continue dedicating 30 megahertz of spectrum in the upper portion of the 5.9 GHz band at 5.895–5.925 GHz to support ITS operations in the band. The Commission proposes that designating 30 megahertz of spectrum will be sufficient to support ITS-related functions in the 5.9 GHz band—public safety applications involving safety of life and property— which will be part of a larger wireless ecosystem that advances national transportation and vehicular safety- related goals. The Commission seeks comment on these proposals. Additionally, it seeks comment on whether there are actions it should take, or requirements that it should adopt, to promote rapid and effective deployment of ITS (e.g., establishing appropriate benchmarks for infrastructure deployment or in-vehicle installation).

Comment C2C-CC

Please refer to C2C-CC statements above in the general response “Regarding 1. C2C-CC urges FCC to preserve the 75 MHz spectrum band for transportation safety” as well as “Regarding 2.

²⁷ See March 2 2020, U.S. Department of Transportation Publishes Report on Automated Vehicles and Adverse Weather <https://rosap.ntl.bts.gov/view/dot/43772>.

²⁸ Businessinsider, "Hackers stuck a 2-inch strip of tape on a 35-mph speed sign and successfully tricked 2 Teslas into accelerating to 85 mph," [Online]. Available: <https://www.businessinsider.com/hackers-trick-tesla-accelerating-85mph-using-tape-2020-2>.

C2C-CC identifies that innovative deployment of V2X is stalled with new proposed band plan”, “Regarding 3. C2C-CC sees other regions like EU, Japan overtaking US in development and deployment of cooperative automated driving. Other regions such as e.g. EU, Japan, Korea, Australia, Canada, Mexico, Singapore, Russia extend or established their V2X spectrum.” Regarding 8. C2C-CC sees high risks loose capability to protect Vulnerable Road Users VRU (like pedestrians, bicyclists)” and “Regarding 9. C2C-CC sees United States lacking spectrum resources for establishing cooperative automated driving in comparison to e.g. Europe.

11. C-V2X in the 5.905–5.925 GHz band. The Commission proposes to authorize C-V2X operations in the upper 20 megahertz of the 5.9 GHz band (5.905–5.925 GHz) as a means of authorizing the ITS technology that is most capable of ensuring the rapid development and deployment of continually improving transportation and vehicular safety-related applications now and into the future, that is robust, secure, and spectrally efficient, and that is able to integrate spectrum resources from other bands as part of its transportation and vehicular safety-related system. The Commission seeks specific and detailed comment on this proposal and views.

Comment C2C-CC

C2C-CC doubts that the FCC proposed change in band designation is best for transportation safety in regard to direct V2V, V2I, V2P communication. C2C-CC proposes instead to let US DoT lead studies and let US DoT decide afterwards how a change of current ITS regulation to improve safety is required.

The anticipated benefits of cellular 5G connectivity are not related to the use of C-V2X for peer-to-peer communication. Instead, cellular vehicle-to-network (V2N) connectivity is a distinct function using different technology and different frequency resources and can be combined either with C-V2X (specifically, the PC5 sidelink interface) or with DSRC for safety-critical vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I) and vehicle-to-pedestrian (V2P) connectivity. Even though cellular V2N and C-V2X PC5 interfaces use very similar technology, there is no potential for exploiting synergies between the V2N and the V2V interfaces, as the V2V link must always remain active for safety reasons. The only advantage of C-V2X PC5 over DSRC when combined with a cellular V2N connection is an improved resource allocation for C-V2X (“mode 3”). However, this operating mode is highly complex, has not been implemented in practice, and will only provide slightly improved resource allocations inside the limited coverage area of a high-speed cellular network. Therefore, cellular connectivity for V2N does not need to be combined exclusively with C-V2X PC5 but can also be successfully and efficiently combined with DSRC, which has already been demonstrated in the European SCOOP project with a fleet of 3000 vehicles outfitted with both DSRC (called ITS-G5 in Europe) for safety-critical V2V transmissions and cellular 4G for additional connectivity²⁹. The integration of IEEE802.11 technologies into a 5G core network is available and promoted by the GSMA³⁰.

Even though C-V2X and DSRC are not compatible, they share common technologies and adhere to the same restrictions imposed by physical laws. By default, they use different parameters which either favour transmission range or spectrum efficiency (same trade-off applies to both technologies). However, when similar parameters are chosen, the performance of both technologies is similar and there is no evidence to support that one has a significant advantage over the other³¹. In fact, it was demonstrated that the studies submitted by the 5GAA were not neutral and unfairly exaggerated the performance of C-V2X PC5, for example through an unrealistic increase in transmit power and message repetition leading to a significant increase in spectrum resource usage³².

The maturity of DSRC technology also implies a lower per-device production cost compared to new and not yet mass-produced C-V2X PC5 devices. We reiterate that due to the need to keep both cellular and C-V2X PC5 interfaces active simultaneously, there is no potential for exploiting synergies between these two interfaces that might reduce the hardware cost of C-V2X systems.

²⁹ Project SCOOP, "Connected vehicles and cooperative ITS," [Online]. Available: http://www.scoop.developpement-durable.gouv.fr/en/IMG/pdf/scoop_f_-_presentation_5_april_2018.pdf.

³⁰ The 5G Guide – A reference for operators, April 2019

³¹ NXP, Autotalks, "IEEE802.11p ahead of LTE-V2V for safety applications," [Online]. Available: <https://www.nxp.com/docs/en/white-paper/LTE-V2V-WP.pdf>.

³² u-blox, "A review of 5GAA's "V2X Functional and Performance Test Report" P-180106," [Online]. Available: <https://www.u-blox.com/sites/default/files/Comments-on-5GAA-PetitionWaver-18-357.pdf>.

Furthermore, we expect that the maturity of DSRC technology will not only translate to lower hardware costs, but also to lower and more predictable patent licensing costs. Contrary to that, recent lawsuits^{33 34 35} regarding cellular connectivity in cars have shown that patents on cellular technology may result in high legal uncertainty due to unexpectedly high patent costs and lawsuits that could even threaten to cause production stops for car manufacturers. While these patent costs can still be considered as small relative to the total price of a car, the costs can already amount to up to 40 % of the cost for the communication module itself³⁶. Due to both relative immaturity and high complexity of C-V2X technology, such patent issues and fees could become a great concern. We emphasize that in a voluntary deployment scheme, any additional costs for the communication module may significantly delay market adoption.

The success of adopting ITS technology of any kind is also determined by spectrum allocations in other regions. International harmonization of the ITS spectrum would not only improve traffic safety for cross-border traffic and simplify spectrum management but would also result in lower development costs per device. With DSRC technology gaining more and more momentum in Europe, for example with Volkswagen's announcement³⁷ to equip all new vehicles of the VW Golf with IEEE 802.11p transmitters, the individual cost of DSRC devices is expected to drop, creating a positive feedback cycle of less expensive devices and more benefit to individual customers due to higher deployment in other vehicles. C2C therefore agrees with the WRC19 and International Telecommunication Union (ITU), which recommends in RECOMMENDATION COM4/1 (WRC-19) "Harmonization of frequency bands for evolving Intelligent Transport Systems applications under mobile-service allocations"³⁸ in conjunction with ITU-R RECOMMENDATION that "administrations should consider using the frequency band 5 850-5 925 MHz, or parts thereof, for current and future ITS applications".³⁹

12. The Commission seeks comment on whether authorizing C-V2X in this spectrum would be the best means for promoting effective use of this spectrum for ITS, both in terms of maximizing the potential benefits of using 5.9 GHz spectrum for vehicular-related systems (including safety features) and promoting rapid deployment of ITS in the band. The Commission also seeks comment on available technical studies on C-V2X that could inform its consideration of C-V2X, including any recent studies that provide information about how C-V2X would operate in the 5.9 GHz band. The Commission requests that commenters provide detailed information on precisely how C-V2X communications would employ use of 5.9 GHz band frequencies, and how it would integrate and make use of the commercial mobile network infrastructure as part of C-V2X.

Comment C2C-CC

Please see combined response to these views after paragraph 11.

13. The Commission also seeks comment on how C-V2X would promote synergies with evolving technologies that use other spectrum resources and that will advance vehicular safety and other

³³ Reuters, "Connected car prices may rise if Qualcomm wins antitrust case: auto makers," [Online]. Available: <https://www.reuters.com/article/us-qualcomm-ftc-intel/connected-car-prices-may-rise-if-qualcomm-wins-antitrust-case-auto-makers-idUSKBN1Y31SU>.

³⁴ RaterPrestia, "Continental Makes a Big Splash in the Connected Car Patent Pool over OEM-Only Licensing Practices," [Online]. Available: <https://www.ratnerprestia.com/2019/05/29/continental-makes-a-big-splash-in-the-connected-car-patent-pool-over-oem-only-licensing-practices/>.

³⁵ Reuters, "Nokia halts legal action against Daimler with mediation offer in patent row," [Online]. Available: <https://www.reuters.com/article/us-eu-antitrust-nokia-daimler/nokia-halts-legal-action-against-daimler-with-mediation-offer-in-patent-row-idUSKBN1YD1EN>.

³⁶ RaterPrestia, "Continental Makes a Big Splash in the Connected Car Patent Pool over OEM-Only Licensing Practices," [Online]. Available: <https://www.ratnerprestia.com/2019/05/29/continental-makes-a-big-splash-in-the-connected-car-patent-pool-over-oem-only-licensing-practices/>.

³⁷ Forbes, "Volkswagen Adds 'Vehicle-To-Everything' Communications To Revamped Golf With NXP Chips," 2019. [Online]. Available: <https://www.forbes.com/sites/samabuelsamid/2019/10/28/volkswagen-includes-nxp-v2x-communications-in-8th-gen-golf/#245e6ebf16bc>.

³⁸ Page 555 <https://www.itu.int/en/ITU-R/conferences/wrc/2019/Documents/PFA-WRC19-E.pdf>

³⁹ ITU, "Recommendation ITU-R M.2121-0, 01/2019, Harmonization of frequency bands for Intelligent Transport Systems in the mobile service," [Online]. Available: https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.2121-0-201901-1!!PDF-E.pdf.

intelligent transportation capabilities of today and those anticipated in the coming years. The Commission requests comments from motor vehicle manufacturers, the associated automotive industry, and communications companies regarding authorization of C-V2X operations in this spectrum, including the extent to which their views on ITS development deployment issues have evolved. If C-V2X is best suited to achieve U.S. goals for ITS, how can the Commission best promote C-V2X use consistent with the goals and objectives of ITS, including safety and other vehicular ITS applications, connectivity, rapid development, and deployment?

Comment C2C-CC

Please see combined response to these views after paragraph 11.

14. C-V2X or DSRC in the 5.895– 5.905 GHz band. The Commission seeks comment on whether the remaining 10 megahertz (5.895–5.905 GHz) of the 5.9 GHz band should also be designated for C-V2X. The Commission seeks comment on how to best optimize the spectrum so that this portion of the 5.9 GHz band can effectively enable the rapid and ongoing development and deployment of transportation and vehicular safety-related functionalities and applications today and in the future.

Comment C2C-CC

Please see the response to paragraph 16.

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16. Alternatively, the Commission seeks comment on whether it should continue to set aside the 10 megahertz of spectrum at 5.895- 5.905 GHz for DSRC. The Commission requests comment on the kinds of DSRC-based services that would be possible using 10 megahertz of spectrum. What effect would the Commission’s proposals have on any applications delivered using Channel 172 and Channel 184, the two DSRC channels that the Commission previously designated for safety of life applications? Can any such services be provided in the 10-megahertz at 5.895– 5.905 GHz? What would be necessary to ensure that DSRC operations adjacent to C-V2X would be compatible? Are there any ITS services that DSRC would provide that cannot effectively be provided using C-V2X? Is dividing the 30 megahertz of ITS spectrum between C-V2X (20 megahertz) and DSRC (10 megahertz) useful and spectrally efficient when it comes to making use of the upper 30-megahertz portion of the band at 5.895–5.925 GHz for ITS services? The Commission asks that commenters supporting DSRC in the 10 megahertz of spectrum at 5.895–5.905 GHz discuss the benefits and costs of their preferred approach. The Commission also seeks comment on whether there is a more appropriate division of the upper 30-megahertz portion of the band at 5.895– 5.925 GHz between C-V2X and DSRC.

Comment C2C-CC

It is important to understand that ITS communication is a safety technology that may result in a similar reduction of fatalities as the adoption of airbags, seatbelts, or ABS did in the past. However, ITS have unique requirements: both sides of the communications link must be compatible. In case the Commission allows only C-V2X in one band and only DSRC in another band, some car manufacturers might adopt a technology that is incompatible to the technology used by other manufacturers, which will significantly reduce the potential safety benefits. Car manufacturers might therefore need to provide interfaces for both DSRC and C-V2X PC5 technologies, increasing costs to consumers and wasting valuable spectrum resources due to the need to transmit the same messages twice on different frequency bands. C2C-CC is therefore strongly against the Commission’s plan to split ITS spectrum between two incompatible technologies not having solved the loss of safety benefits involved at the same time. The Commission’s plan to retain 10 MHz of spectrum for DSRC will not even be remotely sufficient to keep future investments into DSRC technology alive, meaning that all existing investments into this technology will eventually have been wasted. On the other hand, only a single channel with 20 MHz of spectrum will be insufficient for successful adoption of C-V2X.

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D. Transition of Existing DSRC Operations

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19. To what extent are existing DSRC deployments anticipated to be used on a long-term (versus demonstration) basis, and what is the lifespan of existing DSRC pilot projects? To the extent the Commission adopts the proposals detailed in this NPRM, would operators of existing DSRC deployments be likely to pursue C-V2X-based solutions, re-channelize to the remaining DSRC channel (if it adopts such a plan), or simply wind-down operations? To the extent the Commission grants new or renews existing DSRC authorizations, should it only prescribe such authorizations for a relatively short period of time?

Comment C2C-CC

As noted in our response to paragraph 9, DSRC is already deployed in more than 18,000 vehicles, not only as part of demonstration projects, but also in commercially available vehicles. This DSRC deployments are incumbent users of the ITS band and should receive highest priority in protection of their existing radio communication.

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E. Technical Rules

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24. As an initial matter, the Commission proposes that U-NII-4 devices be permitted to operate at the same power levels as U-NII-3 devices, as specified in section 15.407(a)(3) of the Commission's rules. The Commission seeks comment on this proposal or whether it should adopt different power levels. The Commission proposes that U-NII-4 devices, or devices that operate across a single channel that spans the U-NII-3 and U-NII-4 bands, meet an out-of-band emissions (OOBE) limit of -27 dBm/MHz at or above 5.925 GHz, which is the same limit required for U-NII-3 devices at this frequency. The Commission notes that, for U-NII-3 devices, the -27 dBm/MHz limit increases incrementally to a level of 27 dBm/MHz at the band edge, as shown in section 15.407(b)(4) of the Commission's rules. Because the U-NII-4 band is above the U-NII-3 band and closer to adjacent services (e.g., ITS services in the adjacent portion of the 5.9 GHz band (5.895-5.925 GHz) and 6 GHz fixed services), should the Commission also establish a separate limit at the upper U-NII-4 band edge (i.e., at 5.895 GHz)? If so, what should this limit be? U-NII-3 devices are only required to meet an OOBE limit of -4.8 dBm/MHz at 5.895 GHz. Should the slope of the OOBE from U-NII-4 devices at the upper edge of the band be adjusted to match the OOBE limits from U-NII-3 devices or should a different limit be established? If the OOBE limits from the U-NII-4 band are adjusted to match the U-NII-3 band OOBE limits, can unlicensed devices and ITS devices operate directly adjacent to each other as the emissions into the ITS band would be identical from either U-NII-3 or U-NII-4 devices? The Commission seeks comment generally on the OOBE limits it should apply at the upper end of the U-NII-4 band and whether any spectrum must be reserved to protect ITS services, and if so, whether such spectrum should be in the U-NII or ITS segment of the 5.9 GHz band.

Comment C2C-CC

As written in "Regarding 4. C2C-CC urges to protect the 75 MHz band from harmful interference by UN-II devices",

UN-II-3 devices do interfere with DSRC equipment in the 5.850-5.925 GHz band as shown in the NHTSA study, leading to unacceptable packet error rates of up to 70% and above for V2X safety communication. To avoid harmful interference, C2C-CC suggests that adjacent unlicensed devices should be allowed to maximally interfere into V2X communication with the same level as V2X is permitted to interfere outside its channel, which is -40 dBm/MHz out-of-band emissions of U-NII at the band edges of 5.855-5.925 GHz. Any emissions above that level would cause harmful interference into V2X safety communication and would impact the high reliable package reception necessary for transportation safety benefits.

An obligation of Part 15 U-NII operation is to create no harmful interference to licensed operations (Rule CFR 47 §15.5 (b)). A key aspect of that protection comes from limiting out-of-band emissions from U-NII devices into adjacent licensed bands. The Commission has consistently adopted an OOBE limit of -27 dBm/MHz at the edge of all 5 GHz U-NII bands (U-NII-1, U-NII-2A, and U-NII-2C, with U-NII-3 as the sole exception)⁴⁰, and has also proposed that all

⁴⁰ CFR 47 §15.407 General Technical Requirements

U-NII 5/6/7/8 OOB be limited to -27 dBm/MHz below 5.925 GHz⁴¹. The Commission's decision to significantly deviate from the -27 dBm/MHz standard in the U-NII-3 case prompted strong objections from the ITS community in 2016⁴². The current NPRM presents questions about an OOB limit for the proposed U-NII-4 band. Making no concession regarding our immutable position in favour of continuing to allocate the entire 75 MHz band (5.850-5.925 GHz) for ITS, we instead insist on improving the U-NII-3 OOB limits as they are serious interference problems into the ITS band.

"Full protection" for ITS against any U-NII has never been backed up with an OOB limit proposal that would ensure compliance with Rule CFR 47 §15.5 (b). Failure to provide adequate protection for licensed ITS and an insistence that proposed rules are adequate despite evidence to the contrary represent significant errors in judgment. More recently, Wi-Fi advocates and Commission members have advocated for higher and higher interference allowances, while blithely asserting that lifesaving ITS would be protected. The NPRM takes this to an extreme by asking whether OOB limits are even needed, i.e. asking "should the Commission also establish a separate limit at the upper U-NII-4 band edge (i.e., at 5.895 GHz)?"⁴³ Of course OOB limits are needed at the V2X band edge and throughout the 5.850-5.925 GHz portion of the ITS band, and they must be sufficient to ensure conformance to Rule CFR 47 §15.5 (b). The Commission's only OOB proposal is for a limit at 5.925 GHz, i.e. above the ITS band. The Commission does not propose any OOB limit in the range below 5.925 GHz. This indicates that the Commission is more concerned about protecting non-ITS incumbents operating above 5.925 GHz, than about protecting licensed ITS incumbents operating 5.850 - 5.925 GHz. We find this to be arbitrary and it causes us great concern. While promoting the development of unlicensed services is admirable, and a clear priority for the Commission, it is contrary to the public interest to prioritize unlicensed so heavily that the life-saving ITS services for which the ITS band is allocated cannot reliably function. That turns the intended relation between licensed and unlicensed services on its head.

Evidence of harmful interference from U-NII operations into ITS operations is already available; this is not a mere theoretical concern. Tests have amply demonstrated the reality of this harmful interference, and neither the Commission nor commenters should make claims about protecting ITS services without proof. The Commission's own "Phase 1" test report⁴⁴ investigated the problem of unmitigated U-NII operations interfering with ITS communication. For example, Figure 11 of that report clearly demonstrates the reality that such interference exists when prototype U-NII devices transmit. As a commenter noted at the time⁴⁵

"Figure 11 shows the impact on packet completion rate for DSRC occurring on Channel 180, Channel 182, and Channel 184 with a U-NII device operating simultaneously at Channel 177. The figure indicates that DSRC operations at Channel 180 are impacted once the U-NII device's signal power reaches -60 dBm and then falls precipitously until there is a 0% packet completion rate by -48 dBm. The implication is that the signal of a U-NII-4 device operating with the proposed maximum transmit power of +36 dBm Equivalent Isotropically Radiated Power (EIRP) could experience 96 dB of attenuation and still drop out critical DSRC transmissions. Assuming a free-space propagation mode, 96 dB of attenuation is roughly equivalent to an interference range of 250 meters or more. In other words, if high power outdoor U-NII-4 Wi-Fi devices are permitted to operate under the 're-channelization' approach, there could be a permanent interference zone of at least 250 meters around such devices. Considering that a preferred location for such high power outdoor Wi-Fi devices would often be near an intersection or along a street, the test results reveal that the critical DSRC collision avoidance benefits expected in those same areas would likely be permanently lost."

The commenter provides a similar analysis for the evident interference ranges impacting channels 182 and 184. While the test cited above was for the Rechannelization proposal⁴⁶, U-NII-

⁴¹ In the matter of Unlicensed Use of the 6 GHz Band, FCC Notice of Proposed Rulemaking, ET Docket 18-295, October 24, 2018.

⁴² Petition for Reconsideration, ET Docket No. 13-49, Association of Global Automakers, Inc., and Alliance of Automobile Manufacturers, May 6, 2016.

⁴³ Paragraph 24 in "Use of the 5.850-5.925 GHz Band", FCC Notice of Proposed Rulemaking, December 17, 2019.

⁴⁴ PHASE I TESTING OF PROTOTYPE U-NII-4 DEVICES, Report: TR 17-1006, FCC OET, October 22, 2018

⁴⁵ pp. 3-4, Comments of Toyota Motor Corporation, In the matter of Phase I Testing of Prototype U-NII-4 Devices, ET Docket 13-49, November 28, 2018.

⁴⁶ The Commission Seeks to Update and Refresh the Record in the "Unlicensed National Information Infrastructure (U-NI) Devices in the 5 GHz Band" Proceeding, FCC 16-68 Public Notice, June 1, 2016.

4 operation under this NPRM would equally lack any mitigation for ITS in 5.895-5.925 GHz, so the same exact conclusion holds.

Evidence of harmful U-NII interference is also found in reports published by the U.S. Department of Transportation (USDOT). One such report⁴⁷ measures the impact of interference from an IEEE Std. 802.11ac device operating adjacent to DSRC vehicle-to-vehicle communication. The V2V communication was only 75 meters and line-of-sight, for which the packet error ratio (PER) is shown to be negligible in the absence of interference. However, when the IEEE 802.11ac device is operating in 20, 40, 80 or 160 MHz channels, the PER spikes as high as 91%, to levels that would “endanger the function” of ITS safety services, i.e. would by definition⁴⁸ constitute harmful interference. Elevated PERs are seen across the entire DSRC channels under study (5.895-5.925 GHz band), and are expected to be even higher for critical V2V distances above 75 m and/or for non-line-of-sight V2V scenarios. The report concludes, “Cross-channel test results showed the potential for cross-channel interference, having an impact on DSRC performance, up to [an interference] range of 500 meters or more, but typically between 200 and 300 meters.”⁴⁷

Finally, we note that under existing regulations, ITS devices are themselves strictly constrained in their out-of-channel emissions. For example, the Class C transmit spectral mask requires a 10 MHz transmission to be attenuated by 50 dB at 10 MHz above the channel edge⁴⁹. For a typical 10 dBm/MHz transmission, this equates to an out-of-channel power spectral density level of -40 dBm/MHz. It would be illogical to apply a looser constraint to unlicensed devices than is applied to a licensed device.

We strongly urge the Commission to revisit its rules and proposals related to harmful interference to safety-of-life ITS operations emanating from all U-NII bands. These include rules for OOB, for maximum transmit power, and for potential indoor-only operation. The Commission should consider existing test data and develop new test data where appropriate. The Commission should also note that the highest risk for harmful interference to ITS comes from U-NII devices operating in, on, or adjacent to ITS vehicles, road users, and infrastructure, especially at power levels that are more than an order of magnitude above standard ITS levels (36 dBm compared to approximately 20 dBm). If the Commission wishes to avoid having its rules challenged before other federal branches, the final rules must be consistent with Rule CFR 47 §15.5 (b), ensuring that ITS safety services are protected from harmful interference.

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49. The Commission is cognizant that retaining 30 megahertz of spectrum for ITS in the 5.9 GHz band may have other economic benefits or costs that could be affected by its proposal. For instance, in addition to improving traffic safety, the ITS service was envisioned as having the potential to decrease traffic congestion, facilitate the reduction of air pollution, and help conserve vital fossil fuels. To what extent would these potential benefits be affected by the Commission’s proposal? The Commission asks commenters to enumerate and quantify any such alternative effects. Additionally, to the extent that there are benefits and costs associated with the Commission’s proposal for unlicensed operations and ITS services in the 5.9 GHz band, when and over what time horizon would they be realized?

Comment C2C-CC

The NPRM cites preliminary studies submitted by the 5GAA claiming that a single 20 MHz channel provides sufficient throughput for many anticipated ITS features. However, we strongly disagree that a single channel is sufficient for both basic safety messages (BSMs) and non-safety-critical messages. Non-critical messages should not be allowed to use the same channel and thus create potential interference for safety-critical messages. This position is aligned with the Commission’s statements that “vehicle-to-vehicle collision avoidance and mitigation applications are exceptionally time-sensitive and should not be conducted on potentially

⁴⁷ DSRC and Wi-Fi Baseline Cross-channel Interference Test and Measurement Report, Vehicle-to-Vehicle Communications Research Project, U.S. Department of Transportation and CAMP Vehicle Safety Communications 6 consortium, December 2019.

⁴⁸ CFR 47 §15.3 (m) Definition of harmful interference.

⁴⁹ Standard Specification for Telecommunications and Information Exchange Between Roadside and Vehicle Systems – 5 GHz Band Dedicated Short Range Communications (DSRC) Medium Access Control (MAC) and Physical Layer (PHY) Specifications, ASTM International E2213-03, September 2003.

congested channels” and “shared use of a time-critical DSRC channel could be literally life-threatening in the context of collision avoidance.”⁵⁰

For example, platooning of trucks on highways was shown to improve average fuel efficiency by up to 13% for the involved vehicles⁵¹, potentially leading to billions of dollars in savings for the trucking industry and thus providing a major incentive to invest in ITS. In addition to reduced fossil fuel consumption and air pollution, platooning can also reduce traffic congestion. However, it was shown that the involved vehicles must exchange information at very a high rate of up to 30 messages per second⁵² in order to maintain speed and distance, thus creating frequent potential interference of BSMs if BSMs must share the same channel. We conclude that a single channel will be insufficient to support both safety critical ITS communication as well as ITS features that accelerate market adoption. Instead, we anticipate that more than 3 different parallel channels and consequently more than 30 MHz of spectrum will be required for successful adoption of ITS, regardless of whether these channels will use C-V2X or DSRC technology.

To reiterate, we not only believe that these additional services, which require additional spectrum, will provide vast **additional** economic, social, and environmental benefits, but we believe that these services will be **necessary** to drive market adoption in a voluntary deployment scheme, and are therefore not an additional benefit, but a prerequisite for providing traffic safety.

H. Alternate Approaches

50. Are there spectrum band approaches other than those discussed above that may better maximize the effective and efficient use of the 5.9 GHz band? Would creating differently sized sub-bands be a better approach than the Commission’s proposed band plan? Are there any additional emerging vehicle safety technologies the Commission should consider for the 5.9 GHz band? Should the Commission provide automakers and the transportation industry with broad flexibility to introduce additional vehicular safety communications technologies into the band, and permit any and all technologies so long as they can co-exist? This could include DSRC, C-V2X, or future spectrum use protocols that might be developed. If so, how should the Commission define successful co-existence and interoperability, and are there ways to ensure that a technology-neutral approach to any future such developments would provide ready access to the band and enable critical safety services without causing harmful interference to incumbent technologies?

Comment C2C-CC

C2C-CC recommends the use of following definitions of co-existence and interoperability of any new technology, and additionally recommends to define the terms backward-compatibility and fairness, which are similar to the definitions used by the IEEE:

- **Interoperability** – Existing IEEE 802.11p devices are able to decode at least one mode of transmission of new technology devices, and new technology devices are able to decode IEEE 802.11p transmissions
- **Co-existence** – IEEE 802.11p devices are able to detect new technology transmissions (and hence defer from transmissions during new technology transmissions causing collisions) and vice versa
- **Backward compatibility** – Ability of new technology devices to operate in a mode in which they can interoperate with IEEE 802.11p devices
- **Fairness** – Ability of IEEE 802.11p devices to have the same opportunities as new technology devices to access the channel

⁵⁰ FCC, "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," 2006. [Online]. Available:

<https://www.fcc.gov/document/amendment-commissions-rules-regarding-dedicated-short-range>

⁵¹ B. McAuliffe, M. Lammert, X.-Y. Lu, S. Shladover, M.-D. Surcel and A. Kailas, "Influences on Energy Savings of Heavy Trucks Using Cooperative Adaptive Cruise Control," 2018. [Online]. Available:

<https://www.nrel.gov/docs/fy18osti/70868.pdf>.

⁵² CAR 2 CAR Communications Consortium, "Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz," 2018. [Online]. Available: [https://www.car-2-](https://www.car-2-car.org/fileadmin/documents/General_Documents/C2CCC_TR_2050_Spectrum_Needs.pdf)

[car.org/fileadmin/documents/General_Documents/C2CCC_TR_2050_Spectrum_Needs.pdf](https://www.car-2-car.org/fileadmin/documents/General_Documents/C2CCC_TR_2050_Spectrum_Needs.pdf).

On co-existence and interoperability in the dedicated ITS band

In order to protect the large investments already made into DSRC / IEEE 802.11p devices in the 5.9 GHz band, and in order to allow and protect ongoing investments into ITS technology, new technology for ITS devices operating in the same band should be interoperable and backward-compatible to these DSRC devices. We note that the upcoming IEEE 802.11bd standard is an example of a new technology that will be fully interoperable and backward-compatible to IEEE 802.11p.

However, if the Commission decides to allow a different technology that is not interoperable and backward-compatible to IEEE 802.11p, then at the very least, any new technology must ensure co-existence with existing technology, i.e., both technologies must be able to detect each other's transmissions and properly defer channel access. Coexistence is necessary to protect ITS devices from mutual harmful interference. Without co-existence, devices using different technologies might mutually disrupt the delivery of safety-critical messages, which must be avoided at all costs. C2C-CC notes that C-V2X PC5 is currently not designed to be able to co-exist with DSRC / IEEE 802.11p, potentially causing harmful interference to DSRC devices, as well as receiving interference from DSRC devices. Nevertheless, there are ongoing studies and investigations into modifications to C-V2X which might be able to provide a basic level of co-existence.

Furthermore, whether the technologies are compatible, fairness in spectrum sharing between different technologies is highly desirable. Each technology should be able access the channel for an amount of time that is proportional to its deployment. In other words, a small number of newly deployed devices of one technology should not drastically reduce the channel access opportunities for a vast majority of existing devices using a different technology. Currently, C-V2X does not guarantee fair co-existence with IEEE 802.11p devices, but potential modifications are also being investigated in the currently ongoing co-existence studies. We recommend that the Commission should wait for publication and peer-review of these and further studies before allowing C-V2X transmissions and before defining the co-existence method to be used. C2C-CC anticipates that such a possible C-V2X / DSRC co-existence approach would be slightly less harmful to traffic safety than a hard spectrum split between different technologies that leaves both technologies with insufficient spectrum. Such an approach would also allow to continue deployments of DSRC. Nevertheless, for optimal traffic safety, car manufacturers might still need to install both technologies and configure the system to send safety messages via both systems. This would result in the same major problems (increased total cost of ITS devices and waste of spectrum resources) as in the hard spectrum split approach.

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